PET HEALTH AND MANAGEMENT SYSTEM

By

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ABSTRACT

In today's fast-paced world, managing pet health has become increasingly challenging due to the lack of comprehensive tools for monitoring and maintaining pet health. This project introduces the concept of a pet health and management mobile application that provides a holistic solution for managing pet health. The application enables pet owners to easily track their pet's health records, monitor symptoms, and get actionable advice to ensure their pets' health and vitality. For the user interface, the application allows pet owners to effectively record important health data such as vaccination schedules, medication history, and doctor visits. It also includes diagnostic features to help detect early signs of disease based on observable symptoms with an AI-powered diagnosis. Through personalized educational content, the application provides the AI-chatbot assistance for educational purpose which enabling pet owners to gain the knowledge needed to make informed decisions about their pet's health. The application further supports emergency situations by integrating geolocation capabilities, enabling users to quickly find a nearby veterinary clinic or vet hospital based on their current location. With its continuous learning capabilities, the application can adapt to the changing health needs of pets and their owners. The goal of the Pet Health & Management mobile app is to enhance pet care by providing pet owners with the tools to make informed, proactive decisions and foster a healthier, more sustainable lifestyle for their pets. The app addresses the growing need for user-friendly, efficient and technology-driven solutions in the pet health management space.

Area of Study (Minimum 1 and Maximum 2): Mobile Application Development, Artificial Intelligence (AI)

Keywords (Minimum 5 and Maximum 10): Pet Health Management, AI-based Image Recognition, Geolocation Services, Educational Content, Mobile Application Development

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LIST OF ABBREVIATIONS

AI	Artificial Intelligent
ML	Machine Learning
API	Application Programming Interface
NLP	Natural Language Processing
JSON	JavaScript Object Notation
SVM	Support Vector Machine
MRI	Magnetic Resonance Imaging
OEM	Original Equipment Manufacturer
LLMs	Large Language Models
NAVLE	North American Veterinary Licensing Examination
GPS	Global Positioning System
LBS	Location-Based Services
QoS	Quality of Service
SVM	Support Vector Machine
ALS	Alternating Least Squares
SVD++	Singular Value Decomposition with implicit feedback
CCTV	Closed-Circuit Television
RMSE	Root Mean Square Error
APSCC	Asia-Pacific Services Computing Conference
AWS	Amazon Web Services
CT	Computed Tomography

CHAPTER 1

Introduction

In this chapter, we provide the comprehensive overview of the project by presenting the Problem Statement and Motivation, Research Objective, Project Scope and Direction, Contribution and Report Organisation. For the problem statement, we emphasis on specific problem or challenge that the project aims to address and highlighting the existing application gaps. The motivation section explains the important of project, identify the potential benefits to solve the existing application problem. The research objective is to develop an AI-based image recognition system for disease detection, real-time geolocation to find nearby veterinary services, a health management dashboard, and a personalized education AI-Chatbot. The project scope and direction focus on delivering a user-friendly mobile application that integrates health records, diagnostics, emergency support, and learning resources. The project's contributions include improved early disease detection, enhanced emergency response capabilities, and customized health insights for pet owners. This chapter ends with the Report Organization section, which outlines the structure and flow of the remaining chapters.

1.1 Problem Statement and Motivation

Effectively managing pet health is a multifaceted challenge due to the separation of health monitoring management and symptom tracking, limited real-time emergency assistance, and fragmented educational resources. These issues highlight the shortcomings of the tools and technologies currently available to pet owners, hindering many from ensuring the best care for their pets. Pet health management is often **fragmented between tools** that focused on tracking vaccinations, appointments, weight or those used to monitor symptoms or behavioral changes. This lack of integration forces pet owners to use multiple apps or manual methods simultaneously which caused resulting in inefficiencies and missing insight for preventive care. Preventive care relies heavily on recognizing patterns or deviations in health trends, and fragmented tools do not effectively facilitate this. Studies have shown that

fragmented health management systems can lead to missed vaccinations, delayed responses to early symptoms, and a lack of proactive veterinary counseling [6]. All these issues can negatively impact a pet's health. In emergency situations, pet owners often **face challenge to timely access to veterinary care**. This challenge include difficulty in finding a nearby clinic based on their location. Existing applications and tools do not adequately address this challenge because they rarely integrate real-time geolocation and navigation to veterinary clinics, causing the pet owners have to heavily rely on internet searches or manual navigation in the critical situations [7]. This dependency not only delays the delivery of health services, but also increases stress and uncertainty in emergency situations. In addition, many of these internet sources do not provide the exact operation hours or availability of specific services potentially putting their pets at greater risk. **Proactively monitoring pets' health** is also another challenge as early signs of disease are often difficult to discover for non-expert pet owners. Many health issues, such as obesity, dental disease, and chronic illnesses go undetected due to lack of monitoring tools that help for track key health indicators or behavioral changes [8]. While artificial intelligence (AI) and big data technologies have achieved success in predicting health risks in human medicine, these advances remain underutilized in veterinary care. Without such tools, pet owners are left to rely on physical observations, which are often insufficient to detect early-stage disease. Besides than just monitoring tools, the educational content also play an important role for non-expert pet owners. However, the **available of educational sources are too generic**, often failing to address the unique needs of specific breeds, medical conditions, or behavioral traits. This lack of knowledge can lead to preventable health complications and decreased the quality of life for pets.

Therefore, the **motivation** behind this project was based on the growing global awareness of the importance of pets in people’s lives, and the increasing challenges of providing healthcare for pets. While the number of pet owners is increasing, the tools and technologies used to manage pet health have not kept pace with the demands of modern pet care. For most pet owners, caring about their pet’s health is instinctive, but practical challenges such as monitoring health trends, ensuring timely emergency care, and accessing tailored educational resources often hinder their ability to provide optimal care.

One of the motivations is to **develop a unified platform that integrate all the health management needs** into one application. This integration will allow pet owners to easily track and view health data in real time by referring to their set up schedules, eliminating the need to use multiple apps or manually save records. The app will also provide automated insights to help pet owners detect early warning signs of disease and take timely action. Another motivation is to **combines the real-time geolocation and navigation capabilities for pet health** management. By providing a map-based solution that displays nearby veterinary clinics, hours of operation, and available services, the app ensures that pet owners make informed decisions quickly. In addition, the integration of real-time traffic data and estimated arrival times will help pet owners optimize travel in case of an emergency.The third motivation is to **utilize AI-driven analytics for proactive health monitoring**. By integrating AI diagnose into the app, pet owners can capture images of their pets and analyze potential health issues. The AI system will evaluate images and other input data to detect anomalies such as skin conditions and physical injuries. The technology will provide pet owners with actionable insights, including potential diagnoses and recommendations for further action, such as consulting a veterinarian. Lastly, this project is also motivated by the potential of providing a **personalized AI-chatbot** that serves as an educational companion for pet owners. The chatbot acts as an interactive knowledge assistant, allowing pet owners to ask questions in natural language and receive responses that are relevant and easy to understand.

1.2 Research Objectives

The main goal of the project is to develop a comprehensive pet health management application that integrates advanced technologies to improve the care, monitoring and management of pet health. The following specific goals will guide the development and implementation of the application:

1. **To design a user-friendly interface for integrated health and schedule management**

   The goal is to develop an intuitive and easy-to-use mobile application interface that allows pet owners to seamlessly manage health-related records and schedule tasks. The system will allow users to easily track vaccination dates, medication schedules, and veterinary appointments through an organized and interactive dashboard. The interface will prioritize ease of use, ensuring that users of all ages and technical backgrounds can use the app efficiently, receive timely reminders with a notification alert, create accurate and up-to-date health plans for their pets.

2. **To Develop a Real-Time Geolocation for Emergency Services**

   The system will include a geo-location feature that will enable pet owners to find a nearby veterinary clinic or emergency veterinary hospital. It will provide detailed information about the clinic, such as location, hours of operation and contact information, as well as real-time navigation using traffic data to provide the quickest route in case of an emergency.

3. **To Develop AI-Based Image Recognition for Illness Detection**

   The system will allow pet owners to capture images of their pets using their mobile devices. The images will be analysed by the system's artificial intelligence to identify the symptoms of potential health issues, such as rashes, injuries or abnormalities, providing early diagnostic recommendations and veterinary care recommendations.

4. **To implement an AI-powered chatbot that delivers personalized educational content to pet owners**

   The AI chatbot will interact with users, providing relevant information in the form of text responses, articles, video links and care tips, covering key topics such as disease prevention, nutrition, behavioral training and chronic disease management. Educational content will be customized based on each pet's profile (including breed, age, health history and medical needs), ensuring users receive accurate, timely and meaningful guidance to support proactive and informed pet care.

1.3 Project Scope and Direction

This project aims to develop a comprehensive pet health management application that integrates various advanced features to improve the overall care and health monitoring of pets. The primary focus was to create an app that would help pet owners manage their pets' health by providing diagnostic tools, educational resources, and emergency assistance, while also increasing the convenience of accessing veterinary services First, the app will feature a **user-friendly interface design that combines health and schedule management functions** into one intuitive platform. The interface will allow pet owners to easily manage and access their pet's health records, including vaccination history, medical conditions, and treatment records. In addition, it will support scheduling functions such as veterinary appointments and medication reminders. Users will receive timely notifications of upcoming health-related tasks, ensuring that important dates are not missed with the notification alert. The layout and interaction flow will be optimized for users of all technical backgrounds to improve ease of use and encourage users to continuously participate in their pet's health management. Secondly the app will integrate **real-time geolocation for emergency services**. In an emergency, pet owners can use the app to locate the nearest veterinary clinic or animal hospital. The app will provide detailed information about these facilities, such as contact information, available services and hours of operation, as well as real-time routes and estimated travel times based on the user's current

location. The integration of traffic data will help optimize routes and ensure the fastest possible access to treatment in case of an emergency.

Thirdly, the app will use **AI-based image recognition technology** to help pet owners detect potential health problems in their pets through visual symptoms. By utilizing the camera on a mobile device, the app will enable users to capture images of their pets, which will then be analyzed by OpenAI API act as a decision support to detect symptoms of disease, such as skin conditions, rashes, injuries, or behavioral abnormalities. This feature will provide pet owners with early insights into their pet's health, enabling them to take quick action when necessary. In addition, the project will also develop an **AI-based educational chatbot** in the application. This smart assistant will provide pet owners with instant and interactive pet health education content through natural language conversations. The chatbot will provide customized information such as articles, videos and care tips, covering topics such as disease prevention, nutrition, behavioral training and chronic disease management. By analyzing each pet's profile such as breed, age and health history, the chatbot will provide personalized guidance that meets each pet's specific needs. This approach enhances the learning experience, allowing pet owners to obtain relevant and accurate information in real time and make more informed decisions about their pet's care.

1.4 Contributions

The proposed pet health and management system aims to have a profound and lasting impact on pet owners and the wider community by transforming the way pet healthcare is delivered. In today’s fast-paced world, pet owners often struggle to keep track of vaccination schedules, monitor health symptoms, and respond quickly to emergencies. The project addresses these deficiencies by providing an all-in-one mobile app powered by AI, real-time mapping, and personalized education, ultimately improving the quality of pet care and giving owners peace of mind.

One of the project’s most significant contributions is the introduction of an AI-based disease detection feature that enables non-professional pet owners to identify early signs of potential health issues through image analysis. This feature alone has the potential to save lives by enabling early intervention before conditions worsen. Additionally, real-time geolocation and clinic recommendation systems ensure that pet

owners can quickly and efficiently access emergency veterinary services, especially during critical moments when time is of the essence. Furthermore, the addition of a personalized AI chatbot that provides tailored educational content to pets elevates the app from a basic tool to a true pet care companion. It helps users make informed decisions by providing reliable, breed-specific guidance on nutrition, disease prevention, and chronic disease management. This ensures that users are not simply reacting to health issues, but proactively learning and taking preventative measures.

More than just a technological solution, this project is a social good initiative. By simplifying and enhancing pet healthcare management, it reduces stress, prevents avoidable health complications, and strengthens the bond between people and animals. It advocates for responsible pet ownership and sets a new standard for digital veterinary support. For readers, this project is worth their time and attention as it provides an innovative and highly applicable solution to the growing needs of modern families. As more people adopt pets, tools like this app are essential to ensure the lifelong health and well-being of animals that can't speak for themselves.

1.5 Report Organization

The past decade has seen a significant transformation in pet healthcare, driven primarily by the growing acceptance of pets as family members. As pet ownership continues to grow globally, so too has the need for better tools and systems to monitor and maintain pet health. Traditional pet health management involves manual record keeping, paper vaccination cards, regular visits to veterinary clinics, and basic symptom observation. However, these approaches are often inefficient, error-prone, and reactive rather than proactive, resulting in many health issues not being discovered until they have reached a critical stage. With advances in digital technology and artificial intelligence (AI), new opportunities are emerging to transform pet healthcare into a smarter, more data-driven field.

Mobile app development is a core component of this project and plays a vital role in the modernization of health management systems across industries, including human and animal health. With the ubiquity of smartphones, mobile apps have now become a convenient and powerful medium for providing personalized services and real-time support. In the veterinary field, apps such as Digitail, TTCare, and

DogCatApp have introduced features such as health tracking and appointment scheduling. However, these apps often lack integration, personalization, or advanced analytics capabilities. This project aims to address these shortcomings by combining health record management, AI-based diagnostics, and emergency geolocation capabilities into a single, user-friendly application tailored for pet owners.

A key innovation of the project is the use of AI-based image recognition technology for disease detection. Image recognition is a branch of artificial intelligence where systems are trained to identify patterns, objects, or anomalies in digital images. In the field of pet health, this technology allows users to take a photo of their pet and get initial diagnostic recommendations based on visual symptoms such as rashes, swelling, or wounds. Such tools have been successfully used in human medicine, and their application in the veterinary field represents a promising direction for early disease detection and preventive care.

Another important component is real-time geolocation through GPS (Global Positioning System) technology. Real-time location services are widely used in various application areas such as online ride-hailing, food delivery, and navigation. In the field of pet healthcare, this feature helps users find the nearest veterinary clinic, especially in emergency situations. By integrating traffic data and clinic opening hours, the system helps pet owners make more informed decisions faster, thereby saving lives in critical situations.

To ensure long-term effectiveness, the system also includes a personalized AI chatbot that acts as an educational assistant. The chatbot interacts with the user, providing curated content based on the pet's breed, age, and health history. Topics such as illness, nutrition, behavioral training, and chronic disease management are presented in a conversational format, making it easy for non-expert users to understand complex information. Educational empowerment is key to improving pet owner care, and this feature can even help first-time pet owners build confidence in managing their pet's health.

In summary, the project integrates principles and technologies from mobile development, artificial intelligence, location-based services, and pet healthcare to provide a comprehensive solution. For readers who are not familiar with these technical fields, it is important to understand that the combination of artificial intelligence and mobile platforms can automate and personalize pet care in unprecedented ways. This integration not only addresses the existing limitations of pet healthcare tools, but also paves the way for smarter, more agile, and more compassionate approaches to animal welfare.

CHAPTER 2

Literature Reviews

In this chapter, we provide a comprehensive overview of the literature review related to this project, highlighting the previous work, limitations of existing research and system, and suggested solutions. The literature review begins with a review of previous studies and applications in the field of pet health and management, noting their shortcomings. Then we discuss the limitations of these studies, highlighting the functionality, integration, and accessibility that hinder the pet healthcare. Finally, this chapter proposed solutions that aim to address these limitations through innovative approaches and advanced technologies to provide a practical integrated system for pet healthcare and management.

2.1 Previous Works

2.1.1 CHATGPT in Veterinary Medicine: A Practical Guidance of Generative Artificial Intelligence in Clinics, Education and Research

Large language models such as ChatGPT are garnering increasing attention within the veterinary field for their potential to optimise clinical workflows, enrich educational experiences, and support scientific communication. A recent small-scale review synthesising current application practices and cautionary considerations indicates that veterinary practitioners broadly recognise and regularly utilise artificial intelligence tools, yet persistent concerns remain regarding their reliability, privacy protection, and training gaps. A survey involving 3,968 respondents revealed that 83.8% indicated familiarity with AI applications, while 69.5% utilised AI tools weekly or daily. Nevertheless, 36.9% expressed scepticism due to concerns over accuracy, safety, and training issues [9].

In clinical care, ChatGPT is positioned as an adjunct rather than a substitute for professional judgement. Known applications include extracting patient data from free text, generating medical histories, and providing decision support for complex

differential diagnoses, though outputs require clinician oversight. Beyond text processing, multimodal models GPT-4/4o can interpret specific medical imaging. Medical benchmarks cited in this review indicate GPT-4 achieves 63% accuracy in interpreting electrocardiogram images [9]. However, veterinary case studies reveal its shortcomings in identifying atypical rhythms, further underscoring that large language models should not replace FDA-approved specialised equipment.

The report highlights regulatory disparities between human and veterinary medicine. Hundreds of AI or machine learning devices have received FDA approval for human healthcare predominantly in radiology, whereas veterinary AI tools lack specific premarket requirements. To date, no medical device employing generative AI or large language models has gained FDA approval [9]. Given these models' iterative nature, continuous post-deployment monitoring is recommended.

Overall, the existing literature portrays ChatGPT as a versatile auxiliary tool capable of alleviating administrative burdens, establishing learning frameworks through vetted guidance, and facilitating communication by provided clinicians and educators maintain continuous oversight, validate outputs, safeguard data security, and ensure its use complies with the latest guidelines.

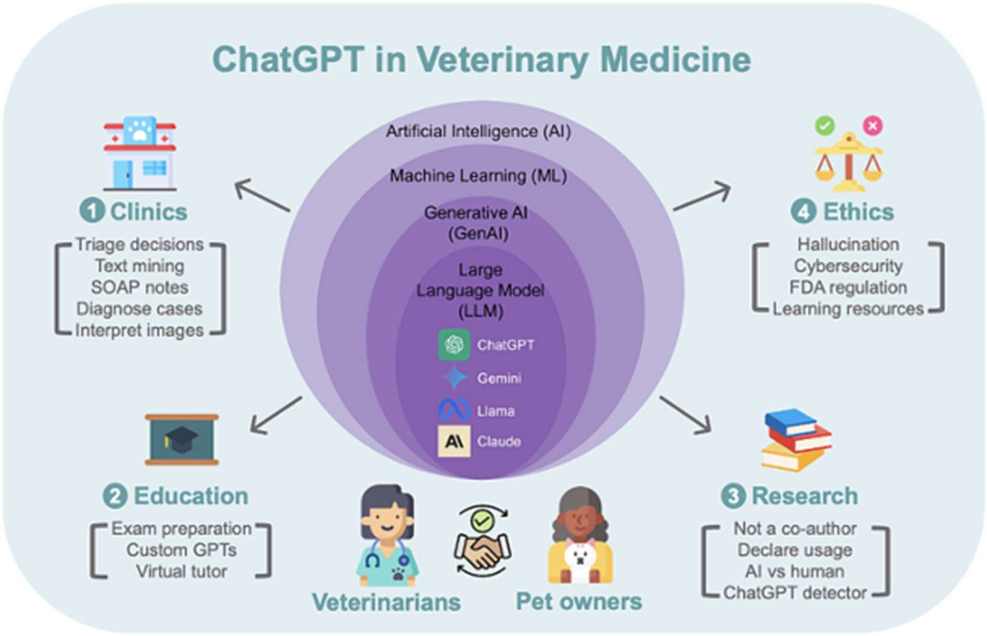


Figure 2.1.1.1 The Media Insights Engine High Level Architecture showing the basic building blocks with components.

2.1.2 Artificial intelligence in veterinary diagnostic imaging: Perspectives and limitations

Artificial intelligence (AI) is increasingly permeating veterinary diagnostic imaging, reshaping routine workflows from image acquisition to interpretation. Recent research synthesises applications across conventional radiography, ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI), highlighting how data-driven approaches, particularly deep learning in support general practitioners and specialists in busy clinical settings where imaging volumes may exceed expert capacity. Current research frontiers particularly emphasise AI's role as a decision support tool [11]. It standardises pattern recognition, flags technical quality issues, and triages cases to enhance reporting efficiency by ensuring veterinary expertise remains central to final clinical judgement.

Within traditional radiographic imaging, research demonstrates that supervised learning methods can now identify common thoracic imaging patterns, estimate cardiac surrogate marker dimensions, and detect easily overlooked lesions. Whilst performance varies across tasks and datasets, accumulating evidence indicates that appropriately validated models can achieve clinically valuable differential diagnostic capabilities. These models provide reliable support for review and second readings, thereby reducing the risk of fatigue-induced oversights.

For CT technology, this review distinguishes between lesion classification and automated organ or pathological segmentation. In tasks such as abdominal lesion characterisation and head-and-neck contouring, the U-Net architecture and its variants are frequently employed to generate volumetric masks or quantitative measurements, thereby facilitating standardised reporting and longitudinal monitoring [11]. Notably, studies indicate that model generalisation capability depends on multicentre, species-balanced datasets and external validation, requirements that remain evolving within the veterinary domain.

The MRI studies synthesised in this review encompass intracranial disease classification, specific tumour grading, spinal cord disease detection, and early applications of AI-assisted reconstruction to enhance image quality or reduce scan times [11]. Collectively, these research directions demonstrate that artificial intelligence can complement neuroradiology by revealing subtle textural or

morphological features difficult to quantify visually in a consistent manner. However, the studies also emphasise that model outputs require holistic interpretation alongside medical history, neurological examination, and other imaging modalities.

Across all research paradigms, the literature focuses on several governance themes. Foremost is the critical importance of the 'human-machine collaboration', the model artificial intelligence systems should augment rather than replace clinical decision-making, and their limitations must be fully acknowledged.

Topic	Reference	Task	Species	Model	Results
Orthopaedics					
	Mcevoy and Amigo, 2013	hip identification	dog	ML	sensitivity 89%
					classification error 6.7%
				DL	sensitivity 86%
					classification error 8.9%
	McEvoy et al., 2021	hip dysplasia classification	dog	DL	sensitivity 53% specificity 92% PPV 91% NPV 81%
	Ergun and Guney, 2021	determining age from long bones images	dog	DL	accuracy 80%; F1 0.80
		dating long bones fractures			accuracy 83%; F1 0.81
		detecting long bones fractures			accuracy 89%; F1 0.89
	Shim et al., 2023	stiffle joint components identification	dog		avarage precision >0.99
		stiffle joint abnormalities classification		DL	accuracy 81.25% - 93.18% sensitivity 79.41% - 89.70%
Thorax					
	Yoon et al., 2018	normal vs abnormal cardiac silhouette and thoracic portions	dog	ML	accuracy 79.6% - 96.9%
					sensitivity 92.9% - 96.9%
				DL	accuracy 74.1–94.8%
					sensitivity 92.1% - 100%
	Kim et al., 2022	presence/absence of cardiogenic pulmonary edema	dog	Vetology®	accuracy 92.3% sensitivity 91.3% specificity 92.4%
	Müller et al., 2022	presence of pleural effusion	dog	Vetology®	accuracy 88.7% sensitivity 90.2% specificity 85.7%
	Pomerantz et al., 2023	presence of pulmonary nodules/masses	dog	Vetology®	accuracy 69.3% sensitivity 55.4% specificity 93.7%
	Ott et al., 2021	detecting pulmonary coccidioidomycosis lesions	dog	DL	AUC of 0.99
	Banzato et al., 2021a	detecting common radiographic findings	dog	DL	accuracy >90%
	Fitzke et al., 2021	detecting thoracic and extra-thoracic radiographic abnormalities	dog+cat	DL	AUROC 0.687–0.994 FPR 0–0.057 Sensitivity 0–0.962
	Banzato et al., 2021b	detecting common radiographic findings	dog	DL	AUC >0.5 - >0.8
	Dumortier et al., 2022	normal vs abnormal	cat	DL	accuracy 82% sensitivity 88% specificity 75%
	Boissady et al., 2020	primary thoracic lesions classfications	dog	DL	overall error rate 10.7%
				Radiologist	overall error rate 17.2%
				DL + Radiologist	overall error rate 16.8%
	Hespel et al., 2022	primary thoracic lesions classfications	dog	DL	overall error rate 15.8%
				Radiologist	overall error rate 13%
	Celniak et al., 2023	primary thoracic lesions classfications	dog+human	DL	ROC AUC 0.77 (LL radiographs) ROC AUC 0.66 (DV radiographs)
Cardiac silhouette					
	Li et al., 2020	detecting left atrial enlargement	dog	DL	accuracy 82.71% sensitivity 68.42% specificity 87.09% concordance with radiologist 85.19%
	Burti et al., 2020	classification of cardiomegaly based on VHS value	dog	DL	AUC of 0.97
	Boissady et al., 2021	automatically measuring VHS	dog + cat	DL and Radiologist	concordance >0.9
	Zhang et al., 2021	identification of landmarks for calculating VHS	dog	DL	average performance 90.9%
	Jeong and Sung, 2022	determining adjusted heart volume index (aHVI)	dog	DL	ROC AUC 0.77–0.83
	Valente et al., 2023	classification of canine MMVD stages	dog	DL	AUC 0.77–0.88 for different stages
Image quality analysis					
	Tahghighi et al., 2023	assessing proper collimation	dog + cat	DL	accuracy 83.17%
	Banzato et al., 2023	determining the most common technical errors	dog	DL	accuracy 81.5% (LL radiographs) accuracy 75.7% (sagittal radiographs)

Topic	Reference	Task	Species	Model	Results
Automatic classification of abdominal and pulmonary lesions					
	Burti et al., 2021	classification of focal liver lesions	dog	ML	accuracy 62%
	Pey et al., 2022	distinction between pheochromocytoma and adrenocortical tumour	dog	ML	CVC invasion: accuracy 81% - 91% RV invasion: accuracy 60% - 88% PAV invasion: accuracy 58% - 60%
	Burti et al., 2022	classification of focal splenic lesions	dog	ML	overall accuracy 0.67
	Shaker et al., 2021	distinguish between benign and malignant hepatic lesions	dog	ML	accuracy 73%
	Marschner et al., 2017	detection of pulmonary thromboembolism	dog	ML (PLS-DA)	sensitivity 94% specificity 96%
				ML (SVM)	sensitivity 99% specificity 100%
	Choi et al., 2023a	distinction between splenic nodular hyperplasia and hemangiosarcoma	dog	ML	accuracy 95.7%
Automatic segmentation of organs and lesions					
	Ji et al., 2022	evaluation of kidney volume	dog	DL	Lin's CCC 0.95
	Ji et al., 2023	detecting kidney stones on pre-contrast CT	dog	DL	DSC 0.74
	Park et al., 2021	segmentation of head and neck organs	dog	DL	DSC 0.83
	Groendahl et al., 2023	segmentation of canine head and neck cancer	dog	DL	overall DSC 0.52
	Schmid et al., 2022	segmentation of the medial retropharyngeal lymph nodes	dog	DL	AIOU of 36% ± 20%

Topic	Reference	Task	Species	Model	Results
Distinction between different types of brain diseases					
	Banzato et al., 2018a	distinction between meningiomas and gliomas	dog	DL	accuracy 91%
	Wanamaker et al., 2021	distinguish between neoplastic and inflammatory brain disease	dog	DL	accuracy 85%
	Spiteri et al., 2019	identification of morphological changes associated with Chiari-like malformations	dog (CKCS)	DL	AUC 0.78–0.82 sensitivity 82% - 93% specificity 67% - 69%
Prediction of the grading of certain intracranial diseases					
	Banzato et al., 2017	predicting meningiomas grading	dog	ML	accuracy 96.8%
	Banzato et al., 2018b	predicting meningiomas grading	dog	ML	accuracy 80%
	Barge et al., 2023	prediction of gliomas histopathological grading	dog	ML	accuracy 77%
Detection of spinal cord diseases					
	Biercher et al., 2021	detection of spinal cord diseases	dog	DL	sensitivity 90.8% - 100% specificity 95.1% - 98.98%
Improvement of MR image quality					
	Choi et al., 2023b	reduce scan time and improve image quality	dog	DL	scan time reduction up to 75%

Figure 2.1.2.1 Peer-reviewed veterinary AI publications concerning conventional radiography.

2.1.3 AI and Veterinary Medicine: Performance of Large Language Models on the North American Licensing Examination

Angel et al. conducted a comprehensive study evaluating the performance of large-scale language models (LLMs) on the North American Veterinary Licensing Examination (NAVLE) and exploring their potential for application in the veterinary field [11]. This study marks an important step in evaluating the diagnostic reasoning and educational capabilities of advanced AI models such as the GPT-3, GPT-4, and Google Bard in the veterinary field. The National Veterinary Licensing Examination (NAVLE) is a rigorous licensing examination that tests veterinary graduates' knowledge and skills in key areas such as diagnostic imaging, pharmacology and animal welfare [11]. The aim of this study was to investigate the applicability of the LLM in this highly specialized field

The study used 164 text-based NAVLE problems (excluding problems involving images or tables) to evaluate the reasoning ability of the LLM. The results show that GPT-4 performs well with an accuracy of 89%, which is significantly better than GPT-3 and Bard, which have an accuracy of 63.4% and 61%, respectively [11]. This superior accuracy highlights the ability of GPT-4 to handle complex veterinary medical reasoning tasks. In contrast, the other models showed limitations in understanding and accurately solving veterinary-specific queries, which highlights the advances in the architecture and training of GPT-4.

Angel et al. noted that the performance of the GPT-4 could provide an adjunctive learning tool for veterinary education, help students develop diagnostic skills, and potentially reduce the manpower required to create realistic clinical scenarios for examination purposes [11]. In addition, GPT-4 applications can be extended to real-world veterinary practices to help veterinarians make precise treatment recommendations, increase diagnostic accuracy, and improve communication with clients. These capabilities provide opportunities to integrate LLM into veterinary workflows and optimize decision-making processes and patient care [11].

Despite the advantages of LLMs, this study highlights key challenges to their implementation in the veterinary field. The inability of LLMs to interpret visual data such as images or x-rays limits their diagnostic application in imaging-dependent cases. In addition, ethical issues surrounding machine-generated medical decisions, possible

biases in algorithms, and the risk that automation of tasks will lead to a reduced need for human veterinary professionals were also identified as significant barriers. Addressing these challenges requires interdisciplinary collaboration to ensure responsible and ethical integration of AI into veterinary practice.

Angel et al. also emphasized the potential for generative language models to reshape veterinary education and practice [11]. By automating routine documentation and generating question-based explanations for examinations, these models can support competency-based veterinary education frameworks. However, the authors caution against over-reliance on AI technologies, stressing the importance of human oversight and the need for continuous validation of AI tools to prevent errors and maintain high-quality care standards.

The authors also highlight the potential of generative language models to reshape veterinary education and practice. By automating routine documentation and generating question-based exam interpretations, these models could support competency-based frameworks for veterinary education.

Model	Raw Score	Percentage
Bard	100/164	61%
GPT-3	104/164	63.4%
GPT-4	146/164	89%

Figure 2.1.3.1 Test Results of Different Large Language Models on the Sample Assessment

2.1.4 Advancements in Pet Care Technology: A Comprehensive Survey

Md. Tauseef et al. provide a comprehensive survey of advances in pet care technology, emphasizing the transformative role of innovative tools in improving pet health, safety, and well-being [12]. The research emphasizes the integration of smart devices, apps, and systems that are reshaping traditional pet care approaches through real-time monitoring, automation, and enhanced connectivity.

The study begins with a discussion of smart collars and trackers, which have revolutionized pet monitoring. These devices combine GPS technology with features such as activity tracking, heart rate monitoring, and geofencing. Md. Tauseef et al. explain how these features provide real-time insight into a pet's location and health, allowing for immediate intervention in emergency situations [12]. They emphasize the role of security alerts in identifying abnormal behavioural patterns to ensure that pets remain within safe boundaries.

Another important development highlighted in the survey was the development of pet health apps and platforms. These apps are centralized hubs for managing medical records, vaccination schedules, dietary recommendations, and veterinary appointments. The authors discuss how these platforms can react to emergency response by providing access to critical health data and facilitating timely online consultations with veterinary professionals [12]. In addition, these apps promote preventive care by providing tailored health advice and facilitating community engagement among pet owners.

The study also looked at the role of automatic feeders and waterers in maintaining a consistent feeding schedule and portion control. The study noted that these devices not only ensure that pets have access to fresh food and water, but also address issues such as obesity and digestive health. IoT feeding systems with programmable settings are a major innovation, allowing owners to manage their pets' diets remotely.

The study also explores the impact of telemedicine and virtual veterinary consultations, especially their growing relevance during the COVID-19 pandemic. These platforms bridge the gap between pet owners and veterinarians by providing remote consultations, reducing the stress of traveling for pets, and providing immediate access to professional advice. The authors emphasize that telemedicine promotes better collaboration between pet owners and veterinarians, resulting in tailored health advice and improved outcomes for pets [12].

Finally, the survey also addressed the development of robotic interactive toys and automated litter boxes. Robotic toys can alleviate separation anxiety in pets through interactive play, promoting mental stimulation and physical exercise. Automated litter boxes are equipped with sensors and self-cleaning devices that simplify maintenance and ensure hygienic conditions for cats.

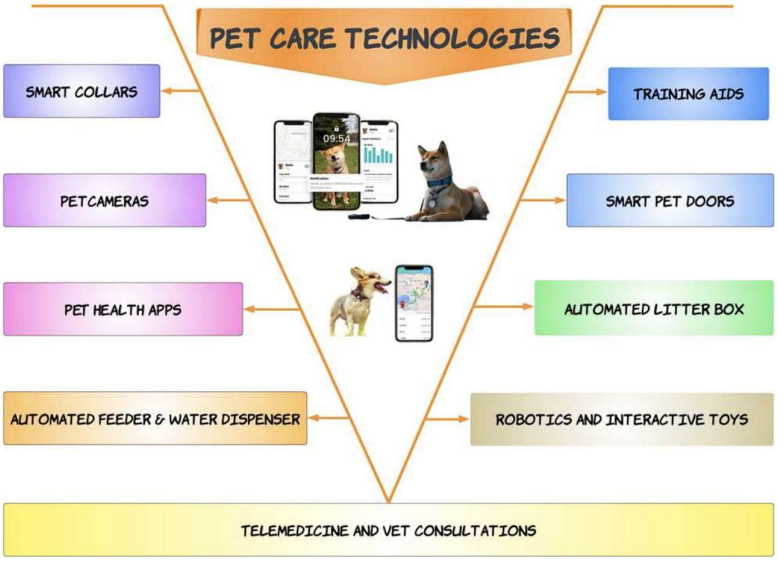


Figure 2.1.4.1 Technology of Pet Care

2.1.5 An Approach to the Location-based Services Collaboration Evaluation Algorithm Oriented to Mobile Internet Environment

Lu et al. propose a new approach to evaluate location-based services (LBS) using collaborative evaluation algorithms tailored for the mobile Internet environment [13]. Their research addresses the challenge of optimizing the combination of location-based services based on user preferences, quality of service (QoS) attributes, and contextual data. The research presents a powerful framework for organizing, combining, and evaluating LBSs to provide personalized, high-quality services to users.

The framework proposed by the authors is divided into three core modules: service description, service composition optimization and service evaluation. In the first module, LBSs are described using six-dimensional vectors, which include attributes such as identifiers (IDs), categories, inputs/outputs (I/Os), and QoS [13]. This detailed description enables efficient discovery and matching of services. The second module focuses on optimizing service combinations using an enhanced ant colony algorithm. The algorithm evaluates multiple service paths to determine the optimal order of combinations to satisfy user requirements while adhering to QoS constraints such as cost, time, and reliability. The last module utilizes a fuzzy evaluation algorithm to rank and select the best sequence of services based on user preferences.

