Mobile Tour Guide Application with On-Site Augmented Reality - Kampar Churches

BY

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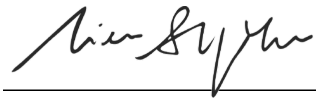

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ABSTRACT

It has been demonstrated in the tourism industry that locating and highlighting interesting sites and places of interest for visitors, particularly through AR technologies, improves the overall visiting experience when they are on-site. AR-based tour guides allow travellers to have intuitive and realistic encounters. It is important to optimise tourism in Kampar so that information technology may benefit visitors and offer novel travel experiences. In general, visitors want to learn about visiting tourist attractions in an appealing way. Nowadays, it is uncommon to find mobile-based application programs that provide information about tourist attractions in Kampar. Therefore, it is crucial to create an application for providing information about tourist attractions, particularly Kampar's churches. The application uses augmented reality technology, which is expanding quickly around the globe, to display historical media about the churches. Using an Android smartphone scan a certain object or location, the software can then display pertinent media and historical data about such tourist attractions by using machine learning. As a result, augmented reality has the potential to be a new kind of advertising for the tourism industry and to boost tourism in Kampar. The project will concentrate on Sacred Heart Church, the only churches that are historically more significant than other modern churches.

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LIST OF ABBREVIATIONS

AR	Augmented Reality
VR	Virtual Reality
CNN	Convolutional Neural Network
R-CNN	Region-based Convolutional Neural Networks
RPN	Region Proposal Network
SVM	Support Vector Machines
YOLO	You Only Look Once Algorithm
IoU	Intersection over Union
mAP	Mean Average Precision

Chapter 1
Introduction

This chapter will encompass the problem statement and project motivation, objectives, project scope, contribution, and background information. AR allows tourists to explore and learn about destinations in new and innovative ways, such as viewing information and digital content about historical sites, museums, and cultural landmarks in real time. The traditional tourism experience can be limited and challenging for some visitors, resulting in disengagement and decreased revenue for businesses. Less popular tourist locations in Malaysia with cultural and historical significance may be overlooked due to a lack of guidance and information. Without tourism, local businesses may find it difficult to survive, resulting in job losses and cultural heritage preservation losses.

1.1 Problem Statement and Motivation

Nowadays, traditional tourism experiences can be limited by the physical environment and may not always provide visitors with an immersive and interactive experience especially lack of time, crowding, dissatisfaction with or unattractiveness of the destination environment [4]. This can lead to disengagement and a lack of enthusiasm towards the location or attraction, resulting in decreased revenue and tourism growth. The previously mentioned scenario gives rise to a new trend known as virtual reality tourism, whereby users get provided with a virtual reality device that includes simulated environments of various locations. These immersive experiences often have interactive components that allow users to interact with the virtual scenes and access relevant information related to the shown destinations. This might feel interesting for people however, most people will still want to visit the place physically because this can engage all a person's senses regarding sight, sound, smell, touch, and even taste to fully immerse themselves in the experience and maybe have a chance to experience some unpredictable moment that virtual environment will not be able to present. Moreover, many of Malaysia's less popular tourist locations provide distinctive cultural and historical experiences that are sometimes disregarded by travellers.

Visitors, however, could miss out on the significance and beauty of these locations due to a lack of sufficient guidance and information. Even though they had a chance to visit, tourists might still not be able to fully understand the cultural and historical value of these locations without access to reliable and interesting historical information, which could result in a wasted chance to discover and engage with the local's rich cultural history. This could have a negative impact if the problem is not solved.

The hypothetical situation brings to light a problem that some of the places in Kampar such as churches encounter. Even while they may not draw as many visitors as popular tourist spots, these locations are still important to the local community and draw lots of residents who come for religious or cultural reasons. However, this could make it challenging for visitors to the site to appreciate its significance. There might not be enough resources available to provide tourists with accurate and interesting historical knowledge, and the dense crowds of people might be overpowering. Visitors may become frustrated and dissatisfied as a result, and they may complain or publish negative reviews or comments about the establishment, harming its reputation and deterring potential customers from going there.

For many local businesses tourism is a significant source of revenue. Without tourists, these firms could find it difficult to survive, which could result in job losses, lower income, and possibly even business closures [5]. This may spread throughout the neighbourhood and have an impact on other businesses that depend on tourism-related spending. Social and cultural effects may also result from a lack of tourism. Without tourism, many local communities' ability to preserve and share their cultural heritage and traditions with tourists may be lost or forgotten [5]. Additionally, the lack of exposure to other cultures and lifestyles that come from travel might result in a more limited perspective on the world as well as less appreciation for and understanding of other civilizations.

To give visitors to Kampar a more realistic interesting, and helpful experience, this project aims to create a mobile tour guide application which contains an object recognition function with location-based augmented reality that will be used on-site to replace those tour guides, guidebooks and audio tours which are examples of most common traditional tourist methods that can have a limited scope and fall short of giving visitors a completely immersive and engaging experience. Contrarily, on-site augmented reality technology enables guests to experience these locations in a more participatory and engaging way, giving them a greater appreciation and comprehension of the history of some Kampar attractions despite physical environment limitations. For instance, tourists can receive comprehensive information such as passages about the historical significance of the attraction, including its origins, architecture, and cultural relevance, by simply scanning a specific item or location within the building using their mobile phones. The mobile tour guide application will create a more inclusive and accessible tourism experience that caters to the needs and interests of all visitors, including those with language barriers. The major objective is still to raise awareness of the value of augmented reality (AR) technology to increase its application across a range of industries, including manufacturing, tourism, education, and other sectors.

1.2 Objectives

The main objective of the AR Tourism Project is to create a mobile tour guide application using open source that leverages augmented reality technology to enhance visitors' experience at the Kampar Churches site. The application provides visitors with comprehensive and engaging information about the history, culture, and significance of the church, making their visit more immersive, interactive, and accessible. A few sub-objectives derive from the main objectives stated above.

- **To train a machine learning model with an accuracy of 75% and above to identify and recognize items in churches.**
  This involves selecting a suitable machine learning algorithm, gathering, and preparing data for training, and iteratively refining the model until it achieves satisfactory accuracy in identifying and recognizing the desired items.
- **To design and implement a user-friendly interface and develop a module for the mobile application.**
  This may include creating wireframes, designing icons and visual elements, and integrating the model into the application's back end. The application also allows users to interact with the machine learning model and receive the output of its recognition capabilities. It contains an attraction list module, mini-game module, translation module and attraction recognition module.
- **Able to completely develop the mobile application during the Final Year Project period.**

The mobile application consists of modules such as attraction and artifact recognition and attraction list which will be completed during the Final Year Project period which is 6 months (2 semesters).

- **To enhance immersive and interesting experiences among tourists by providing historical information through AR-based on-site recognition.**
  This application gives users the ability to acquire historical information about Kampar Churches without requiring them to look for the information on the internet; instead, users just need to scan through the object to obtain the information.

1.3 Project Scope and Direction

The project's scopes include developing a mobile tour guide app with augmented reality technology for on-site use, a thorough database of historical and cultural data about the Kampar Churches site, and a user-friendly interface and navigation system that makes it easy for visitors to access and interact with the app. This project also includes a few significant tasks, including researching and analysing the Kampar Churches site to create a thorough database of historical and cultural data, creating a lightweight and faster machine learning model to process images on-site, planning the creation of augmented reality content and incorporating it into the application, designing and building an Android tour guide app, testing and quality assurance, and quality control. The application must be compatible with Android devices and operate effectively on a variety of mobile devices with diverse specifications and capabilities. This project must be finished in the allotted time of two semesters, or roughly six months. There will be a few modules included in the mobile application are login module, an attraction list module, a live artifact/attraction recognition module, an AR module, a non-real time artifact/attraction recognition module, a mini game module and a settings module.

- **Login Module**
  This module includes several functions, namely the login function, the create account function, and the forget password function. The login function and create account function enable users to authenticate themselves by providing their email address and password. The password reset feature enables users to reset their password by using their email account in case they have forgotten

their password. The login module's primary function, nevertheless, is to provide users access to their unique data, like the minigame module's data.

- **Attraction List Module**

  This module includes an overview of popular tourist attractions offerings in Kampar that are highly recommended for visitors to explore or experience. Each attraction is shown in a card widget. When a user clicks on a card, they are directed to a corresponding page that provides fundamental details like pictures of the attractions, historical context on the area, and a link that takes the visitor to Google Maps where they can check up additional information like the address and operation hours.

- **Live Artifact/Attractions Recognition Module**

  This module enables users to utilise the camera function on their mobile devices to scan and identify various artefacts and architectural structures associated with churches located in Kampar. Upon the identification of an object, the name of said object is then displayed on the screen of the user's mobile device, along with the corresponding detection result and an AR button that lets the user select whether or not to view the artefact in augmented reality. The implementation of this module utilises a machine learning-based object detection technique. The machine learning model is trained by initially gathering photographs captured from various angles to enhance its accuracy. Subsequently, the image is utilised for training the model. Finally, the model has been successfully developed and is now capable of accurately identifying and classifying the object. This module also offers users the capability to visualize artifacts with enhanced clarity. Users have the freedom to zoom in and out on the artifact, allowing for detailed examination. Additionally, they can rotate the artifact a full 360 degrees horizontally, enabling them to inspect both the front and back perspectives comprehensively. This interactive functionality facilitates a more immersive and insightful viewing experience, enhancing the understanding and appreciation of the artifact's intricacies and features. Upon detecting the artifact and activating the AR feature by tapping the button in the live artifact/attraction recognition module, users will immediately observe the corresponding 3D model of the artifact appearing at the center of their phone screen, seamlessly superimposed onto the real-world environment.

- **Non-Real Time Artifact/Attractions Recognition Module**
  This module is similar to the Live Artifact/Attraction Recognition Module in that its primary function is to do artifact recognition. Unlike the Live Artifact/Attraction Recognition Module, which only works in real time, this module allows users to upload photographs or videos from their device's gallery for recognition by just tapping a button. This feature broadens the reach of recognition beyond live situations, allowing users to analyse previously collected media for relevant content.
- **Mini Game Module**
  This module contains a minigame that users can take part in. When players take part in the process of scanning or detecting various objects, such as artefacts within these churches, once users have successfully detected an artifact the artifact will then be unlocked, and they gain access to a wealth of historical information associated with it. This mini game bears resemblance to a treasure hunt but with the objective of discovering an attraction. The purpose of adding this module is to enhance the users' experience.
- **Setting Module**
  Several important features that are designed to improve user control and experience are included in this module. It gives users the ability to customise their accounts by offering alternatives to change both usernames and passwords. Users can also safely log out at any time to maintain security and privacy. The reset minigame function, which allows users to return the minigame module to its original state if desired, is another special feature of this module.

1.4 Contributions

The proposed phone tour guide application has the power to transform how visitors encounter and value regional historical and cultural places. The application uses augmented reality technology to provide users with a realistic and interactive experience that can help them comprehend and appreciate the significance of Kampar's churches. For less well-known destinations that might not get as much attention from conventional tourism tactics, this can be especially helpful. Visitors can visit the churches at their leisure while using this application to quickly and easily access authentic historical information on their mobile devices. The application also can increase visitor pleasure by giving them a more enriching experience. This might lead to favourable evaluations and word-of-mouth recommendations that could draw additional tourists to the area. In turn, this can aid in sustaining regional economies and small enterprises that depend on tourism-related income. The application can help conserve and share the cultural legacy and traditions of the local community with tourists, preventing future loss and creating respect and admiration for regional customs. This is done by fostering cultural appreciation and understanding. This may encourage cross-cultural and social interaction between tourists and residents, leading to a broader and richer perspective on the world. Last but not least, this project can be combined with other projects of similar kind that have been completed in the past or will be carried out in the future to widen the attraction's scope or to construct an application that is more complete regarding all tourist attractions ranging from Kampar or even larger to the entire state of Perak.

1.5 Background Information

Tourism and travel have always been vital components of human life. Travel is done for a variety of objectives, including business, pleasure, and education. However, visiting a new location without proper guidance can be overwhelming, particularly if one is unfamiliar with the region. While the most common and well-known types of tour guides provided to tourists are booklets or tour maps, local tour guides who direct tour routes and orally explain information or provide the background of certain sites may be tedious or uninteresting enough compared to multimedia tour guides. Fortunately, the creation of mobile applications that meet tourist needs has increased accessibility and convenience to travel.

Augmented reality refers to a technological idea that seamlessly integrates digital information with the user's physical surroundings in real-time. AR is a technology that superimposes virtual things onto real-world situations using a camera or display device. This enables the integration of computer-generated images, sound, movies, text, filters, infographics, or other sensory inputs into a user's perception of their immediate surroundings [25]. It allows users to interact with both the real environment and the virtual object with AR, giving them a deeper experience. Despite being futuristic, augmented reality is spreading, and by 2022, it's predicted that $45.1 billion will have been spent globally on it [1]. AR is employed in many different fields, including medicine, education, product development, manufacturing, and marketing. Glasses, cellphones, headsets, and screens are just a few of the gadgets that can display augmented reality projections. Depending on the type of AR, they can collect data about the user's surroundings via cameras, gyroscopes, accelerometers, depth sensors, and light sensors [1]. After processing the data, the animation is displayed in a timely and appropriate manner. To function properly, AR technology needs several crucial components, including sensors, algorithms, and output devices. Pokémon Go, a mobile game that debuted in 2016 and amassed more than $6 billion in sales by 2020, is most likely the most well-known example of augmented reality [1]. The game mixes digital technology with active participation by having users visually locate cartoon characters in real-world settings.