The ant colony algorithm used in this study is particularly impressive in addressing the computational complexity associated with large-scale local service portfolios. By iteratively refining the pheromone trajectory, the algorithm identifies high-quality service paths that satisfy user needs. In addition, the integration of fuzzy evaluation enables a fine-grained ranking system that considers multidimensional QoS attributes, thus ensuring that the final recommendations are in line with the user's priorities [13].

The proposed approach is experimentally validated using real scenarios involving transportation, restaurant and movie services. The results show that the framework can efficiently generate and evaluate service sequences with significantly reduced computation time compared to traditional methods. It can optimize 450 service paths into five high-quality sequences, which are then ranked to provide users with the best choices. This validation highlights the potential of the framework for real-time applications in dynamic mobile environments [13].

Despite its strengths, the study recognizes certain limitations, such as the reliance on accurate QoS data and the need for domain-specific ontologies to enhance semantic matching. The authors also point out future research opportunities, including the integration of machine learning techniques to improve service prediction and user preference modeling [13]. These advances could further refine the evaluation process and improve the scalability of the system.

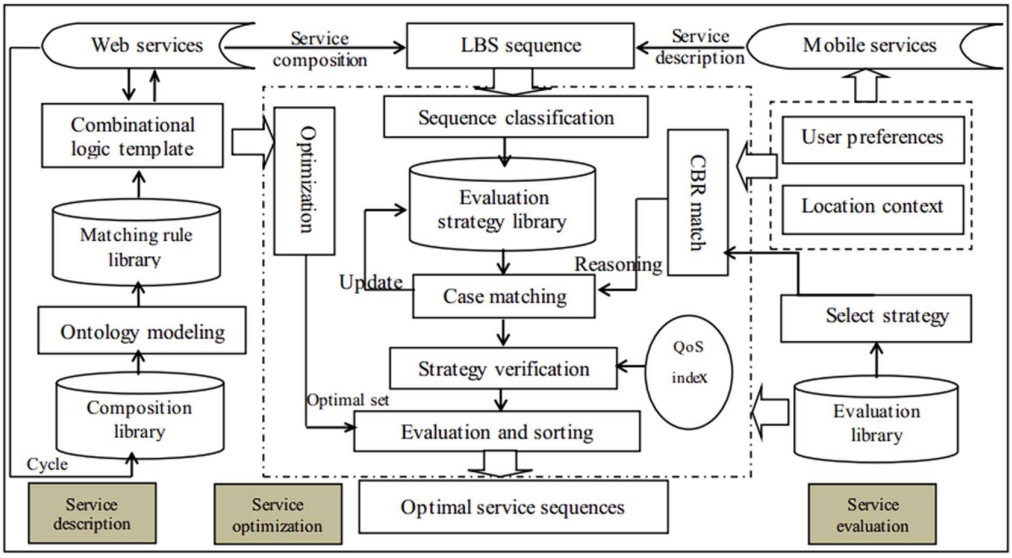


Figure 2.1.5.1 A framework of LBS composition evaluation

2.1.6 Personalised Location-based Recommendation System using Apache Spark

Swetha et al. propose a location-based personalized recommendation system that leverages the Apache Spark framework to address the challenges of managing large datasets and providing contextually relevant recommendations [14]. Their research focuses on optimizing location-based services (LBS) for users based on preferences, interests, and geographic relevance, particularly within the context of restaurants in Indianapolis [14]. The research emphasizes the combination of machine learning algorithms with distributed computing frameworks to improve the accuracy and efficiency of recommendations.

The system architecture integrates several components, including data preprocessing, exploratory analysis, and collaborative filtering. The authors use a Yelp dataset containing user reviews and business data to analyse consumer behaviour and generate personalized recommendations [14]. The dataset is filtered to focus on businesses related to restaurants within a specific geographic location, ensuring that recommendations are always relevant to the user's context.

The implementation of the Alternating Least Squares (ALS) and Singular Value Decomposition Plus Plus (SVD++) algorithms are the core contributions of this work. Alternating Least Squares (ALS) is a matrix factorization technique that is used for

collaborative filtering to predict user-item interactions, while SVD++ improves prediction accuracy by incorporating implicit feedback. The authors report a Root Mean Square Error (RMSE) of 1.4 for ALS and 1.3 for SVD++, suggesting superior performance of the latter in this case. These algorithms effectively balance computational complexity and accuracy, leveraging Spark's distributed computing power to handle large-scale data.

The authors emphasize the scalability and real-time processing capabilities of Apache Spark. By executing tasks in parallel on distributed nodes, the system demonstrates the ability to process massive datasets without compromising performance [14]. This approach addresses the challenges associated with traditional centralized systems, such as latency and computational inefficiency, making it suitable for dynamic and large-scale applications.

Despite the advantages of the system, there are limitations in generalizing the system to other locations and categories as the study focused primarily on restaurants in Indianapolis. In addition, while the proposed approach yielded promising results, the authors suggest exploring deep learning algorithms in the future to further improve recommendation accuracy and incorporate more complex user behaviours. They also highlight the potential of integrating real-time traffic data and user movement patterns to expand the applicability of the system.

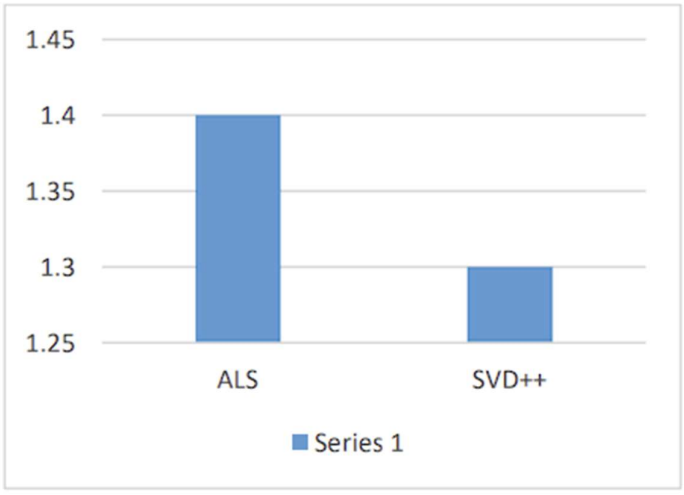


Figure 2.1.6.1 Comparison of two algorithms

2.1.7 An Innovative New Approach to Animal Care

Johnson et al. propose an innovative approach to animal care by developing a web and mobile application called VetLink [15]. The system aims to address the challenges faced by farmers by providing convenient, reliable and actionable information on livestock management and health. This study emphasized the integration of smart media technologies with user-friendly interfaces to bridge the gap between farmers and veterinarians, especially for those who have difficulty in accessing veterinarians due to geographical constraints [15].

The VetLink system utilizes the mobile Internet technology to provide information on common livestock diseases, symptoms, management tips and prevention methods. The authors emphasize the importance of real-time and user-specific messaging to enable farmers to make informed decisions quickly. The application also includes multimedia resources such as videos and images to improve comprehension and even for users with little technical expertise. By centralizing livestock management data, the system simplifies disease diagnosis and provides treatment recommendations for small-scale farmers.

A key feature of VetLink is that its database structure is designed to be searchable and intuitive [15]. The database includes a detailed description of the disease, symptoms and possible treatments. Farmers can access this information using any smart device, ensuring flexibility and convenience. In addition, the system provides features such as a directory of veterinary contacts and geographic visualization of disease outbreaks, which facilitates preventive measures and timely interventions. Such visualization capabilities enable government agencies and researchers to effectively monitor and respond to disease trends, providing the dual benefits of individual and community health management. The app also integrates features such as GPS location of nearby vets and real-time notifications which enhancing its usefulness in emergency situations.

Despite the database's strengths, the study also identified challenges it faces, including the need to update the database regularly and the limited scope of the diseases analysis. The authors suggest future improvements by integrating machine learning algorithms to predict disease outbreaks and expanding the database to cover a more comprehensive range of livestock species and conditions. They also emphasize the

potential for community-based functions where farmers can share insights and experiences and promote collaborative problem solving.

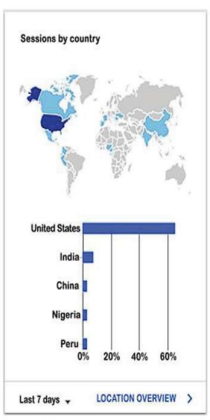


Fig. 3b.

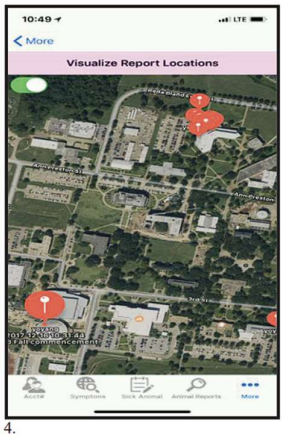


Fig. 4.

Figure 2.1.7.1 Real-Time Notifications

2.1.8 Health Experts for Pets Using Mobile Apps

Kumar et al. presented a comprehensive study on the utilization of mobile technology to enhance pet healthcare through the development of advanced mobile applications [16]. The study focuses on the integration of innovative technologies such as nano sensors, GPS and wireless communications to address significant challenges in pet health monitoring and management.

One of the core innovations of this research is the use of nano sensor technology for biomedical monitoring [16]. Nano sensors embedded in the mobile system detect and analyse small changes in the pet's physiological parameters, such as body temperature, respiratory rate and heart rate. These sensors are designed to recognize early signs of diseases such as erythema, anthrax and avian flu. By processing this data in real time, the system alerts pet owners and veterinarians for timely medical intervention. The integration of nano sensors demonstrates the potential of combining mobile technology with advanced biomedical engineering to improve diagnostic accuracy and preventive care.

Another important feature of the system is real-time GPS tracking [16]. Not only does this feature help find lost pets, but it can also play an important role in medical emergencies. In the study case, the app can use GPS to quickly dispatch an ambulance and locate the nearest veterinary hospital [16]. This feature bridges the gap between pet owners and emergency veterinary services, ensuring faster response times and reducing the risk of health complications in critical situations.

The health application also introduces a biomedical monitoring framework that transmits health parameters to veterinarians in real time [16]. This wireless communication ensures accurate monitoring and timely medical intervention. In addition, the app bridges the gap of offline appointment systems by facilitating online booking which improving efficiency and convenience for pet owners. It also includes identifying nearby pet hospitals, recommending age-specific nutritional supplements, and providing emergency medical care.

2.1.9 Generative AI Meets Animal Welfare: Evaluating GPT-4 for Pet Emotion Detection

Recent research has explored whether cutting-edge generative models (GPT-4) can discern pet emotions through image recognition, thereby supporting animal welfare assessments and human-animal interaction studies [17]. This study outlines a phased evaluation process: first establishing benchmarks via multi-species “pet emotion” tasks, followed by designing canine-specific tasks to validate whether customised data and prompt design enhance recognition reliability.

Conceptually, this work situates animal emotion recognition within a methodological framework encompassing studies on animal adaptation to the human facial action coding system (FACS) such as DogFACS, CatFACS, and EquiFACS while integrating classical observational methods with contemporary machine learning techniques [17]. The research proposes generative multimodal models as a complementary approach, capable of both generating predictions and providing natural language explanations. This framework highlights that canine expression repertoires are relatively accessible to human interpretation due to co-evolution, while

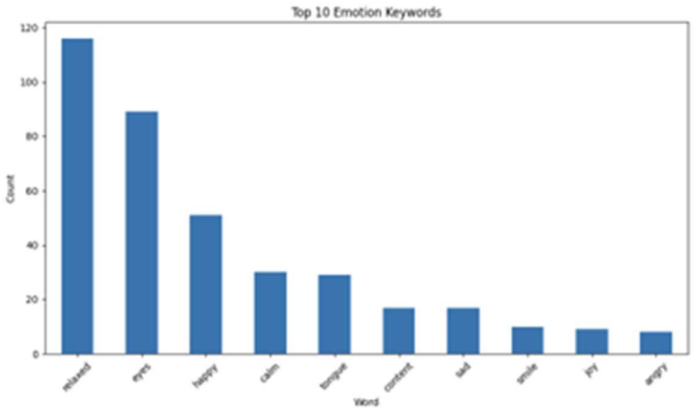
acknowledging the scalability limitations of artificial coding and the data requirements of supervised deep learning.

In generalised multi-species tasks, the model demonstrated moderate performance: overall accuracy of 50.2%, precision of 0.556, recall of 0.512, and an F1 score of 0.533 [17]. The “happy” category proved most readily identifiable, whilst “sad” and “angry” proved more challenging to distinguish that consistent with the diversity of facial morphology and expressions across species. These findings provide a practical benchmark for applying generative models across heterogeneous species without requiring task-specific fine-tuning.

Specialised training on canine data significantly enhanced model performance. During the dog-specific training phase, the model achieved 76.6% accuracy (precision 0.768, recall 0.788, F1 score 0.767), with particularly strong recall for the “Angry” category (93.7%) and robust performance for “Happy” and “Relaxed”; Misclassifications predominantly occurred in the overlapping region between the ‘relaxed’ and ‘sad’ categories, with some “happy” images erroneously labelled as ‘angry’[1]. Detailed confusion matrices, for example, 331 true ‘happy’ images, 292 true “relaxed” images, 254 true ‘angry’ images, and specific cross-label confusion patterns revealed which categories most benefited from canine-specific settings and which grey areas remain contentious [17].

Case discussions anchor reasoning to the DogFACS model, mapping features such as bared teeth, flattened ears, and tense body posture to specific action units for example, AU110, AU145, AU25 [17]. Error analysis further reveals that panting open-mouth behaviours. In summary, the evidence from this study indicates that GPT-4 holds significant application potential in the field of canine emotion classification, performing most efficiently when restricted to species-adapted datasets and explicit instructions while establishing a prudent benchmark for cross-species applications. This stems from the considerable differences in morphological characteristics and facial expressions between species.

	Labeled "Angry"	Labeled "Happy"	Labeled "Sad"
Predicted "Angry"	96	3	9
Predicted "Happy"	147	235	188
Predicted "Sad"	2	9	47
Predicted "Unsure"	5	3	6
Precision = 0.556			
Recall Score = 0.512			
F1 Score = 0.533			
Accuracy Score = 0.502			



2.1.9.1 Confusion matrix and performance metrics of Phase1of the prediction model.

	Labeled "Angry"	Labeled "Happy"	Labeled "Relaxed"	Labeled "Sad"
Labeled "Angry"	254	3	6	8
Labeled "Happy"	91	331	7	4
Labeled "Relaxed"	18	47	292	111
Labeled "Sad"	10	0	50	284
Precision = 0.768				
Recall Score = 0.788				
F1 Score = 0.767				
Accuracy Score = 0.766				

2.1.9.2 Confusion matrix and performance metrics of Phase2 of the prediction model.

2.1.10 AI-chatbots in pet health care: Opportunities and challenges for owners

The convergence of artificial intelligence (AI) and animal healthcare has opened up new avenues for pet owners to access information, guidance, and monitor their pets' health using AI chatbots. Jokar et al. [18] explored the capabilities and limitations of such chatbots, particularly ChatGPT, and highlighted the opportunities and potential risks of their application in the veterinary field.

One of the main advantages of AI chatbots is the ability to instantly access a broad range of veterinary knowledge, including research data, diagnostic recommendations, and treatment options. These systems are available 24/7, are cost-effective, and can be accessed through a variety of devices, allowing pet owners to obtain guidance without the need for traditional appointments. Chatbots also provide educational value by presenting veterinary topics such as nutrition, behaviour, and disease management in a user-friendly and interactive format. This makes them valuable not only in routine care but also in emergency situations, where immediate guidance and first aid advice can save lives.

The article cites the case of a border collie whose condition was initially misdiagnosed by a veterinarian but was successfully helped by ChatGPT. This suggests that chatbots have the potential to supplement professional veterinary care by providing diagnostic recommendations based on test results and symptoms entered by the user. However, the authors emphasize that AI chatbots are not intended to replace practicing veterinarians, but rather to serve as a supplementary tool.

The article also highlights key concerns, including the risk of misdiagnosis, over-reliance by users, and inappropriate treatment based on inaccurate recommendations. These risks are exacerbated by the potential for antibiotic misuse and delayed medical intervention. Jokar et al. [18] advocate for better education of pet owners about the limitations of AI and emphasize the need for a regulatory framework to guide the development and deployment of chatbots. They suggest that future AI tools should be designed to work in tandem with veterinarians, acting as initial advisors while ensuring that final decisions are made by professionals.

In summary, Jokar et al.'s review supports the view that AI chatbots can improve accessibility, knowledge, and efficiency of pet health management if used responsibly and in conjunction with expert care [18]. These findings further emphasize the importance of incorporating personalized AI chatbots into proposed pet health and management systems that provide educational guidance and frontline support while also engaging professional veterinarians.

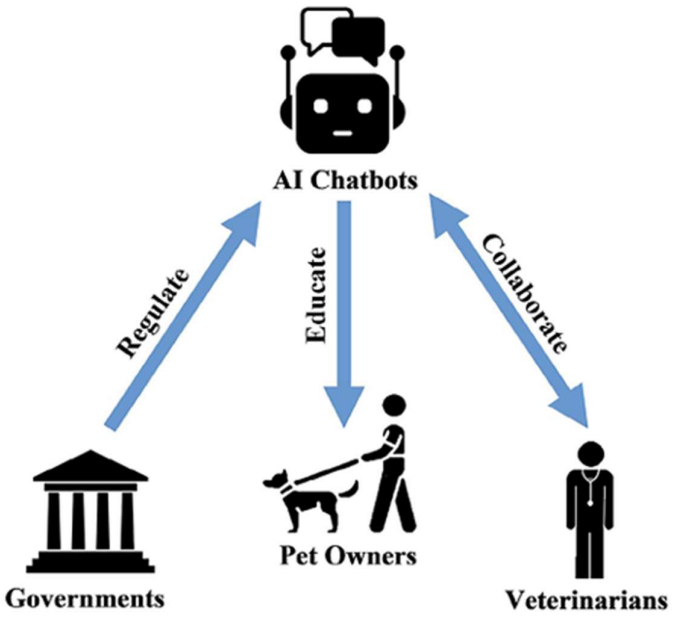


Figure 2.1.10.1 The web of responsibilities within the realm of artificial intelligence (AI) and pet care

2.1.11 Digitail-Smarter Pet Care

Digitail-Smarter Pet Care is a comprehensive mobile and web-based application designed to improve pet health management for pet owners and veterinary professionals. One of Digitail's key features is its health management system, which allows pet owners to store and organize all important health data, including vaccination records, medication records, and clinic visits. The app's dashboard provides a clear, comprehensive view of a pet's health, allowing owners to monitor key information in one place. In addition, Digitail includes an appointment scheduling system that allows users to schedule visits to veterinary clinics directly through the app. The system provides timely reminders for upcoming appointments and medication dosages to ensure that pet owners do not miss out on necessary wellness checkups.

Another important feature of Digitail is its telemedicine integration, which facilitates communication between pet owners and veterinarians through messages or video consultations [19]. This is beneficial for non-emergency issues, follow-up consultations, or situations where an in-person visit is not available. The ability to consult with a professional remotely provides added convenience for pet owners and supports the ongoing care of their pet without having to leave their home.

The benefits of Digitail-Smarter Pet Care are the app's centralized health management system, makes it easier for pet owners and veterinarians to access and update pet health information. This centralization improves the efficiency of veterinary care and makes it easier for owners to stay on top of their pet's health. Besides, the appointment scheduling and reminder system further enhances convenience by allowing users to book and track appointments without the risk of forgetting important dates. The telemedicine feature offers significant benefits which allowing owners to consult their veterinarian remotely, which is especially useful for users in rural or underserved areas [19].

However, Digitail has limitations. One of its main drawbacks is its UL bugs when the user closes the app, it will log him out without any permission and the user cannot edit or delete typos in the vet information [19].

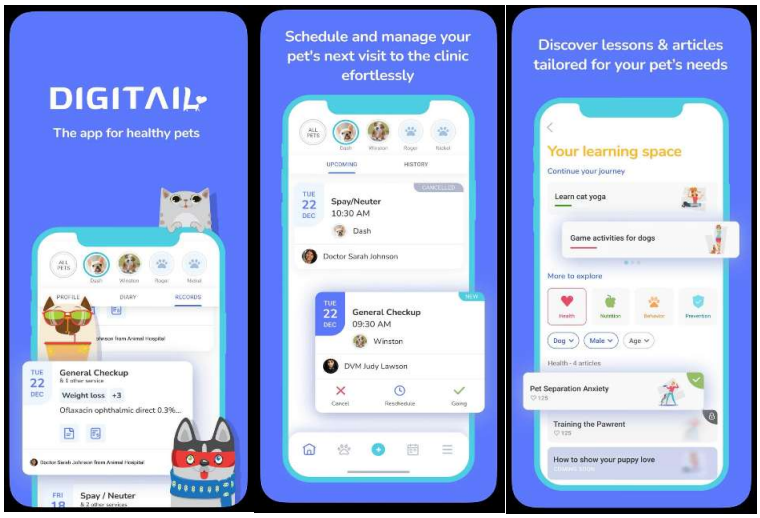


Figure 2.1.11.1 Digitail-Smarter Pet Care Application

2.1.12 DogCatApp

DogCatApp is a mobile application designed to help pet owners manage the health and welfare of their pets. One of the core features of DogCatApp is the health and medical record tracking system. Pet owners can store important information such as vaccination records, medical history and medication schedules in one place. This centralized health data facilitates easy access to important information at any time, whether it's a routine checkup or a consultation with a veterinarian [20].

Another key feature of DogCatApp is its medication management system, which helps owners keep track of medications, including dosage, frequency and refill dates. When it's time for medication, the system sends reminders to pet owners to prevent missed doses. This feature is especially beneficial for pets with chronic illnesses or those undergoing long-term treatment. In addition, the pet owners also can store their favourable pictures of their pet into the gallery that provided by the apps [20].

DogCatApp has several advantages that make it a useful tool for pet care management. Its centralized health record management allows pet owners to easily track and update their pet's health information. The appointment scheduling and reminder system ensures that pet owners do not miss important checkups or vaccinations, which promotes better preventive care. The medication management

system reduces the likelihood of missed medications, which is critical for pets on long-term medications [20].

However, DogCatApp have limitations. One of its main drawbacks is its reliance on manual data entry. While the app offers useful tracking features, it requires pet owners to manually enter information about their pet's health and behaviour. This can be time-consuming for pet owners, especially those with busy schedules or multiple pets. Additionally, DogCatApp lacks advanced features such as real-time health monitoring or integration with wearables that track vital signs, which are offered in more specialized pet health apps [20].

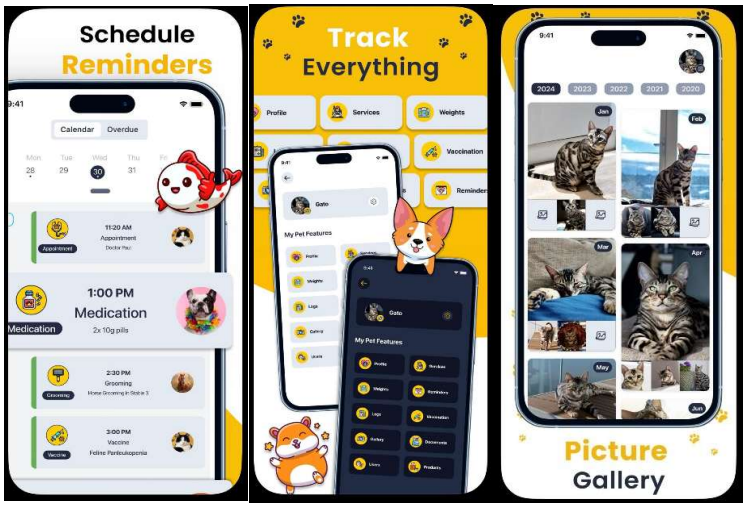


Figure 2.1.12.1 DogCat Application

2.1.13 PetFinder.my

PetFinder.my is a well-known online platform in Malaysia that plays a vital role in promoting pet adoption and foster care. The platform aims to improve animal welfare by connecting potential pet owners with rescue groups, shelters and individuals looking to rehome their pets. By offering a user-friendly interface and a vast database of adoptable animals, PetFinder.my serves as a central hub for pet adoption, education and volunteering, making it easier for people to find the right pet and give them a forever home [21].

One of the main features of PetFinder.my is a pet adoption service that allows users to browse a wide range of pets available for adoption. The platform provides detailed information about each animal, including information about its health, temperament, breed, age, and specific needs. Pet seekers can filter the listings based on a variety of criteria such as species, size and location, making it easier to find a pet that fits their living situation. Each pet's profile is accompanied by photos and videos that give a more complete picture of the animal's appearance and behaviour, thus helping potential adopters make an informed decision [21].

In addition to adoption, PetFinder.my also offers foster homes and volunteering capabilities. For people who are unable to permanently adopt a pet, the platform offers the opportunity to temporarily foster animals until they are adopted. This is a valuable feature for animal shelters, which often need temporary care for animals until they find permanent homes. Additionally, PetFinder.my encourages users to volunteer supporting the broader pet welfare and rescue community. The addition of fostering and volunteering options enhances the platform's impact on animal care and provides multiple ways for people to get involved to improve the lives of pets in need [21].

Another important advantage of PetFinder.my is its educational resources for pet owners. The platform offers a wide range of articles, tips and guides on responsible pet ownership, pet health, behaviour and training [21]. These resources are invaluable to both novice and experienced pet owners who want to ensure that they are providing the best care for their pets.

Although PetFinder.my has many advantages, it also has some limitations. One of the main drawbacks is its geographical limitation. While the platform is a great resource for pet adopters in Malaysia, it may not be as accessible or relevant to those outside of Malaysia [21]. This limits its impact to the local level, limiting its ability to support international adoptions or connect users to global pet welfare initiatives.

Another limiting factor is the adoption process itself, which can sometimes be lengthy and involve multiple steps, including home checks, interviews and adoption fees. While these procedures are designed to ensure that pets are placed in safe and appropriate homes, they may deter some potential adopters. Some users may find these requirements burdensome, which could delay pet adoption or lead to abandonment of the adoption process.

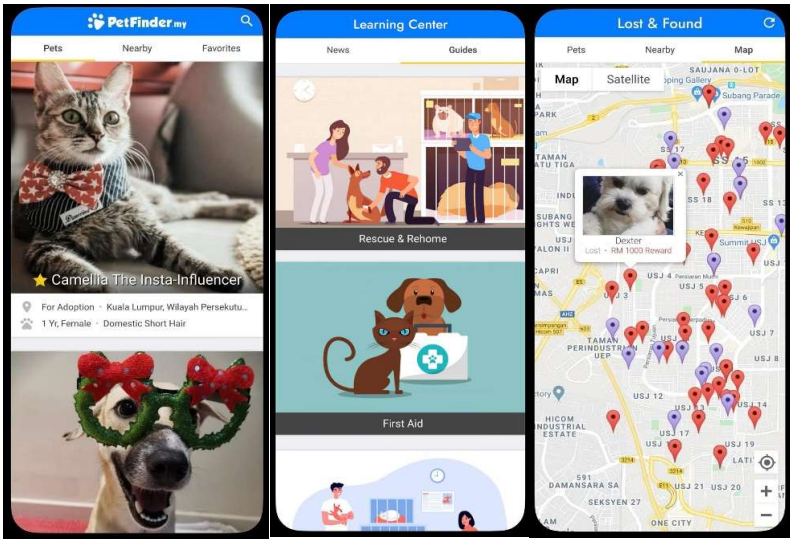


Figure 2.1.13.1 PetFinder.my Application

2.1.14 TTCare

TTCare for Pet is a mobile application designed to help pet owners identify and assess potential health problems in their pets using image recognition technology [22]. The app provides a user-friendly interface that allows pet owners to take photos of their pets and identify symptoms or possible diseases based on visual cues. The use of advanced Artificial Intelligence (AI) in image recognition allows the app to analyse photos of pets and provide instant feedback, suggesting health conditions that may require further attention or professional veterinary consultation.

The main feature of TTCare for Pet is an image recognition system that allows pet owners to upload photos of their pets to the app. The app analyses these images to identify visible symptoms such as rashes, wounds, or physical abnormalities that may indicate disease. Once the image processing is complete, the app provides the pet owner with a possible diagnosis based on the visual data and makes recommendations on further steps to take [22]. This helps the owner decide whether the problem requires immediate veterinary attention or can be dealt with at home. While this feature is not intended to replace professional veterinary diagnosis, it can be used as an initial screening tool to provide valuable insights to pet owners before they seek medical attention.

One of the key benefits of TTCare for Pet is the ability to provide early detection of health problems based on visible symptoms. This is useful for diseases that manifest on the skin or other external areas, providing pet owners with a quick and easy way to assess their pet's health. Additionally, the app's ability to analyse images and suggest potential health issues helps save time and reduces the number of unnecessary trips to the veterinarian for minor ailments. By providing early insight into a pet's health, the app enables owners to take timely action to ensure that their pets receive the necessary care before health problems worsen [22].

However, TTCare for Pet also has some limitations that must be considered. While the app's image recognition capabilities are robust, its effectiveness depends heavily on the quality of the photos taken. If the image is blurry or poorly lit, the app may struggle to provide accurate results, which could lead to missed or false alarms. Additionally, TTCare for Pet focuses primarily on visible symptoms, which means it cannot detect internal health issues or conditions that are not easily recognized. As a result, pet owners should use the app as an aid rather than a substitute for professional veterinary advice, especially for more complex or hidden health issues.

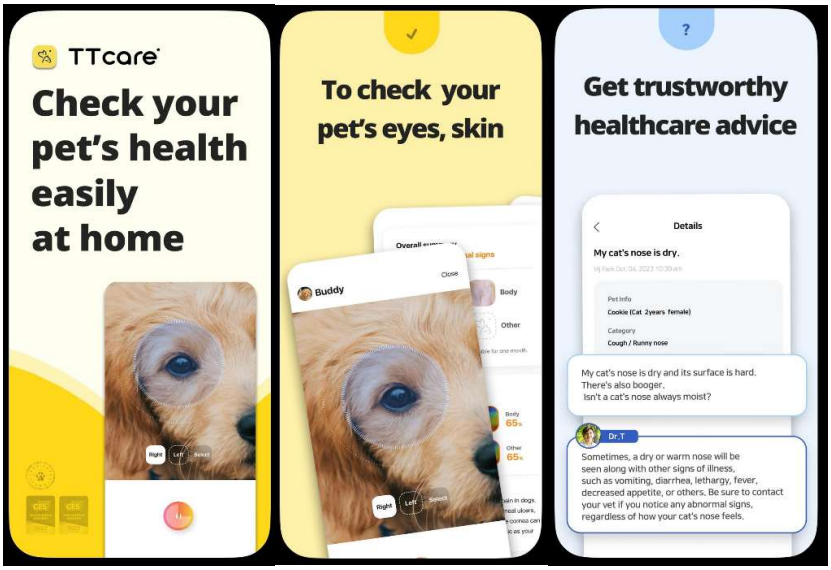


Figure 2.1.14.1 TTCare Application

2.1.15 Feline Grimace Scale

The Cat Facial Expression Scale (FGS) is a tool that assesses the level of pain in cats by analysing their facial expressions [23]. Unlike humans, who can verbalize pain, cats often hide signs of physical discomfort, making it difficult for pet owners and veterinarians to recognize when a cat is suffering. The Feline Facial Expression Scale aims to fill this gap by providing a structured and validated method for assessing pain in cats based on their facial features.

One of the main strengths of the Feline Facial Expression Scale is that it provides a non-invasive, objective method of pain assessment, which is crucial for cats who are unable to express discomfort in the same way as humans or other animals. The app's ability to analyse facial expressions makes it possible to detect pain even in situations where behavioural changes may not be immediately noticeable [23]. In addition, the Feline Facial Expression Scale has been validated in a variety of clinical settings and correlates well with other pain assessment methods such as the Visual Analog Scale (VAS) and behavioural assessments. This validation ensures the reliability and consistency of the tool, making it a trusted resource for veterinary professionals.

However, despite its strengths, the Feline Grimacing Scale has its limitations. One of the main challenges is that it requires training and experience to use effectively. Although the scoring system is standardized, there is still a degree of subjectivity, especially when interpreting the more subtle facial expressions of cats. Then, veterinary professionals must be well trained to recognize subtle changes in facial features that signal pain as inconsistent scoring may lead to inaccurate scoring. In addition, the scale only assesses visible pain, which means it may not be effective in detecting more subtle forms of internal pain [23].

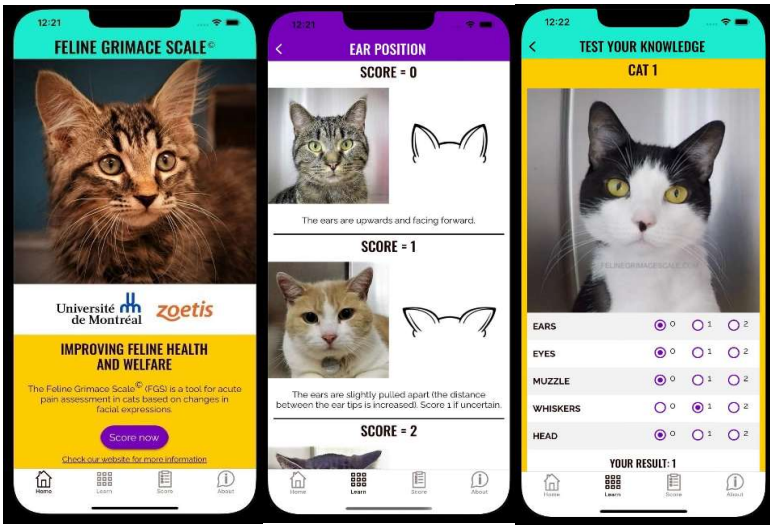


Figure 2.1.15.1 Feline Grimace Scale Application

2.1.16 App Comparison

App	Features	Advantages	Disadvantages
Digitail-Smarter Pet Care	-Store and organize all important health data - Appointment scheduling system -Telemedicine integration	- Centralized health management system - Allow track appointments with reminder system - Communicate with veterinarian remotely	- UL bugs
DogCatApp	-Medical record tracking system -Medication management system	- Centralized health record management - Reduces the missed medications	- Rely on manual data entry -Time consuming - lacks advanced features like real-time health monitoring
PetFinder.my	- Pet adoption service - Volunteering capabilities	- Supporting the broader pet welfare and rescue community -Educational resources	- Geographical limitation -Complex adoption process
TTCare	-Image recognition system	- Ability to provide early detection -Analyze images and suggest potential health issues	- Blurry picture may cause image not to recognize
Feline Grimace Scale	-Assesses the level of pain in cats by questionaires	- Provides a non-invasive, objective method of pain assessment for unexpressed discomfort cats	- Requires training and experience - Unable detect internal pain

Proposed Solution App	- Image recognition system - Provide real time available vet clinic - Health Record Management and Reminders - Educational Resources with Chatbot	-provide Early Detection of Health Issues -Real-Time Access to Veterinary Care -Prevention-Focused -Educational ask and answer Empowerment -Convenience	- lack of online appointment for vet consultation

Table 2.1.16.1 App Comparison

CHAPTER 3
SYSTEM METHODOLOGY

3.1 System Design Diagram

3.1.1 System Architecture Diagram

The pet health and management system follow the MVC (Model-View-Controller) architecture. The view layer is built with XML layouts and is responsible for handling user interactions. The controller layer is developed in Kotlin and is responsible for handling user input, communicating with the model, and updating the view. The model layer manages the data and business logic of the application and interacts with Firebase, Room Database, OpenAI API, and Google Maps services. This architecture ensures a clear separation between the interface layer, logic layer, and data layer, making the system more organized, easy to maintain, and scalable.