Thus, combining the technology and tourism industry, AR is increasingly being used to enhance the visitor experience by providing interactive and immersive experiences [2]. AR technology allows tourists to explore and learn about destinations in new and innovative ways. Tourists can use AR-enabled mobile devices to view information and digital content about historical sites, museums, and cultural landmarks in real time [2]. As an example, Byung-Kuk et al. created an augmented reality framework that employs context awareness to locate a wooden block in Gyeongbok-gung, Korea, provide historical context, and determine the user's present location without the use of positional sensors or compasses [3]. The AR also allows tourists to visualize what a destination will look like before they visit, which can help with trip planning and decision-making. AR technology can also be used to create interactive experiences that engage tourists in new and exciting ways [2]. For example, AR games can be developed that allow tourists to explore a destination while learning about its history and culture. This kind of gamification can boost involvement and provide visitors with a more unique experience.

In this paper, a mobile app that gives insider tours of Kampar's churches using augmented reality (AR) will be developed. Kampar is thought to be less well-known than the most well-known tourist locations in Malaysia. However, there are still some historical locations that are worthwhile for travellers to visit. As a result, there are no tour guides, such as pamphlets and local guides, accessible to explain the historical background. The recommended augmented reality tour guide mobile application offers historical and structural information by performing on-site augmentation on an artifact or building structure without the usage of location sensors or compasses.

1.6 Report Organization

This report is structured into seven chapters: Chapter 1 introduces the project, covering aspects such as the Problem Statement, Motivation, project background, scope, objectives, contributions, and organisation of the report. Chapter 2 presents a literature review conducted on existing AR tourism systems and object recognition systems to assess their strengths and weaknesses. Chapter 3 discusses the overall methodology and approach of the project, including the methodology used, system architecture diagram, use case diagram, and activity diagram. Chapter 4 focuses on the system design, including block diagrams, flow charts, user requirements, and database design. Chapter 5 provides details on the implementation of the system design. Chapter 6 delves into the selection of testing metrics and presents the test results. Finally, Chapter 7 concludes the report and offers recommendations for future endeavours.

Chapter 2
Literature Review

2.1 Previous work on AR tourism

2.1.1 Augmented Reality-Based On-Site Tour Guide: A Study in Gyeongbokgung

The four components of the proposed AR tour guide framework by Byung-Kuk et al. are input agent, context awareness, augmentation, and output agent. The input agent collects tourist profiles from a GUI menu and photos of the target scenes. The location of the visitor is determined in the context-awareness component by comparing snapshot photographs to a database of reference images. These images are then provided to management agents for the purpose of gathering contextual and location-related data. The augmentation component renders 3-D virtual characters onto the actual places in real-time using live video footage. The output agent provides pre-recorded narration through a speaker that is synced to the rendered 3-D virtual characters while displaying information, contents, and a tour map on GUI windows. They also outline a method for designing an individualised augmented reality (AR) tour guide for culturally significant locations. The tour guide provides pertinent information and content based on the visitor's location and profile, including age and language. By using picture matching to identify wooden tablets at the heritage site, the location of the visitor can be determined. The tablets offer background data on the location, and a database contains photographs of the tablets. The k-nearest neighbour algorithm is used to do the recognition by finding feature points in the snapshot image, computing their descriptors, and comparing them to the descriptors of reference images. The method was examined and confirmed to be trustworthy. They then proposed a technique for overlaying 3D virtual models to actual scenes in real-time without the use of additional sensor equipment. The technique employs a planar-based visual tracking strategy to monitor simple geometric primitives, which are rectangles of doorframes in the target scenes, to estimate the camera pose. Identifying the target scene's boundaries, locating the doorframe rectangles' contours, extracting the rectangle under specific restrictions, and calculating the camera pose using planar-based pose estimation are all steps in the procedure. The rendering and tracking modules make up the tracking module. While the rendering module superimposes and renders 3D virtual models on actual scenes based on user views, the tracking module localises the camera with respect to the target scenes. The prototype of the AR tour guide is then tested using a laptop and USB camera [3].

- Strength
  - Gathers user profiles to produce material and information based on their ages and languages.
  - Superimposed a 3D model on top of their augmented reality.
  - Determine the user's location without the usage of positional sensors or compasses.
- Weakness
  - AR devices used in tourism are heavy, bulky, or located in inconvenient places, which can limit their use by tourists.
  - The equipment and software required to create AR experiences in the previous study are expensive and hard to use.

2.1.2 Ray-on, an On-Site Photometric Augmented Reality Device

The authors in this paper developed an AR device using mixed reality techniques on the virtual side, they have developed a uchronic window that combines the real and virtual sites. Geometric and aesthetic coherence between the real and virtual worlds are the two key ideas that are emphasised. To serve as a window, a large, fixed display that can be rotated across two axes to aim at any nearby location is needed. To mirror the real view, the virtual site needs to be rendered with photorealism. The alignment of virtual models and actual objects is necessary for geometric consistency, and it is accomplished by accurately representing the user's viewpoint in the virtual rendering. The user's location is imposed rather than measured, and the device is free to move around two axes. On the basis of average measurements for the device's height and the length of the arms, an average virtual camera is calculated. Absolute sensors track the device's alignment to prevent input drift. To minimise point of view fluctuations that can be evident as a result of the rendering technique utilised, the centre of rotation is placed near to the display. The earlier idea works for actual things that are close to the device, but outside situations necessitate a two-step solution. When stationary, the object serves as a window revealing the historic location. The virtual camera's range of view narrows when it is moved by a visitor, zooming in to reveal details that are hidden from a distance. The virtual camera serves as a spotting scope by tracking any motion of the screen. Due to the intricacy of the virtual mockup of the historical location, the authors adopted an image-based rendering method (IBR) to achieve visual consistency when simulating a uchronic window. IBR includes computing a significant portion of the render in advance and transferring only the lighting to the virtual result. By combining numerous renderings of the same panorama with the difference being the placement of a single directed light, the process entails rendering a whole panorama from the perspective of the device and recreating any lighting conditions. In this three-step process, the panorama is rendered, a high dynamic range (HDR) image probe of the lighting environment is captured and decomposed into the same directions as those used for rendering, and then the renderings are added up using the weights determined for each direction in the previous step. Through the provision of a calibrated lighting environment, the lighting reproduction approach can make it easier to combine virtual and actual live video streams. Geometrically combining the sources and applying tone-mapping to the resulting HDR image constitute the two steps of the merging process. This method provides uniformity between the merged sources and is resistant to variations in lighting. Due to shifting lighting circumstances, on-site installations need automatic ways to change colour balances and exposure or brightness settings [13].

- Strength
  - Ability to emphasise both geometric and aesthetic consistency while integrating the physical and digital realms.
  - Absolute sensors to monitor alignment and eliminate input drift.
  - Tourists could zoom in using the devices to see things that are obscured from a distance.
- Weakness
  - AR devices used in tourism are heavy, bulky, or located in inconvenient places, which can limit their use by tourists.

- The equipment and software required to create AR experiences in the previous study are expensive and hard to use.

2.1.3 The Loupe: Tangible Augmented Reality for Learning to Look at Ancient Greek Art

The Loupe was developed by the APM to provide access to multiple layers of information and perspectives using the same device. The Loupe was designed to provoke a more active attitude from visitors, encourage longer and more intense viewing of objects, and create a new way of storytelling in museums. The Loupe was imagined through a co-design workshop session, where early interaction ideas were tested and evaluated. The Loupe was distilled from the idea of a monocular that could zoom in on objects but was discarded due to its individualistic nature. The Loupe would allow more than one person to use it and capture information on the display until actively discarded. The Loupe was designed to show visual information and intuitively instil a "look through" and "observe" attitude in visitors. The Loupe is a wooden casing that holds an iPhone 4s and runs an AR application using the Vuforia SDK, allowing users to search for objects in a museum by matching the outline displayed on the phone's screen to the physical object. The Loupe can be tilted to navigate, and the AR exhibit is designed based on three variables: the target object, the Loupe's interaction, and the content presented. The Loupe's casing is made using a 3-axis milling machine, and the main challenges are calibrating its location and creating appropriate visual and textual content [17].

- Strength
  - Users' interest and sense of immersion in the artwork are increased by the tool's physical manipulation capabilities, which allow them to zoom in on certain features.
  - Offers a multi-sensory experience that improves viewers' knowledge and appreciation of the artwork.
- Weakness
  - AR devices used in tourism are heavy, bulky, or located in inconvenient places, which can limit their use by tourists.

- The equipment and software required to create AR experiences in the previous study are expensive and hard to use.

2.2 Previous work on object recognition/ detection

2.2.1 A Tourist Place Recommendation and Recognition System

This study presents a mobile application that integrates the functionalities of place recommendation and recognition. However, the focus and review will just be on the recognition aspect. The application has undergone training to develop the ability to identify a specific location by analysing image input of such location, utilising a compilation of places sourced from the TripAdvisor dataset. The dataset utilised for training the model was obtained through web crawling of Google Images, specifically targeting the locations referenced within the TripAdvisor dataset. A web crawler specifically intended for collecting photographs from Google image searches was utilised to acquire a total of 100 images for each location. The dataset of 100 photographs is subsequently divided into three different categories, which in the ratio of 7:2:1 for training, validation and testing [6]. These images are then organised and kept in separate folders according to their respective categories and places. This approach is recommended for situations where the dataset is not accessible online or is insufficient in quantity. Following the completion of data preprocessing, the CNN is initialised by first assigning the weights to be utilised. In the context of convolution, the author proposes a technique called Conv2D(). The approach utilises a two-dimensional convolutional layer, which produces a convolution kernel that is subsequently applied to the input of the layer. This process yields a tensor including output values. Subsequently, the pooling layer is employed to spatially downsample the volume, operating independently on each depth slice. The pooling layer in this study was implemented using the MaxPooling2D() function. The maximum pooling operation is employed to facilitate information extraction between two consecutive convolutional layers [6]. Subsequently, the utilisation of a flattening layer is employed to transform the output of the convolutional component into a one-dimensional array. The previously stated objective is accomplished by the process of flattening the output generated by the initial layers. Finally, the dense layer is employed to alter the dimensions of the vector. The CNN model achieved an ideal result of 46.4% accuracy when trained using a parameter of 50 steps per epoch for 100 epochs, with 200 validation steps. In terms of future works, the author proposes enhancing the accuracy of the place recognition system and expanding its coverage to include a wider range of global locations [6].

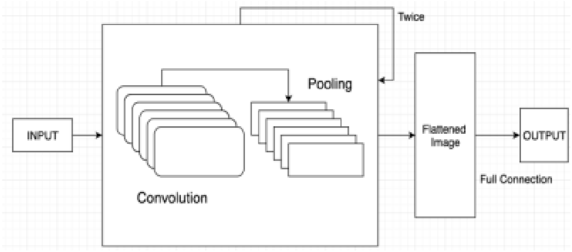

Figure 2.1 Architecture of CNN algorithm.

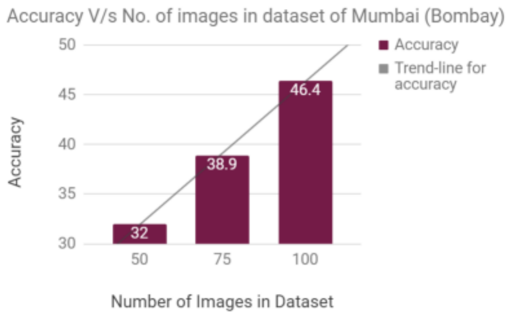

Figure 2.2 Accuracy vs No.of Images.

- Strength
  - The application is useful for users who are visiting a place for the first time.
  - The total training process requires less human effort as CNN possesses the ability to learn and recognise patterns in images autonomously, eliminating the necessity for manual feature engineering.
  - The trained model shows robustness to noise as a result of CNN's ability to identify patterns in images, particularly those sourced from the internet, even in the presence of distortion or corruption.
- Weakness
  - The author claimed that the accuracy is high; but, in my review, I claim that the average accuracy falls short of being sufficiently high, as it fails to attain a minimum accuracy of fifty per cent. The situation might be due to the author's use of a limited number of 70 photos for each place for training the

model. This quantity is considered insufficient as most convolutional neural network models require a larger dataset to achieve better accuracy.

- The CNN model requires high computational capabilities, including processing power and memory, for training. This can be a barrier for users or programmers seeking to employ the method for many locations in the future.
- The training process of CNN models is often defined by a slightly slower training speed when compared to alternative algorithms.