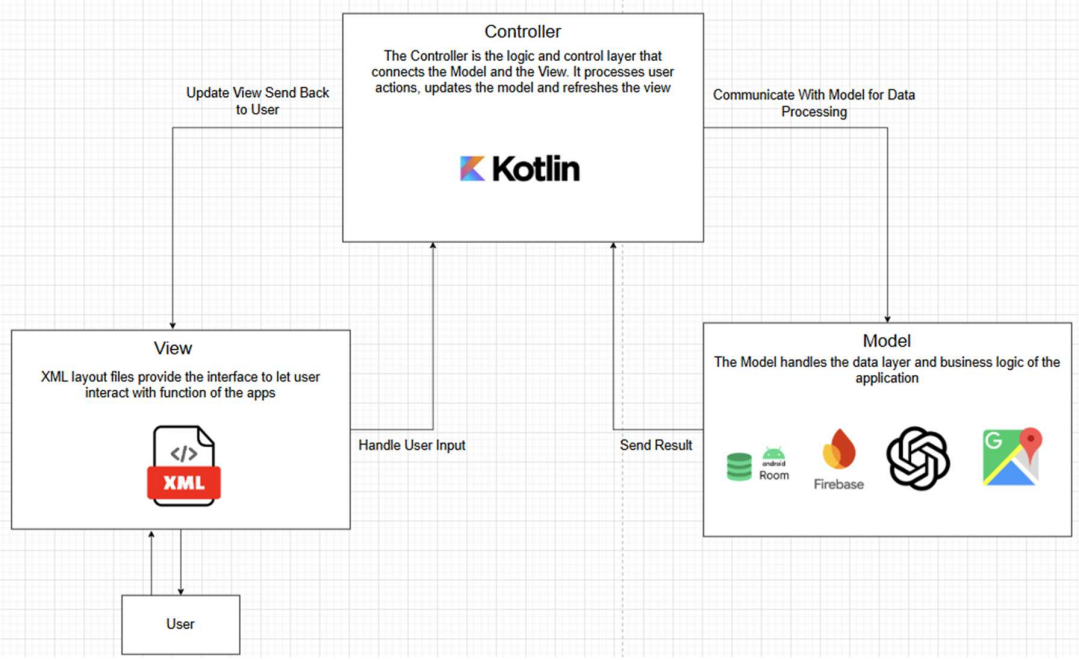


Figure 3.1.1.1 System Architecture Diagram for Pet and Health Management System

3.1.2 Methodology and General Work Procedures

This project will be divided into four phases, which includes project pre-development, app development, content development, testing and refinement, and lastly the completed system. Figure 3.1 shows the overall development phase of the project.

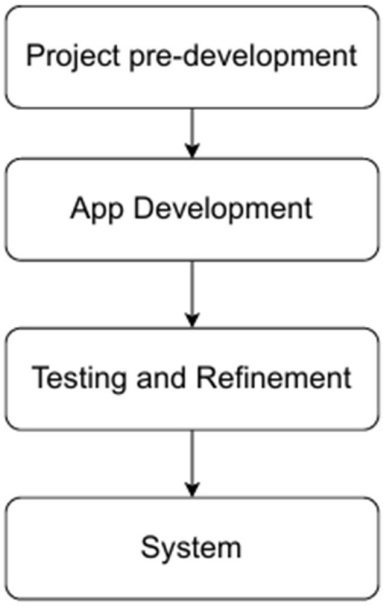


Figure 3.1.2 Overall Development Phase of Project

3.1.2.1 Project pre-development

Extensive research started by carry out to study the current state of pet health management technologies. This includes reviewing academic papers and case studies on AI-based illness detection, mobile health tracking apps, and real-time veterinary navigation services. Existing public datasets and pretrained models for animal symptom analysis will be evaluated for their suitability and coverage. A competitive analysis of leading pet care apps such as Digitail, TTCare, and DogCatApp will be performed to identify feature gaps and opportunities for innovation.

Based on the research results, the project's objectives, scope, and technical requirements will be clarified. The project will focus on integrating AI image recognition technology for symptom analysis, developing a personalized AI chatbot for pet health education, and implementing a real-time geolocation service to find

veterinary clinics. The overall project approach will also be finalized at this stage, using an agile methodologies approach to achieve flexibility, iterative development, and continuous feedback as shown in Figure

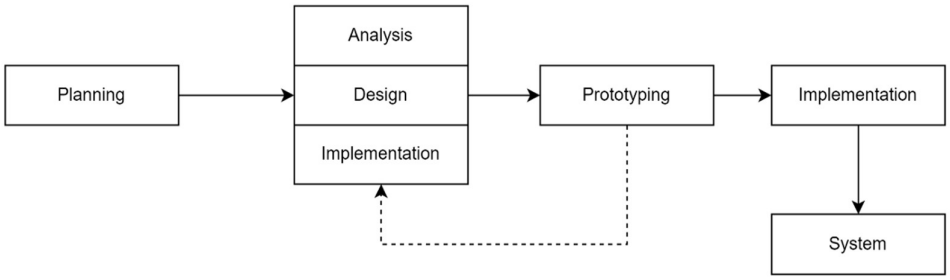


Figure 3.1.2.1 Prototype Methodologies

During the planning phase, the problems and opportunities surrounding pet health management will be identified. Project goals, scope, and system requirements will be determined based on user needs and available technical solutions. During the analysis phase, solution brainstorming and competitive benchmarking will help identify key features and prioritize system functions, such as health record tracking, AI-driven diagnosis, and emergency navigation support and the AI-chatbot.

During the design phase, we will develop initial low-fidelity prototypes, including rough layouts of the main dashboard, disease detection module, and chatbot interface. These prototypes will be used to collect early feedback from target users pet owners to improve user experience and interface design.

Next, the system prototype phase will build vertical slices of the application, focusing on core modules such as AI disease detection, emergency veterinary locator, and AI chatbot flow. This phase aims to validate the design, usability, and system integration of the application through iterative feedback.

Once the prototype is validated, the implementation phase will begin to fully develop the system modules. The project will include OpenAI API integration for pet health diseases, Firebase and Room Database backend data management setup, and Google Maps API integration for real-time positioning and planning of diagnosis and treatment routes. Continuous integration and regular testing will ensure the reliability and stability of the application.

Eventually, all functions will be gradually opened to users, starting with key modules such as health record management and disease detection. AI chatbots and emergency navigation will be launched later, and the system will continue to be improved based on actual user feedback, performance analysis and usability testing, ultimately creating a seamless and efficient pet health management system.

3.1.2.3 App Development

The app development process starts with designing an intuitive user interface (UI) that is easy for pet owners to navigate. The main dashboard will serve as a central hub, providing access to health record management, AI-based disease detection, real-time veterinary clinic locator, and AI educational chatbots. Each module will be developed independently to allow for parallel testing and integration.

In terms of backend services, Firebase will be used to manage user authentication, store pet profiles, medical records, appointment scheduling. Firebase Storage will be used to securely store uploaded pet images. The app will integrate Google Maps API to provide real-time clinic locations and emergency navigation services, showing the nearest veterinary clinics with operating status and estimated travel time.

The AI disease detection feature is powered by the OpenAI API. When a user captures or uploads an image, the app via a secure backend submits it to OpenAI's vision model and receives a structured analysis containing possible disease conditions, a confidence level, and clear guidance on whether a veterinary consultation is recommended.

This AI educational chatbot will provide guidance on disease prevention, nutrition, chronic disease management, and behavioural recommendations for pets, integrated through the OpenAI API. The chatbot will provide personalized responses based on the pet's breed, age, and medical history.

3.1.1.4 Testing and Refinement

After the development phase is complete, the pet health and management system will undergo comprehensive testing and refinement to ensure its functionality, reliability, and user-friendliness. Testing will begin with unit testing, where individual modules such as health record management, AI disease detection, real-time veterinary clinic locator, and AI educational chatbot will be independently tested to verify that

they operate as expected. Each module will be evaluated based on specific test cases to ensure its accurate and stable performance.

After the individual modules pass unit testing, integration testing will be conducted to verify the seamless interaction between different system components. For example, after the AI model generates a health diagnosis, the system must correctly recommend nearby clinics and provide appropriate educational guidance through the chatbot. This phase ensures that data is properly transferred between the AI model, database, geolocation service, and user interface, maintaining a consistent and reasonable user experience.

Usability testing will also play a key role in this phase. A group of target users including pet owners will interact with the application, performing some common tasks such as recording vaccinations, scanning symptoms, and asking the chatbot for advice. User feedback will be collected on the application design, ease of navigation, and overall user satisfaction. These observations and feedback will guide improvements in interface layout, functional accessibility, and information clarity.

Based on the results of all testing activities, the system will be iteratively improved. Issues such as inconsistent user interfaces, AI model classification errors, slow response times, or irrelevant answers from the chatbot will be systematically addressed. The project adopts continuous integration practices to update the application, fix bugs, and make enhancements without disrupting other system functions.

Finally, the user acceptance testing (UAT) will be conducted to verify that the system is ready for actual deployment. The final validation will ensure that the application meets both the functional requirements outlined during planning and the expectations of end users. Through this comprehensive testing and improvement process, the pet health and management system will achieve a high level of quality, usability, and reliability, ensuring a positive and effective experience for users.

3.1.3 Use Case Diagram and Description

The use case diagram models the Pet Health and Management System groups the behaviour into five functional areas, AI symptom checking, nearby clinics and navigation, AI education, scheduling, and user management. First, the AI-Symptom Checker helps the owner assess a health concern. This flow includes upload pet image and diagnose the image result because the assessment requires an image and a diagnosis step every time. When the analysis flags health risk, the behaviour extends to suggest visiting clinic if the pet is unhealthy, which is triggered only for abnormal outcomes. Second, retrieve current location with GPS supports access to care. It includes Display Nearby Clinic List that sorted from shortest to longest distance so the owner can compare options. From that list the behaviour may extend to either navigate to nearby vet clinic or navigate to further vet clinic, which are optional paths invoked only when the owner chooses navigation. Third, interact with AI-Chatbot for educational purpose delivers learning support. It includes provide educational content for pet care to ensure every conversation returns curated guidance. On demand, the behaviour can extend to use quick button for asking, predefined prompts and to translate the generated response when the owner requests another language. Fourth, arrange schedule for pet manages reminders per pet. The base flow includes add health schedule, add vaccination schedule, and add medications feeding schedule because these are the core actions the owner can create. Each schedule then offers optional maintenance that extends to update schedule and delete schedule as needed. All active schedule include receive notification for reminder so alerts are issued at the configured times. Finally, the diagram captures User Management. Existing users access User Profile, which can extend to Update User Profile when edits are made. New users perform Register User Profile to create their account before using the other functions. For new user, once register it require user to add pet profile. Then the pet profile can extend to update and delete the pet profile. For the registered user, user can extend to create a new pet profile

Figure 3.1.3.1 User Case Diagram for Pet and Health Management System

3.1.4 Activity Diagram

3.1.4.1 User and Pet Sign In Sign Up Activity Diagram

This activity describes the user registration and login flow in the pet health and management system. Users can choose either register with normal register or google service by entering personal information or log in using existing credentials. After registration, the user data is saved to Firebase or google service. During login, the user's credentials are retrieved and validated. If the login information is invalid, the user is redirected back to login page. If the login information is valid, system will check whether is the new users. If are the new users, redirect them to create a pet profile. After completing the pet registration or the user successfully logs in, the user is redirected to the dashboard.

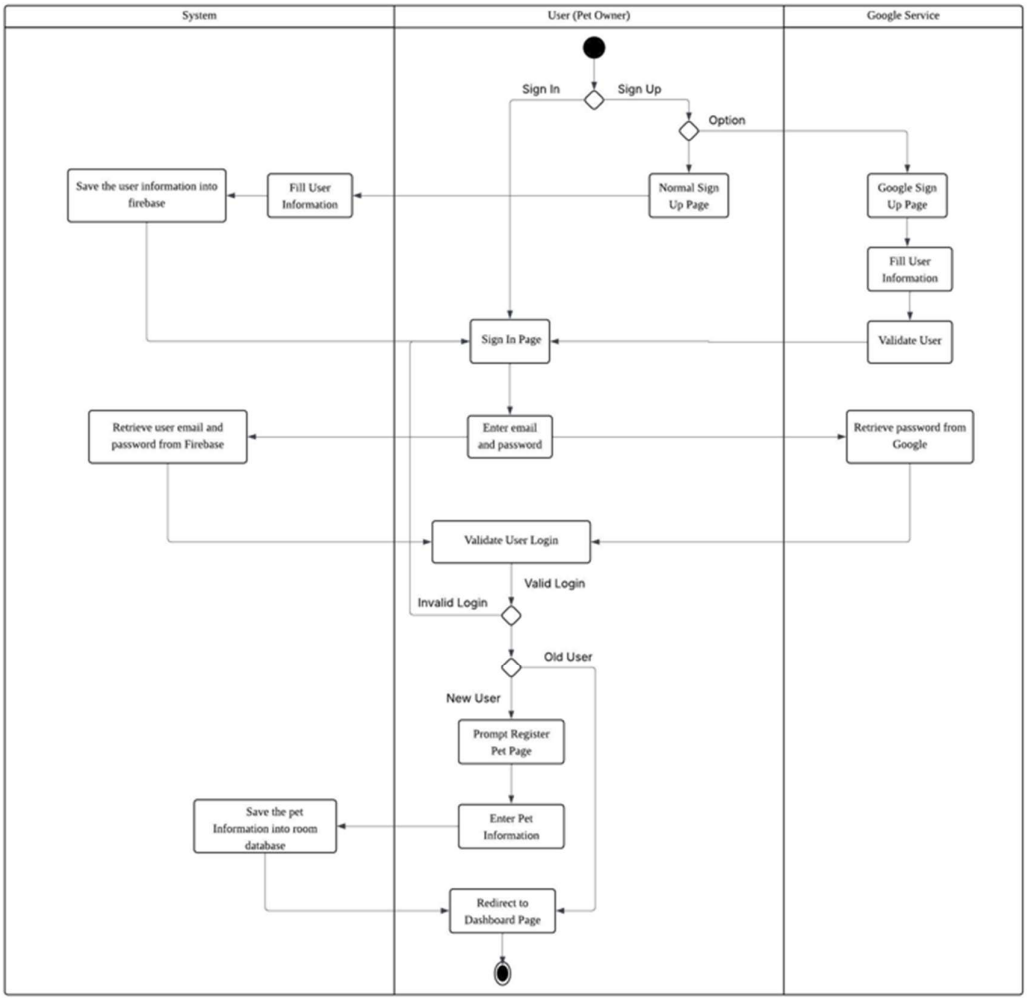


Figure 3.1.4.1 User and Pet Sign In Sign Up Activity Diagram

3.1.4.2 User Profile Activity Diagram

The activity diagram shows the flow of managing user profile information. The system first retrieves the current user and pet data from Firebase. The system then displays their existing information to the user and provides the option to update it. If the user chooses not to perform an update, the system simply displays the existing information. If the user decides to update their profile, the system saves the updated data back to Firebase, completing the update process.

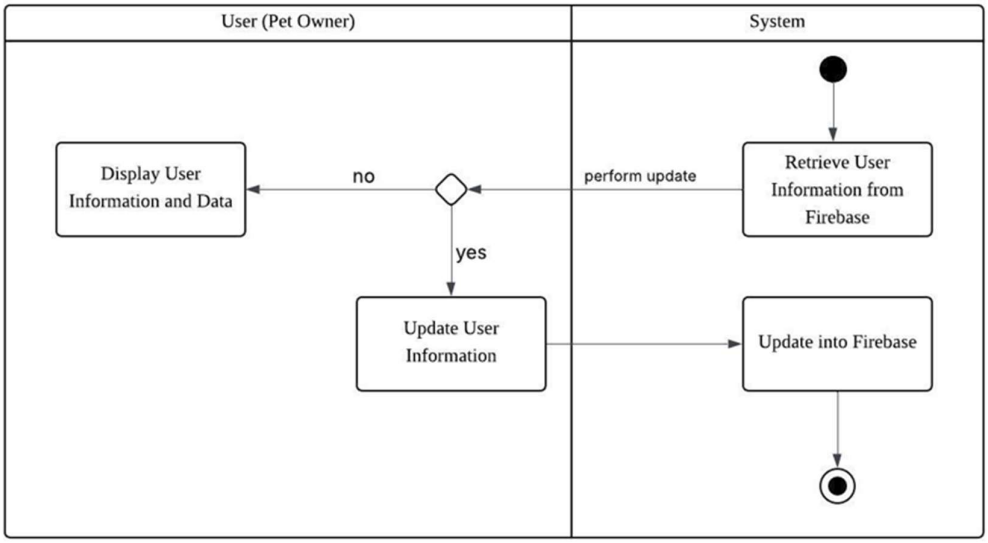


Figure 3.1.4.2 User Profile Activity Diagram

3.1.4.3 Pet Profile Activity Diagram

The activity diagram shows the flow of managing pet profile information. The system first retrieves the current pet data from Room Database. The system then displays their existing information to the user and provides the option to update or delete it. If the user chooses not to perform an update or delete, the system simply displays the existing information. If the user decides to update or delete their pet profile, the system saves the updated data back to Room Database, completing the update or delete process.

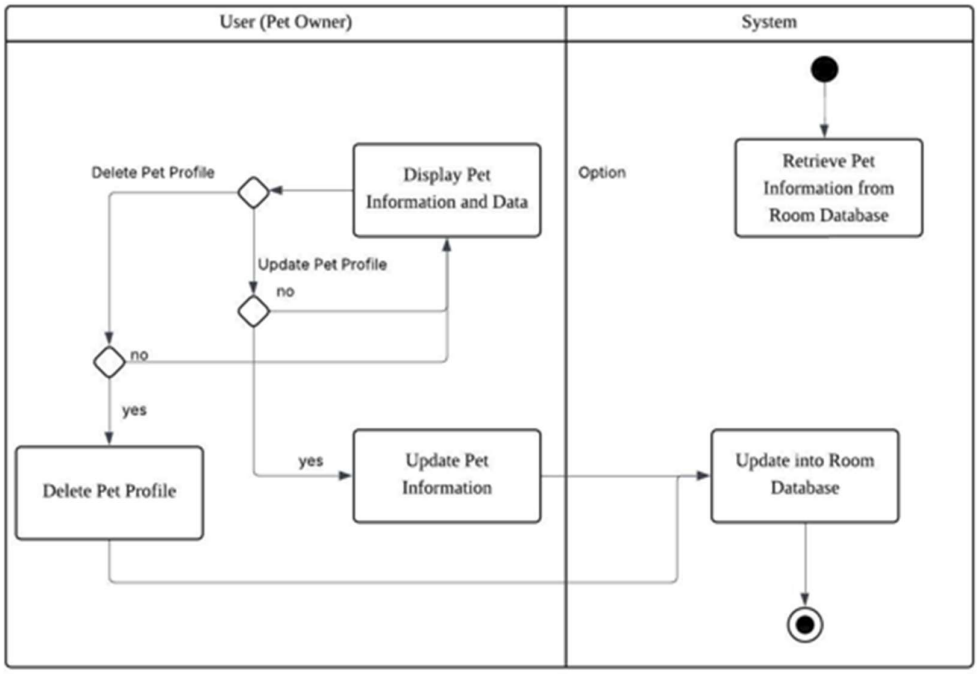


Figure 3.1.4.3 Pet Profile Activity Diagram

3.1.4.4 AI-Symptom Checker Activity Diagram

The activity diagram shows the process of diagnosing a pet's health using the AI Symptom Checker. The user takes or uploads an image of the pet, and the system processes it. If the image is invalid, an upload failure message is displayed. If the image is valid, the system analyses the image and generates a diagnosis. If the pet is healthy, the system makes preventive care recommendations. If the pet does not look healthy, the system prompts the user to visit a nearby veterinary clinic or hospital for further consultation.

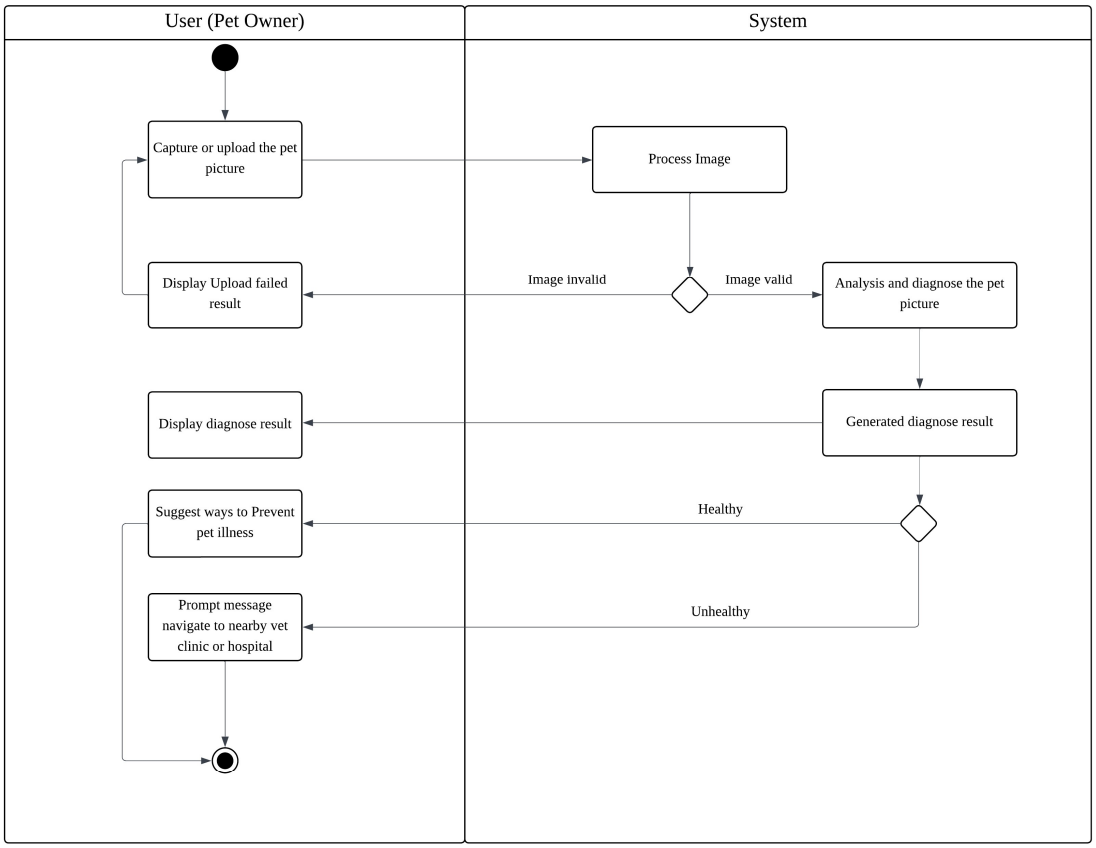


Figure 3.1.4.4 AI-Symptom Checker Activity Diagram

3.1.4.5 Nearby Clinic Finder Activity Diagram

The activity diagram shows the process of finding a nearby veterinary clinic or hospital. The user first grants location permission, allowing the system to track their current location and search for nearby veterinary services. The system then displays a list of the nearest clinics or hospitals. The user can view the details of each clinic and select a preferred location. Once selected, the system navigates the user to the selected clinic using third-party Google Maps navigation.

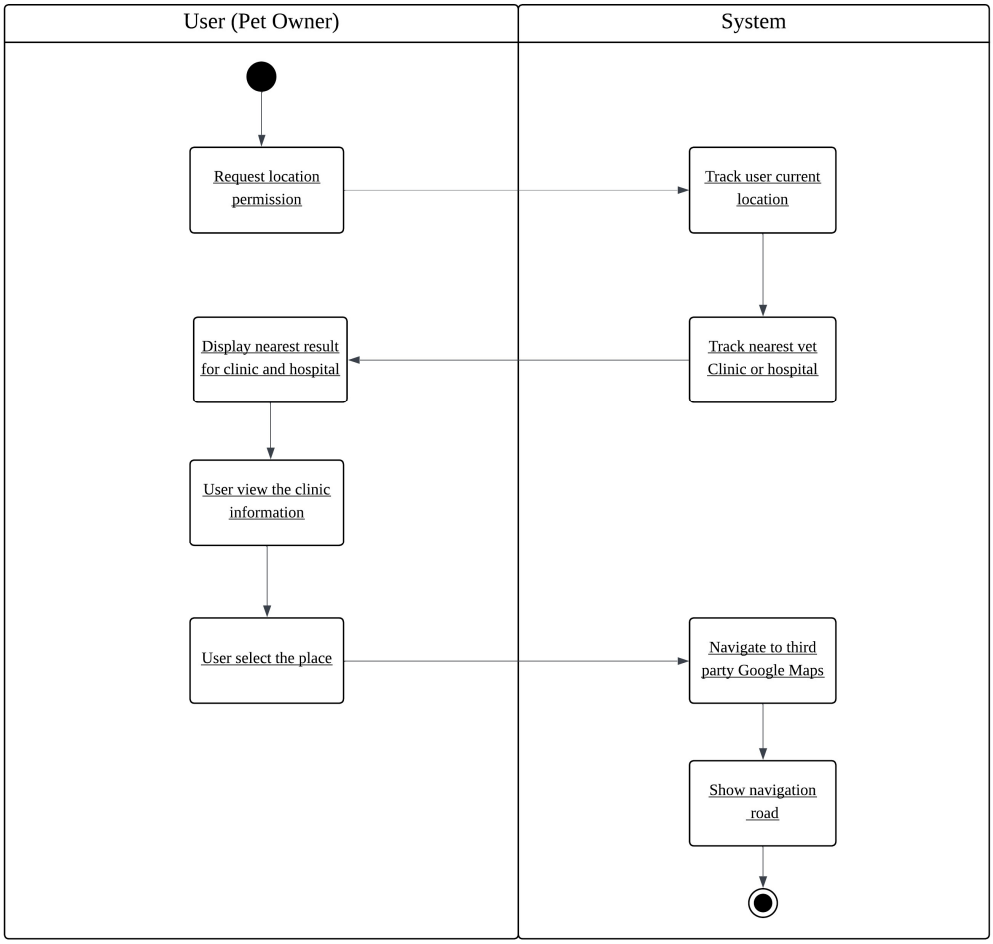


Figure 3.1.4.5 Nearby Clinic Finder Activity Diagram

3.1.4.6 AI-Chatbot for Educational Activity Diagram

The activity diagram shows the interaction between the user and the AI chatbot. The user starts the chat session by asking a question. The system reads the question, generates an appropriate answer, and displays the response to the user. If the user chooses to translate the response, the system translates and displays the translated version. If no translation is required, the original response is displayed directly. This process ensures that users can receive personalized health education support in their preferred language.

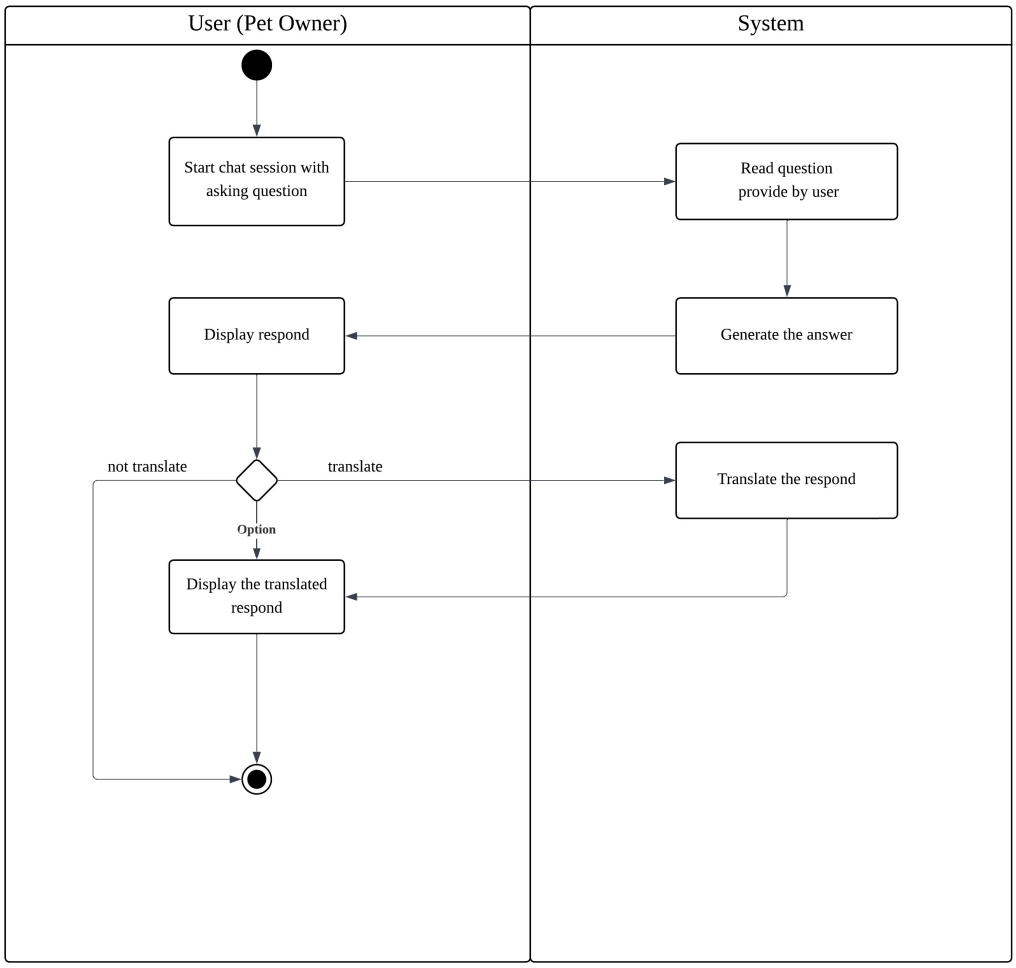


Figure 3.1.4.6 AI-Chatbot for Educational Activity Diagram

3.1.4.7 Pet Managing Health Schedule Activity Diagram

The activity diagram describes the process of managing a pet's health plan. The system first retrieves existing plan data from Room Database. If a plan exists, it is displayed. If not, the user can add a new plan by filling out and submitting a form, which is then saved to Room Database. After viewing the plan, the user can choose to update or delete it. If an update is made, the updated information is submitted and saved back to Room Database to ensure that the plan remains up to date. If a delete is made, the schedule is deleted and update to Room Database.

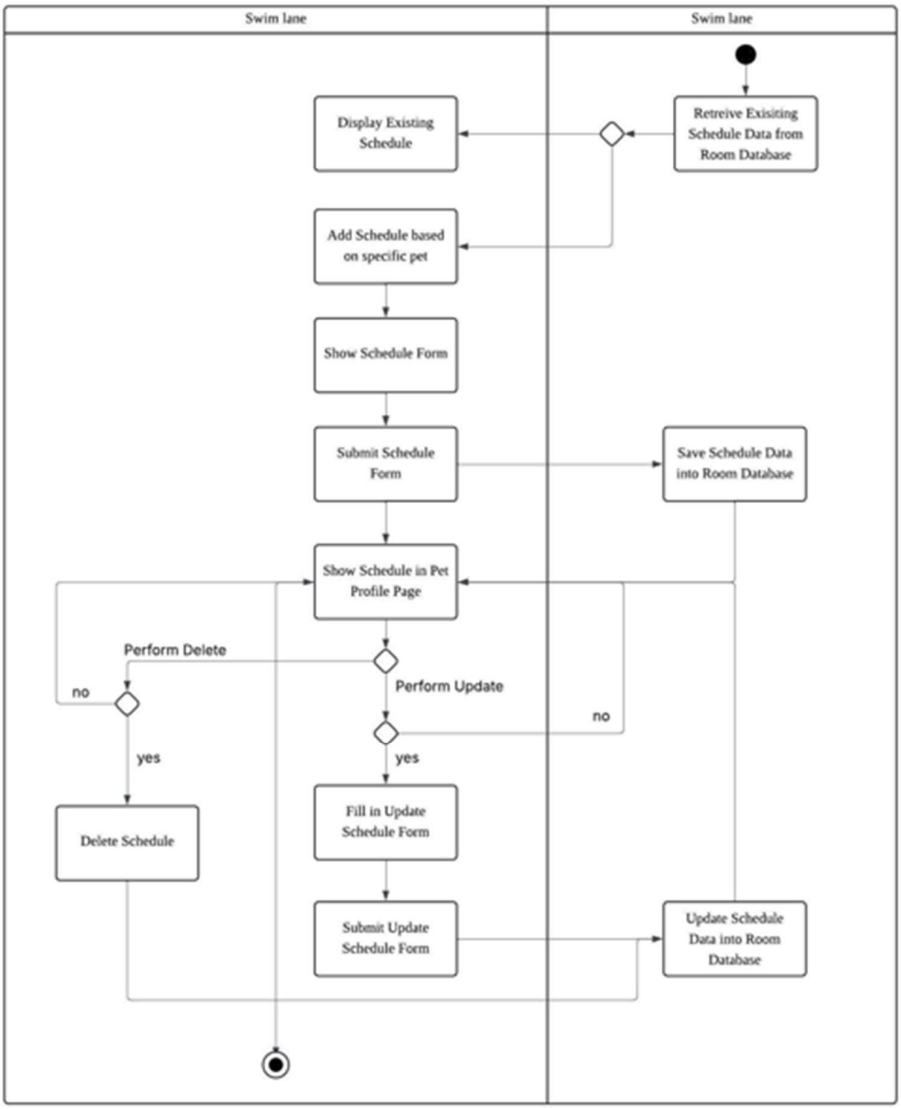


Figure 3.1.4.7 Pet Managing Health Schedule Activity Diagram

3.1.5.1 Gantt Chart FYP1

The figure shown the timeline for the overall FYP 1progress.

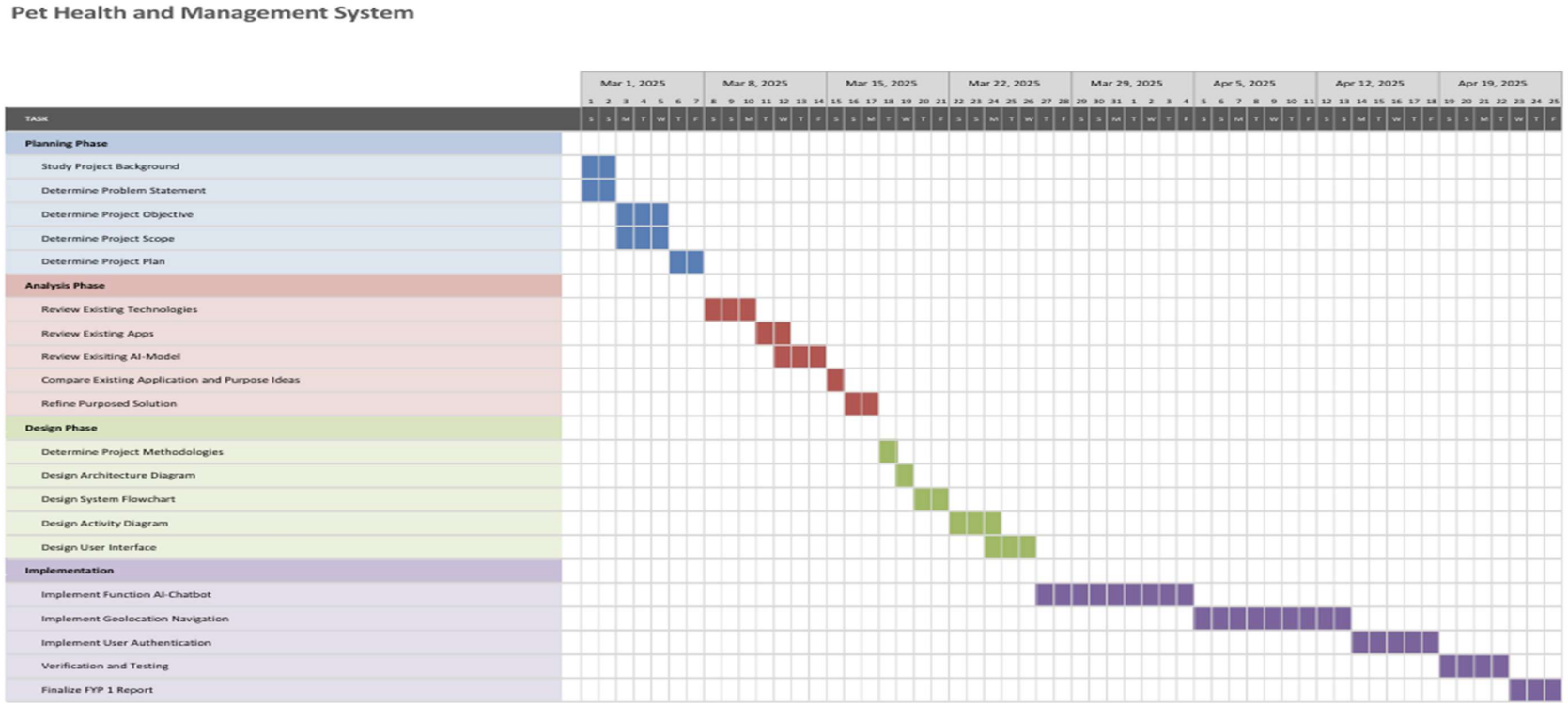


Figure 3.2.4.1 Gantt Chart for FYP1

3.1.5.2 Gantt Chart FYP2

The figure shown the timeline for the overall FYP2 progress.

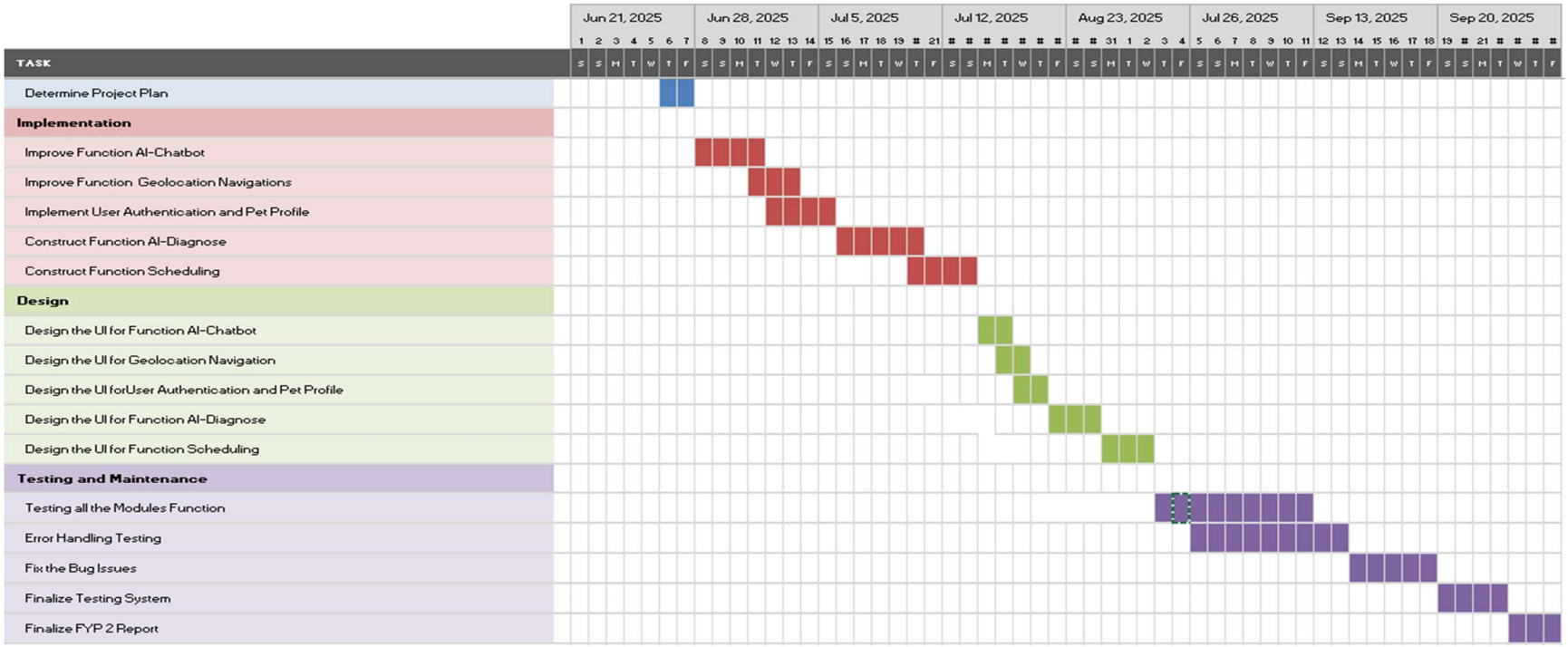


Figure 3.2.4.2 Gantt Chart for FYP2

CHAPTER 4

SYSTEM DESIGN

4.1 System Block Diagram

The block diagram shown in the figure demonstrates the basic functions of the pet health management system. The system starts with the pet health dashboard, which serves as the main navigation for users. Through the dashboard, users can access the AI symptom check and health diagnosis modules to capture and analyse pet images to enable early disease detection. The health sceheduling record management module allows users to schedule and manage appointments related to pet healthcare. The personalized education content module connects users to an AI chatbot that provides educational with bot respond. Finally, the geolocation and clinic finder module enable users to retrieve and navigate to a list of nearby veterinary clinics based on their current location.

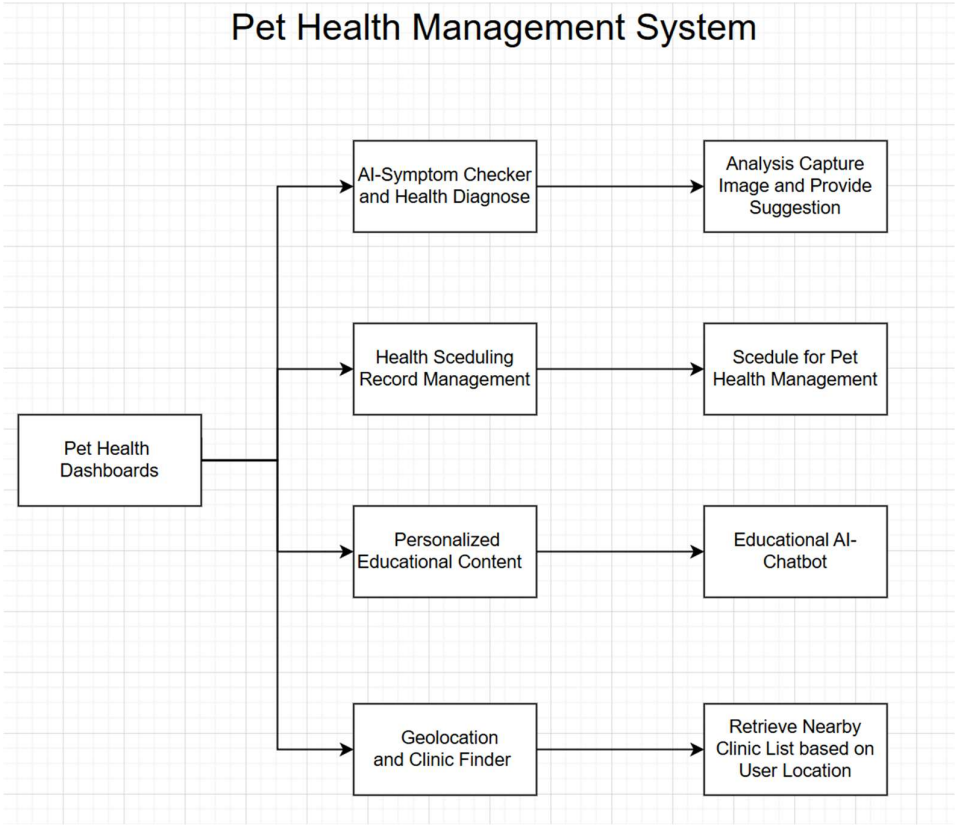


Figure 4.1 Block Diagram for Pet and Health Management System

4.2 System Flowchart

4.2.2.1 Overall Flowchart for Pet and Health Management System

This flowchart shows the overall process of the pet health management system. First, the user logs in or creates an account, and then checks whether the pet profile exists. If it does not exist, the system prompts the user to create a profile and navigate to the control panel. The control panel provides four main functions pet management, AI symptom check, nearby veterinary clinic search, and AI chatbot. In the appointment module, users can view, create, update, or delete appointments schedule and receive reminder notifications. AI symptom check allows users to upload or take pet images for health diagnosis. Invalid images will be rejected, and valid results will provide suggestions or prompt users to go to the clinic. The nearby clinic module uses location services to list nearby veterinary clinics and allows users to navigate to these clinics through third party Google Maps. Finally, the AI chatbot allows users to ask health-related questions and get real-time guided responses, with the option of translation as needed.

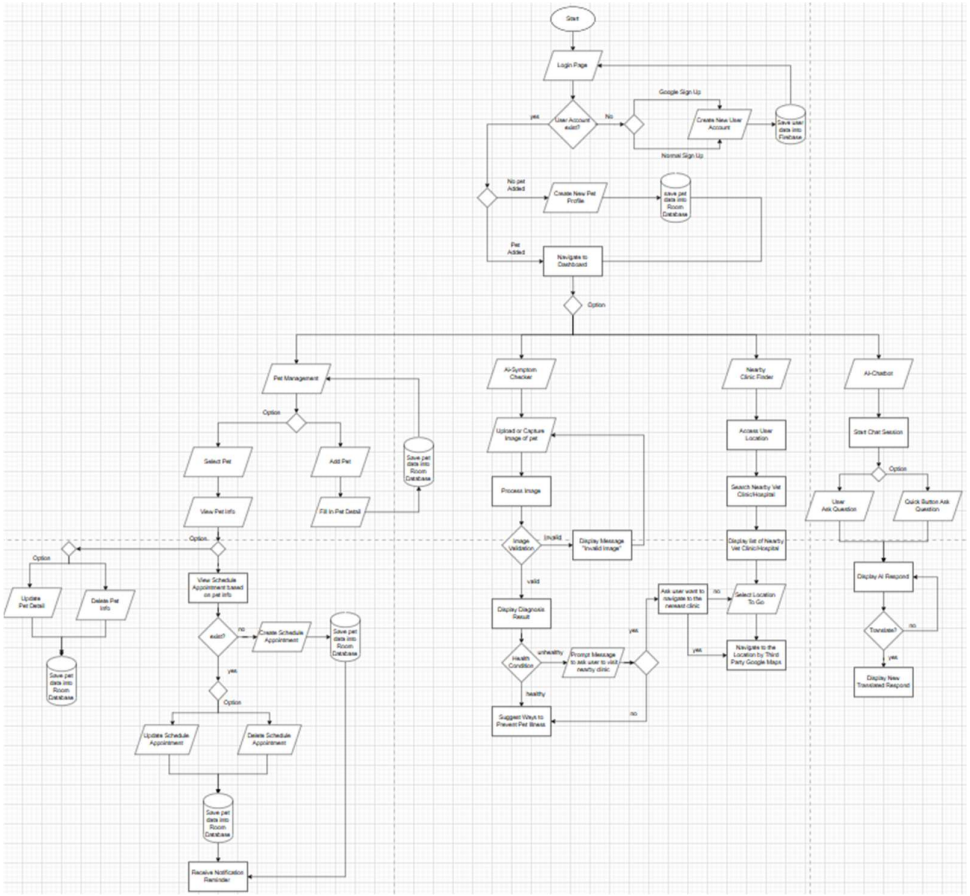


Figure 4.2.2.1 Overall Flowchart for Pet and Health Management System

4.2.2.2 User Login and Sign Up

The user journey begins on the login page. If an existing user account is detected, the user is directed to the pet check; if not, the user is prompted to register via Google or a standard email process. Both registration methods create a new user account and save the user data to Firebase after then the user is returned to the login page to log in. After a successful login, the app checks whether the user has at least one pet profile. If no pet has been added, the user is directed to create a new pet profile. After creating a pet profile, the pet data is saved locally in the Room database. If a pet profile already exists, creation is skipped. Once at least one pet profile exists either existing or newly created, the user is directed to the dashboard. During this process, Firebase serves as cloud storage for the user account and profile information created during registration, while the Room database stores the pet profile on the device for fast, offline access.

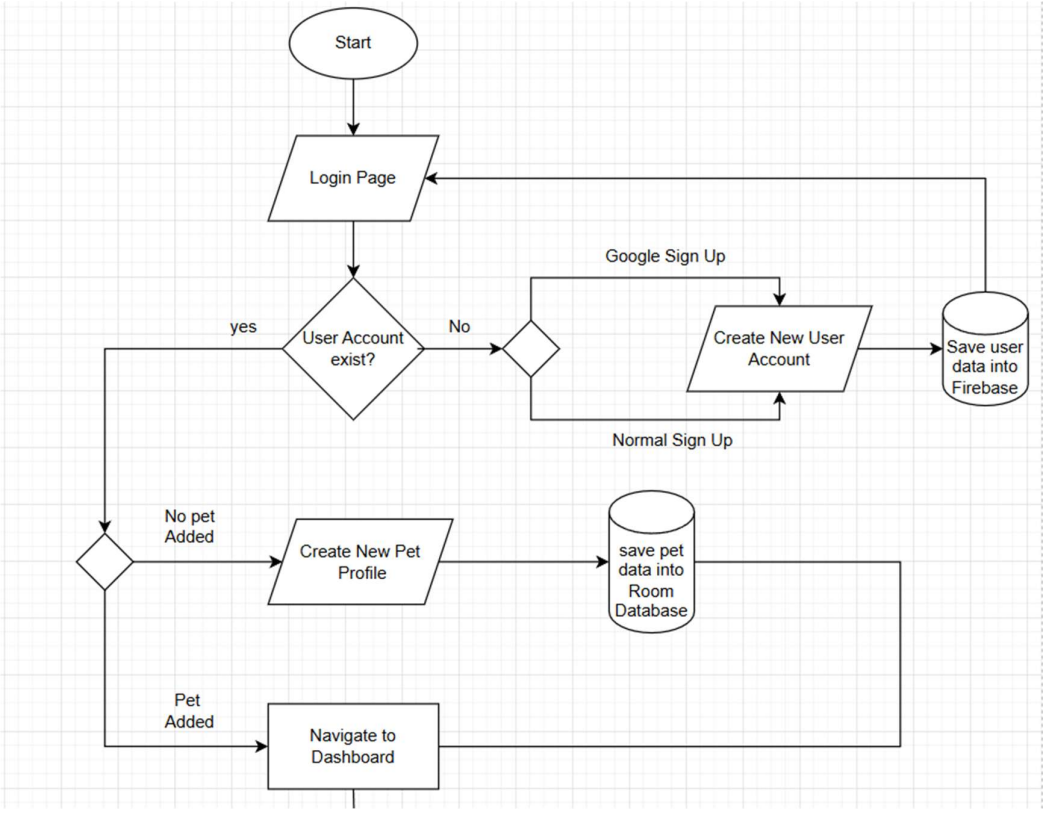


Figure 4.2.2.2 User Login and Sign Up

4.2.2.3 Pet Management

From the Dashboard, the user opens Pet Management. At this point the user chooses either to Select Pet or to Add Pet. If the user selects Add Pet, the app displays a form to Fill In Pet Detail. Once the form is completed, the new pet profile is saved to the Room Database, and the user returns to Pet Management where the pet can now be managed. If the user chooses Select Pet, the app shows View Pet Info for the chosen animal. From here, the user can either Update Pet Detail or Delete Pet Info. When details are updated, the edited fields are saved to the Room Database and the user returns to the pet's info page. When the pet is deleted, the pet record is removed from the Room Database and control returns to Pet Management. From View Pet Info, the user can also open View Schedule/Appointment based on pet info to manage reminders for that pet. The system checks whether any schedule items already exist. If no items are found, the user proceeds to Create Schedule Appointment, and the new entry is saved to the Room Database. If items do exist, the user is given an option to Update Schedule Appointment or Delete Schedule Appointment. Updating writes the revised schedule back to the Room Database; deleting removes it from the Room Database. After schedules are created or updated, the system registers or reschedules the corresponding notification; when schedules are deleted, their notifications are cancelled. Finally, the user returns to Pet Management and can navigate back to the Dashboard.

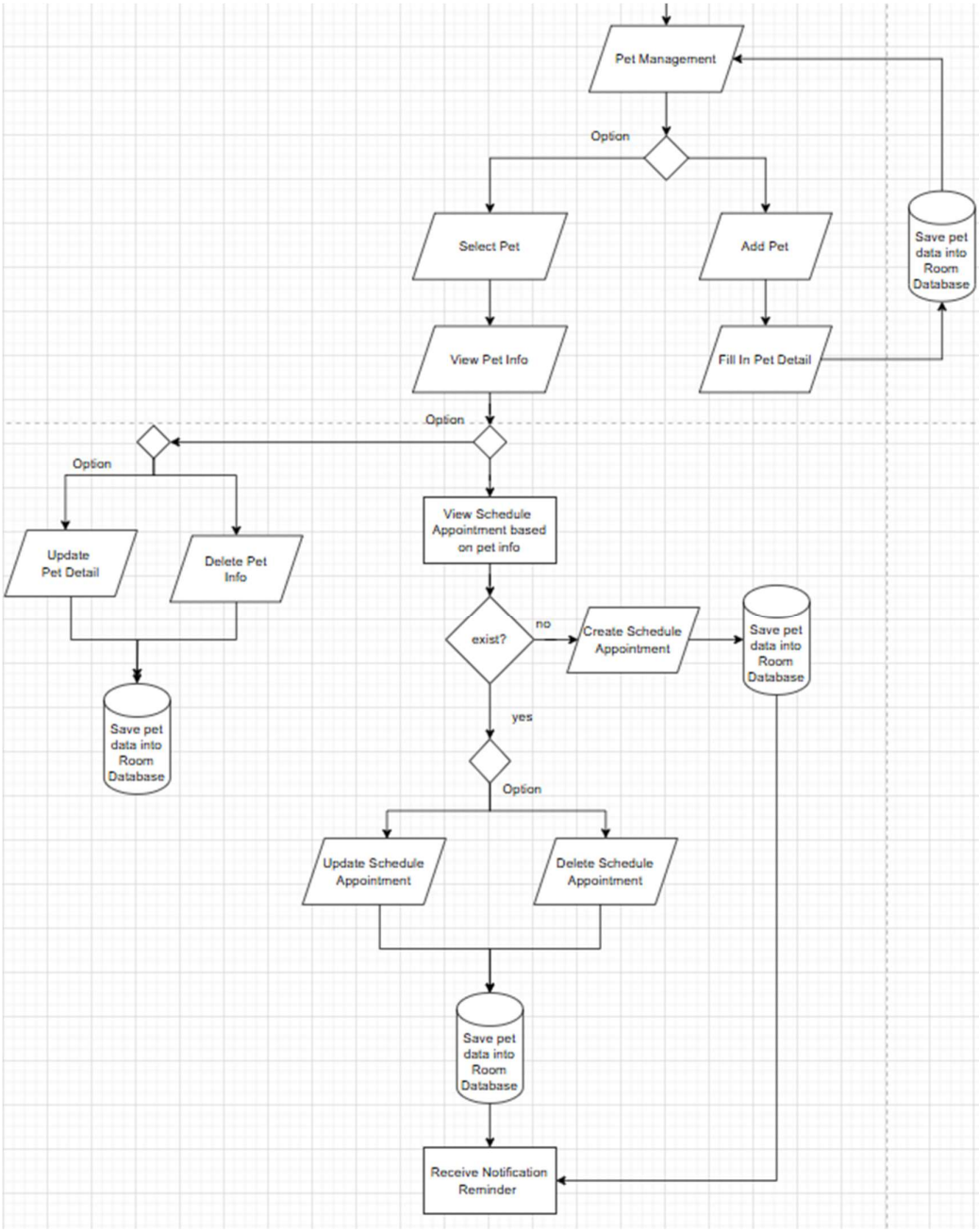


Figure 4.2.2.3 Pet Management

4.2.2.4 AI Symptom Checker

From the Dashboard, the user launches the AI-Symptom Checker. The app then asks the user to upload or capture an image of the pet and proceeds to process the image and preparing it for analysis. Next, the system performs Image Validation. If the image is invalid, for example, because of blur, poor lighting, or an incorrect subject ,the app displays Invalid Image and returns the user to the upload step to try again. If the image is valid, the AI analysis runs and the app displays the diagnosis result. Based on the AI assessment, the app evaluates the Health Condition. If the pet appears unhealthy, the app prompts the user to visit a nearby clinic and then asks whether the user wants to navigate to the nearest clinic. If the user chooses Yes, the app opens Select Location To Go and then navigates to the chosen location via Google Maps. If the user chooses No, the user remains on the result screen and can return to the Dashboard when ready. If the pet appears healthy, the app suggests ways to prevent pet illness, offering practical, preventive tips. After viewing the suggestions or completing navigation, the user can return to the Dashboard to continue using other features.

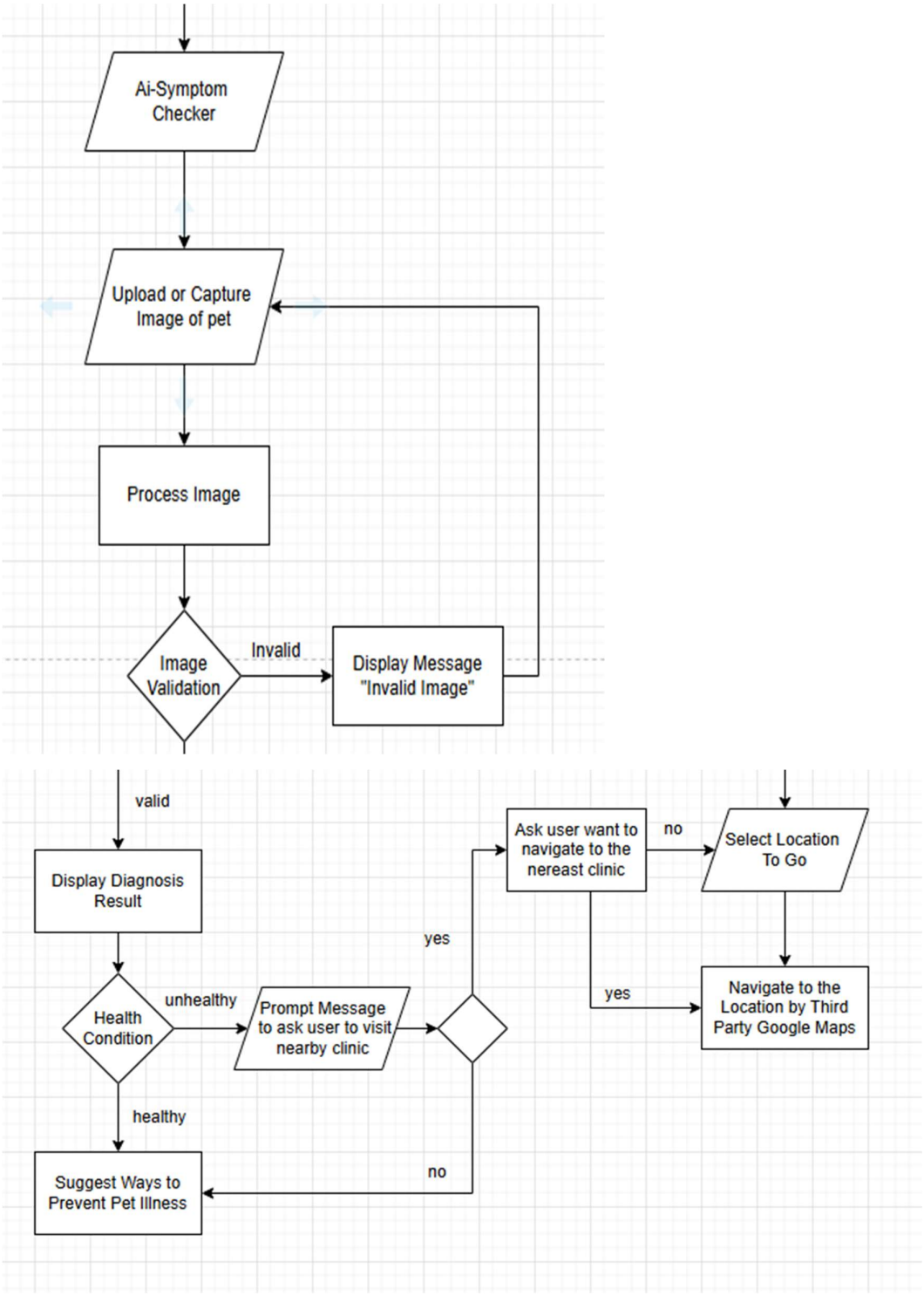


Figure 4.2.2.4 AI Symptom Checker

4.2.2.5 Nearby Clinic Finder

From the Dashboard, the user opens the Nearby Clinic Finder feature. The app requests permission and then accesses the user's current location. Using that location, it searches for nearby veterinary clinics and animal hospitals within a defined radius. The results are displayed as a list showing each clinic's name, distance, address, and basic details so the user can compare options. The user selects a preferred location, and the app hands off the destination to Google Maps for turn-by-turn navigation. After navigation, the user can return to the Dashboard to continue using the app.

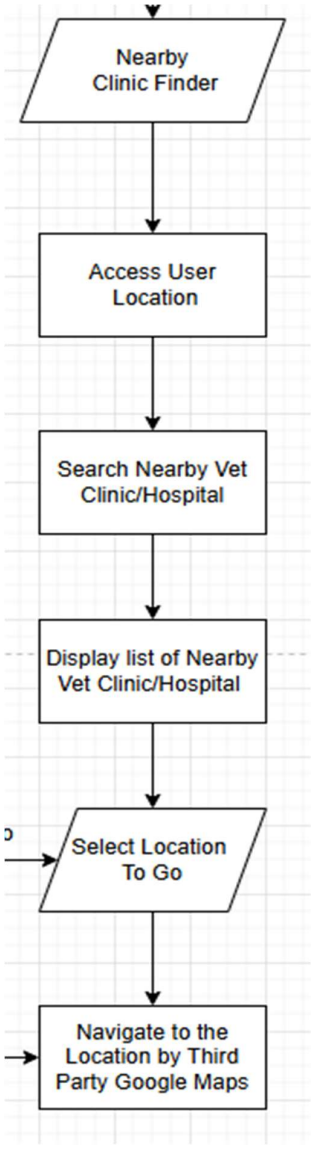


Figure 4.2.2.5 Nearby Clinic Finder

4.2.2.6 AI-Chatbot

From the Dashboard, the user opens the AI-Chatbot feature. The app starts a new chat session and presents two ways to ask: the user can type a question or tap a Quick Button that submits a predefined question. After a question is sent, the chatbot processes it and displays the AI response on the screen. The app then asks whether the user would like to translate the response. If the user chooses Yes, the system generates and displays a new translated response; if the user selects No, the original response remains. The user may continue asking additional questions in the same session or return to the Dashboard at any time.

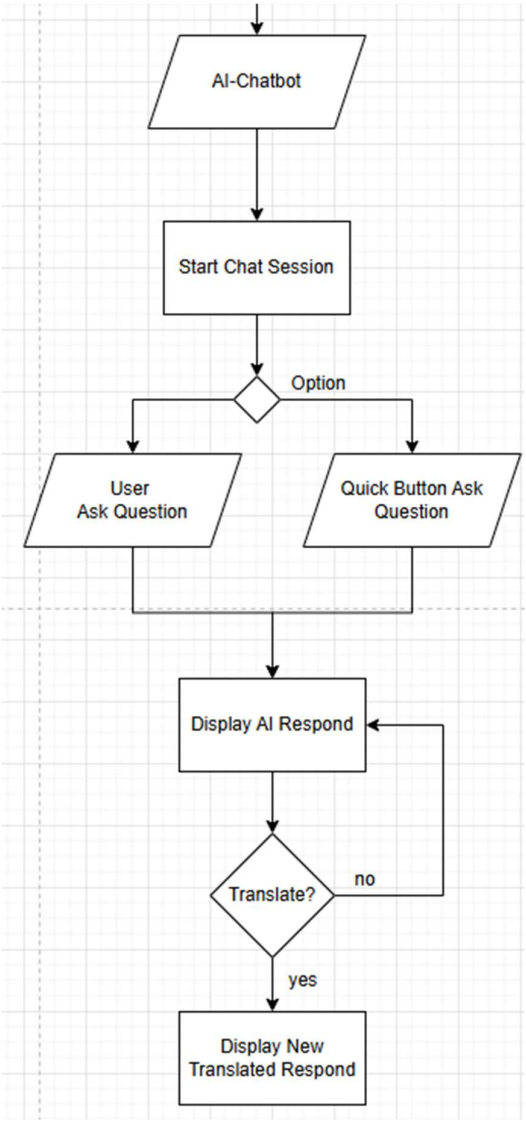


Figure 4.2.2.6 AI Chatbot

4.3 System Components Specifications

4.3.1 User Sign Up Page

Purpose:

To allow new users to create an account in the application. Upon successful registration, the system will redirect user to sign in page.

Dependencies:

Depends on Firebase system and google sign up service to store new user account information. Navigation component to move users to the sign in page after successful registration.

4.3.2 User Sign In Page

Purpose:

To allow registered users to log in to the application using their credentials. Upon successful log in, system will redirect users to Dashboard Page.

Dependencies:

Depends on Firebase system or google log in service for user authentication. Navigation component to move users to the Dashboard page after successful login.

4.3.3 Dashboard Page

Purpose:

Provide a welcoming interface for users upon log in and to facilitate the navigation to the main functions of the system, Pet management in term of scheduling, AI- diagnose disease detection, nearby clinic navigation and AI-chatbot. It also came with the Up Coming Event to see what event is coming that user had schedule.

Dependencies:

Depends on navigation component to handle the transition between the Dashboard Page and other section of the app. Depend on what user had schedule, read the event and activities that user had made from the event schedule.

4.3.4 User Profile Page

To allow users to view and maintain their personal account information. Users can view stored profile details. The page allows users to update and save changes of their information. The page also provides actions such as changing password and signing out.

Dependencies:

Depends on Firebase Authentication for storing profile metadata and preferences. Requires an active internet connection for writes and the app's navigation component will return to the dashboard after updates.

4.3.5 Pet Profile Page

Purpose:

To let user view a selected pet's details and perform maintenance actions. Users can view the stored pets' information, update any field and save the changes, and delete the pets' detail after a confirmation prompt.User can also made deletions by removing the pet record.

Dependencies:

Depends on the Room Database for local persistence and retrieval. Navigation component will be return to Pet Management once after the action been made.

4.3.6 Pet Schedule Function Page

Purpose:

To let user create and manage per-pet schedules for three item types: Appointments, Medications, and Vaccinations. Users can add a new schedule view the upcoming items for the selected pet, update an entry, or delete it after confirmation.

Dependencies:

Depends on the Room Database for local persistence. A notification system implemented to receive and deliver reminders at the set times component to return to P Dashboard after actions.

4.3.7 AI-Diagnose Disease Function Page

Purpose:

To assess a pet's condition from an uploaded image and provide actionable guidance. After the user submits a photo, the page sends it to the OpenAI vision model and displays a structured result that lists likely conditions, key visual cues, and a severity assessment. If the result indicates the pet is unhealthy, the page shows the suspected diseases and immediately prompts the user to open the Nearby Clinic feature to get care. If the result indicates the pet is healthy, the page remains in place and presents preventive suggestions and home-care tips.

Dependencies:

Depends on the OpenAI for image analysis, an active internet connection and the app's gallery components with runtime permissions for image input. Requires a response JSON parser to render model outputs consistently. The app's navigation component will launch the Nearby Clinic flow when unhealthy results are detected and a Maps intent plus Location permission is a must to perform the navigation.

4.3.8 Nearby Clinic Navigation Function Page

Purpose:

To help users find and navigate to a veterinary clinic near their current location. The page acquires the user's location, displays a list of nearby clinics and lets the user **select** a preferred clinic and then launches turn-by-turn navigation to that destination in Third Party Google Maps. Users can also view clinic details before choosing.

Dependencies:

Depends on the device Location service and runtime permission to get the current position, an active internet connection and a places source of Google Places API to retrieve nearby clinics. The app will navigate to third party google Maps to start external navigation.

4.3.9 AI-Chatbot for Education Function Page

Purpose:

To provide on-demand, conversational guidance for pet care and wellness. Users can type a question or tap quick buttons (predefined prompts) to receive concise, evidence-based explanations on topics. The page displays the AI response in a chat view, offers an option to translate the answer into the user's preferred language, and allows follow-up questions within the same session. Users may also attach an image to get context-aware guidance.

Dependencies:

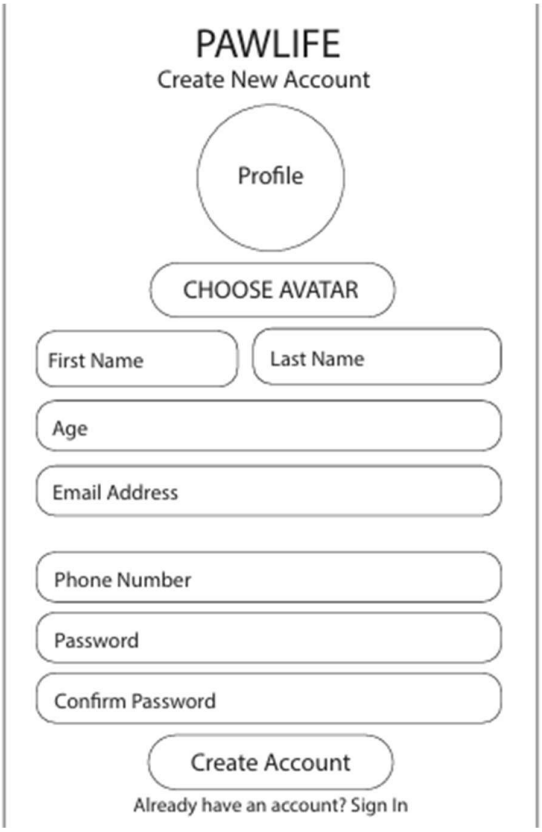
Depends on a secure backend service that calls the OpenAI API for text and image prompts, an active internet connection and image picker permissions are required when users attach images. Navigation to return to the dashboard page if user end the session. The translation is offered and depends on the OpenAI model's translation capability.