2.2.2 Application of the Faster R-CNN Algorithm in Scene Recognition Function Design

The method proposed in this paper is using a Faster R-CNN algorithm for scene recognition. The reason that the author chose Faster R-CNN is because it provides higher accuracy as well as acceptable recognition speed which are the most important attributes for scene recognition. The Faster R-CNN network architecture is slightly different compared to traditional object detection methods. While it shares similarities with conventional approaches, its component organization differs significantly [7]. Notable features include shared convolutions in the convolutional layer, Region Proposal Networks (RPN) for proposal generation, and a neural network for region proposal classification and localization. The scene recognition algorithm's network structure leverages RPN and shared convolutional layers from the detection network. This reduces computation time for image recognition while maintaining scene detection accuracy. The process involves image input, feature map extraction through an inceptionV2 model, RPN-based candidate box regression, and improved scene candidate box determination via the detection network. The RPN operates on scenery images from the dataset, followed by dividing the process into two lines. One of them involves classifying anchors into scene and non-scene categories using softmax, while the other focuses on regressing proposal positions [7]. This regression computes the deviations for the anchor boundary boxes, generating a set of region proposals while filtering out overly small or out-of-bounds proposals. The program then underwent initial training by gathering a dataset from the internet that covered a range of complex scenarios. Next, the author proceeds to filter a selection of images by eliminating any pictures that show blurriness or damage. Subsequently, data annotations are conducted using the labelimg tool. Once the annotation process finished, the dataset was further divided into three subsets: a training set comprising 60% of the data, and two additional subsets for verification and testing, each taking up 20% of the dataset. The model was further trained and tested from various perspectives, yielding a high accuracy rate of 98% [7].

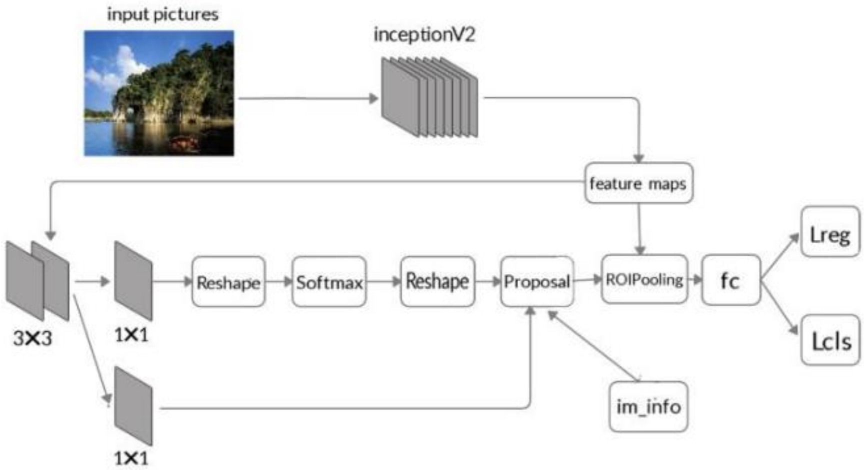

Figure 2.3 Scene recognition algorithm network structure

- Strength
  - The model achieves a high accuracy of 98% while ensuring the speed of scene recognition.
  - The used algorithm contains RPN, resulting in a significant reduction in the time required for proposal generation and overcoming the bottleneck associated with detection speed.
- Weakness
  - The system has not been subjected to testing in extreme environments, which could potentially reduce the accuracy of scene recognition.
  -

2.2.3 Recognition of Tourist Attractions

The present research suggests using CNN for the purpose of feature extraction, followed by SVM for prediction tasks on the input images. The Places-CNN model, which is built upon the AlexNet architecture, has been trained on a dataset consisting of scenery photos sourced from the Places database. This distinguishes it from the

AlexNet model, which has been trained on object images obtained from ImageNet. The feature extraction process of AlexNet and Places-CNN begins to diverge following the initial convolution layer as a result of the different training images used in their respective training processes [10]. The Places-CNN model demonstrated better results in terms of test accuracy (50.0%) when evaluated on a dataset of scenic images, as compared to the combination of AlexNet and an SVM classifier, which produced a lower accuracy of 40.8%. Therefore, Places-CNN is considered more appropriate for the author's application as tourist attractions are seen as scenery rather than objects, enabling the author to employ transfer learning instead of training the neural network from the beginning. The methodology involves using Places-CNN as a fixed feature extractor and subsequently training a classifier on these extracted features. While the use of softmax as the final layer in classification networks is common, there have been seen benefits in replacing it with a linear SVM [10]. The final layer of PlacesCNN is used to extract features, which are subsequently employed to train both softmax and SVM classifiers. A comparison is performed to determine the most effective approach for the given dataset. The dataset was initially produced by the author, consisting of 1000 images for each category. Subsequently, the dataset was partitioned into three subsets: 700 images for training, 200 images for validation, and 100 images for testing. Next, features were extracted from each image using the Places-CNN model. The pixel ratio of each pixel was then computed in order to distinguish whether the image was shot during the day or night and to subsequently determine which model should be utilised. Then, the softmax classifier is trained to utilise 10 distinct classes and stochastic gradient descent with momentum is employed as an optimisation algorithm to minimise the cross-entropy loss. A training procedure consisting of 10,000 epochs was conducted utilising a grid search methodology [10]. The model that yielded the highest validation accuracy was observed when the learning rate was set to 0.01 and the momentum was set to 0.9. The utilisation of early stopping by the author was employed as a way of preventing overfitting. This was done by evaluating the validation error at regular intervals, namely every 10th epoch, and terminating the training process if no decrease in error was observed after 100 epochs. Subsequently, a SVM was selected as the classifier for the purpose of binary categorization of images into either day or night classes. In contrast to softmax, SVM aims to determine a hyperplane that maximises the margin between classes. Additionally, SVMs are capable of handling non-linearly separable data by employing a soft-margin technique. Furthermore, a multiclass SVM was trained to classify attractions into 10 different classes. This was achieved by employing the one-vs-all strategy, where each class is separated from the remaining classes. The output of the model indicates the class that exhibits the maximum distance from the hyperplane. Based on the evaluation of validation accuracy, it was determined that multiclass SVM exhibited greater suitability for classification compared to softmax, as evidenced by the final test accuracy of 84.1% [10].

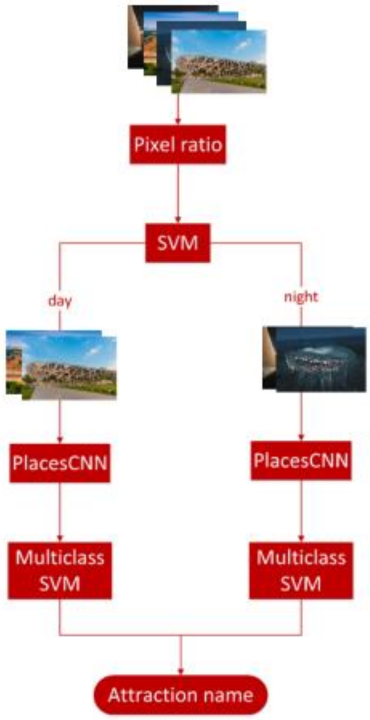

Figure 2.4 Complete classification pipeline.

- Strength
  - The model achieves a notable accuracy of 84.1% using a two-step approach. Initially, a SVM is utilised to distinguish between images captured during the day and those taken at night. This is necessary due to the presence of overlapping pixel ratio features between day and night images, which pose challenges in linearly separating them. Subsequently, the model employs another SVM model to classify the image based on the determined category.
  - SVM exhibit higher accuracy in processing data obtained through the computation of pixel ratios to distinguish between day and night. This is due

to their ability to effectively separate the two classes by maximising the distance between them.

- Weakness
  - SVM may not be well-suited for large datasets with numerous features because of its potential for slow processing and high memory consumption. This limitation could provide challenges in recognising additional locations in the future, requiring a larger number of photos.
  - Places CNN is a type of CNN thus it also requires high computational capabilities, including processing power and memory, for training. This can be a barrier for users or programmers seeking to employ the method for many locations in the future.

2.2.4 Deep learning based real-time tourist spots detection and recognition mechanism

This study presents a novel approach to the identification of tourist sites through the implementation of a tourist spot recognition system. The system utilises the YOLOv3 model, developed within the Tensorflow AI framework, to accurately identify tourist spots by capturing images using a smartphone's camera. The process of collecting photos of scenic spots involves the research team physically visiting Hsinchu's scenic spots, resulting in 28 locations and 15,351 images [8]. The system also dynamically retrieves a list of tourist attractions from the Hsinchu City Government's Information Open Platform for 77 additional spots. For feature value labelling, the system employs LabelImg, which utilizes the YOLO format to mark object features in training photos. This format includes object class number, object centre's X and Y ratios, and object width and height ratios. The YOLOv3 algorithm is used in the third step for building the object detection model. YOLOv3 performs both object recognition and classification in a single process, making it more efficient. It divides the image into blocks of the same size, constructs a bounding box to identify potential areas with objects, detects possible items in the image block and combines the two results. Model training follows the eighty-twenty rule, with 80% of data for training and 20% for testing. The model's recognition accuracy is refined through parameter tuning, utilizing the mAP metric to adjust object identification accuracy [8]. AP is derived from precision and recall, reflecting the AI model's object detection performance. After that, the dataset is further trained on Faster R-CNN and SSD. When evaluating deep learning models on the same dataset, the recognition times for Single-Shot Multibox Detector, Faster R-CNN and YOLOv3 algorithms are 9 seconds, 5 seconds, and 4.5 seconds, respectively. Additionally, the mean average precision for each model at an IoU of 0.6 is 43.19%, 85%, and 88.63% respectively. Experimental results demonstrate that the YOLOv3 algorithm outperforms the Faster R-CNN and SSD algorithms in terms of efficiency and precision [8].

	Faster-R-CNN	YOLOv3	SSD
Object detection type	Two-stage	One-stage	One-stage
Batch size	256	64	64
# of iteration	15,000	3223	15,000
# of object class	28	28	28
# of scenic-spot images	15,351	15,351	15,351
IoU = 0.5	mAP = 86%	mAP = 84.00%	mAP = 47.35%
IoU = 0.6	mAP = 85%	mAP = 88.63%	mAP = 43.19%
IoU = 0.7	mAP = 86%	mAP = 81.50%	mAP = 48.65%

Figure 2.5 Performance comparison of YOLOV3, faster R-CNN and SSD.

The proposed architecture of the system consists of various components. Users access the system via an Android-based APP, connecting to an XAMPP server linked to a MySQL database server. Initial user authentication occurs through XAMPP. Once the user's identity is confirmed, they can search for scenic spots, access descriptions of popular spots, plan itineraries, and navigate using scenic spot images. When users search with a picture, the APP uploads the image to the database. XAMPP forwards the image to the YOLOv3 object analysis system, which operates on the TensorFlow Artificial Intelligence Framework. This system analyzes and identifies the depicted scenic spot. Once analysis is done, results are sent back to the XAMPP server, stored in the database, and returned to the user via the APP [8].

- Strength
    - The YOLOv3 model demonstrates notable speed and accuracy when evaluated based on mAP and IOU metrics. It runs significantly faster than other detection methods with comparable performance.
- Weakness

- YOLOv3 can struggle to detect smaller objects due to its anchor box design and large stride.

2.2.5 Landmark Recognition Model for Smart Tourism Using Lightweight Deep Learning and Linear Discriminant Analysis

The paper proposed a model that employs a CNN, specifically utilizing the EFFNET architecture, to extract lightweight features. These EFFNET features are lighter than those from other CNN models. To further enhance the model, the author uses Linear Discriminant Analysis (LDA) for feature selection which can effectively reduce dimensionality while improving classification performance. The CNN-based training of the recognition model is remarkably efficient, achieving excellent classification results with a minimal number of epochs [9]. Firstly, data acquisition is performed by collecting around 100 images of each category with different camera angles. Next, a transfer learning approach for feature extraction was employed, utilizing the weights of pre-trained CNN models. Four specific models, namely EfficientNet (EFFNET), RESNET152, NASNetMobile, and MobileNetV2, were considered for feature extraction. The resulting features are represented as a one-dimensional (1D) matrix. These features are intended for input into both traditional machine learning classifiers and a 1D CNN classifier (Conv1D). Additionally, to accommodate a 2D CNN classifier (Conv2D), the 1D feature matrix is reshaped into a 2D feature matrix. Then, Feature selection is performed to enhance recognition model performance by reducing feature dimensionality and creating more meaningful features [9]. The extracted 1D features, obtained from Conv1D, were used for training various classifiers. LSVM employed a linear kernel with a one-versus-all (OVA) training strategy. For the Conv2D features extracted by EFFNET, a 2D Convolutional Neural Network classifier was applied, which includes a fully connected layer. The CNN architecture incorporates convolution layers with filters like RELU, followed by pooling layers to down-sample and reduce feature map dimensions. The pooled and flattened feature maps are processed through fully connected layers for image classification [9]. The entire process involves training and testing phases on the dataset to train the classification model. The performance of the model on the testing set was evaluated using the accuracy metric as the performance measure. The result shows that EFFNET combined with a CNN classifier demonstrates superior performance as both a feature extraction method and a classifier. The EFFNET-CNN model demonstrated classification accuracies of 100% and 94.26% on the UMS-Scene and Scene-15 datasets, respectively [9].