4.4 App Design Wireframe

4.4.1 Login Page

4.4.1 Login Page

4.4.2 User Profile Page



4.4.2 User Profile Page

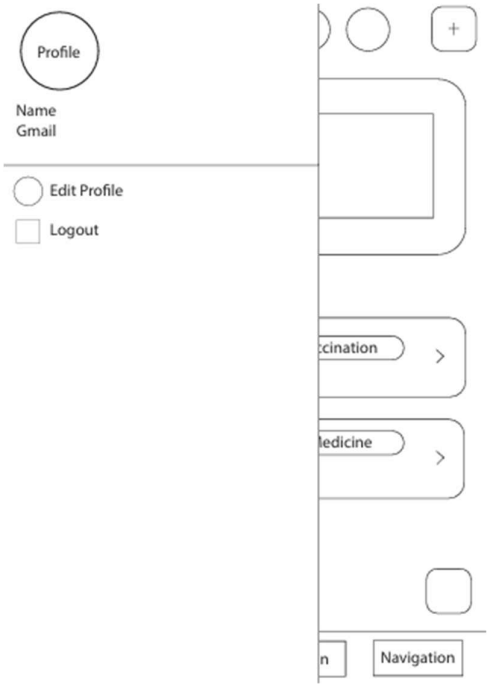
4.4.3 Edit User Profile Page

4.4.3 Edit User Profile Page

4.4.4 Dashboard Page

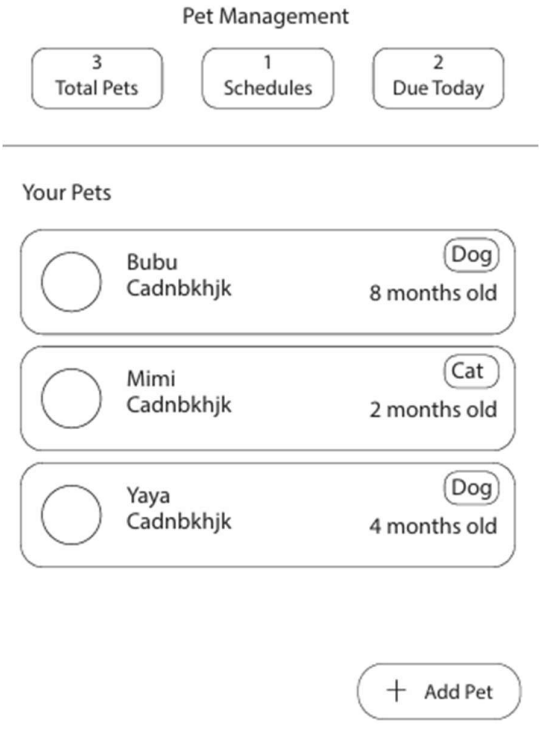
4.4.4 Dashboard Page

4.4.5 Logout Page



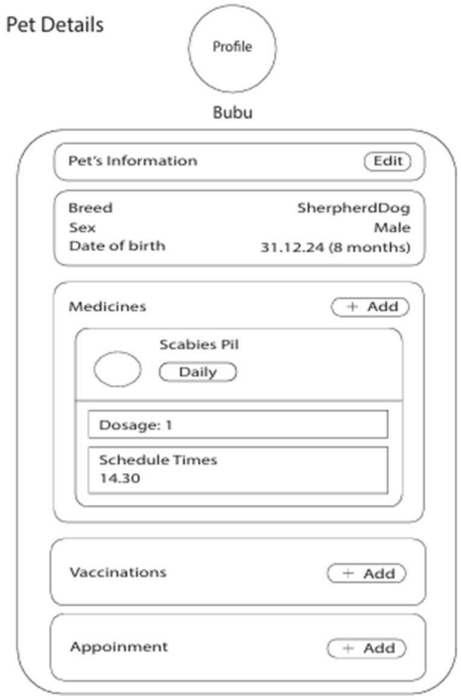
4.4.5 Logout Page

4.4.6 View Per-Pet Profile Page



4.4.6 View Pet Profile Page

4.4.7 View Pet Profile for Schedule Page

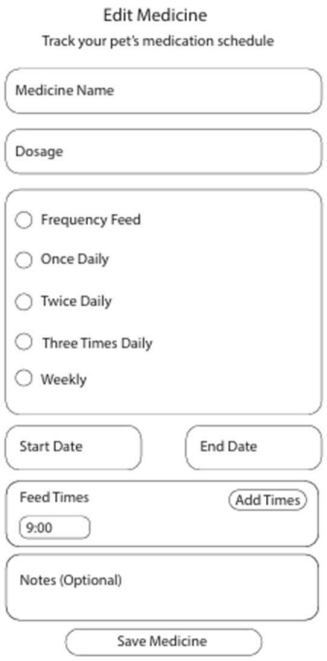


4.4.7 View Pet Profile for Schedule Page

4.4.8 Add Medicine Schedule Page

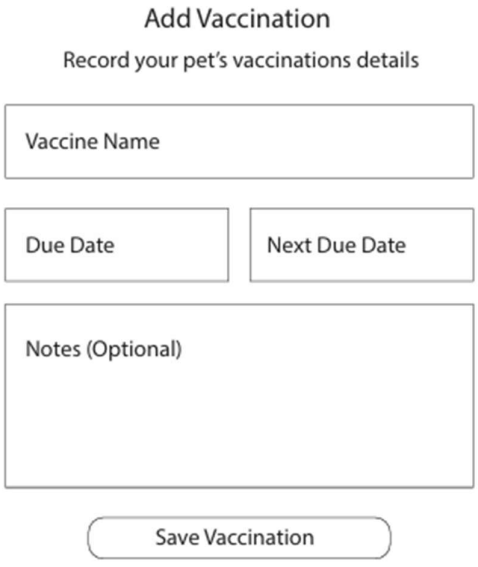
4.4.8 Add Medicine Schedule Page

4.4.9 Edit Medicine Schedule Page



4.4.9 Edit Medicine Schedule Page

4.4.10 Add Vaccination Schedule Page

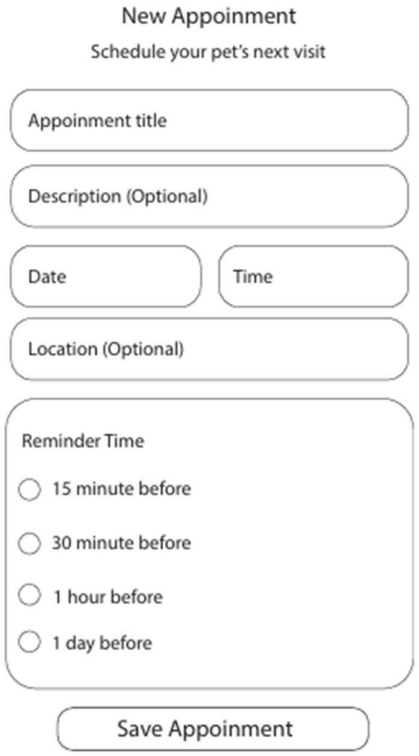


4.4.10 Add Vaccination Schedule Page

4.4.11 Edit Vaccination Schedule Page

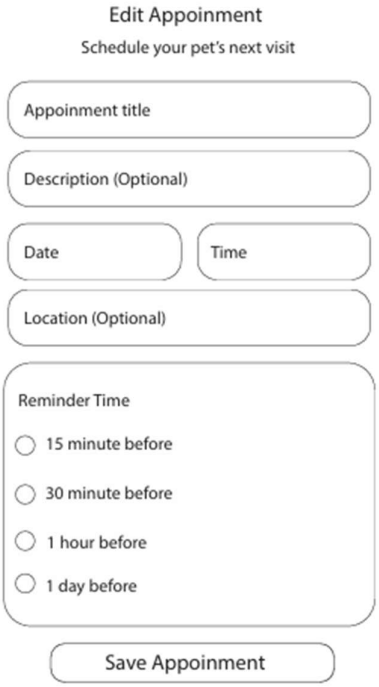
4.4.11 Edit Vaccination Schedule Page

4.4.12 Add Appointment Schedule Page



4.4.12 Add Appointment Schedule Page

4.4.13 Edit Appointment Schedule Page



4.4.13 Edit Appointment Schedule Page

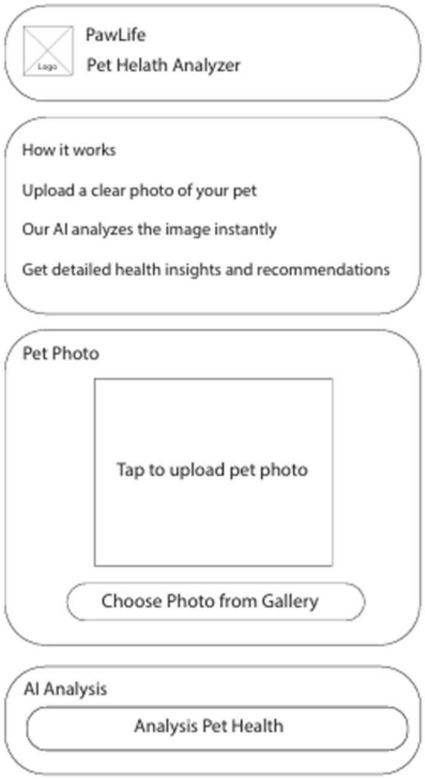
4.4.14 Add Pet Profile Page

4.4.14 Add Pet Profile Page

4.4.15 Edit Pet Profile Page

4.4.15 Edit Pet Profile Page

4.4.16 AI Diagnose Diseases Page



4.4.16 AI Diagnose Diseases Page

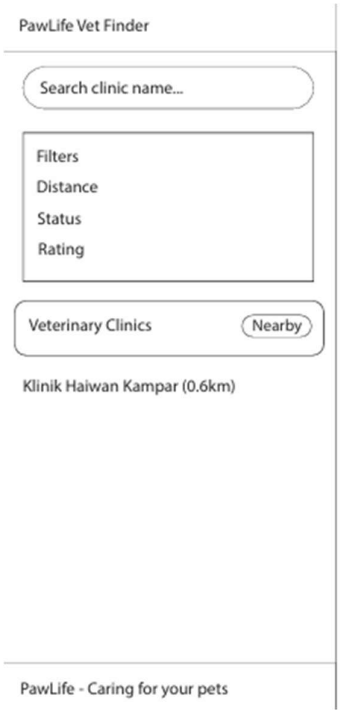
4.4.17 AI Diagnose Diseases Result Page

4.4.17 AI Diagnose Diseases Result Page

4.4.18 Nearby Clinic Navigation Page

4.4.18 Nearby Clinic Navigation Page

4.4.19 Nearby Clinic Navigation Selection Page



4.4.19 Nearby Clinic Navigation Selection Page

4.4.20 AI-Chatbot Page

4.4.20 AI-Chatbot Page

4.4.21 New Register User Adding Pet Profile Navigation Page

4.4.21 New Register User Adding Pet Profile Navigation Page

Chapter 5

System Implementation

5.1 Hardware Setup

Before running the android project in actual device, some setup should be done to turn on developer option in the device.

Firstly, in the device's "Settings", select the "System" as shown in figure 5.1

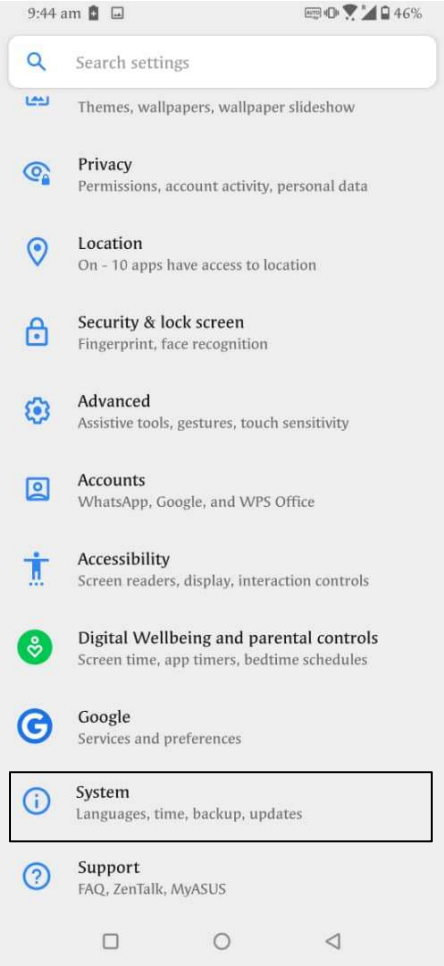


Figure 5.1.1 Device Setup

Next, Select the developer option and turn on developer options as shown in Figure 5.2

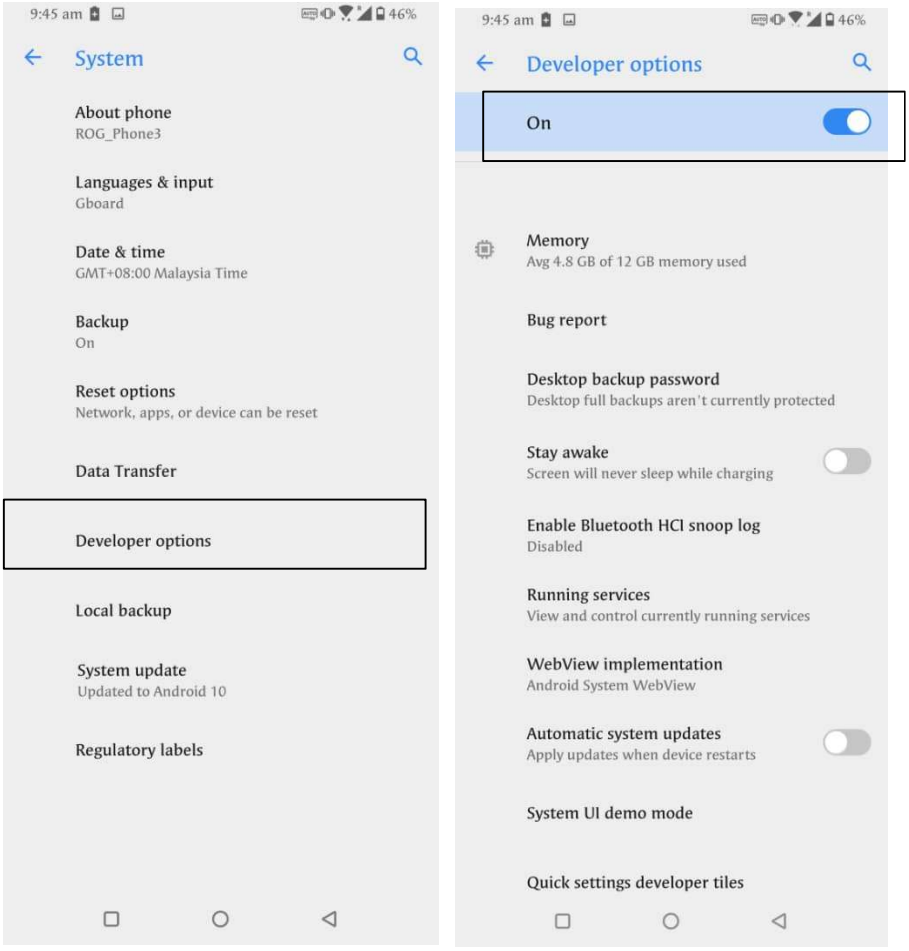


Figure 5.1.2 Device Setup 2

After turning on the “Developer Options”, scroll down and turn on the USB debugging which allow user to transfer the packets to the mobile device as shown in Figure 5.1.3. Then connect the PC to the device using USB cable.

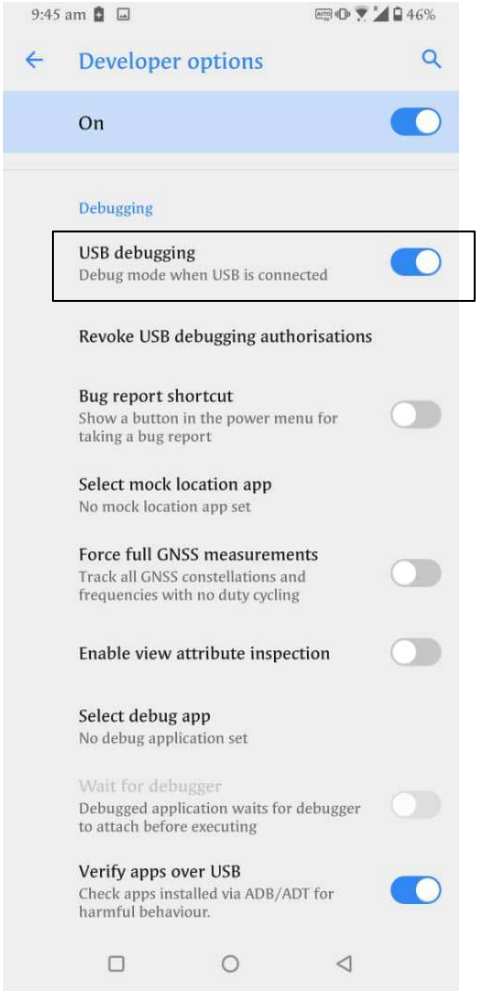


Figure 5.1.3 Device Setup 3

5.2 Software Setup

Before starting the development of the pet health and management system, there are two software needed to be installed and download in my laptop and smartphone respectively:

1. Android Studio HedgeHog
2. Google Maps (Third Party Navigation)

5.2.1 Android Studio Setup

To start a new project, the “Empty View Activity” was selected as shown in figure 5.2.1.1

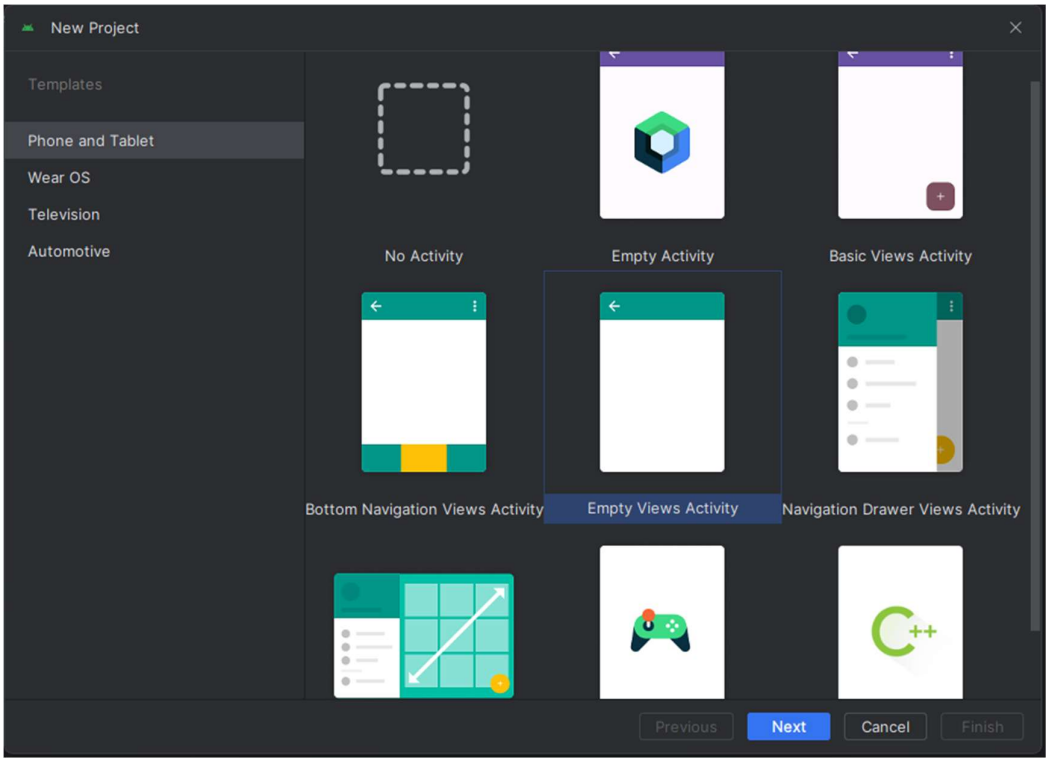


Figure 5.2.1.1 Empty View Activity

Then, the project using Kotlin as the primary language for development and the minimum SDK to run this application is API 24 (“Nougat”), android 7.0 as shown in figure 5.2.1.2.

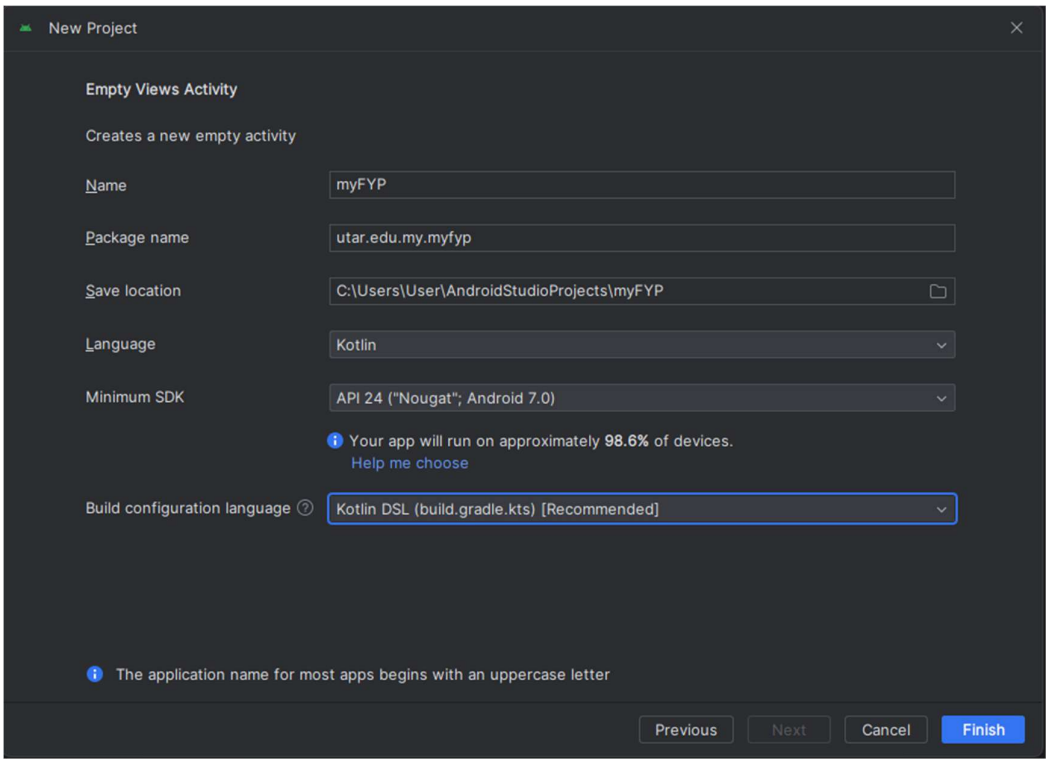


Figure 5.2.1.2 Project Setup

To run this device in virtual android device, the hardware name "Pixel_3a_API_35_extension_level_13_x86_64" with API 35 was chosen for the development.

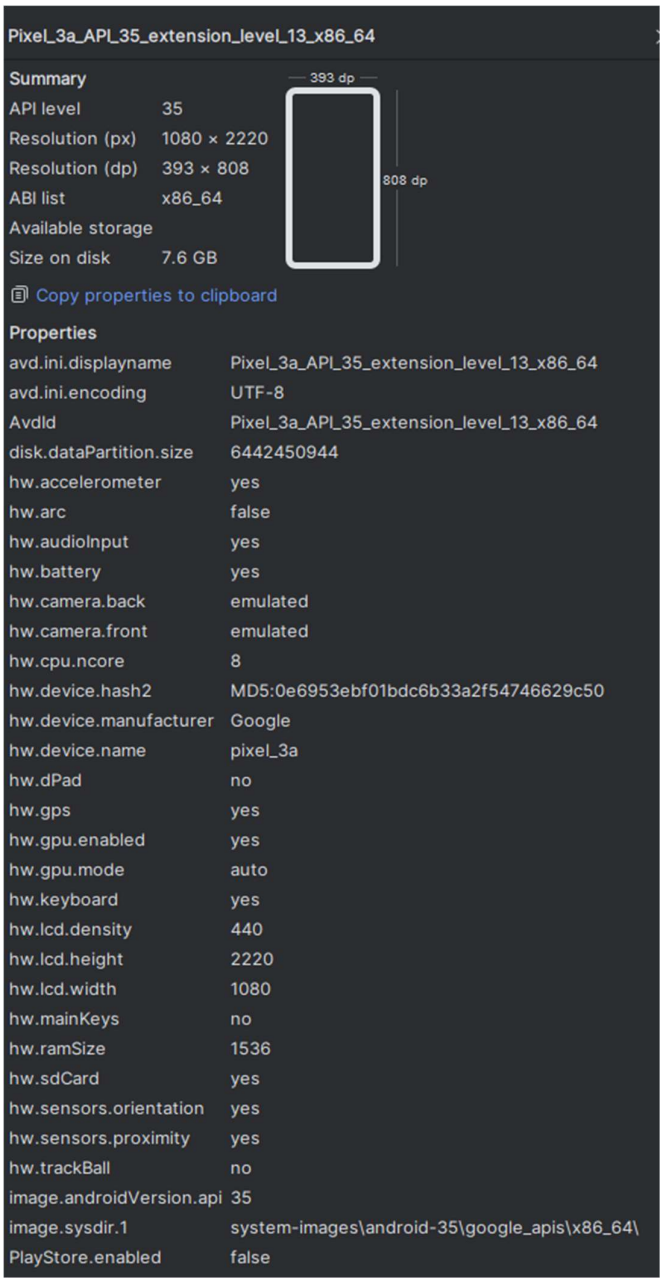


Figure 5.2.1.3 Virtual Android Device

To run the project on an actual device that proceed to the physical section, the device name “asus ASUS_I003DD” was connect through the USB cable. On the phone settings, turn on developer mode and allow USB debugging from the computer so the application can run on the device.

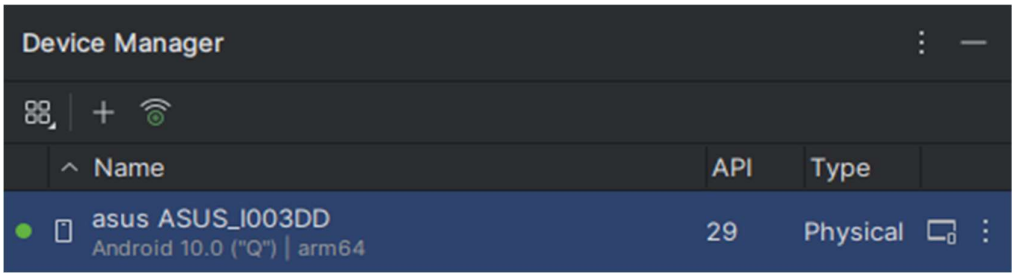


Figure 5.2.1.4 Physical Android Device

5.3 Setting and Configuration

Before running the apps to be functionable, there are two settings and configuration need to be added respectively:

1. Environment Configuration
2. Service Configuration

5.3.1 Environment Configuration

In this project, the Android runtime environment is configured with a set of permissions that enable networking, location, camera and media access, notifications, and reliable alarms for reminders. The app requires Internet access to communicate with the secure backend that proxies OpenAI API calls and to reach Firebase, and it checks the network state before attempting uploads or requests. For the Nearby Clinic feature, the app requests fine and coarse location at runtime so it can determine the user’s position and pass accurate destinations to Google Maps. To support AI-Diagnose, the app asks for the camera when capturing photos and for photo-library access when selecting existing images; on Android 13 and above this is handled by the READ_MEDIA_IMAGES scope, while legacy devices up to Android 13 rely on the older external-storage permissions that are limited with maxSdkVersion="34". The scheduling module delivers reminders through system notifications so the app requests POST_NOTIFICATIONS at runtime on Android 13+ and uses exact-alarm capabilities

to fire time-critical events—such as medication times—precisely, rescheduling them after reboot with RECEIVE_BOOT_COMPLETED and ensuring delivery with a short WAKE_LOCK when needed.

```
<uses-permission android:name="android.permission.INTERNET" />
<uses-permission android:name="android.permission.ACCESS_FINE_LOCATION" />
<uses-permission android:name="android.permission.ACCESS_COARSE_LOCATION" />
<uses-permission android:name="android.permission.ACCESS_NETWORK_STATE" />
<uses-permission android:name="android.permission.CAMERA" />
<uses-permission android:name="android.permission.POST_NOTIFICATIONS" />
<uses-permission android:name="android.permission.READ_MEDIA_IMAGES" />
<uses-permission android:name="android.permission.READ_EXTERNAL_STORAGE" />
<uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE"
    android:maxSdkVersion="28" />
<uses-permission android:name="android.permission.POST_NOTIFICATIONS" />
<uses-permission android:name="android.permission.WAKE_LOCK" />
<uses-permission android:name="android.permission.RECEIVE_BOOT_COMPLETED" />
<uses-permission android:name="android.permission.POST_NOTIFICATIONS"/>
<uses-permission android:name="android.permission.WAKE_LOCK"/>

<uses-permission android:name="android.permission.SCHEDULE_EXACT_ALARM"/>
<uses-permission android:name="android.permission.USE_EXACT_ALARM" />
```

```
android { this: BaseAppModuleExtension
    namespace = "utar.edu.my.fyp"
    compileSdk = 34

    defaultConfig { this: ApplicationDefaultConfig
        applicationId = "utar.edu.my.fyp"
        minSdk = 24
        targetSdk = 34
        versionCode = 1
        versionName = "1.0"

        testInstrumentationRunner = "androidx.test.runner.AndroidJUnitRunner"
    }
```

5.3.1 Environment Configuration

5.3.2 Service Configuration

Firebase

The app uses Firebase Authentication to sign users in with email password and Google, and it uses Cloud Firestore to store user profiles. Firebase on Android requires a JSON file named google-services.json as shown in Figure 5.3.2.1.

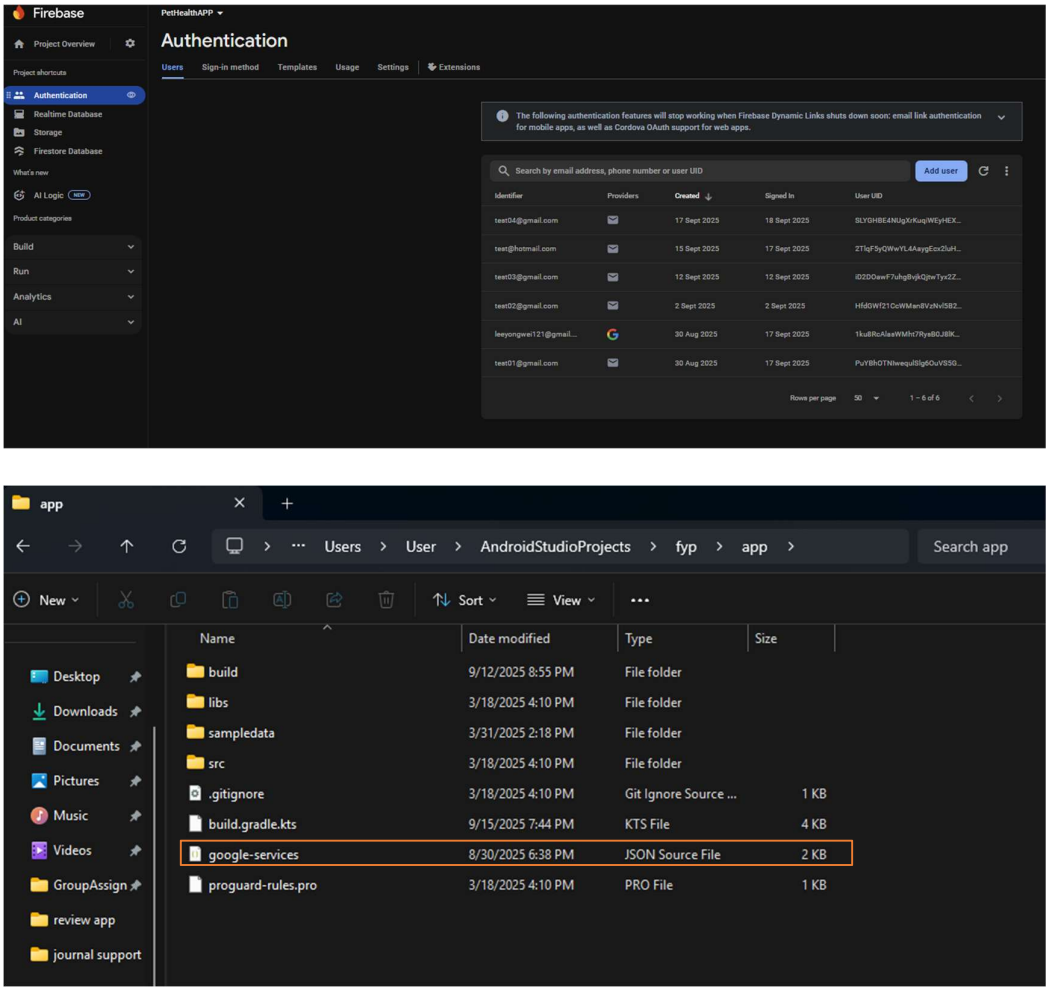


Figure 5.3.2 Firebase Service and google-service JSON File

OpenAI API Key

The app uses the OpenAI API via a secure backend to function the AI-Diagnose and the AI-Chatbot. The backend reads OPENAI_API_KEY from a server-side environment file and call the model through JSONObject and provide the result as shown in Figure 5.3.2.2.

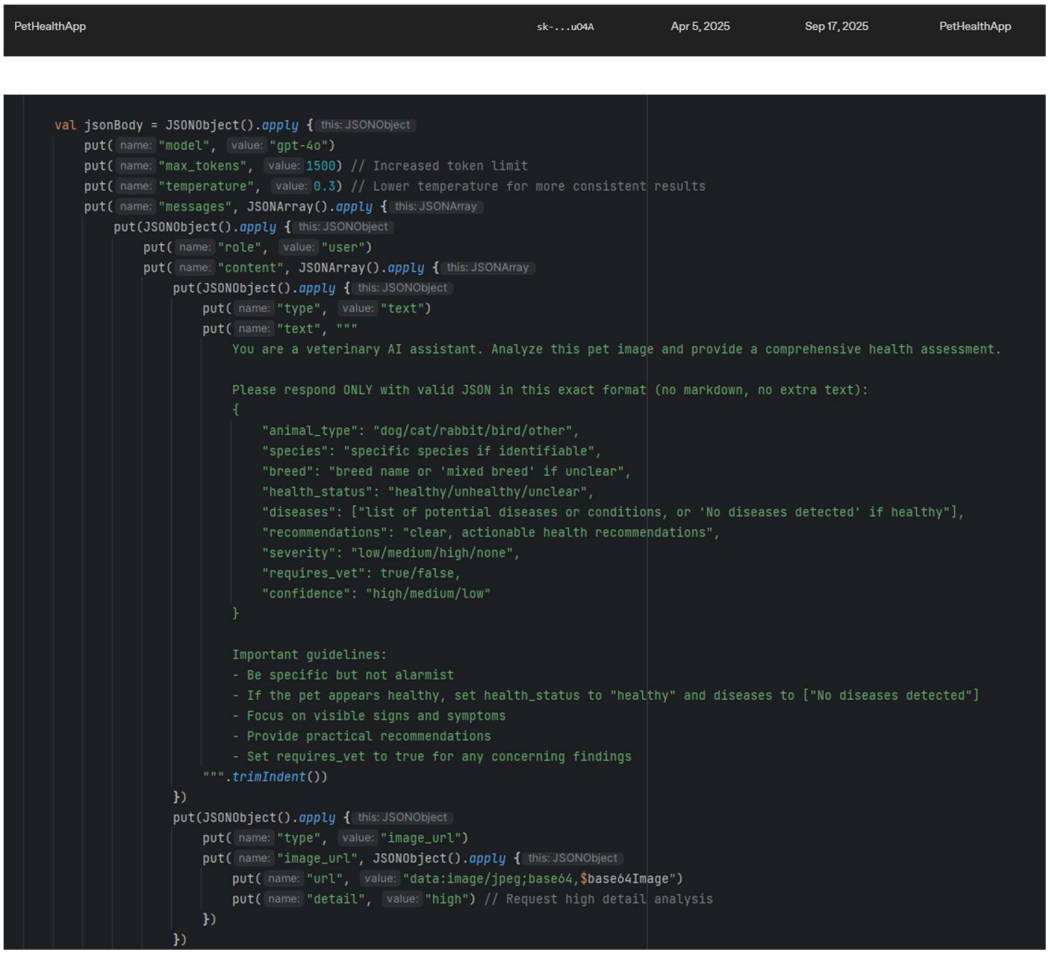


Figure 5.3.2.2 OpenAI API Key and JSONObject

Google Maps

The app uses Google Maps and Places API to show nearby veterinary clinics and launch turn-by-turn navigation. The API key in the Android app enable the Maps and Places services to be function in Google Cloud project as shown in Figure 5.3.2.3.