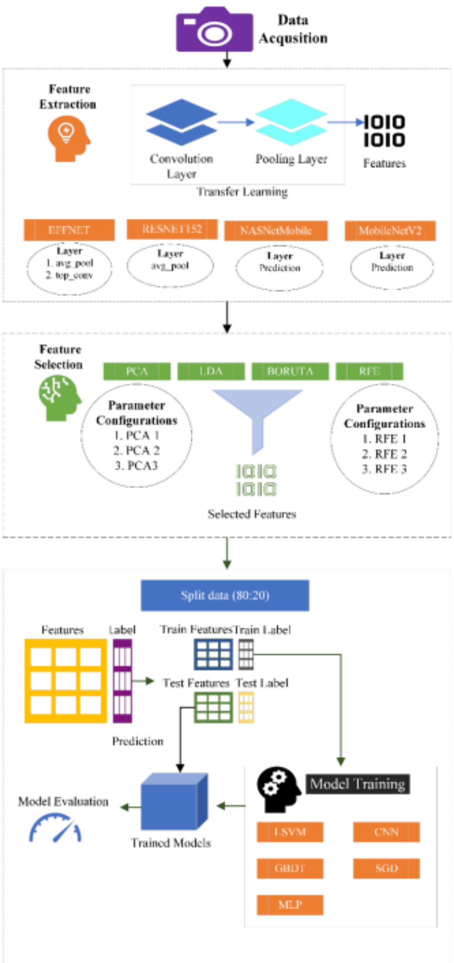

Figure 2.6 Methodology of the research paper.

- **Strength**
  - The model is trained with feature selection which can effectively reduce dimensionality while improving classification performance.
- **Weakness**
  - Despite the development of a highly efficient landmark recognition model with minimal computational requirements, it is necessary to use additional pre-processing measures to decrease the dimensionality of

features. This is important to reduce the possible impact of excessive computational expenses during the processing stage.

2.3 Review of existing system

2.3.1 Google Lens

Google Lens is a set of computational skills that rely on visual perception. It can understand the user's intended search query and utilizes this information to do tasks such as text replication or translation, object identification, geographical exploration, product discovery, and image comparison, among others [11]. This technology enables users to conduct searches by utilizing photographs, cameras, or images, thereby seeking comparable outcomes from the vast expanse of the internet. The Lens application operates by initially doing a comparison between the desired object specified by the user and other images sourced from the internet. These images are subsequently ranked according to their likeness and relevance to the object in order to retrieve relevant outcomes. Once Google Lens has determined with a high level of certainty the object that the user intended to search, it will proceed to provide the corresponding search results [11].

Figure 2.7 Google Lens.

- Strength
  - The system has a high accuracy because it can recognize a majority of commonly seen items.
  - It provides informative details for the image taken from the user.
  - The system integrates augmented reality elements which allow users to use the application and to get information in a more interactive way.

- Weakness
  - The system is not capable of detecting uncommon things which may result in wrong recognition.
  - The system also required the internet to work on the recognition functionality.

2.3.2 Lens AI – Find, Search and Ask

This application integrates ChatGPT in order to enhance the user's knowledge and experience. The application lets users use their smartphone's camera to identify, explore, translate, and perform other functions that are available in the application. The main function of this application is to let users capture images of their surroundings and provide them with relevant details. In addition, the application offers other additional features, including the ability to track users' calorie consumption by capturing photos of their meals to obtain nutritional information or recipes, identifying various plants and flowers, facilitating direct translation, discovering places, and providing real-time object detection functionality. All the above functions operate only through the use of the smartphone's camera.

- **Strength**
  - The system classifies various functions for the purpose of detecting certain objects, hence enabling more precise object detection and retrieval of detailed information.
  - The software offers a wide range of features that respond to the daily needs of users.
- **Weakness**
  - Although each function has been categorised to detect specific criteria, the accuracy of certain functions remains very poor.
  - The system shows limitations in its ability to detect uncommon or unpopular things, such as celebrities, as it was mainly designed to detect Western celebrities.

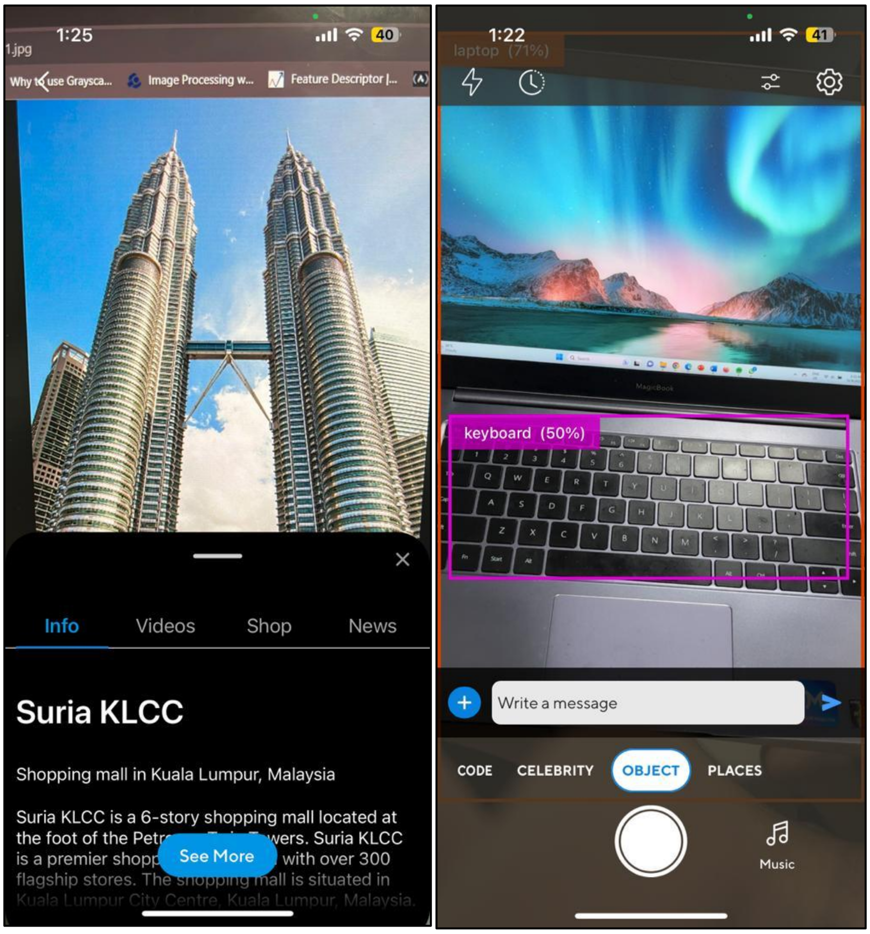

Figure 2.8 & 2.9 Lens AI – Find, Search and Ask.

2.4 Summary

The table below shows the overview of the strengths and weaknesses of each literature review above.

<table>
<tr><th>Literature Review</th><th>Strength</th><th>Weakness</th></tr>
<tr><td>2.1.1</td><td>- User personalized
- Include AR
- Utilise marker-based AR</td><td rowspan="3">- AR devices used in tourism are hard to use.
- Required expensive and complex equipment and software.</td></tr>
<tr><td>2.1.2</td><td>- Prioritize geometric and aesthetic consistency in merging physical and digital realms.
- Implement absolute sensors.
- Enable tourists to reveal distant details.</td></tr>
<tr><td>2.1.3</td><td>- Enable tourists to zoom in using devices to reveal distant details.</td></tr>
<tr><td>2.2.1</td><td>- Useful for first-time users.
- Require less human effort.
- Robustness to noise.</td><td>- Low accuracy due to fewer datasets.
- High computational requirements.
- Slower training speed.</td></tr>
<tr><td>2.2.2</td><td>- High accuracy
- Contains RPN
- Faster detection speed</td><td>- Lower accuracy in extreme environment</td></tr>
<tr><td>2.2.3</td><td>- 2 steps approach
- High accuracy</td><td>- Not suitable for large datasets.
- High computational capabilities</td></tr>
<tr><td>2.2.4</td><td>- Notable speed and accuracy.</td><td>- Struggle to detect smaller objects</td></tr>
<tr><td>2.2.5</td><td>- Train with feature selection to increase performance</td><td>- Additional pre-processing measures are required</td></tr>
</table>

Existing System	Strength	Weakness
	- High accuracy - Provides informative details. - Integrates AR	- Unable to detect uncommon things. - Requires Internet
	- Classified various functions for greater performance. - Offers a wide range of feature	- Poor Accuracy - Unable to detect uncommon things.

Table 2.1 Overview of strengths and weaknesses of literature review and existing system.

Chapter 3
System Methodology/Approach

3.1 Methodologies and General Work Procedures

The application development process used in this project is prototyping, specifically under the framework of Rapid Application Development (RAD). The initial step in the application development involves the creation of a prototype, then the prototype is put to testing and refinement based on feedback from customers. This iterative process is continued until a final prototype that meets the requirements of the users has been achieved, resulting in the basis for the development of the final product. The system is partially set up before or during the analysis phase, thereby providing users the option of observing the product at an early stage in its life cycle [12]. The initial step includes carrying out discussions with clients and then constructing an initial high-level paper model. The purpose of this document is to construct the initial prototype that includes just the basic specifications as specified by the user. After the user determines the issues, the prototype undergoes refinement to reduce or eliminate the issues found. The iterative process continues until the user gives approval to the prototype and considers the functional model to be acceptable [12]. The reason for using this method is because it has the potential to detect errors at an earlier stage which can save a lot of work and expense and improve the overall quality of the software. Furthermore, modifications can be readily included, resulting in a more efficient and quicker user interface. This approach also emphasises the development of prototypes, enabling developers to concentrate more on the coding part rather than the design, as the design of this project does not have much importance compared to the code [12].

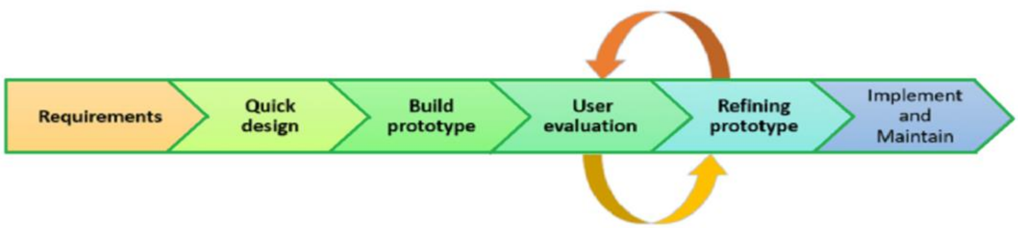

Figure 3.1 Stages of prototype methodologies.

The prototype methodologies consist of a total of 6 SDLC stages.

I. **Requirement Stage**

The prototyping approaches begin with the initial stage of requirements gathering. During this phase, the requirements of the application are carefully defined. For instance, the app might include what kind of functions, and it is essential to identify the main module of this application.

II. **Quick Design Stage**

The subsequent stage is the development of a preliminary design, also referred to as a quick design. During this phase, a basic system design is developed. However, the current design is not complete. It only provides user with a simple idea of the system. This stage also helps the development of the prototype.

III. **Build Prototype Stage**

During this stage, an actual prototype is developed using the data obtained from the quick design stage. The proposed application is represented by a small prototype which is also the first version of the prototype in this stage. For example, the application only consists of the main module, which allows the user to just do testing.

IV. **User Evaluation Stage**

During this stage, the proposed system is introduced to the user for an initial assessment. It helps evaluate the strengths and limitations of the functional model. Then, feedback and recommendations are gathered from the user and subsequently delivered to the developer. In this scenario, the supervisor and friends are going to play the role of users to test the functional module.

V. **Refining Prototype Stage**

If the user is not satisfied with the existing prototype, it is necessary for the developer to make improvements to the prototype based on the comments and suggestions provided by the user. This phase will not end until all the requirements set by the user have been fulfilled. After the user shows satisfaction with the developed prototype, a final system is then developed, considering the approved final prototype.

VI. **Implement and Maintain Stage**

After the completion of the final system, which is based on the final prototype, it undergoes full testing and is then implemented for production purposes. The system undergoes regular maintenance procedures to minimise downtime and prevent significant faults.

3.2 System Design Diagram

3.2.1 System Architecture Diagram

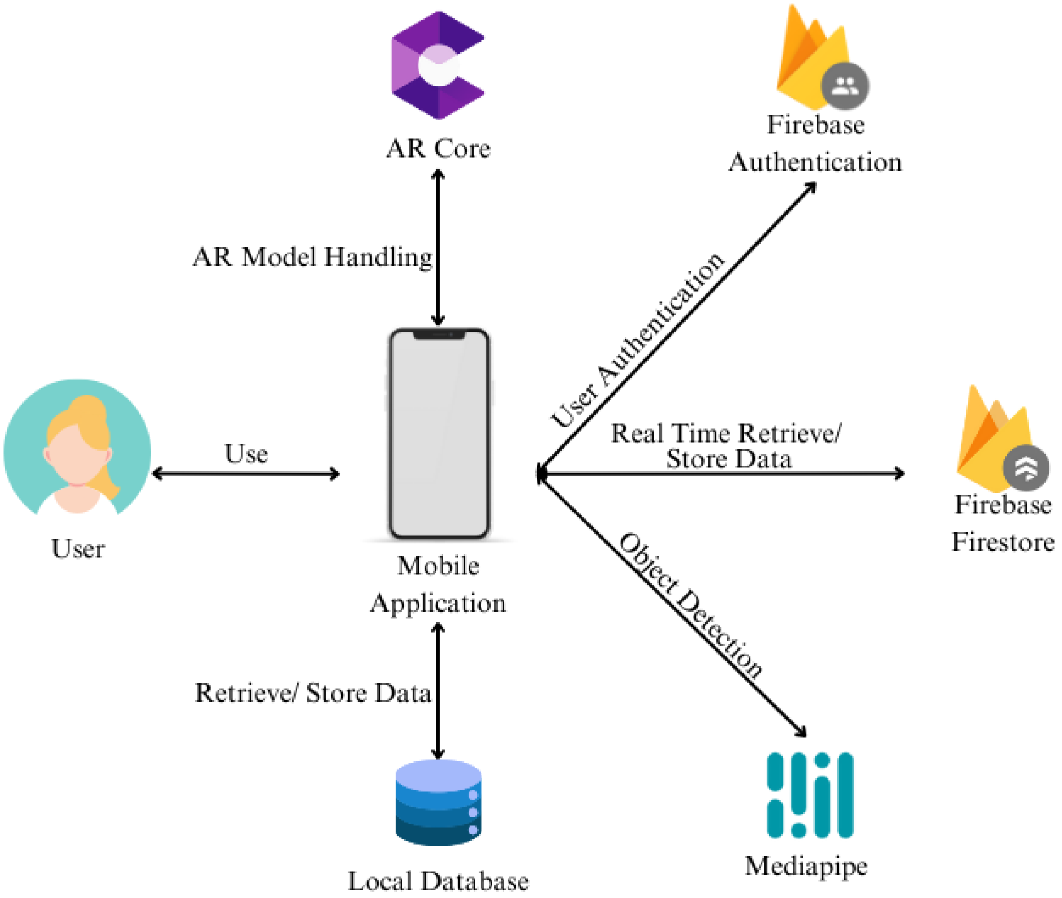

Figure 3.2 System Architecture Diagram.

The mobile application comprises several key components, including AR Core, Firebase Authentication, Firebase Firestore, Mediapipe, and a local database. AR Core is employed to integrate 3D models into the real-world environment by defining coordinates and implementing event-handling functions. Firebase Authentication manages user authentication processes such as login, signup, password recovery, and resetting. Firebase Firestore is primarily used within the mini-game module to facilitate real-time NoSQL database operations for storing and retrieving user-specific data. Mediapipe is utilised for object detection, particularly for identifying artifacts. Additionally, a local database is used to store device-specific information, such as whether the user is accessing the application for the first time.

3.2.2 Use Case Diagram and Description

3.2.2.1 Use Case Diagram

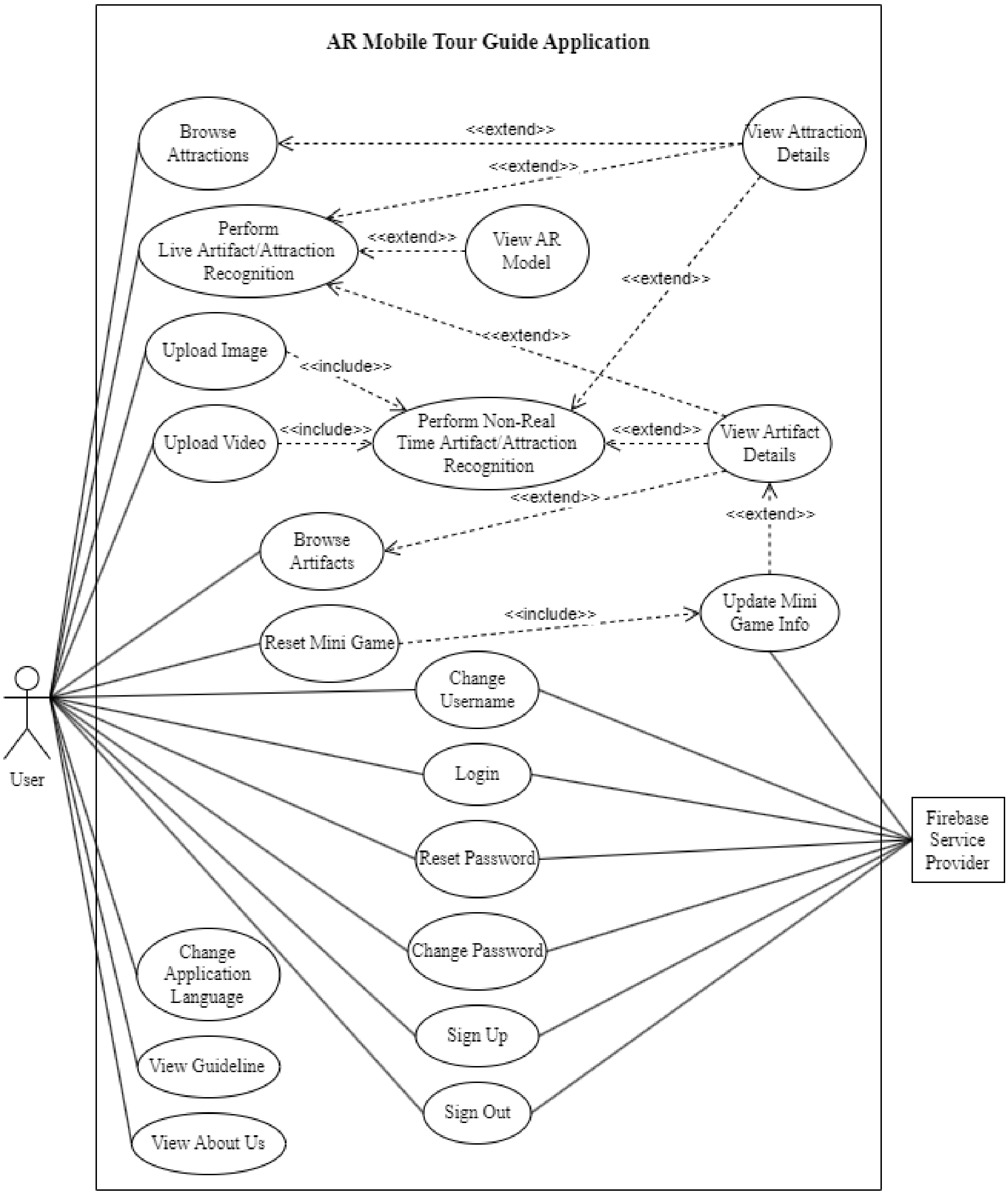

Figure 3.3 Use Case Diagram.

3.2.2.2 Use Case Description

ID	001	**Importance Level**	High
Use Case Name	Browse Attractions		
Stakeholders and Interests	User – wants to view all the attractions in Kampar.		
Description	This use case describes how the system handles the process of users browsing attractions from a list.		
Trigger	After the user login successfully.		
Relationship	**Association**	User	
	Include	View Attraction Details	
	Extend	Not Applicable	
	Generalization	Not Applicable	
Normal Flow of Events	1	System navigates the user to the attraction list page after the user logs in successfully.	
	2	System displays a list of attractions.	
	3	User browses through the list of attractions.	
	4	User clicks on an attraction.	
	5	System navigates users to the attraction details page.	
	6	System displays attraction details of the selected attraction.	
Sub Flow	Not Applicable.		
Exceptional Flow	Not Applicable.		

Table 3.1 Use Case Description of Browse Artifact.

ID	002		Importance Level	High
Use Case Name	Perform Live Artifact/Attraction Recognition			
Stakeholders and Interests	User – wants to perform live artifact/attraction recognition.			
Description	This use case describes how the system handles the process of performing live artifact/attraction recognition.			
Trigger	User clicks on the camera button on the navigation bar.			
Relationship	**Association**	User, Firebase Service Provider		
	Include	Not Applicable		
	Extend	View AR Model, View Artifact Details, Update Mini Game Info, View Attraction Details		
	Generalization	Not Applicable		
Normal Flow of Events	1	Users navigate to the live artifact/attraction recognition page.		
	2	System displays live artifact/attraction recognition page.		
	3	Users move the phone camera around to scan through an artifact.		
	4	System sends a frame to the object detection model in the system.		
	5	System detected artifact/attraction on the frame using an object detection model.		
	6	System displays a bounding box which contains the detected result around the detected artifact/attraction along with its navigation buttons.		
	7	User chooses a button to click.		
Sub Flow – Click on Artifact/ Attraction Details Buton	**7a.1**	Users click on the artifact/attraction details button.		
	7a.2	Firebase Service Provider update artifact state.		
	7a.3	System navigates the user to the artifact/attraction details page.		
	7a.4	System displays artifact/attraction details page with information of the detected artifact.		
Sub Flow – Click on Artifact AR Model Buton	**7b.1**	Users click on the artifact AR model button.		
	7b.2	System navigates the user to the AR model page.		
	7b.3	System display AR model page.		
	7b.4	System load and display selected artifact AR model.		
Sub Flow – No button clicked	**7c.1**	System continues to step 4 in the main flow.		

Exceptional Flow	**5.1**	System continues to step 4 in the main flow.

Table 3.2 Use Case Description of Perform Live Artifact/Attraction Recognition.

ID	003	**Importance Level**	High
Use Case Name	Upload Image		
Stakeholders and Interests	User – wants to perform artifact/attraction recognition by uploading image from the device.		
Description	This use case describes how the system handles the process of performing artifact/attraction recognition on an image.		
Trigger	User clicks on the plus button on the non-real time artifact/attraction recognition page.		
Relationship	**Association**	User, Firebase Service Provider	
	Include	Perform Non-Real Time Artifact/Attraction Recognition	
	Extend	View Artifact Details, Update Mini Game Info, View Attraction Details	
	Generalization	Not Applicable	
Normal Flow of Events	**1**	Users click on the plus button.	
	2	Users choose an image and upload it.	
	3	System passes the image to the object detection model.	
	4	System detected an artifact/attraction on the image using an object detection model.	
	5	System displays a bounding box which contains the detected result on the image along with its navigation buttons.	
	6	User clicks on the artifact/attraction details button.	
	7	Firebase Service Provider updates artifact state.	
	8	System navigates the user to the artifact/attraction details page.	
	9	System displays artifact/attraction details page with information of the detected artifact/attraction.	
Sub Flow	Not Applicable		
Exceptional Flow	**4.1**	System displays the message “Nothing Detected”.	

Table 3.3 Use Case Description of Upload Image.

<table>
<tr><td>ID</td><td colspan="2">004</td><td>Importance Level</td><td>High</td></tr>
<tr><td>Use Case Name</td><td colspan="4">Upload Video</td></tr>
<tr><td>Stakeholders and Interests</td><td colspan="4">User – wants to perform artifact/attraction recognition by uploading video from the device.</td></tr>
<tr><td>Description</td><td colspan="4">This use case describes how the system handles the process of performing artifact/attraction recognition on a video.</td></tr>
<tr><td>Trigger</td><td colspan="4">User clicks on the plus button on the non-real time artifact/attraction recognition page.</td></tr>
<tr><td rowspan="4">Relationship</td><td colspan="2">Association</td><td colspan="2">User, Firebase Service Provider</td></tr>
<tr><td colspan="2">Include</td><td colspan="2">Perform Non-Real Time Artifact/Attraction Recognition</td></tr>
<tr><td colspan="2">Extend</td><td colspan="2">View Artifact Details, Update Mini Game Info, View Attraction Details</td></tr>
<tr><td colspan="2">Generalization</td><td colspan="2">Not Applicable</td></tr>
<tr><td rowspan="9">Normal Flow of Events</td><td>1</td><td colspan="3">User clicks on the plus button.</td></tr>
<tr><td>2</td><td colspan="3">User chooses a video and uploads it.</td></tr>
<tr><td>3</td><td colspan="3">System passes each frame of the video to the object detection model.</td></tr>
<tr><td>4</td><td colspan="3">System detected an artifact/attraction on the frame using an object detection model.</td></tr>
<tr><td>5</td><td colspan="3">System displays a bounding box which contains the detected result on the frame from the video along with its navigation buttons.</td></tr>
<tr><td>6</td><td colspan="3">User clicks on the artifact/attraction details button.</td></tr>
<tr><td>7</td><td colspan="3">Firebase Service Provider updates artifact state.</td></tr>
<tr><td>8</td><td colspan="3">System navigates the user to the artifact/attraction details page.</td></tr>
<tr><td>9</td><td colspan="3">System displays artifact/attraction details page with information of the detected artifact/attraction.</td></tr>
<tr><td>Sub Flow</td><td colspan="4">Not Applicable</td></tr>
<tr><td>Exceptional Flow</td><td>4.1</td><td colspan="3">System displays the message “Nothing Detected”.</td></tr>
</table>

Table 3.4 Use Case Description of Upload Video.

ID	005	**Importance Level**	High
Use Case Name	Browse Artifacts		
Stakeholders and Interests	User – wants to view all the artifacts.		
Description	This use case describes how the system handles the process of user browsing artifacts from a list.		
Trigger	User clicks on the game button on the navigation bar.		
Relationship	**Association**	User	
	Include	Not Applicable	
	Extend	View Artifact Details	
	Generalization	Not Applicable	
Normal Flow of Events	**1**	User clicks on the game button on the navigation bar.	
	2	System navigates users to mini game page	
	3	System displays the mini game page.	
	4	User browses through and clicks on an artifact.	
	5	System validates that the selected artifact is unlocked.	
	6	System navigates the user to the artifact details page.	
	7	System displays artifact details page and details of selected artifacts.	
Sub Flow	Not Applicable		
Exceptional Flow	**5.1**	System display hint for the selected artifact.	