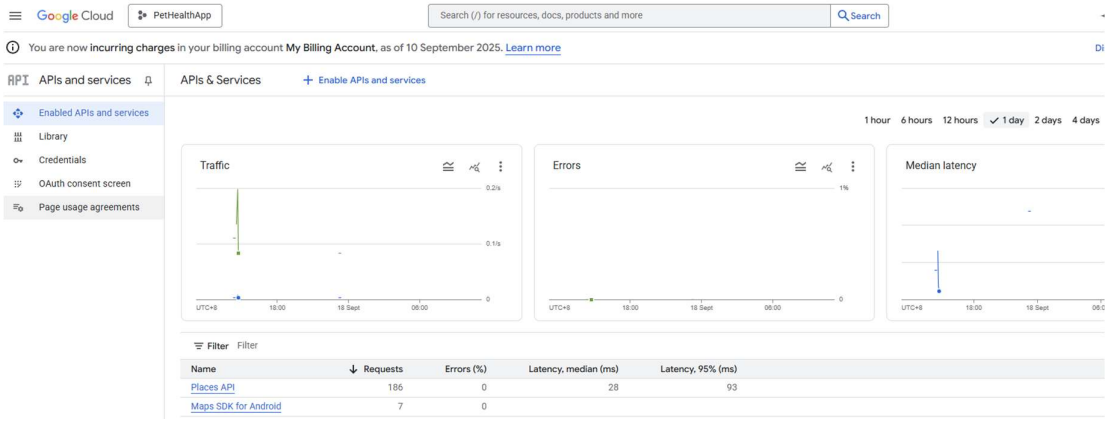


Figure 5.3.2.3 Google Maps and Place API Key

5.4 System Operation

5.4.1 User Login Page

Figure 5.4.1.1 shows the application splash screen when user starts the application. The user is presented with a sign-in page to enter an email and password or choose Google Sign-In. After pressing the Sign In button, the credentials are verified through Firebase Authentication. If valid, the user is redirected to the Dashboard. If the account is not registered, the user can proceed to the Sign Up page to create a new account. If "Remember Me" is enabled, the launcher will skip the sign-in step and go directly to the Dashboard.

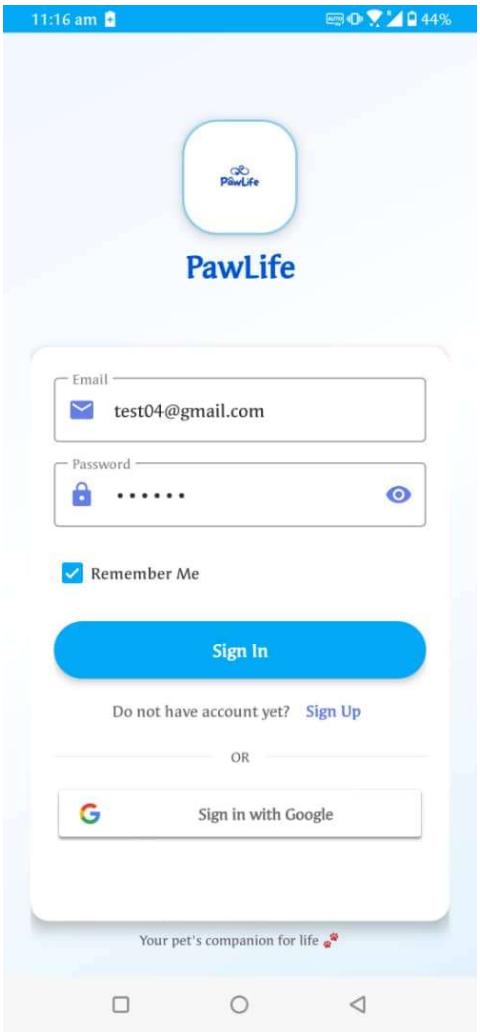


Figure 5.4.1 User Login Page

5.4.2 User Sign Up Page

Figure 5.4.2 shows the User Sign Up page. The user enters first name, last name, age, email, phone number, password, and confirm password, and may optionally choose an avatar. After pressing Create Account, the inputs are validated and the account is created with Firebase Authentication. A profile document is then stored in Firestore, and the user is redirected to the Login page to sign in. If any field is invalid or the email is already registered, an error message is shown and the user remains on the Sign Up page to correct the details. If user selects a Google account Sign Up, user can straight away selecting existing account to register and do not need to enter users' details.

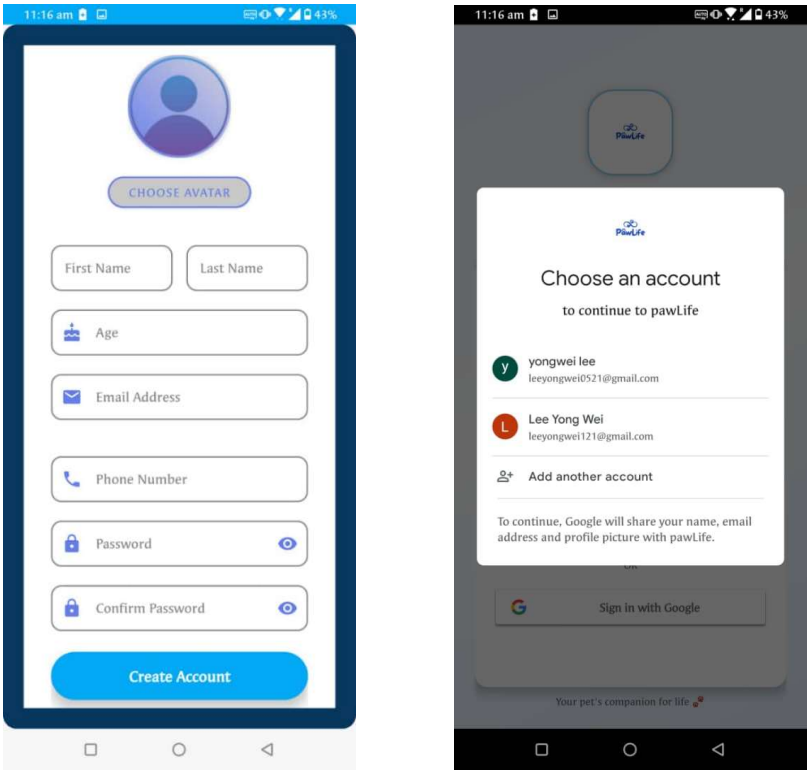
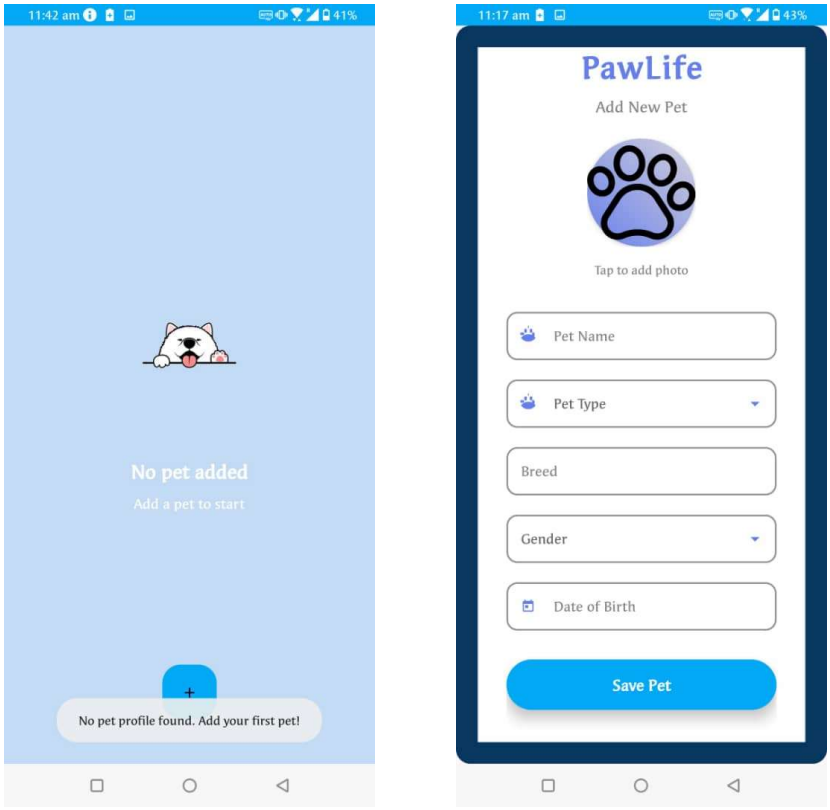


Figure 5.4.2 User Sign Up page

5.4.3 Pet Sign Up Page

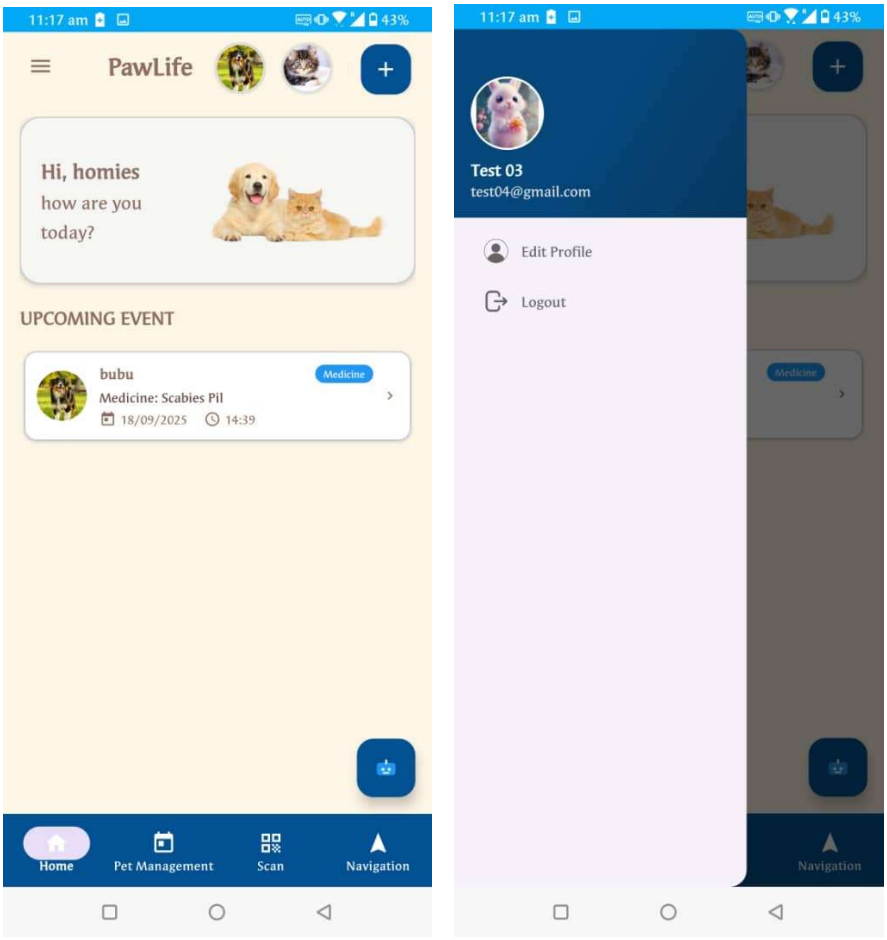
Figure 5.4.3 shows the Pet Sign-Up flow. After the first successful login, the system checks whether the user has any pet profiles. If no pet is found, the app navigates to the Pet Sign-Up page and prompts the user to add a pet and fill in the details photo, name, type, breed, gender, and date of birth. When the user taps Save Pet, the data is validated and stored in the Room Database, and the user is redirected to the Dashboard. If the user is already registered and has at least one pet profile, the app skips the Pet Sign-Up page and navigates directly to the Dashboard. If validation fails, an error message is shown and the user remains on the Pet Sign-Up page to correct the input.



5.4.3 Pet Sign Up Page

5.4.4 Dashboard Page

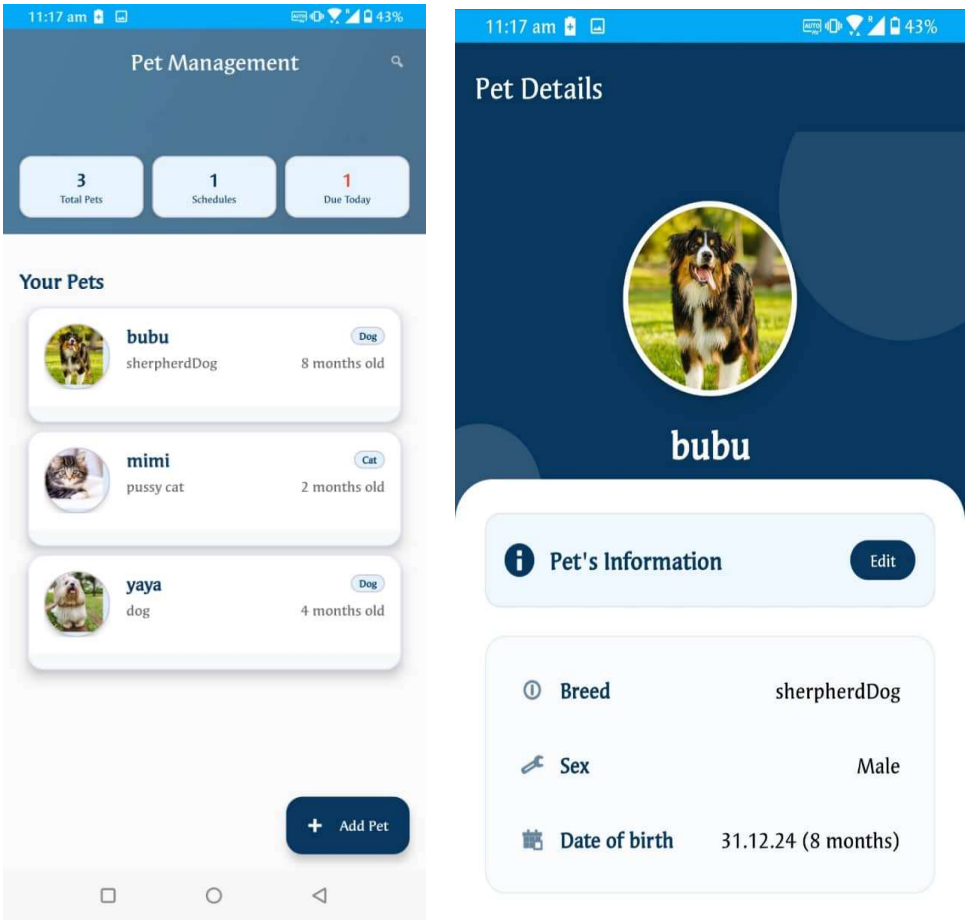
Figure 5.4.4 shows the Dashboard page that loads after a successful sign-in. The page fetches the current user and reads the upcoming schedules for the selected pet, then displays the next event schedule of medication, vaccination, or appointment. The bottom bar provides quick access to Pet Management, AI-Diagnose Disease and Nearby Clinic Navigation. A slide-out drawer can be opened from the Dashboard. Choosing Edit Profile loads the user profile for update and choosing Logout clears the Firebase session tokens and returns the user to the Sign-In page.



5.4.4 Dashboard Page

5.4.5 Pet Management Page

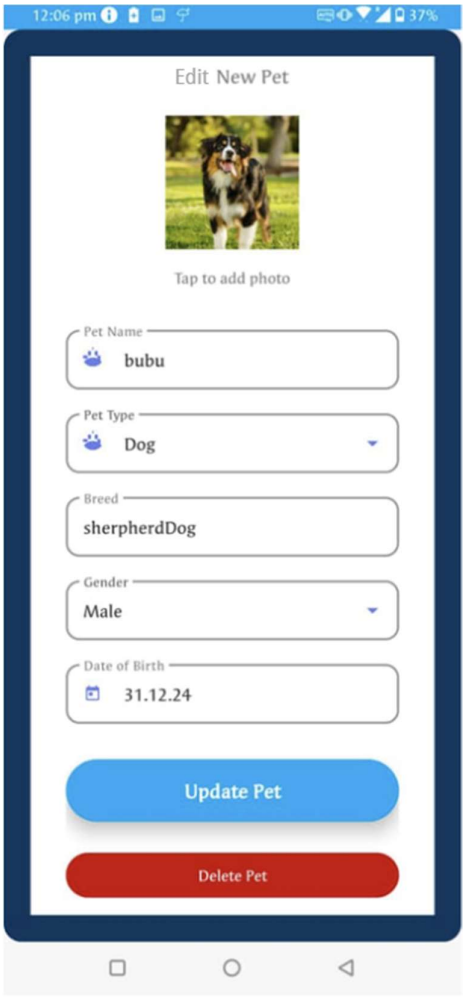
Figure 5.4.5 shows the Pet Management page. The app queries the Room Database and displays all pets registered to the current user together with quick statistics of total pets, total schedules, and items due today. Selecting a pet to opens Pet Details, it stored pets' profile name, species, breed, sex, and date of birth and it also can be edited.



5.4.5 Pet Management Page

5.4.6 Edit Pet Profile Page

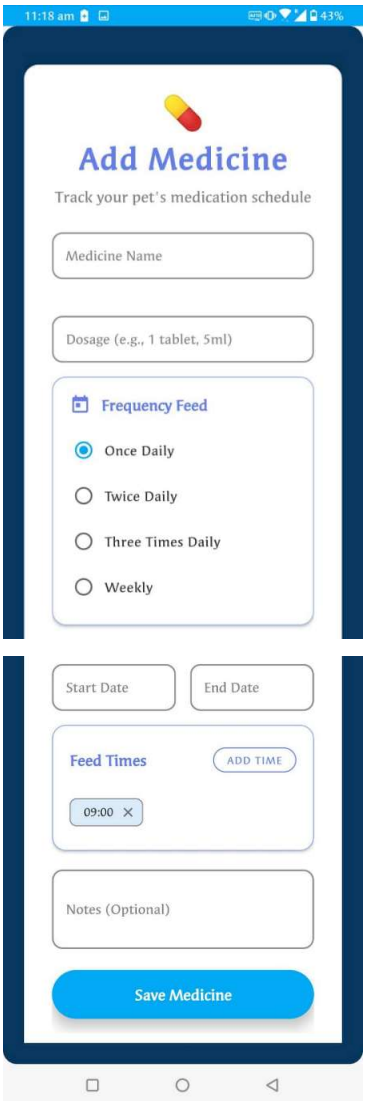
Figure 5.16 shows the Edit Pet Profile page. When opened, the app loads the selected pet's current data from the Room Database and pre-fills the form, photo, name, type, breed, gender and date of birth. After the user edits any field and taps Update Pet, the inputs are validated and the record is updated in Room and the Pet Management list and Pet Details view are refreshed to reflect the changes. If the user taps Delete Pet, the system prompts for confirmation, removes the pet record from Room and cancels any reminders associated with that pet's schedules before returning to Pet Management.

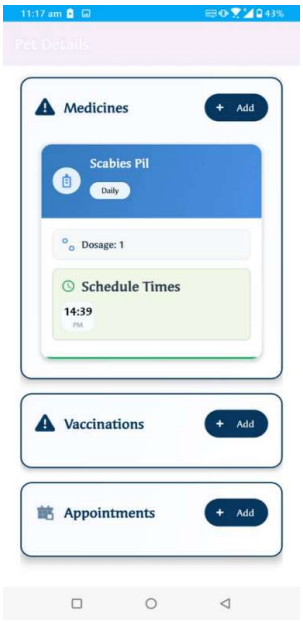


5.4.6 Edit Pet Profile Page

5.4.7 Add Medicine Page

Figure 5.4.6 shows the Add Medicine page. The user can enters the medicine name and dosage, selects a frequency once daily, twice daily, three times daily, or weekly, and sets a start date, optional end date, and one or more feed times. Optional notes can be added for special instructions. When the user taps Save Medicine, the app validates the inputs, links the record to the current pet and saves it in the Room Database. The scheduler then registers local notifications at the chosen times for the selected days. After a successful save, the app returns to Pet Details and displays the new medicine entry under the Medicines section as last picture in Figure 5.4.6 and showing the dosage and the scheduled time so the owner can review upcoming doses.

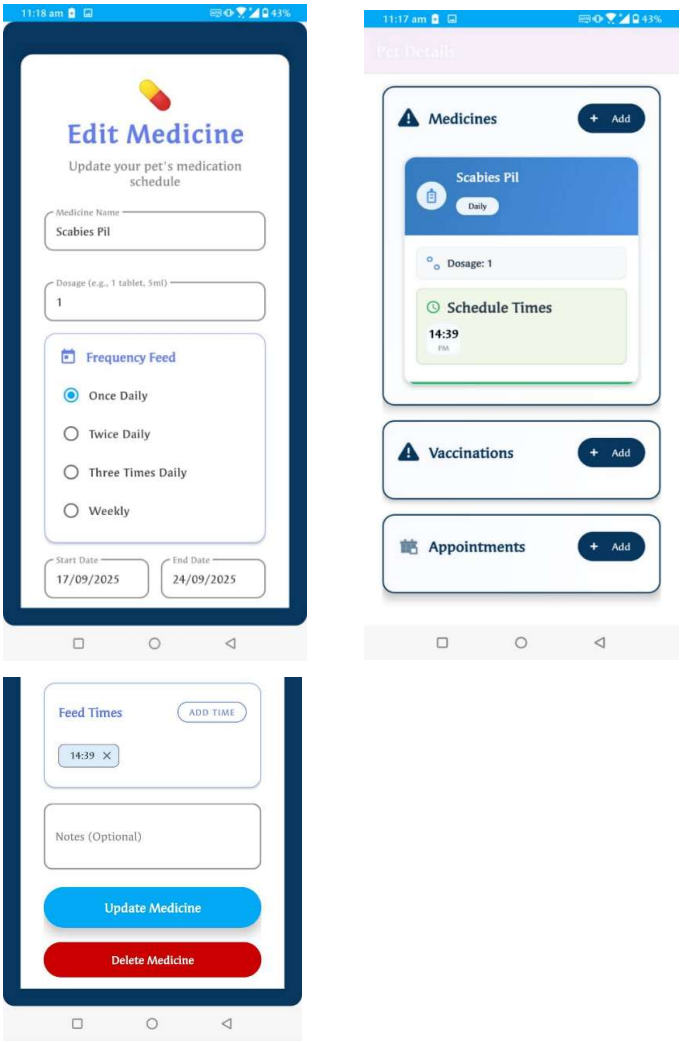




5.4.7 Add Medicine Page

5.4.8 Edit Medicine Page

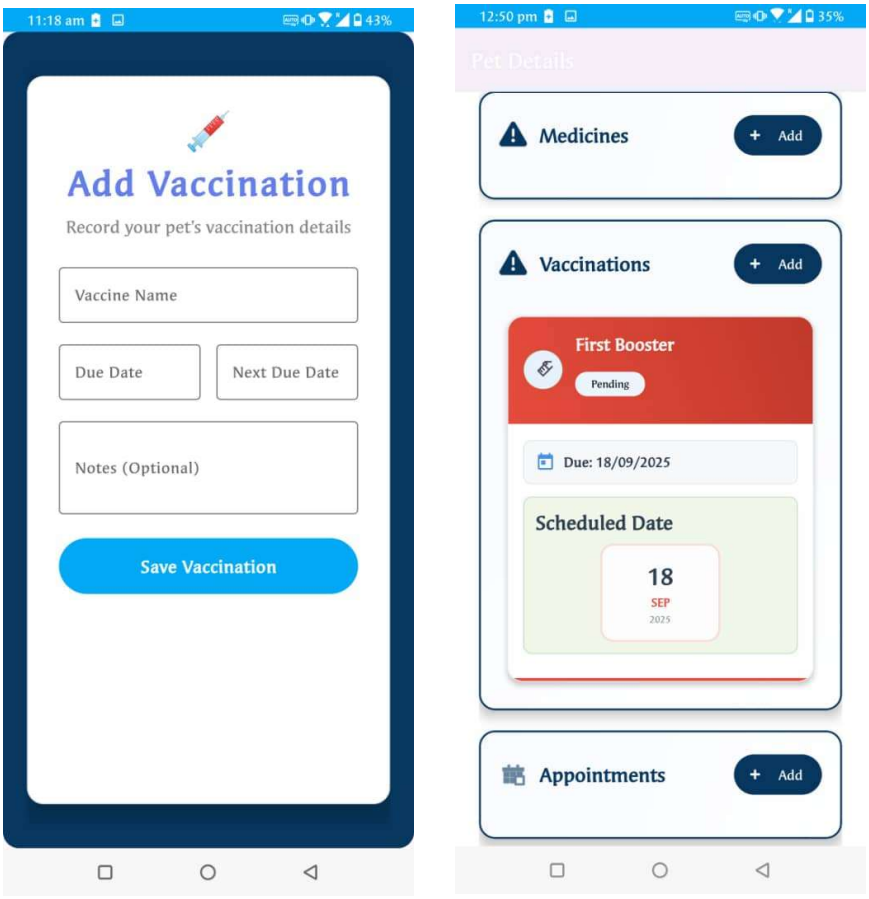
Figure 5.4.7 shows the Edit Medicine page. When opened, the app loads the selected medicine entry for the current pet and pre-fills the form name, dosage, frequency, start/end dates, and feed times. After the user changes any field and taps Update Medicine, the inputs are validated, the record is updated into the Room Database and all associated reminders are rescheduled to reflect the new frequency and times. If the user taps Delete Medicine, the system prompts for confirmation, removes the entry from Room, and cancels its scheduled notifications. The app then returns to the pet's Medicines section with the list refreshed.



5.4.8 Edit Medicine Page

5.4.9 Add Vaccination Page

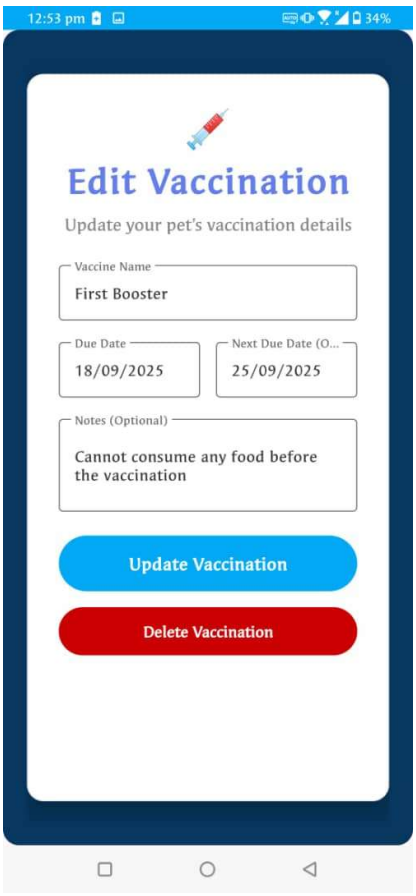
Figure 5.4.8 shows the Add Vaccination page. The user enters the vaccine name, sets the Due Date, and optionally sets a Next Due Date for the upcoming booster, with an additional notes field for special instructions. When the user taps Save Vaccination, the app validates the inputs, links the record to the current pet, and saves it in the Room Database. The scheduler then registers a local reminder for the selected due date. After a successful save, the app returns to Pet Details and displays the new entry under the Vaccinations section as last picture in Figure 5.4.8, indicating the scheduled date and current status so the owner can review what is pending.

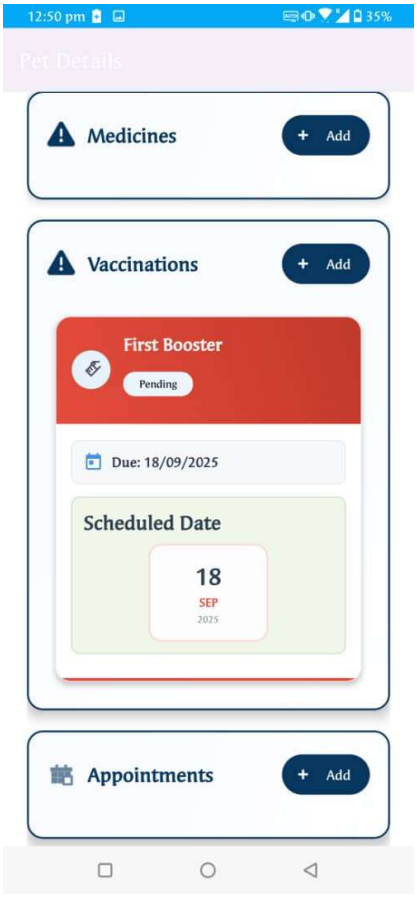


5.4.9 Add Vaccination Page

5.4.10 Edit Vaccination Page

Figure 5.4.9 shows the Edit Vaccination page. When opened, the app loads the selected vaccination record and pre-fills the vaccine name, due date, optional next due date, and notes. After the user makes changes and taps Update Vaccination, the inputs are validated, the record is updated in the Room Database, and the reminders is rescheduled to the new due date. If the user taps Delete Vaccination, the system prompts for confirmation, removes the record from the Room Database, and cancels its scheduled reminder. The app then returns to Pet Details with the Vaccinations list refreshed.

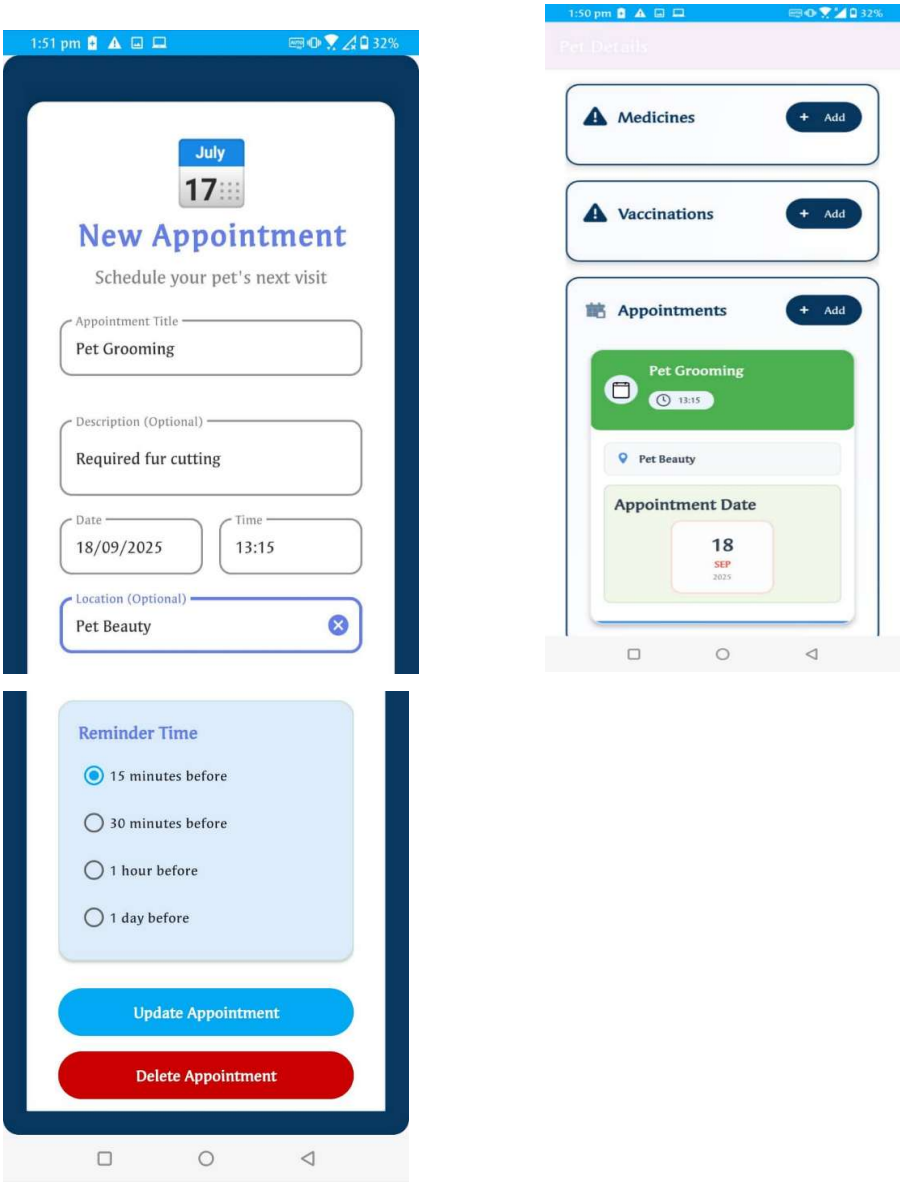




5.4.10 Edit Vaccination Page

5.4.11 Add Appointment Page

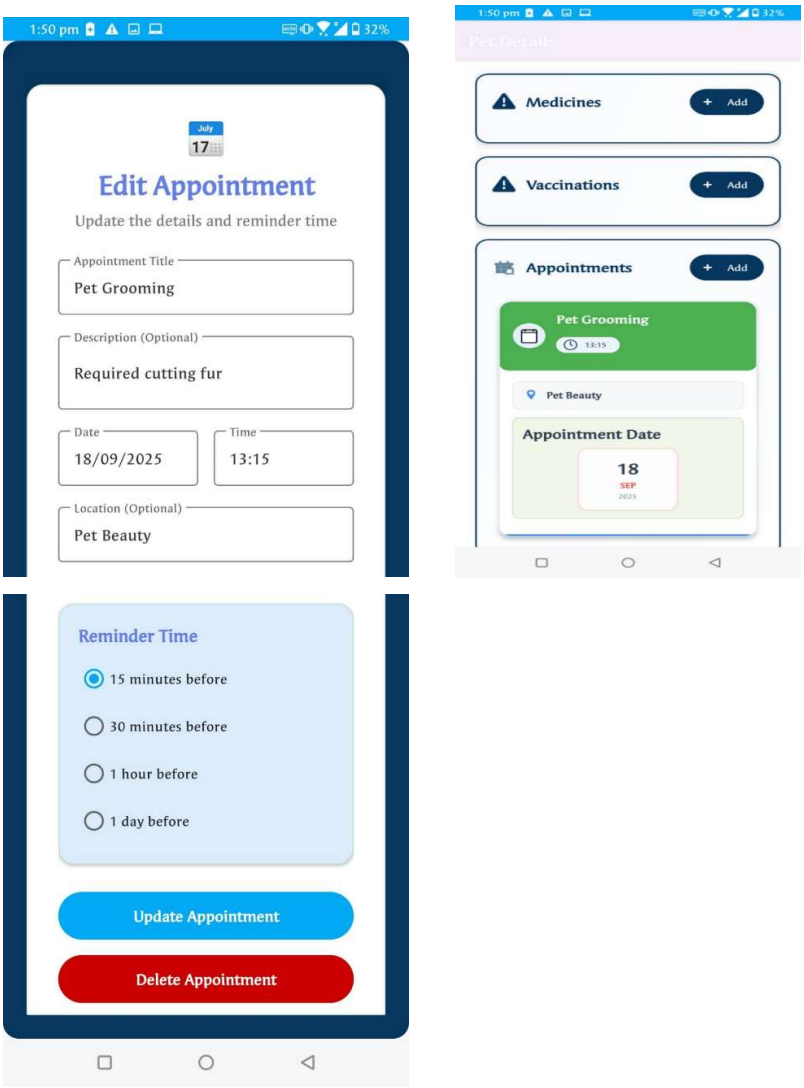
Figure 5.4.10 shows the Add Appointment page. The user enters an appointment title and an optional description, selects the date and time, and may add an optional location for the visit. The user then chooses a Reminder Time, 15 minutes, 30 minutes, 1 hour, or 1 day before. When Save Appointment is pressed, the app validates the inputs, links the record to the current pet, and saves it in the Room Database. The scheduler registers a local notification according to the chosen reminder offset. After a successful save, the app returns to Pet Details, where the new appointment appears under the Appointments section as last picture in Figure 5.4.10.