Table 3.5 Use Case Description of Browse Artifacts.

ID	006		**Importance Level**	High
Use Case Name	Reset Mini Game			
Stakeholders and Interests	User – wants to reset the mini game.			
Description	This use case describes how the system handles the process of resetting the mini game.			
Trigger	User clicks on the reset mini game button on the settings page.			
Relationship	**Association**		User, Firebase Service Provider	
	Include		Update Mini Game Info	
	Extend		Not Applicable	
	Generalization		Not Applicable	
Normal Flow of Events	**1**	User clicks on the reset mini game button on the settings page.		
	2	Firebase Service Provider updates artifact state.		
	3	System displays “Reset Successfully”.		
Sub Flow	Not Applicable			
Exceptional Flow	Not Applicable			

Table 3.6 Use Case Description of Reset Mini Game.

ID	007		**Importance Level**	High
Use Case Name	Change Username			
Stakeholders and Interests	User – wants to change username.			
Description	This use case describes how the system handles the process of changing username.			
Trigger	User clicks on the change username button in the settings page.			
Relationship	**Association**		User, Firebase Service Provider	
	Include		Not Applicable	
	Extend		Not Applicable	
	Generalization		Not Applicable	
Normal Flow of Events	**1**	User clicks on the change username button in the settings page.		
	2	System navigates the user to change username page.		
	3	System displays the change username page.		
	4	User enters the username.		
	5	User clicks on the submit button.		
	6	System validates that user input was valid.		
	7	Firebase Service Provider successfully updated the username.		
	8	System displays "update successfully".		
Sub Flow	Not Applicable			
Exceptional Flow	6.1	System displays an error message for the input that is in the wrong format.		
	7.1	System display "Failed to update".		

Table 3.7 Use Case Description of Change Username.

<table>
<tr><td>ID</td><td colspan="2">008</td><td>Importance Level</td><td>High</td></tr>
<tr><td>Use Case Name</td><td colspan="4">Login</td></tr>
<tr><td>Stakeholders and Interests</td><td colspan="4">User – wants to log in.</td></tr>
<tr><td>Description</td><td colspan="4">This use case describes how the system handles the process of login.</td></tr>
<tr><td>Trigger</td><td colspan="4">After displaying the splash screen.</td></tr>
<tr><td rowspan="4">Relationship</td><td colspan="2">Association</td><td colspan="2">User, Firebase Service Provider</td></tr>
<tr><td colspan="2">Include</td><td colspan="2">Not Applicable</td></tr>
<tr><td colspan="2">Extend</td><td colspan="2">Not Applicable</td></tr>
<tr><td colspan="2">Generalization</td><td colspan="2">Not Applicable</td></tr>
<tr><td rowspan="7">Normal Flow of Events</td><td>1</td><td colspan="3">System navigates the user to the login page.</td></tr>
<tr><td>2</td><td colspan="3">System displays the login page.</td></tr>
<tr><td>3</td><td colspan="3">User enters login details.</td></tr>
<tr><td>4</td><td colspan="3">User clicks on the submit button.</td></tr>
<tr><td>5</td><td colspan="3">System validates that user input was valid.</td></tr>
<tr><td>6</td><td colspan="3">Firebase Service Provider perform authentication successfully.</td></tr>
<tr><td>7</td><td colspan="3">System displays “Login successfully”</td></tr>
<tr><td>Sub Flow</td><td colspan="4">Not Applicable</td></tr>
<tr><td rowspan="2">Exceptional Flow</td><td>5.1</td><td colspan="3">System displays an error message for the input that is in the wrong format.</td></tr>
<tr><td>6.1</td><td colspan="3">System displays an error message based on the message returned by the Firebase Service Provider.</td></tr>
</table>

Table 3.8 Use Case Description of Login.

<table>
<tr><td>ID</td><td colspan="2">009</td><td>Importance Level</td><td>High</td></tr>
<tr><td>Use Case Name</td><td colspan="4">Reset Password</td></tr>
<tr><td>Stakeholders and Interests</td><td colspan="4">User – wants to reset password.</td></tr>
<tr><td>Description</td><td colspan="4">This use case describes how the system handles the process of resetting passwords.</td></tr>
<tr><td>Trigger</td><td colspan="4">User clicks on the forget password button.</td></tr>
<tr><td rowspan="4">Relationship</td><td colspan="2">Association</td><td colspan="2">User, Firebase Service Provider</td></tr>
<tr><td colspan="2">Include</td><td colspan="2">Not Applicable</td></tr>
<tr><td colspan="2">Extend</td><td colspan="2">Not Applicable</td></tr>
<tr><td colspan="2">Generalization</td><td colspan="2">Not Applicable</td></tr>
<tr><td rowspan="8">Normal Flow of Events</td><td>1</td><td colspan="3">User clicks on the forget password button on the login page.</td></tr>
<tr><td>2</td><td colspan="3">System navigates the user to the forget password page.</td></tr>
<tr><td>3</td><td colspan="3">System displays the forget password page.</td></tr>
<tr><td>4</td><td colspan="3">User enters the email.</td></tr>
<tr><td>5</td><td colspan="3">User clicks on the submit button.</td></tr>
<tr><td>6</td><td colspan="3">System validates that user input was valid.</td></tr>
<tr><td>7</td><td colspan="3">Firebase Service Provider sends an email to the user successfully.</td></tr>
<tr><td>8</td><td colspan="3">System displays “Email sent”</td></tr>
<tr><td>Sub Flow</td><td colspan="4">Not Applicable</td></tr>
<tr><td rowspan="2">Exceptional Flow</td><td>6.1</td><td colspan="3">System displays an error message for the input that is in the wrong format.</td></tr>
<tr><td>7.1</td><td colspan="3">System displays an error message based on the message returned by the Firebase Service Provider.</td></tr>
</table>

Table 3.9 Use Case Description of Reset Password.

<table>
<tr><td>ID</td><td colspan="2">010</td><td>Importance Level</td><td>High</td></tr>
<tr><td>Use Case Name</td><td colspan="4">Change Password</td></tr>
<tr><td>Stakeholders and Interests</td><td colspan="4">User – wants to change password.</td></tr>
<tr><td>Description</td><td colspan="4">This use case describes how the system handles the process of changing passwords.</td></tr>
<tr><td>Trigger</td><td colspan="4">User clicks on the change password button.</td></tr>
<tr><td rowspan="4">Relationship</td><td colspan="2">Association</td><td colspan="2">User, Firebase Service Provider</td></tr>
<tr><td colspan="2">Include</td><td colspan="2">Not Applicable</td></tr>
<tr><td colspan="2">Extend</td><td colspan="2">Not Applicable</td></tr>
<tr><td colspan="2">Generalization</td><td colspan="2">Not Applicable</td></tr>
<tr><td rowspan="8">Normal Flow of Events</td><td>1</td><td colspan="3">User clicks on the change password button on the settings page.</td></tr>
<tr><td>2</td><td colspan="3">System navigates the user to the change password page.</td></tr>
<tr><td>3</td><td colspan="3">System displays the change password page.</td></tr>
<tr><td>4</td><td colspan="3">User enters the details needed.</td></tr>
<tr><td>5</td><td colspan="3">User clicks on the submit button.</td></tr>
<tr><td>6</td><td colspan="3">System validates that user input was valid.</td></tr>
<tr><td>7</td><td colspan="3">Firebase Service Provider updated the password successfully.</td></tr>
<tr><td>8</td><td colspan="3">System displays “Update Successfully”.</td></tr>
<tr><td>Sub Flow</td><td colspan="4">Not Applicable</td></tr>
<tr><td rowspan="2">Exceptional Flow</td><td>6.1</td><td colspan="3">System displays an error message for the input that is in the wrong format.</td></tr>
<tr><td>7.1</td><td colspan="3">System displays an error message based on the message returned by the Firebase Service Provider.</td></tr>
</table>

Table 3.10 Use Case Description of Change Password.

ID	011		**Importance Level**	High
Use Case Name	Sign Up			
Stakeholders and Interests	User – wants to sign up for an account.			
Description	This use case describes how the system handles the process of signing up for a new account.			
Trigger	User clicks on the signup button.			
Relationship	**Association**		User, Firebase Service Provider	
	Include		Not Applicable	
	Extend		Not Applicable	
	Generalization		Not Applicable	
Normal Flow of Events	**1**	User clicks on the signup button on the login page.		
	2	System navigates the user to the signup page.		
	3	System displays the signup page.		
	4	User enters the details needed.		
	5	User clicks on the submit button.		
	6	System validates that user input was valid.		
	7	Firebase Service Provider create an account for the user successfully.		
	8	System displays “Registration Successful”.		
Sub Flow	Not Applicable			
Exceptional Flow	6.1	System displays an error message for the input that is in the wrong format.		
	7.1	System displays an error message based on the message returned by the Firebase Service Provider.		

Table 3.11 Use Case Description of Sign Up.

ID	012	**Importance Level**	High
Use Case Name	View Guideline		
Stakeholders and Interests	User – wants to view the guideline.		
Description	This use case describes how the system handles the process of viewing guidelines.		
Trigger	User clicks on the guideline button on the settings page or when the user first enters the application.		
Relationship	**Association**	User	
	Include	Not Applicable	
	Extend	Not Applicable	
	Generalization	Not Applicable	
Normal Flow of Events	**1**	User clicks on the guideline button on the settings page.	
	2	System navigates the user to the guideline page.	
	3	System displays the guideline page.	
Sub Flow	Not Applicable		
Exceptional Flow	Not Applicable		

Table 3.12 Use Case Description of View Guideline.

ID	013	Importance Level	High
Use Case Name	View About Us		
Stakeholders and Interests	User – wants to view the about us.		
Description	This use case describes how the system handles the process of viewing about us.		
Trigger	User clicks on the about us button on the settings page.		
Relationship	**Association**	User	
	Include	Not Applicable	
	Extend	Not Applicable	
	Generalization	Not Applicable	
Normal Flow of Events	**1**	User clicks on the About Us button on the settings page.	
	2	System navigates the user to the About Us page.	
	3	System displays the About Us page.	
Sub Flow	Not Applicable		
Exceptional Flow	Not Applicable		

Table 3.13 Use Case Description of View About Us.

ID	014	**Importance Level**	High
Use Case Name	Change Application Language		
Stakeholders and Interests	User – wants to change application language.		
Description	This use case describes how the system handles the process of changing application language.		
Trigger	User changes the system language and relaunches the application.		
Relationship	**Association**	User	
	Include	Not Applicable	
	Extend	Not Applicable	
	Generalization	Not Applicable	
Normal Flow of Events	**1**	User changes the system language.	
	2	User starts the application.	
	3	System displays content based on the system language.	
Sub Flow	Not Applicable		
Exceptional Flow	Not Applicable		

Table 3.14 Use Case Description of Change Application Language.

ID	015	**Importance Level**	High
Use Case Name	Sign Out		
Stakeholders and Interests	User – wants to sign out.		
Description	This use case describes how the system handles the process of signing out.		
Trigger	User clicks the sign out button on the settings page.		
Relationship	**Association**	User, Firebase Service Provider	
	Include	Not Applicable	
	Extend	Not Applicable	
	Generalization	Not Applicable	
Normal Flow of Events	**1**	User clicks on the sign out button on the settings page.	
	2	Firebase Service Provider perform sign out successfully.	
	3	System navigates the user to the login page.	
Sub Flow	Not Applicable		
Exceptional Flow	Not Applicable		

Table 3.15 Use Case Description of Sign Out.

3.2.3 Activity Diagram

Browse Attractions

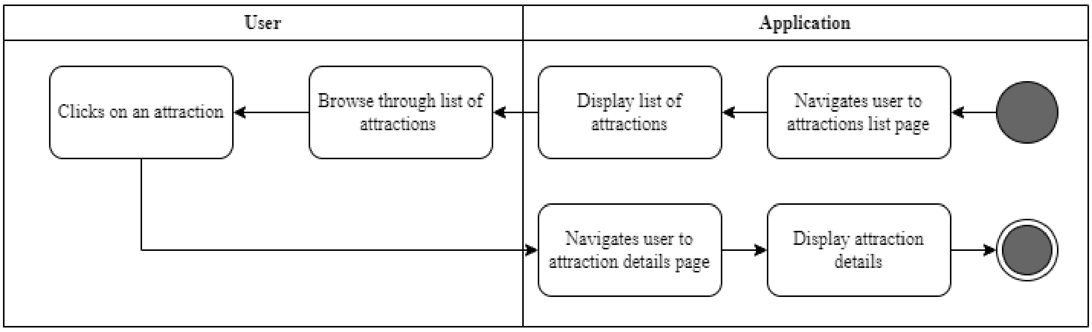

Figure 3.4 Browse Attractions Activity Diagram.