5.4.11 Add Appointment Page

5.4.12 Edit Appointment Page

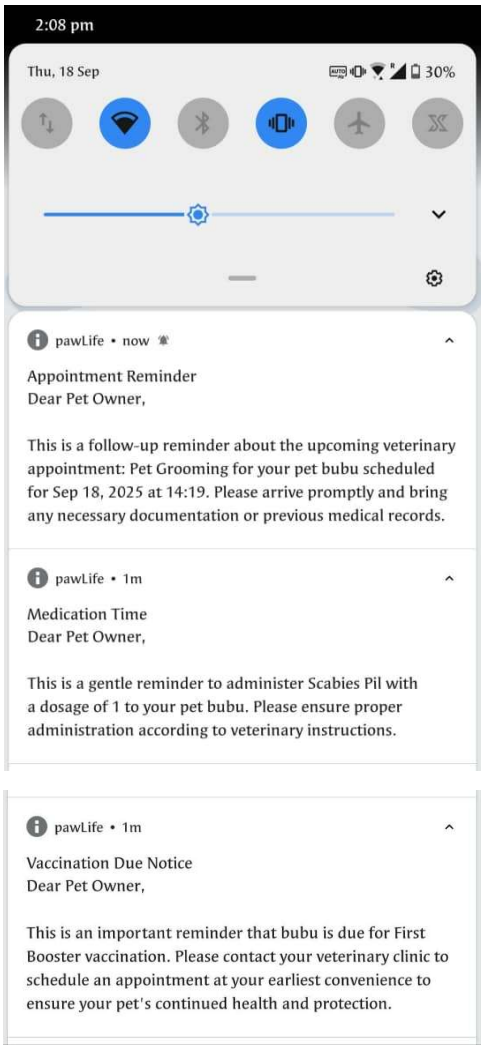
Figure 5.4.11 shows the Edit Appointment page. The app loads the selected appointment and pre-fills the title, optional description, date, time, and optional location. The user can also adjust the Reminder Time 15 minutes, 30 minutes, 1 hour, or 1 day before. When Save Appointment is pressed, the inputs are validated, the record is updated in the Room Database, and the reminder is rescheduled according to the new settings. The app then returns to Pet Details with the Appointments list refreshed.



5.4.12 Edit Appointment Page

5.4.13 Notification Worker

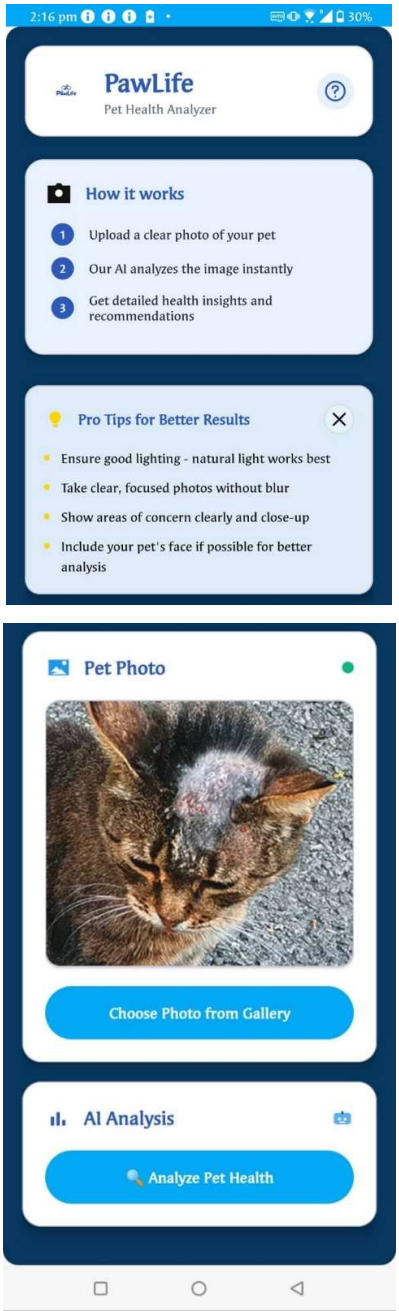
Figure 5.4.12 shows the Notification Worker. When the user saves an appointment, medicine, or vaccination, the app stores the schedule in Room and registers a system alarm and WorkManager task for the selected date and time. Upon the trigger, the worker builds the message from the saved payload and posts a notification on the Pet Reminders channel appointment details, medication name and dosage, or vaccination due date. If the device reboots, a boot receiver restores pending alarms from Room so reminders are not lost. When a schedule is edited, alarms are rescheduled while when a schedule is deleted, its notifications are cancelled.



5.4.13 Notification Worker

5.4.14 AI Diagnose Disease Page

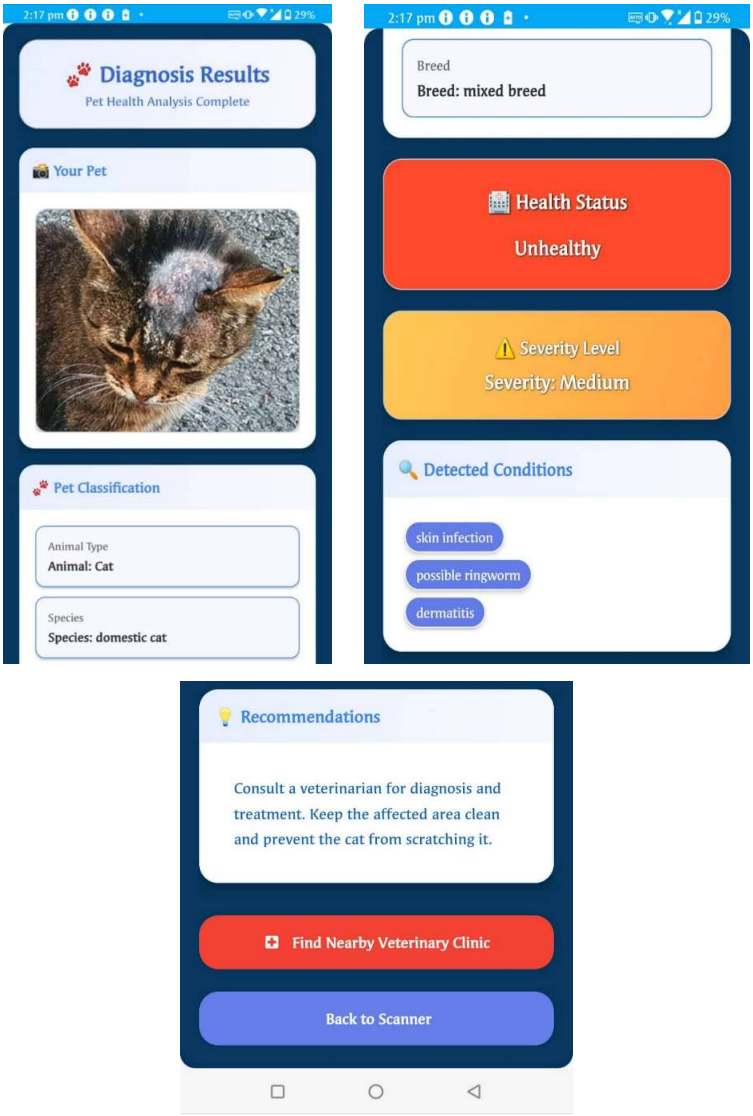
Figure 5.4.13 shows the AI-Diagnose Disease page. The user selects a pet photo and then taps Analyse Pet Health. The app uploads the image to the secure backend, which calls the OpenAI vision model and returns a structured result with likely conditions, key visual cues, and a severity assessment.Another features is that when the user taps the ? button in the top-right corner, the page reveals capture tips as to improve analysis quality.

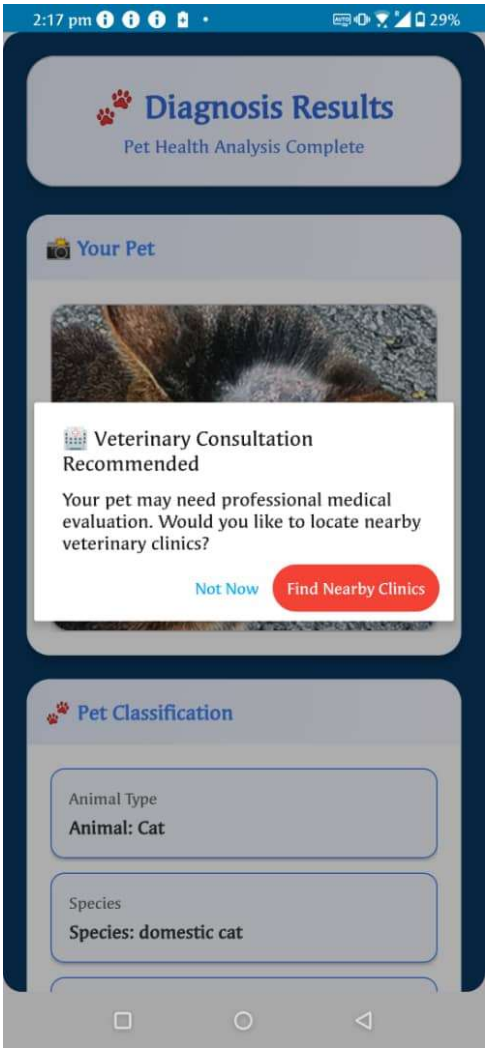


5.4.14 AI Diagnose Disease Page

5.4.15 AI Diagnose Disease Result Page (Unhealthy)

Figure 5.4.14 shows the Diagnosis Results (Unhealthy) flow beginning with a safety-first prompt. Immediately after analysis, the app displays a “Veterinary Consultation Recommended” dialog asking whether to Find Nearby Clinics. If the user selects Find Nearby Clinics, the app launches the Nearby Clinic navigation flow. If the user taps Not Now, the dialog is dismissed and the full results page becomes visible, the submitted photo, pet classification, overall Health Status and Severity Level. A list of Detected Conditions and actionable Recommendations are shown to user to let user know their pet health condition. The user can still open Find Nearby Veterinary Clinic or return Back to Scanner to analyse another image.

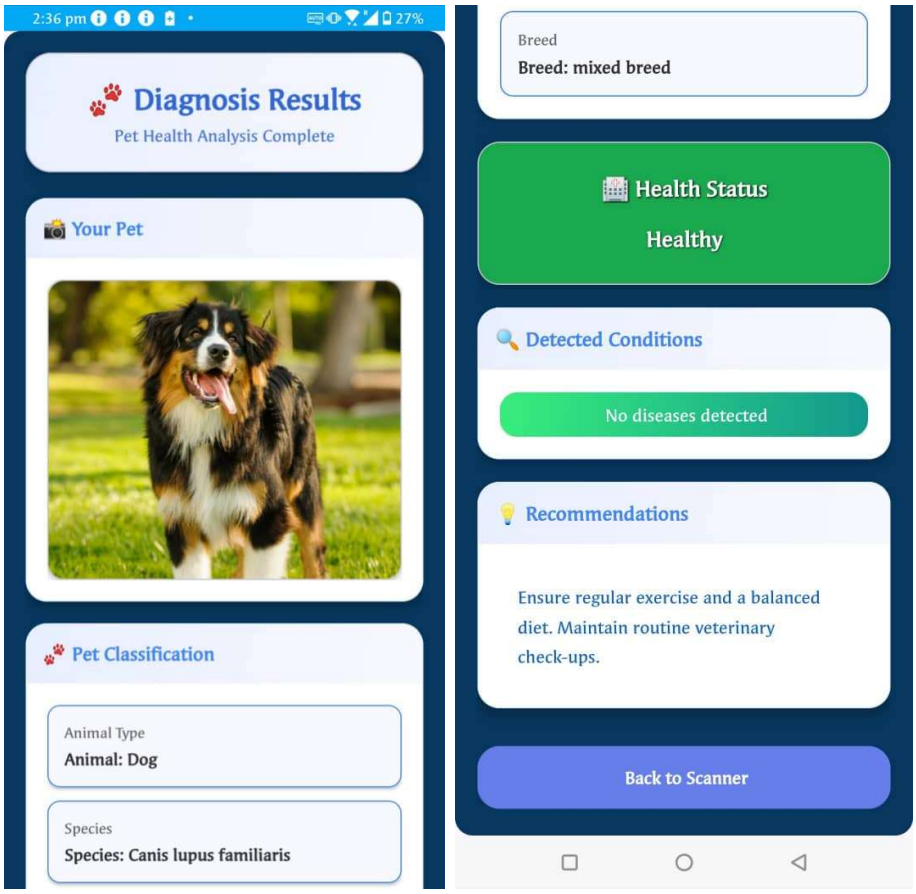




5.4.15 AI Diagnose Disease Result Page (Unhealthy)

5.4.16 AI Diagnose Disease Result Page (Healthy)

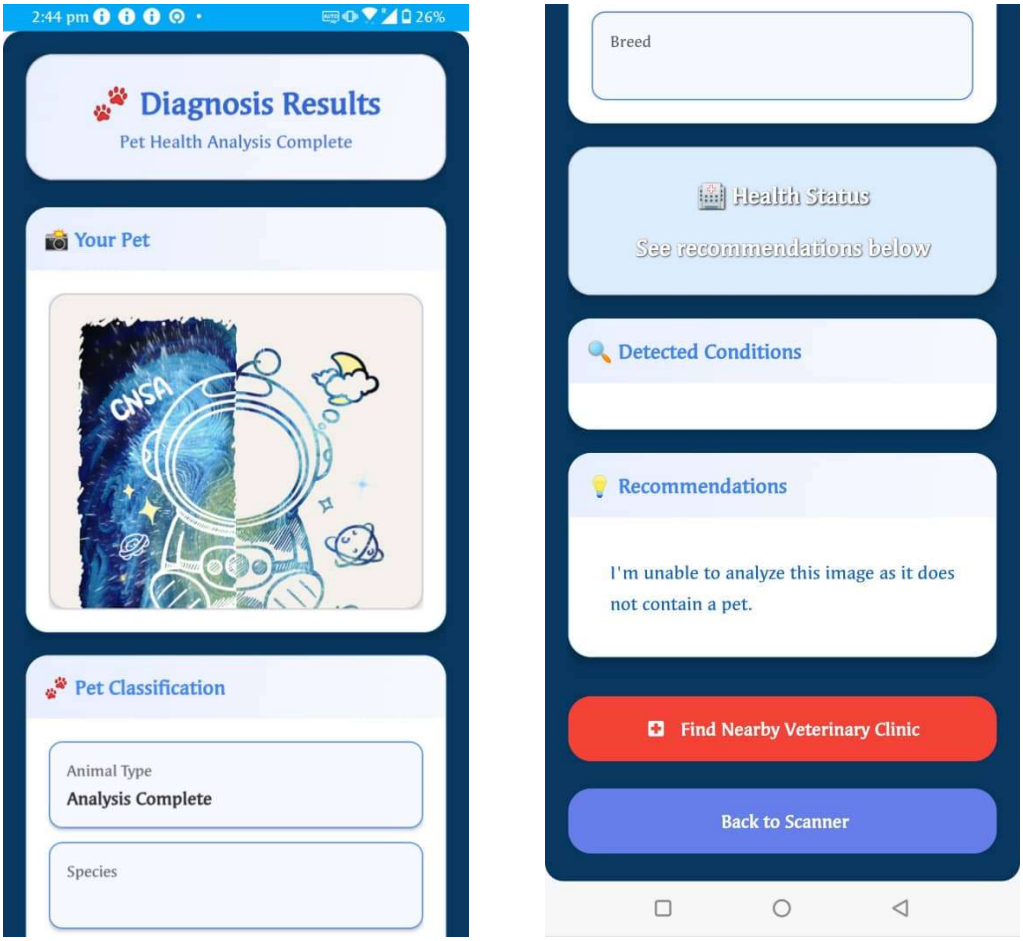
Figure 5.4.15 shows the AI-Diagnose (Healthy) page. After analysis, the result displays the submitted photo, pet classification animal, species, breed and an overall Health Status of Healthy. The Detected Conditions section reports no diseases detected and the page provides general Recommendations such as regular exercise, a balanced diet, and routine veterinary check-ups. The user can tap Back to Scanner to analyse another image.



5.4.16 AI Diagnose Disease Result Page (Healthy)

5.4.17 AI Diagnose Disease Result Page (Invalid Pet)

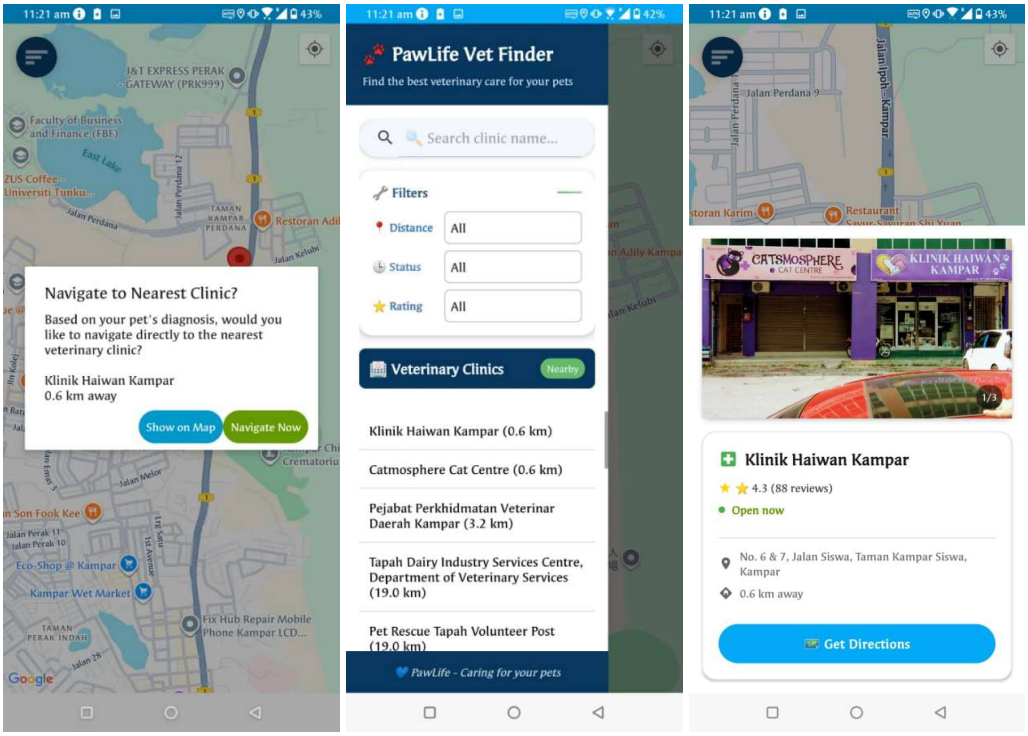
Figure 5.4.16 shows the Diagnose Result (Invalid Pet). After analysis, the system determines that the image does not contain a pet and cannot be assessed. The page displays the submitted image, leaves the classification fields empty, and sets Health Status to a neutral message with no detected conditions. A clear recommendation explains that the image is not suitable for analysis and asks the user to upload a clear photo of a pet. The user can tap Back to Scanner to try again or optionally open Find Nearby Veterinary Clinic if they still need assistance.

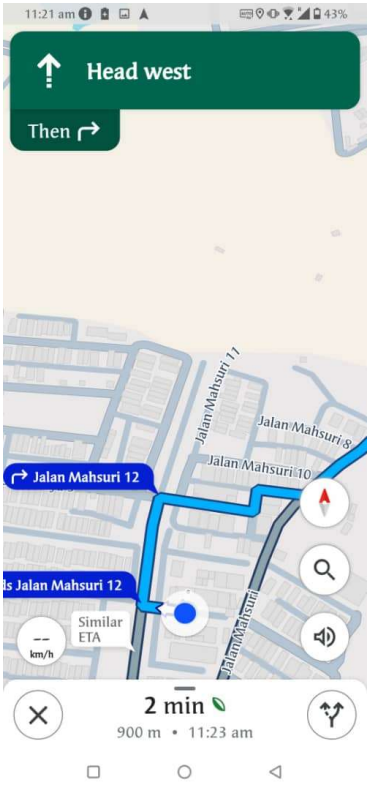


5.4.17 AI Diagnose Disease Result Page (Invalid Pet)

5.4.18 Nearby Clinic Navigation Page

Figure 5.4.17 shows the Nearby Clinic Navigation.For the alert in the first image, it appears only when the AI-Diagnose result indicates disease, prompting the user to navigate to the nearest clinic immediately. If the user chooses Show on Map, the page reveals the clinic card with photo, rating, status, address, distance, and a Get Directions action. The slide-out Vet Finder panel lets users search and filter clinics by name, distance, status, and rating, and select any clinic from the list. When the user taps Navigate Now or Get Directions, the app jumps directly to Google Maps (third-party) to start turn-by-turn navigation to the selected clinic.

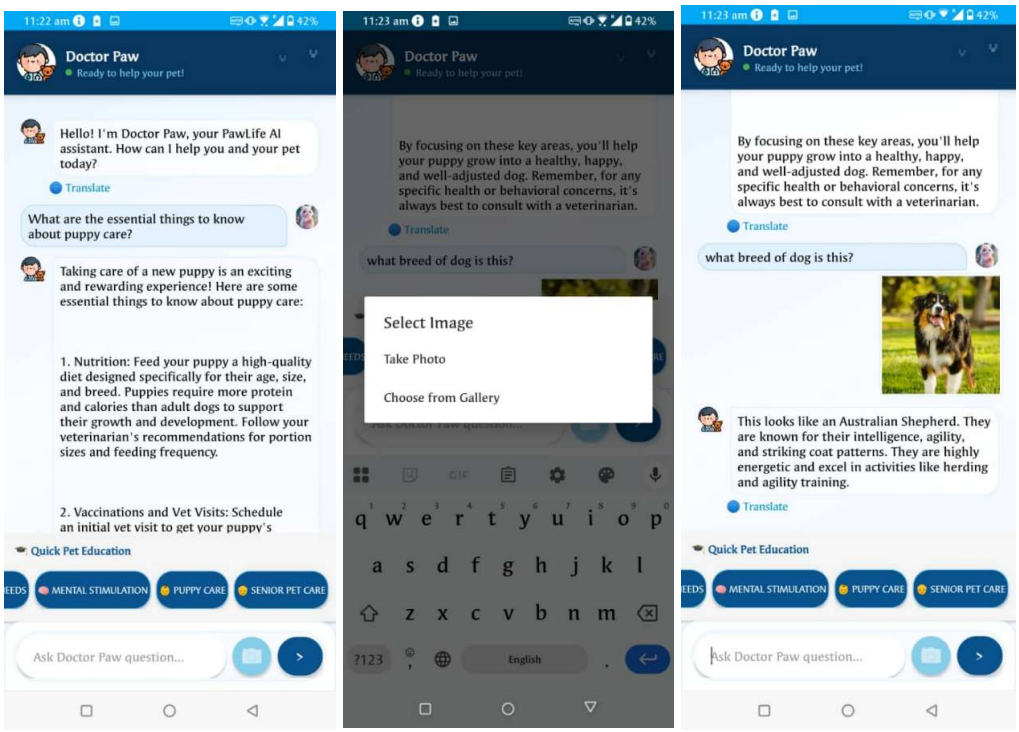


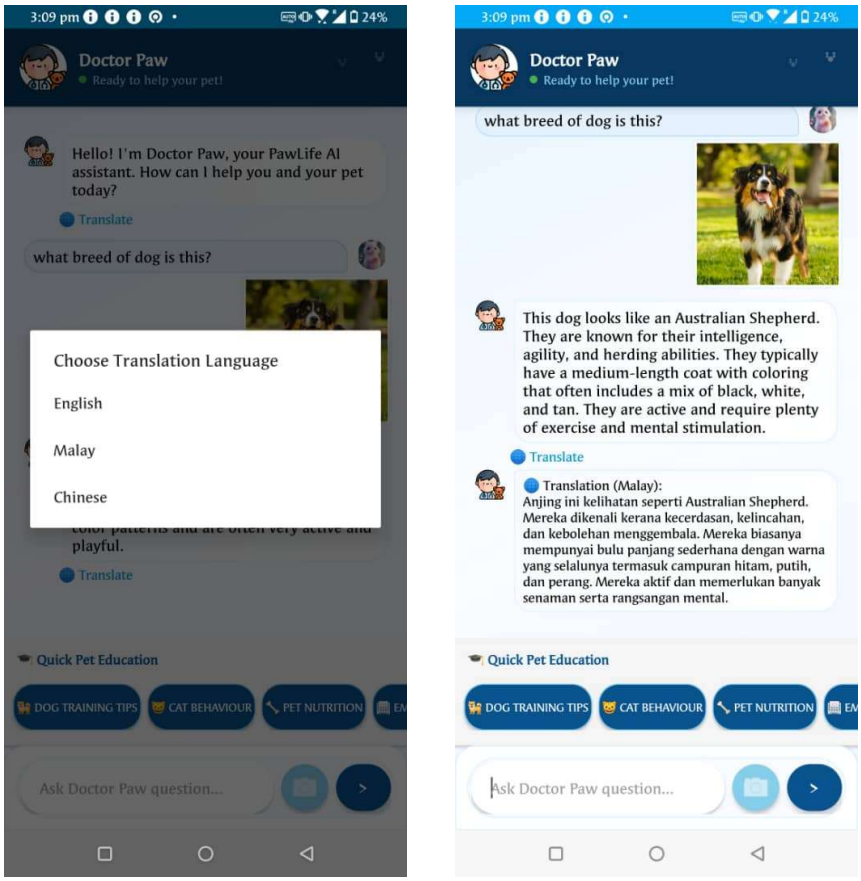


5.4.18 Nearby Clinic Navigation Page

5.4.19 AI-Chatbot Education Page

Figure 5.4.18 shows the AI-Chatbot Education page. The chat supports two input modes: free-text questions and Quick Buttons that post predefined educational prompts for fast learning. Users can also attach an image or photo from the camera or gallery. Then, the message is sent to the backend, which calls the OpenAI vision model to interpret the picture and returns a concise educational reply. Each bot message includes an optional Translate action to render the response in the user's preferred language.





5.4.19 AI-Chatbot Education Page

5.5 Implementation Issues and Challenges

During the development and testing of the Pet Health and Management System, I encountered several implementation challenges.

One of the main challenges was related to the integration of the AI Education Chatbot. The chatbot relies on real-time API communication and during testing, the chatbot would time out and fail to respond if the device was not connected to a stable internet connection. This behaviour highlighted the system's reliance on internet availability, and it was necessary to implement additional error handling mechanisms to notify the user when the connection was lost.

Another issue also emerged with the AI-Chatbot image input feature. In some environments, especially when using Android Studio's Virtual Machine (VM) emulator, it was not possible to capture real pet images using the virtual camera. The VM can only simulate fixed images or blank inputs, which limits the ability to fully test the image capture feature. Therefore, testing had to be moved to a physical Android device to capture real images through the device's built-in camera.

Finally, the real-time location retrieval feature of the Nearby Clinic Finder also faced challenges in emulator testing. The Android Studio emulator does not natively support real-time GPS data, which made it impossible to obtain real-time user locations for mapping during initial testing. To address this, we deployed the app to a physical mobile device that could access and verify real GPS data to ensure that location-based search and navigation functions worked properly.

These issues highlight the importance of physical device testing of features that rely on hardware sensors camera, GPS and a live internet connection to ensure that the final system can operate reliably under real-world conditions.

5.6 Concluding Remark

Chapter 5 discuss the end-to-end implementation process of the PawLife system. It begins by enabling developer options andUSB debugging on physical Android devices, whilst simultaneously preparing both emulators and real handsets for deployment to ensure reliable device-side testing in hardware configuration. At the software level, the project was developed using Android Studio (Kotlin language, API 24+) and integrated with Google Maps to implement external navigation functionality, establishing a stable foundation for subsequent modules in software configuration. Subsequently, the application environment and service configurations, including network, location, camera, notification, and precise alarm permissions were configured to ensure core functionalities operate in correct settings and configuration.

System operations underpin all key user processes, pet-specific schedules for medication, vaccinations, and appointments are persistently stored within Room and distributed via notification workers based on WorkManager and Alarm. This mechanism enables timely reminders and secure recovery of alerts after system restarts. The AI diagnostic function supports photo uploads and returns structured results. Upon detecting abnormalities, the system prioritises prompting users to seek veterinary care, offering direct access to the ‘Nearby Clinics’ process. Normal results display preventive guidance. Clinic search and navigation are integrated, allowing users to filter nearby vets and jump to Google Maps for turn-by-turn directions. Concurrently, the AI chatbot supports free-text input, quick-prompt Q&A, image attachments, and instant translation, delivering concise health education (Chatbot).

Finally, I identified and mitigated implementation challenges, the chatbot's reliance on stable networks, simulator limitations in camera and image testing, and the simulator's lack of real-time GPS functionality. These challenges prompted testing on physical devices and strengthened error-handling mechanisms during network interruptions. Overall, Chapter 5 demonstrates that PawLife's software and hardware infrastructure, configuration schemes, core operations, and fault-tolerance mechanisms have been deployed and validated on real devices. This not only achieves functional objectives but also lays the groundwork for comprehensive system evaluation and future upgrades.

Chapter 6: System Evaluation and Discussion

6.1 System Testing and Performance Metrics

In this chapter describes the black-box testing strategy used to evaluate the Pet Health and Management application. Each Modules will be conducted to determine the performance of the system. System testing begin commences with the authentication, Login Page and user registration process, Sign Up page. Test cases must verify that users can complete registration using valid credentials and ensuring that error inputs such as empty fields, correct passwords, or duplicate email addresses are explicitly rejected with clear validation prompts. The google sign register should be follow actually the valid credentials of the google service and once sign up it show navigate to the correct path of the apps. Next following by the registration, initial login behaviour must be tested to confirm the application guides users through creating an initial pet profile by enforces completion of mandatory fields and returns to the expected interface upon successful submission. For existing users, testing must verify that valid credentials permit normal login, while invalid credentials will be triggered appropriate error messages without causing application to be crashed.

After that, testing the navigation on the dashboard page. The navigation and routing functionality shall be validated. By referring to the dashboard and bottom navigation bar, each core functional module shall be sequentially activated including the AI Diagnose Diseases, Nearby Clinics, AI Chatbot, and dedicated pet appointment module as to ensure corresponding interfaces load correctly. The navigation shall return to the previous operational state and no unintended states are lost during feature switching. For the menu slider, it should able to let users to edit their profile. In Addition, the Edit Profile function shall be validated end-to-end from the menu slider. The system shall open the profile screen with the user's current details pre-filled, allow changes to editable fields name, phone, email, avatar photo, and enforce client-side validation required fields, email format, phone length with clear, non-technical error messages. Selecting a new profile image shall launch the gallery, display a preview, and update the avatar on save. Tapping Save shall persist the changes and immediately reflect them on the profile screen and in any avatar locations across the app. For the logout part, the Logout function shall also be validated from the menu slider. Invoking

Logout shall terminate the authenticated session, clear any session tokens and sensitive in-memory data, and return the user to the Login page.

The pet profile management functionality shall tested through create, read, update, and delete workflows by utilising only visible user interface controls. The testing process includes creating a new pet profile, reopening it to verify accurate information display, modifying selected fields and confirming changes persist after a full application restart. Finally, deleting the profile must be ensure it no longer appears in any lists or selectors. Throughout testing, observe the application's handling of missing photographs, oversized images, and unsupported characters within text fields.

Next, the scheduling functionality shall be tested per pet. Test cases require creating future events such as making appointment, vaccinations and medication administration times and verifying that each newly added event immediately appears in the pet's Details page in to-do lists and confirming that deadlines and times are displayed in the correct format. The editing and deletion functions shall be supported, tests must modify existing entries and verify that updated details reflect in the list. Subsequently, delete the entry and confirm it has been removed and cannot be reopened and for each of the item event shall be placed in the Upcoming Event in the Dashboard page. Tests boundary conditions including time conflicts, expired entries, and empty titles to confirm the interface must be tested as to prevents invalid input.

The AI diagnose diseases must be end-to-end testing. The application requires the capture or upload of images of varying quality to validate its image verification functionality. This includes identifying common issues such as blurriness, insufficient lighting, or missing subjects, prompting users to retake photographs where necessary. For valid images, the detector must return structured results and maintain continuous on-screen display, including summaries of potential conditions and explicit triage recommendations. When indicating high risk, the system should unequivocally advise users to seek veterinary care. If in low-risk scenarios, it provides preventative guidance. If the user uploaded the invalid animal result, the system should prompt the messages of invalid result and ask them to rescan again.

The ‘Nearby Clinics’ must set the permissions whether are granted or denied. When permissions are granted, the system must acquire location data, display a list of clinics sorted by distance, and pass the selected destination to Google Maps. When permissions are denied, the system must provide a non-technical explanation, allow the user to enable location services or cancel the operation, and not impede other application functions.

The Educational AI chatbots must support among free-form text queries, image capture or uploaded and pre-set quick-access buttons for testing. Each request must generate a highly readable response within a reasonable timeframe. Optional translation controls should convert answers into specified languages while preserving original meaning. Testing must address input edge cases like excessively long messages, unsupported symbols, or empty submissions to verify whether the user interface effectively constrains or sanitises input content and provides practical guidance.

Lastly, the notification reminders shall be validated via the user interface without requiring direct access to the scheduler. Upon creation or updating of a schedule item, the system shall register a reminder, when triggered at the designated time, this reminder must display the correct title and pet context, and upon clicking shall open the corresponding interface for each medicines, vaccination and appointment. When a schedule item is deleted, the associated reminder must cease triggering. The consistency of reminder functionality shall be verified through device reboots and forced application terminations.