Perform Live Artifact/Attraction Recognition

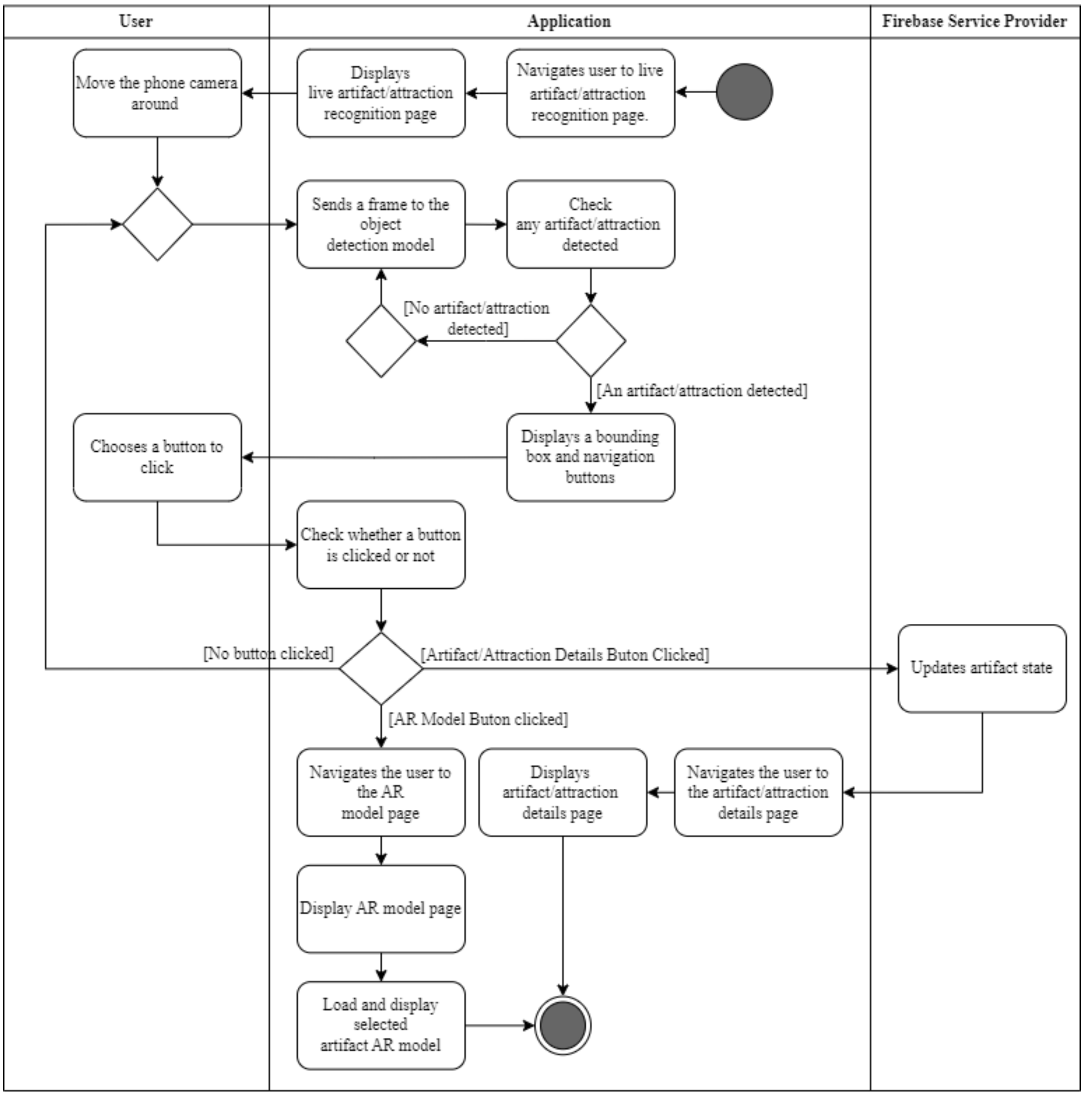

Figure 3.5 Perform Live Artifact/Attraction Recognition Activity Diagram.

Upload Image

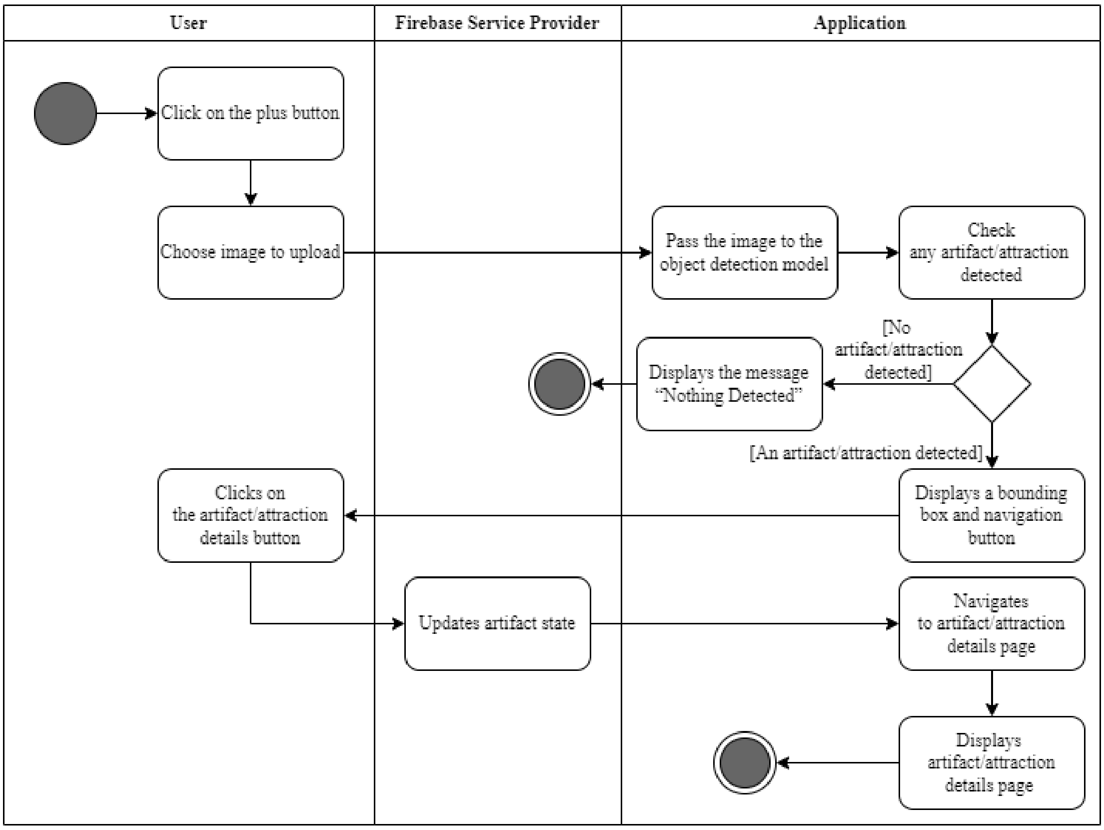

Figure 3.6 Upload Image Activity Diagram.

Upload Video

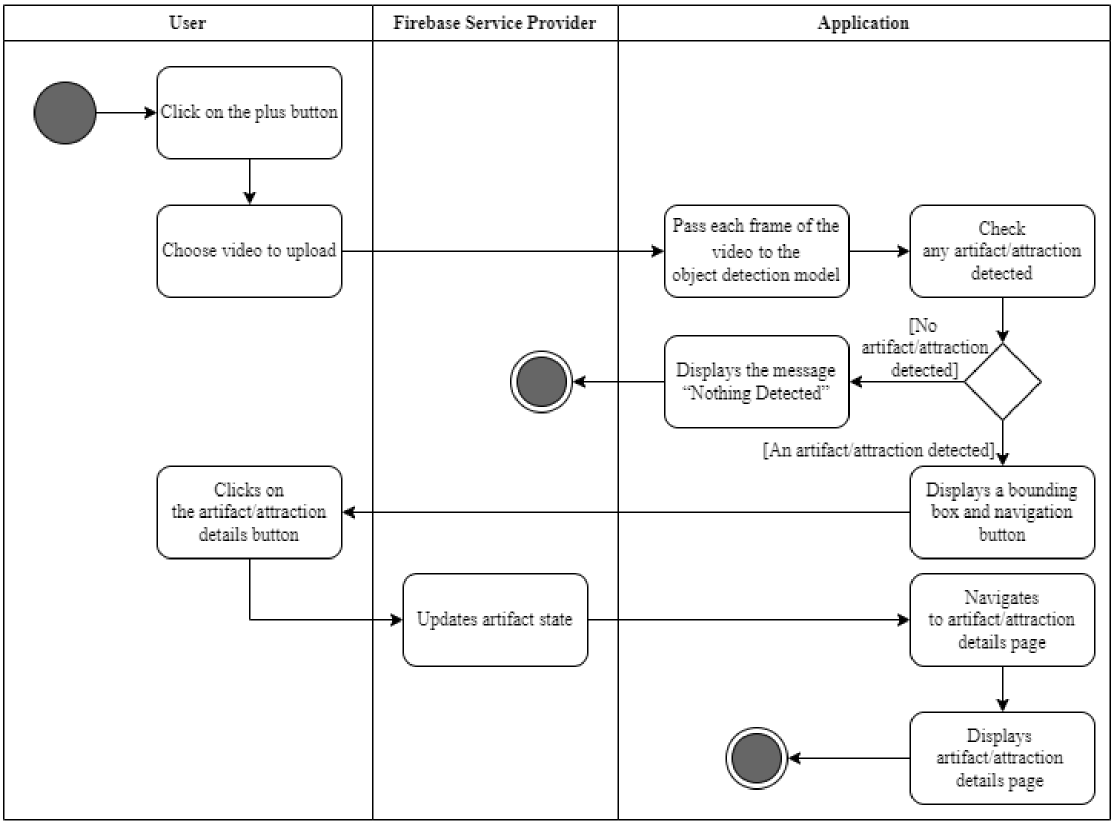

Figure 3.7 Upload Video Activity Diagram.

Browse Artifacts

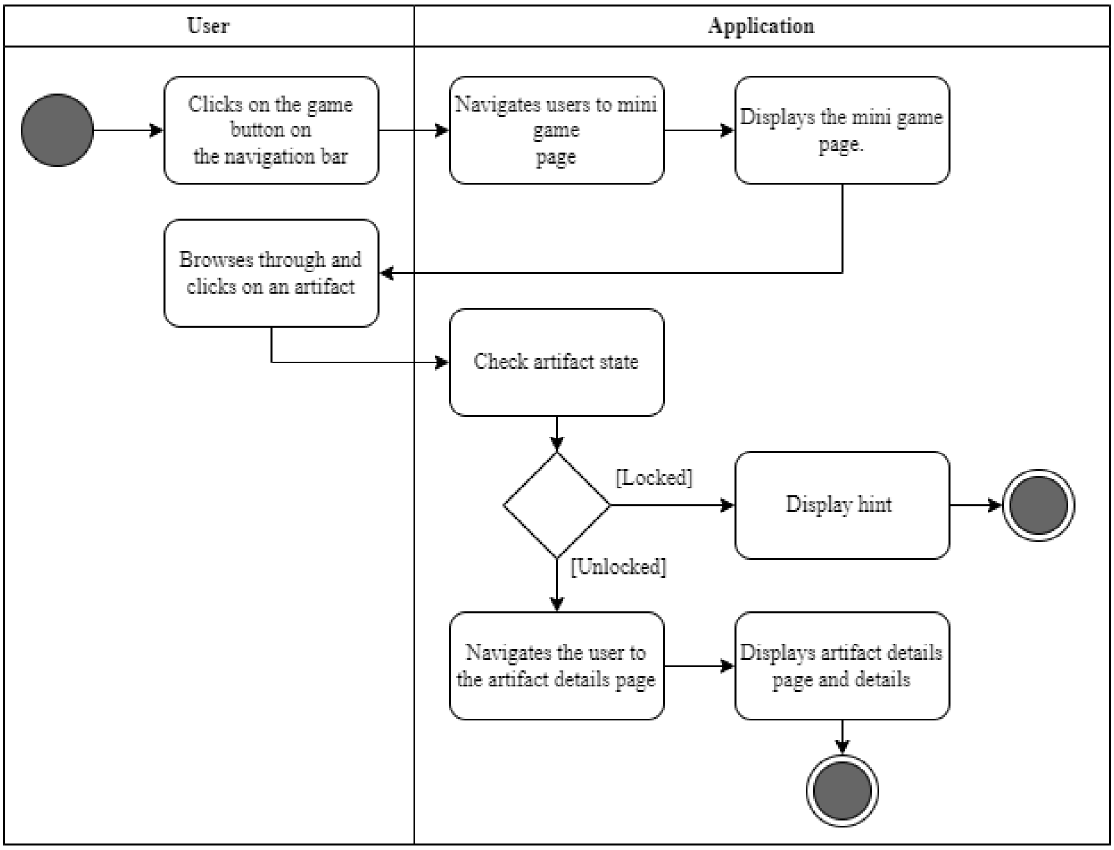

Figure 3.8 Browse Artifacts Activity Diagram.

Reset Mini Game

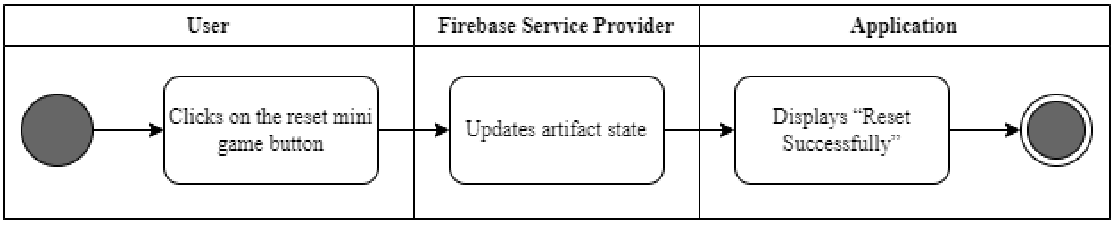

Figure 3.9 Reset Mini Game Activity Diagram.