6.2 Testing Setup and Result

6.2.1 User Sign In Function Testing

No	Test Case	Test Data	Expected Output	Actual Output	Result (Pass/Fail)
1.	Launches the application	-	System displays splash screen, then shows Login page requesting email and password.	System displays splash screen, then shows Login page requesting email and password.	Pass
2.	Opens Sign Up from Login	-	System directs user to Sign Up page.	System directs user to Sign Up page.	Pass
3.	Login with valid existing credentials (returning user)	Email: test@hotmail.com Password: test00	System signs in and navigates to Dashboard.	System signs in and navigates to Dashboard.	Pass
4.	Login with valid newly registered credentials (first login)	Email: test@hotmail.com Password: test00	System signs in and navigates to Create Pet Profile.	System signs in and navigates to Create Pet Profile.	Pass
5.	Login with non-existent email	Email: non@hotmail.com Password: non00	System shows “Invalid Credential”. No crash.	System shows “Invalid Credential”. No crash.	Pass
6.	Login with incorrect password	Email: own@hotmail.com Password: wrong	System shows “Incorrect password”. No crash.	System shows “Incorrect password”. No crash.	Pass
7.	Submit with empty fields	Email: — ; Password: —	System shows “Please fill in all fields”.	System shows “Please fill in all fields”.	Pass

6.2.2 User Sign Up Function Testing

No	Test Case	Test Data	Expected Output	Actual Output	Result (Pass/Fail)
1.	Open Sign Up page	-	Splash appears, then Login Page with email & password fields is shown.	Splash appears, then Login Page with email & password fields is shown.	Pass
2.	Register with valid email, password and age	Email: new@hotmail.com Password: new01; Name: Alex; Age: 21	Account is created, success message shown, user is returned to Login Page.	Account is created, success message shown, user is returned to Login Page.	Pass
3.	Register with duplicate email	Email: new@hotmail.com Password: new01; Name: Alex; Age: 21	System rejects and shows “Email already in use”.	System rejects and shows “Email already in use”.	Pass
4.	Register with short length password (less than 6 digits)	Email: new@hotmail.com Password: new	System rejects and shows “Password is too short at least 6 digits”.	System rejects and shows “Password is too short at least 6 digits”.	Pass
5.	Submit with empty required fields	Email: — ; Password: — ; Name: —	System rejects and shows “Please fill in all required fields”.	System rejects and shows “Please fill in all required fields”.	Pass
6.	Google Sign-In with valid Google account	Google account: valid	System authenticates via Google and navigates to the correct path (first login → Create Pet Profile; otherwise → Dashboard).	System authenticates via Google and navigates to the correct path (first login → Create Pet Profile; otherwise → Dashboard).	Pass

7.	Google Sign-In cancelled or invalid	Google dialog: Cancel or invalid token	System shows non-technical error and stays on Sign Up page.	System shows non-technical error and stays on Sign Up page.	Pass
8.	First login after successful registration	Valid Credentials	System signs in and guides user to Create Pet Profile; mandatory fields enforced.	System signs in and guides user to Create Pet Profile; mandatory fields enforced.	Pass

6.2.3 Create Pet Profile Function Testing

No	Test Case	Test Data	Expected Output	Actual Output	Result (Pass/Fail)
1.	Open Create Pet Profile screen	-	Create Pet Profile form is displayed with fields (Pet Name, Breed, DOB, Gender, Photo) and Save buttons.	Create Pet Profile form is displayed with fields (Pet Name, Breed, DOB, Gender, Photo) and Save buttons.	Pass
2.	Submit with all fields empty	Name: —; Species: —; DOB: —	System blocks submission and shows validation prompts (“Please fill in required fields”).	System blocks submission and shows validation prompts (“Please fill in required fields”).	Pass
3.	Invalid characters or length in name	Name: @@@ or >50 chars	System rejects value and shows friendly message (“Invalid name”).	System rejects value and shows friendly message (“Invalid name”).	Pass
4.	Use date picker with future date	DOB: future date	System prevents future date selection	System prevents future date selection	Pass

5.	Add pet photo from gallery	Select valid image (≤ size limit)	Preview appears; photo attached to form.	Preview appears; photo attached to form.	Pass
6.	Attach unsupported or oversized image	TIFF / very large file	System rejects file and shows "Unsupported or too large image".	System rejects file and shows "Unsupported or too large image".	Pass
7.	Save with valid required fields only	Name: Coco; Species: Dog; DOB: 2022-05-01	System saves profile to Room DB, shows success toast, returns to previous screen (e.g., Pet Management /Dashboard) with new pet visible.	System saves profile to Room DB, shows success toast, returns to previous screen (e.g., Pet Management /Dashboard) with new pet visible.	Pass
8.	Duplicate pet name (allowed)	Name: Coco (existing), Species/DOB vary	System allowed and save as separate record.	System allowed and save as separate record.	Pass

6.2.4 Dashboard Function Testing

No	Test Case	Test Data	Expected Output	Actual Output	Result (Pass/Fail)
1.	Load Dashboard (first open after login)	Signed-in user with at least 1 pet	Dashboard loads without error; app bar shows “PawLife”; greeting card visible; “UPCOMING EVENT” section rendered.	Dashboard loads without error; app bar shows “PawLife”; greeting card visible; “UPCOMING EVENT” section rendered.	Pass
2.	Empty state of Upcoming Event	User has no upcoming items	“UPCOMING EVENT” shows an empty state message or icon “No upcoming events” and no cards.	“UPCOMING EVENT” shows an empty state message or icon “No upcoming events” and no cards.	Pass
3.	Populate Upcoming Event list	User has 1 or more upcoming item	Event cards render with pet avatar, pet name, event title	Event cards render with pet avatar, pet name, event title	Pass
4.	Event card (view details)	Tap anywhere on the event card	Navigates to the corresponding event detail screen for that pet and item.	Navigates to the corresponding event detail screen for that pet and item.	Pass
5.	Top-right “+” add button	Tap “+” on Dashboard	Navigate to ask user create a pet profile without crash	Navigate to ask user create a pet profile without crash	Pass
6.	Floating button (bottom-right)	Tap floating action button	Navigate to AI-Chatbot Education	Navigate to AI-Chatbot Education	Pass
7.	Bottom Navigation (Home)	Tap “Home” (current)	Stays on Dashboard, no duplicate reload or flicker.	Stays on Dashboard, no duplicate reload or flicker.	Pass

8.	Bottom Navigation (Pet Management)	Tap “Pet Management”	Navigates to Pet Management screen.	Navigates to Pet Management screen.	Pass
9.	Bottom Navigation (AI-Diagnose)	Tap “AI-Diagnose”	Navigates to AI-Diagnose creen.	Navigates to AI-Diagnose creen.	Pass
10.	Bottom Navigation (Nearby Clinic Navigation)	Tap “Navigation”	Opens Nearby Clinics feature	Opens Nearby Clinics feature	Pass
11.	Drawer open	Tap hamburger icon	Side drawer slides in showing profile avatar, display name, and email.	Side drawer slides in showing profile avatar, display name, and email.	Pass
12.	Drawer (Edit Profile)	Tap Edit Profile	Navigates to Edit Profile screen with fields prefilled	Navigates to Edit Profile screen with fields prefilled	Pass
13.	Drawer (Logout)	Tap Logout	Signs out, clears session, and shows Login page	Signs out, clears session, and shows Login page	Pass

6.2.5 Medicine Schedule Function Testing

No	Test Case	Test Data	Expected Output	Actual Output	Result (Pass/Fail)
1.	Open Pet Details (Medicines section)	Existing pet	"Medicines" card is visible with Add button and any existing medicine cards listed.	"Medicines" card is visible with Add button and any existing medicine cards listed.	Pass
2.	Tap Add (Medicines)	-	Navigates to Add Medicine form with fields: Medicine Name, Dosage, Frequency (Once/Twice/Three/ Weekly), Start Date, End Date, Feed Times (Add Time), Notes, Save Medicine.	Navigates to Add Medicine form with fields: Medicine Name, Dosage, Frequency (Once/Twice/Three/Weekly), Start Date, End Date, Feed Times (Add Time), Notes, Save Medicine.	Pass
3.	Submit with all required fields empty	-	Form blocks submit; shows validation prompts for required fields.	Form blocks submit; shows validation prompts for required fields.	Pass
4.	Missing Medicine Name only	Dosage: 1; Frequency: Once Daily; Start: valid; Feed Time: 09:00	Form blocks submit; highlights Medicine Name as required.	Form blocks submit; highlights Medicine Name as required.	Pass
5.	Missing Dosage only	Name: "Scabies Pil"; Frequency: Once Daily; Start: valid; Feed Time: 09:00	Form blocks submit; highlights Dosage as required.	Form blocks submit; highlights Dosage as required.	Pass

6.	Missing Feed Times	Name + Dosage + Frequency set; no time added	Form blocks submit; prompts to add at least one feed time.	Form blocks submit; prompts to add at least one feed time.	Pass
7.	Invalid Dosage input	Dosage: letters or symbols or negative	Form rejects value; shows friendly message “Enter a valid positive dosage”.	Form rejects value; shows friendly message “Enter a valid positive dosage”.	Pass
8.	Future-only date check	Start/End in future	Form accepts valid future dates.	Form accepts valid future dates.	Pass
9.	Start date after End date	Start: 24/09/2025; End: 17/09/2025	Form blocks submit; prompts “End date must be after start date”.	Form blocks submit; prompts “End date must be after start date”.	Pass
10.	Frequency tally with the feed time	Name: Scabies Pil; Dosage: 1; Start: 17/09/2025; End: 24/09/2025; Feed Times: [14:39]	Form accepts; Save Medicine creates record.	Form accepts; Save Medicine creates record.	Pass
11.	Remove a time chip	Tap the X on time 09:00	Time is removed from list instantly; validation updates accordingly.	Time is removed from list instantly; validation updates accordingly.	Pass
12.	Save success path	Valid inputs	Success snackbar shown; navigates back to Pet Details; new medicine card appears.	Success snackbar shown; navigates back to Pet Details; new medicine card appears.	Pass
13.	Open Edit Medicine from card	Tap the medicine card	Navigates to Edit Medicine screen with fields pre-filled and buttons Update	Navigates to Edit Medicine screen with fields pre-filled and buttons Update	Pass

			Medicine and Delete Medicine.	Medicine and Delete Medicine.	
14.	Update any field	Change Dosage: 2; add time 20:00	Update Medicine saves changes; returns to Pet Details; card reflects new dosage and times.	Update Medicine saves changes; returns to Pet Details; card reflects new dosage and times.	Pass
15.	Update with invalid data	Clear Medicine Name	Update is blocked; field highlighted; no changes saved.	Update is blocked; field highlighted; no changes saved.	Pass
16.	Delete medicine	Tap Delete Medicine	Item is removed from Pet Details list; any related reminders are cancelled; no crash.	Item is removed from Pet Details list; any related reminders are cancelled; no crash.	Pass
17.	Long text handling	Very long medicine name or notes	Text truncates or wraps gracefully; layout remains intact.	Text truncates or wraps gracefully; layout remains intact.	Pass
18.	Dashboard linkage	After save/update	Upcoming Event on Dashboard shows the medicine schedule at the correct time; tapping the event opens the detail or edit view	Upcoming Event on Dashboard shows the medicine schedule at the correct time; tapping the event opens the detail or edit view	Pass

6.2.6 Vaccination Schedule Function Testing

No	Test Case	Test Data	Expected Output	Actual Output	Result (Pass/Fail)
1.	Open Pet Details (Vaccinations section)	Existing pet	"Vaccinations" panel is visible with Add button; existing vaccination cards are listed.	"Vaccinations" panel is visible with Add button; existing vaccination cards are listed.	Pass
2.	Tap Add (Vaccinations)	-	Navigates to Add Vaccination form with fields: Vaccine Name, Due Date, Next Due Date (optional), Notes (optional), Save Vaccination.	Navigates to Add Vaccination form with fields: Vaccine Name, Due Date, Next Due Date (optional), Notes (optional), Save Vaccination.	Pass
3.	Submit with all required fields empty	-	Save is blocked; validation prompts indicate required fields.	Save is blocked; validation prompts indicate required fields.	Pass
4.	Missing Vaccine Name only	Due Date set	Save is blocked; Vaccine Name highlighted as required.	Save is blocked; Vaccine Name highlighted as required.	Pass
5.	Next Due Date before Due Date	Due: 18/09/2025; Next Due: 10/09/2025	Save is blocked; message "Next Due Date must be after Due Date."	Save is blocked; message "Next Due Date must be after Due Date."	Pass
6.	Save with all fields	Name: "First Booster"; Due: 18/09/2025; Next	Record is saved; all values render on card; notes available in detail or edit.	Record is saved; all values render on card; notes available in detail or edit.	Pass

		Due: 25/09/2025; Notes filled			
7.	Vaccination card rendering	Saved item	Card shows vaccine name, status chip (e.g., Pending), "Due: dd/mm/yyyy", and Scheduled Date calendar tile matching Due Date.	Card shows vaccine name, status chip (e.g., Pending), "Due: dd/mm/yyyy", and Scheduled Date calendar tile matching Due Date.	Pass
8.	Open Edit Vaccination from card	Tap vaccination card	Navigates to Edit Vaccination with fields pre-filled and buttons Update Vaccination or Delete Vaccination.	Navigates to Edit Vaccination with fields pre-filled and buttons Update Vaccination or Delete Vaccination.	Pass
9.	Update any field	Change Next Due Date	Update Vaccination saves changes; returns to Pet Details; card reflects new date.	Update Vaccination saves changes; returns to Pet Details; card reflects new date.	Pass
10.	Update with invalid data	Clear Vaccine Name	Update is blocked; field highlighted; no data changed.	Update is blocked; field highlighted; no data changed.	Pass
11.	Delete vaccination	Tap Delete Vaccination	Item is removed from list; any related reminders (if implemented) are cancelled; no crash.	Item is removed from list; any related reminders (if implemented) are cancelled; no crash.	Pass
12.	Long text handling	Very long vaccine name/notes	Text truncates or wraps gracefully; UI layout remains intact.	Text truncates or wraps gracefully; UI layout remains intact.	Pass
13.	Dashboard linkage	After save or update	Upcoming Event on Dashboard shows this	Upcoming Event on Dashboard shows this	Pass

			vaccination on the correct date; tapping it opens the vaccination detail/edit view.	vaccination on the correct date; tapping it opens the vaccination detail/edit view.	

6.2.7 Appointment Schedule Function Testing

No	Test Case	Test Data	Expected Output	Actual Output	Result (Pass/Fail)
1.	Open Pet Detail (Appointment)	Existing pet	"Appointments" panel is visible with Add button; existing appointment cards	"Appointments" panel is visible with Add button; existing appointment cards	Pass
2.	Tap Add (Appointments)	-	Navigates to New Appointment form with fields: Title, Description (optional), Date, Time, Location (optional), Reminder Time (15m/30m/1h/1d), Save/Update button.	Navigates to New Appointment form with fields: Title, Description (optional), Date, Time, Location (optional), Reminder Time (15m/30m/1h/1d), Save/Update button.	Pass
3.	Submit with required fields empty	-	Save blocked; validation prompts for Title, Date, and Time.	Save blocked; validation prompts for Title, Date, and Time.	Pass
4.	Missing Title only	Date+Time set	Save blocked; Title highlighted as required.	Save blocked; Title highlighted as required.	Pass

5.	Missing Date only	Title set; Time set	Save blocked; Date highlighted as required.	Save blocked; Date highlighted as required.	Pass
6.	Missing Time only	Title set; Date set	Save blocked; Time highlighted as required.	Save blocked; Time highlighted as required.	Pass
7.	Past Date/Time	Yesterday 09:00	If disallowed, save blocked with message ("Date/Time must be in the future"); if allowed, item saved and appears as "Due/Overdue."	If disallowed, save blocked with message ("Date/Time must be in the future"); if allowed, item saved and appears as "Due/Overdue."	Pass
8.	Set Reminder Time	Select "15 minutes before"	Selected radio persists; will trigger a reminder 15 min before event.	Selected radio persists; will trigger a reminder 15 min before event.	Pass
9.	Save with valid data	Title: Pet Grooming; Date: 18/09/2025; Time: 13:15; Location: Pet Beauty; Reminder: 15m	Record saved; success toast; return to Pet Details; new green appointment card appears showing title, time chip, location, and calendar tile for the date.	Record saved; success toast; return to Pet Details; new green appointment card appears showing title, time chip, location, and calendar tile for the date.	Pass
10.	Card rendering (long location)	Very long location text	Text wraps or truncates gracefully; no overlap; card remains tappable.	Text wraps or truncates gracefully; no overlap; card remains tappable.	Pass
11.	Open Edit Appointment	Tap the appointment card	Navigates to Edit Appointment with fields pre-filled and buttons Update	Navigates to Edit Appointment with fields pre-filled and buttons Update	Pass

			Appointment and Delete Appointment.	Appointment and Delete Appointment.	
12.	Update details	Change Description or Reminder Time	Update Appointment saves changes; return to Pet Details; card reflects new values; reminder rescheduled.	Update Appointment saves changes; return to Pet Details; card reflects new values; reminder rescheduled.	Pass
13.	Update with invalid data	Clear Title	Update blocked; Title highlighted; no changes saved.	Update blocked; Title highlighted; no changes saved.	Pass
14.	Delete appointment	Tap Delete Appointment	Appointment removed from list; associated reminder cancelled; no crash.	Appointment removed from list; associated reminder cancelled; no crash.	Pass
15.	Dashboard linkage	After save or update	Upcoming Event on Dashboard shows this appointment on the correct date/time; tapping it opens the appointment detail/edit view.	Upcoming Event on Dashboard shows this appointment on the correct date/time; tapping it opens the appointment detail/edit view.	Pass

6.2.8 Notification Worker Function Testing

No	Test Case	Test Data	Expected Output	Actual Output	Result (Pass/Fail)
1.	Appointment reminder fires at offset	Event 14:19, "15 min before"	Tray notification at 14:04 with channel sound; small icon shows; tapping opens Appointment detail via PendingIntent.	Tray notification at 14:04 with channel sound; small icon shows; tapping opens Appointment detail via PendingIntent.	Pass
2.	Medication reminder fires on time	Feed time 14:39	Notification posts at 14:39 with title "Medication Time"; vibration and sound per channel.	Notification posts at 14:39 with title "Medication Time"; vibration and sound per channel.	Pass
3.	Vaccination due notice	Due date today	Notification posts at scheduled time with vaccine name; tapping opens Vaccination detail	Notification posts at scheduled time with vaccine name; tapping opens Vaccination detail	Pass
4.	Tap action	Tap any notification	App opens the correct detail screen in a task	App opens the correct detail screen in a task	Pass
5.	Multiple notification	Appointment + Medicine within 1 min	Two separate notifications appear (unique IDs); each opens correct screen; no overwrite.	Two separate notifications appear (unique IDs); each opens correct screen; no overwrite.	Pass
6.	Update and Delete	Change time 14:31 to 15:10; delete item	Old notification is cancelled; new schedules for 15:10; deleted item does not fire.	Old notification is cancelled; new schedules for 15:10; deleted item does not fire.	Pass
7.					Pass

8.	Device reboot	Reboot before due time	BOOT_COMPLETED receiver reschedules work; notification still fires at the correct wall-clock time.	BOOT_COMPLETED receiver reschedules work; notification still fires at the correct wall-clock time.	Pass

6.2.9 AI Diagnose Diseases and Result Function Testing

No	Test Case	Test Data	Expected Output	Actual Output	Result (Pass/Fail)
1.	Load AI Analyser screen	Open "Scan AI Analysis" from Dashboard	"How it works" and "Pro Tips" cards are visible; "Choose Photo from Gallery" and "Analyze Pet Health" buttons are enabled.	"How it works" and "Pro Tips" cards are visible; "Choose Photo from Gallery" and "Analyze Pet Health" buttons are enabled.	Pass
2.	Open gallery picker	Tap "Choose Photo from Gallery"	Android gallery opens; user can pick an image; on cancel, returns to screen with no crash.	Android gallery opens; user can pick an image; on cancel, returns to screen with no crash.	Pass
3.	Select valid pet image	Pick clear pet photo	Thumbnail preview appears in "Pet Photo" card; status dot turns green/ready.	Thumbnail preview appears in "Pet Photo" card; status dot turns green/ready.	Pass
4.	Select very large image	Pick high-res file	App accepts or downscales; preview loads; no ANR/crash.	App accepts or downscales; preview loads; no ANR/crash.	Pass
5.	No image then analyze	Tap "Analyze Pet Health" with no photo	App blocks action and prompts user to select a photo first.	App blocks action and prompts user to select a photo first.	Pass

6.	Start analysis	Valid image; tap Analyze	Shows progress/loader; sends request; no duplicate requests on double-tap.	Shows progress/loader; sends request; no duplicate requests on double-tap.	Pass
7.	Display completeness	Successful response	"Diagnosis Results" page shows: Your Pet preview, Pet Classification (Animal Type/Species/Breed), Health Status card, Severity Level card (if unhealthy), Detected Conditions list/chips, Recommendations panel, action buttons ("Find Nearby Veterinary Clinic", "Back to Scanner").	"Diagnosis Results" page shows: Your Pet preview, Pet Classification (Animal Type/Species/Breed), Health Status card, Severity Level card (if unhealthy), Detected Conditions list/chips, Recommendations panel, action buttons ("Find Nearby Veterinary Clinic", "Back to Scanner").	Pass
8.	Unhealthy outcome	-	Alert recommends visiting a clinic (as shown); "Find Nearby Clinics" opens location feature; "Not Now" dismisses.	Alert recommends visiting a clinic (as shown); "Find Nearby Clinics" opens location feature; "Not Now" dismisses.	Pass
9.	Healthy outcome	-	"Health Status: Healthy" (green), "No diseases detected" chip, general wellness	"Health Status: Healthy" (green), "No diseases detected" chip, general wellness Recommendations; no	Pass

			Recommendations; no clinic navigation button.	clinic navigation button.	
10.	Invalid Pet	-	Results page shows neutral status and Recommendation like "unable to analyze…does not contain a pet."	Results page shows neutral status and Recommendation like "unable to analyze…does not contain a pet."	Pass
11.	Severity shown when unhealthy	Unhealthy case	"Severity Level: Low/Medium/High" appears and matches color theme; absent for healthy flow.	"Severity Level: Low/Medium/High" appears and matches color theme; absent for healthy flow.	Pass
12.	Detected conditions chips	Unhealthy case	Conditions render as chips (e.g., "skin infection", "possible ringworm", "dermatitis"); chips are readable and not clipped.	Conditions render as chips (e.g., "skin infection", "possible ringworm", "dermatitis"); chips are readable and not clipped.	Pass
13.	Recommendations content	Any case	Recommendations paragraph is present and readable; no placeholders	Recommendations paragraph is present and readable; no placeholders	Pass
14.	"Find Nearby Veterinary Clinic" action	Tap button	Navigates to Nearby Clinics module (location permission flow if needed); Back returns to results.	Navigates to Nearby Clinics module (location permission flow if needed); Back returns to results.	Pass
15.	"Back to Scanner" action	Tap button	Returns to AI Analyzer screen with the last photo cleared	Returns to AI Analyzer screen with the last photo cleared	Pass

			or preserved per design	or preserved per design	
16.	Rapid re-analysis	Tap Analyze twice quickly	Only one request is processed; UI prevents spamming; no duplicate result pages.	Only one request is processed; UI prevents spamming; no duplicate result pages.	Pass

6.2.10 Nearby Clinic Navigation Function Testing

No	Test Case	Test Data	Expected Output	Actual Output	Result (Pass/Fail)
1.	Open PawLife Vet Finder from bottom nav	Location permission already granted	Vet Finder screen loads with map + left panel showing Search, Filters (Distance/Status/Rating), and Veterinary Clinics list sorted by distance.	Vet Finder screen loads with map + left panel showing Search, Filters (Distance/Status/Rating), and Veterinary Clinics list sorted by distance.	Pass
2.	Open Vet Finder from AI Diagnose modal	Unhealthy result and tap Find Nearby Clinics	Prompt the alert message to display nearby clinic based on user current location	Prompt the alert message to display nearby clinic based on user current location	Pass
3.	Search by clinic name	Type “Klinik Haiwan” in search field	List filters to matching clinics; map markers remain. Clear button restores full list.	List filters to matching clinics; map markers remain. Clear button restores full list.	Pass
4.	Apply Distance filter	Set Distance = “≤5 km”	List updates to clinics within range; badge	List updates to clinics within range; badge or	Pass

			or chip shows active filter.	chip shows active filter.	
5.	Apply Status filter	Set Status = "Open Now"	Only open clinics are shown; "Open now" label appears on items.	Only open clinics are shown; "Open now" label appears on items.	Pass
6.	Apply Rating filter	Set Rating = "≥4★"	List shows clinics with rating ≥ 4.0; ordering by distance preserved within filter set.	List shows clinics with rating ≥ 4.0; ordering by distance preserved within filter set.	Pass
7.	List Details	Tap a clinic row "Klinik Haiwan" (0.6 km)"	Details card opens with photo carousel, name, rating + review count, Open now status, full address, distance and Get Directions button.	Details card opens with photo carousel, name, rating + review count, Open now status, full address, distance and Get Directions button.	Pass
8.	Details consistency	-	Name, address and distance in details match the list row; no mismatched data.	Name, address and distance in details match the list row; no mismatched data.	Pass
9.	Launch Google Maps	Tap Get Directions	Android opens Google Maps turn-by-turn navigation to the selected clinic; route + ETA visible.	Android opens Google Maps turn-by-turn navigation to the selected clinic; route + ETA visible.	Pass
10.	Nearest clinic quick-nav (from Diagnose)	On Diagnose modal tap Navigate Now	App jumps directly to Google Maps navigation to the nearest clinic shown in the modal.	App jumps directly to Google Maps navigation to the nearest clinic shown in the modal.	Pass

11.	Long names handling	Clinic with very long name or address	Truncates gracefully in list and details; Get Directions remains tappable.	Truncates gracefully in list and details; Get Directions remains tappable.	Pass
12.	Error handling (no results)	Set filters to produce zero matches	"No clinics found" empty-state appears with option to clear filters or widen radius.	"No clinics found" empty-state appears with option to clear filters or widen radius.	Pass

6.2.11 AI-Chatbot Function Testing

No	Test Case	Test Data	Expected Output	Actual Output	Result (Pass/Fail)
1.	Open AI Chatbot	-	Chat header shows "Doctor Paw", greeting message appears, input box + send button visible, Quick Pet Education chip row shown.	Chat header shows "Doctor Paw", greeting message appears, input box + send button visible, Quick Pet Education chip row shown.	Pass
2.	Send a simple text question	"What are the essential things to know during pet sick?"	Bot returns a multi-point answer within chat bubble; message timestamped; no crash.	Bot returns a multi-point answer within chat bubble; message timestamped; no crash.	Pass
3.	Empty input	Tap send with blank input	Bot reply to ask user "How can I help you today?"	Bot reply to ask user "How can I help you today?"	Pass
4.	Quick button	Tap PUPPY CARE chip	Pre-filled question is sent automatically (or input is filled per design); bot returns targeted education content; chip remains selectable.	Pre-filled question is sent automatically (or input is filled per design); bot returns targeted education content; chip remains selectable.	Pass
5.	Quick buttons overflow	Swipe chip row horizontally	Chips scroll smoothly; focus and selection remains correct.	Chips scroll smoothly; focus and selection remains correct.	Pass
6.	Choose from Gallery	Select dog photo	Thumbnail is inserted with the user message; bot replies	Thumbnail is inserted with the user message; bot replies with breed	Pass

			with breed and description as in screenshot.	and description as in screenshot.	
7.	Take Photo	Capture image from camera	Photo is attached to message and analyzed; bot returns description; permissions handled gracefully.	Photo is attached to message and analyzed; bot returns description; permissions handled gracefully.	Pass
8.	Unsupported/too large image	Pick non-image or very large file	App rejects with friendly error; no crash; chat remains usable.	App rejects with friendly error; no crash; chat remains usable.	Pass
9.	Translation prompt visible	After bot reply	Translate link appears under bot message.	Translate link appears under bot message.	Pass
10.	Open translation menu	Tap Translate	Language chooser dialog appears (English, Malay, Chinese).	Language chooser dialog appears (English, Malay, Chinese).	Pass
11.	Switch language	Tap Translate again to Chinese	New translated bubble is shown in Chinese; previous translations persist or are replaced per design.	New translated bubble is shown in Chinese; previous translations persist or are replaced per design.	Pass
12.	Scroll	Long conversation	Chat can scroll; older messages remain accessible; scroll-to-bottom appears.	Chat can scroll; older messages remain accessible; scroll-to-bottom appears.	Pass

6.3 Project Challenges

During development, designing the AI-Diagnose output component are particularly challenging as any phrasing resembling “clinical” terminology could be misinterpreted as medical advice. Users are highly susceptible to misinterpreting model outputs as definitive diagnoses. Consequently, the application must unequivocally state its scope of application and avoid any phrasing implying professional judgement. It does not display confidence scores which can be mistaken for diagnostic certainty and it never suggests treatment steps, medication names, or dosages. Instead, it presents neutral, bounded result labels such as “no diseases detected,” “potential diseases detected,” or “invalid diagnose,” in term of visual cues only. For any escalated issues, the component displays a standardized escalation message only by directing the users to seek a veterinary evaluation through the in-app clinic finder. This careful design avoids language that sounds like veterinary advice, reducing the risk of misunderstanding while ensuring functionality is limited to decision support.

Another project challenge is the reliability of time-based reminders on Android. Due to the operating system restricts background work through Doze mode, Battery Saver policies, OEM-specific throttling, and behaviour changes after device reboots, sometimes, the reminders for medicines, vaccinations, and appointments might be delayed or suppressed. This makes it difficult to guarantee that alerts will appear precisely at the scheduled time across different devices and OS versions, and it requires careful scheduling design to maintain user trust in the reminder function.

In addition, the obtaining accurate geolocation and handing off navigation to external map applications presents practical difficulties. Indoor positioning, permission denials, and inconsistent behaviour across Android versions and OEM devices can degrade location accuracy and interrupt the navigation flow. These factors complicate the user experience for locating nearby veterinary clinics and require robust fallbacks to prevent dead-ends when permissions are withheld or GPS signals are weak.

6.4 Objectives Evaluation

Objective (a): Design a user-friendly interface for integrated health and schedule management.

This objective has been successfully achieved. The application presents an intuitive Dashboard that centralizes access to Pet Management, AI-Diagnose, Nearby Clinic Navigation, and the AI-Chatbot, while the "Upcoming Event" panel surfaces imminent items for medicines, vaccinations, and appointments. Per-pet schedules are created, viewed, updated, and deleted through dedicated forms, with data persisted locally via Room and reflected immediately in the pet's details and Dashboard lists. Notification reminders fire at configured times and reopen the correct detail screens when tapped, confirming that the interface supports complete end-to-end schedule management in a clear, accessible manner for users of varied technical backgrounds.

Objective (b): Develop a real-time geolocation feature for emergency services.

This objective has been successfully achieved. The Nearby Clinic module acquires the user's current location with runtime permission handling, listing the veterinary clinics sorted by distance and exposes filters such as distance, open-now status, and rating to support rapid decision-making. Clinic detail cards able to display address, distance, rating, and an action to "Get Directions," which hands off seamlessly to Google Maps for turn-by-turn navigation. The flow is also integrated with AI-Diagnose: when an unhealthy outcome is indicated, the system prompts the user to open the clinic finder immediately, demonstrating a reliable pathway from assessment to care.

Objective (c): Develop AI-based image recognition for illness detection.

This objective has been successfully achieved. The AI-Diagnose module accepts gallery images, performs image validation and returns a structured and user-readable result. The outcomes are presented in safety-constrained terms like healthy, potential concern, or not analysable with observable visual cues and general guidance. For elevated concerns, the result view displays a standardized escalation prompt to seek veterinary care and links directly to the Nearby Clinic module. Healthy outcomes present preventive suggestions. The module consistently renders complete results and preserves a decision-support scope appropriate for non-clinical use.

Objective (d): Implement an AI-powered chatbot that delivers personalized educational content

This objective has been successfully achieved. The AI-Chatbot supports free-text questions and Quick Buttons for common topics, returning concise, readable guidance on disease prevention, nutrition, behaviour, and chronic care. Users can optionally attach an image to obtain context-aware explanations. The built-in Translate action renders responses based on user's preferred language. Conversation flows remain responsive and stable across varied inputs, and the feature complements the diagnostic and scheduling modules by providing timely explainable education tailored to each pet's needs.

6.5 Concluding Remark

In summary, Chapter 6 presents the system's verification using black-box testing across all major modules, including authentication and onboarding, dashboard navigation, pet management, per-pet scheduling with notifications, the AI-Diagnose feature, the Nearby Clinics navigation, and the AI-Chatbot. The tests confirm correct handling of valid and invalid inputs, reliable state transitions, accurate data persistence, timely reminders subject to documented Android constraints, and safety-scoped AI outputs that escalate higher-risk cases to professional care. The objectives evaluation shows that all planned functions were successfully implemented and operate as intended on real devices. Overall, the chapter concludes that the application is functionally complete, stable, and ready for broader evaluation and iterative refinement.

CHAPTER 7 CONCLUSION AND RECOMMENDATION

7.1 Conclusion

As a conclusion, this project aims to solve the problem of fragmented and inefficient pet medical management. Many pet owners have difficulty tracking their pets' vaccinations, monitoring health symptoms, and obtaining emergency veterinary services in a timely manner. In order to meet the needs of users for a comprehensive and user-friendly solution, we proposed a "Pet Health and Management System" that aims to simplify and centralize pet health management through a mobile application.

The system integrates multiple core functions, including AI-based pet image disease detection, a veterinary clinic locator based on real-time geolocation, health record and schedule management, and an AI-based educational chatbot that provides personalized pet care recommendations. These features are designed to help pet owners detect early signs of disease, maintain well-organized health records, and make informed decisions for their pets' health.

A key innovation of the project is the use of a personalized AI educational chatbot that not only answers users' queries, but also provides customized health recommendations based on the pet's breed, age, and health history, thereby enhancing the relevance and value of the educational support provided. The project successfully combines mobile development, AI integration, and real-time services into a single platform to provide practical and effective solutions to common challenges faced by pet owners.

7.2 Recommendation

A part from my development, there is some recommendation which the project can added in. Firstly, The application should be extended to support online and face-to-face consultation as an additional feature. Within each pet profile, users would be able to request a video consultation for non-urgent concerns or book an in-clinic visit for cases that require physical examination. The consultation flow should capture basic intake information, allow image upload, present a clear statement that the service provides decision support and is not a substitute for emergency care, and write confirmed bookings into the pet's schedule so that the care record remains complete.

Another recommendation is that the AI Chatbot should be enhanced with speech-to-text input to improve accessibility and ease of use. A microphone control on the chat screen would allow users to dictate questions, review the transcribed text, and submit it for an AI response. Visual indicators should make recording status clear, short recordings should be encouraged to keep interactions responsive, and a brief consent message should inform users that audio is being captured for transcription.

Lastly the Nearby Clinics and Navigation feature should include a direct phone call action for appointment arrangements. Each clinic card should display a prominent call button alongside the navigation option, with a confirmation prompt to prevent accidental dialing. After a call ends, the interface should offer to create or update an appointment entry under the selected pet so that the conversation results are immediately reflected in the scheduling module and the user's care journey remains traceable.

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Poster


PAW LIFE
1 INTRO
Pet Health and Management System is a mobile app that simplifies pet healthcare by enabling owners to track health records, detect early symptoms through AI and access real-time emergency services. Combining intelligent image recognition and an AI educational chatbot, the app promotes preventive care and strengthens the bond between pets and their owners, ensuring timely and personalized support.
2 Objective
1. To design a user-friendly interface for integrated health and schedule management
2. To Develop a Real-Time Geolocation for Emergency Services
3. To Develop AI-Based Image Recognition for Illness Detection
4. To implement an AI-powered chatbot that delivers personalized educational content to pet owners
3 Methods
Pet Scedule Reminder
AI Symptom Checker
Nearby Geolocation Finder
AI-Chatbot
4 Result
AI-Diagnose Report
AI-Chatbot Education
Schedule
Nearby Clinic Navigation