View Guideline

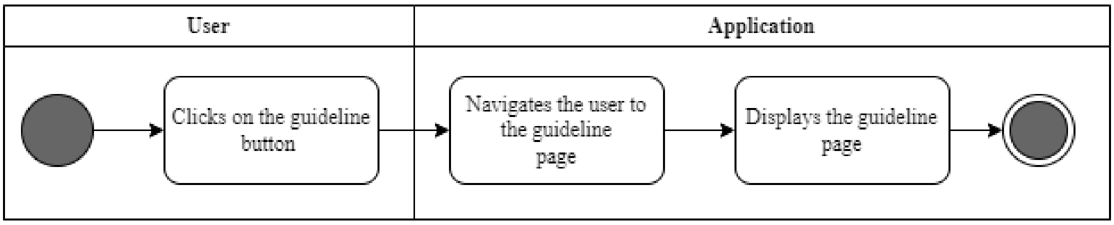

Figure 3.10 View Guideline Activity Diagram.

View About Us

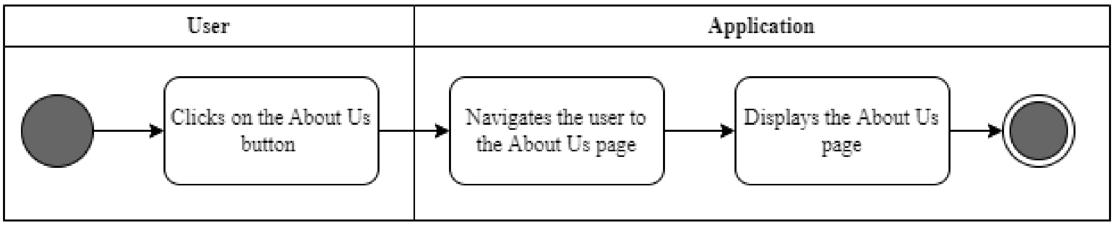

Figure 3.11 View About Us Activity Diagram.

Change Username

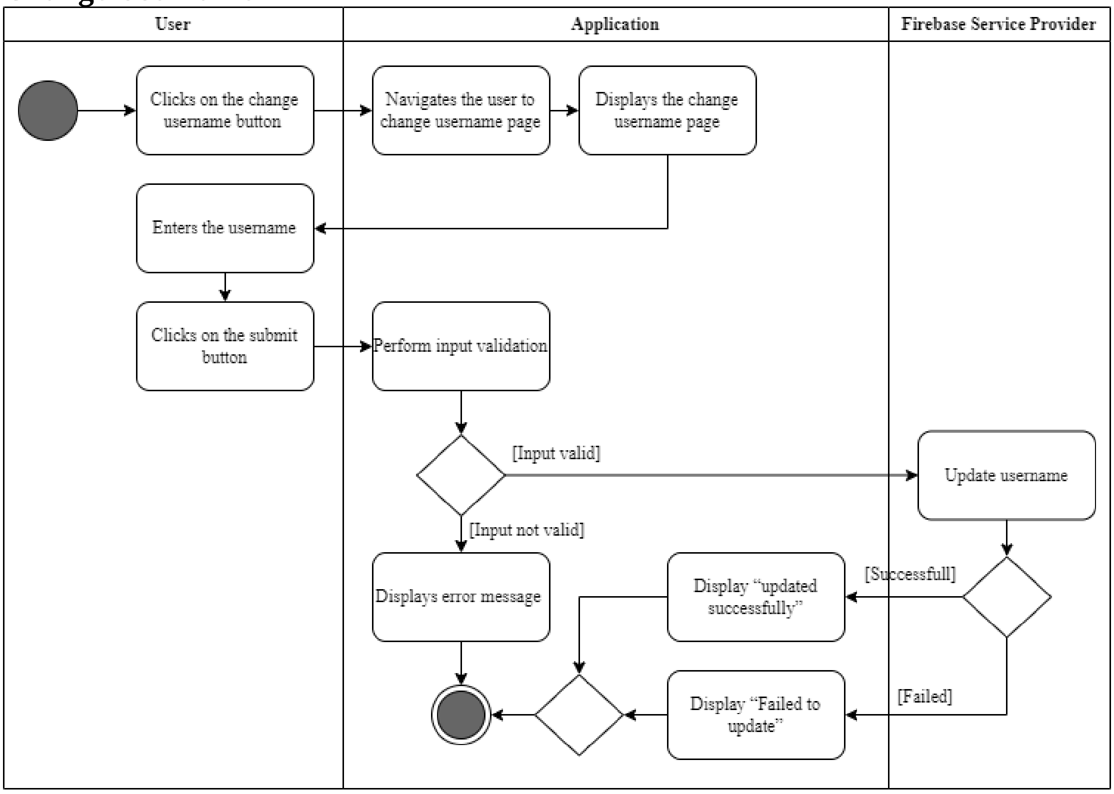

Figure 3.12 Change Username Activity Diagram.

Login

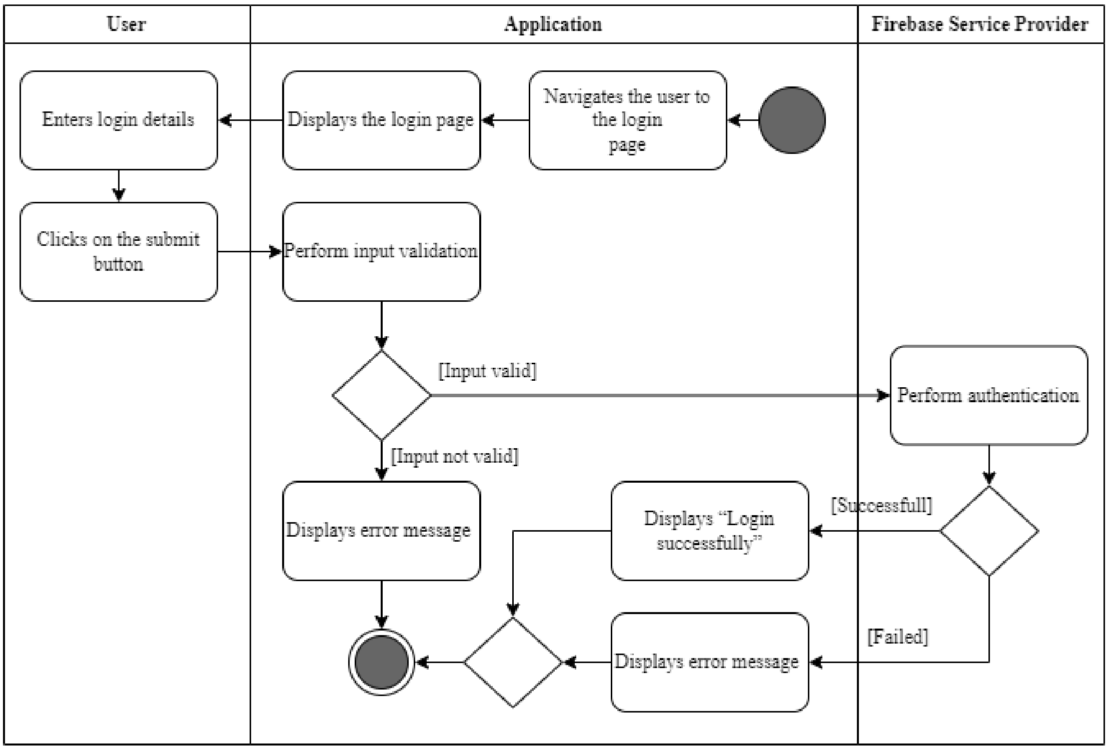

Figure 3.13 Login Activity Diagram.

Reset Password

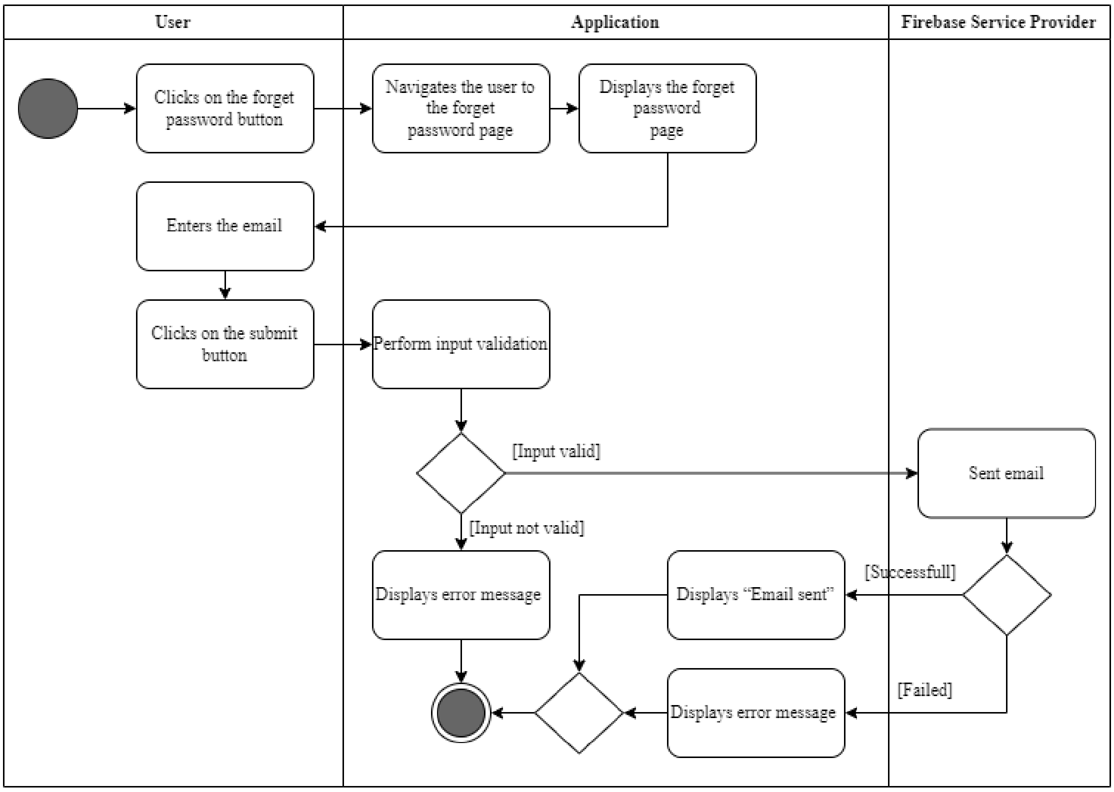

Figure 3.14 Reset Password Activity Diagram.

Change Password

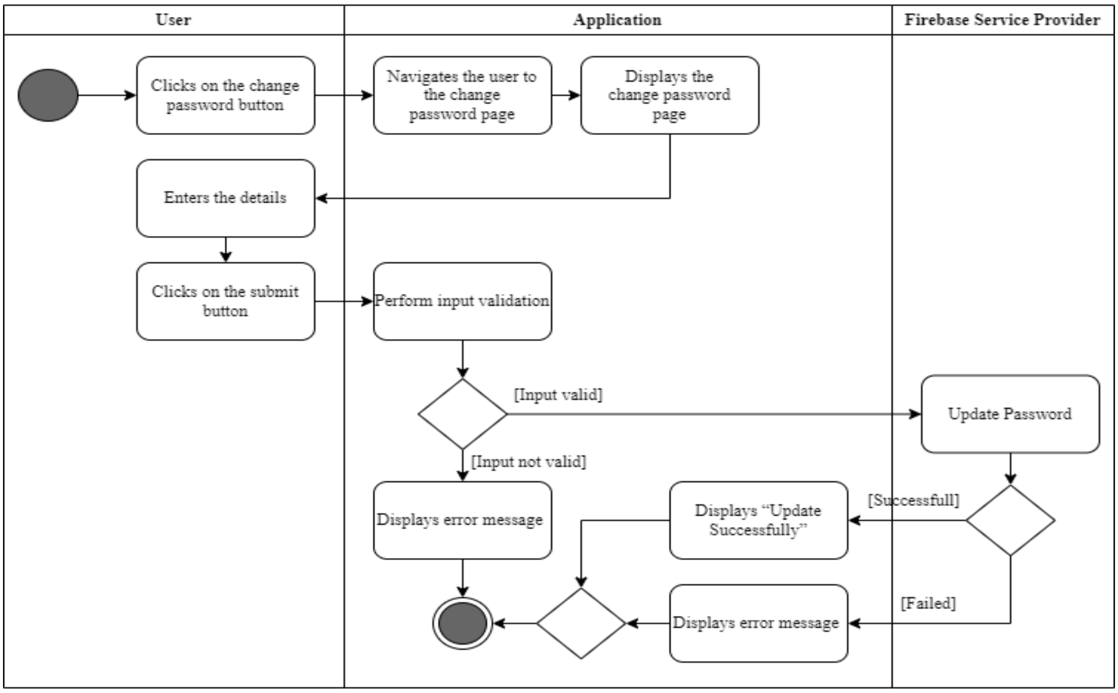

Figure 3.15 Change Password Activity Diagram.

Sign Up

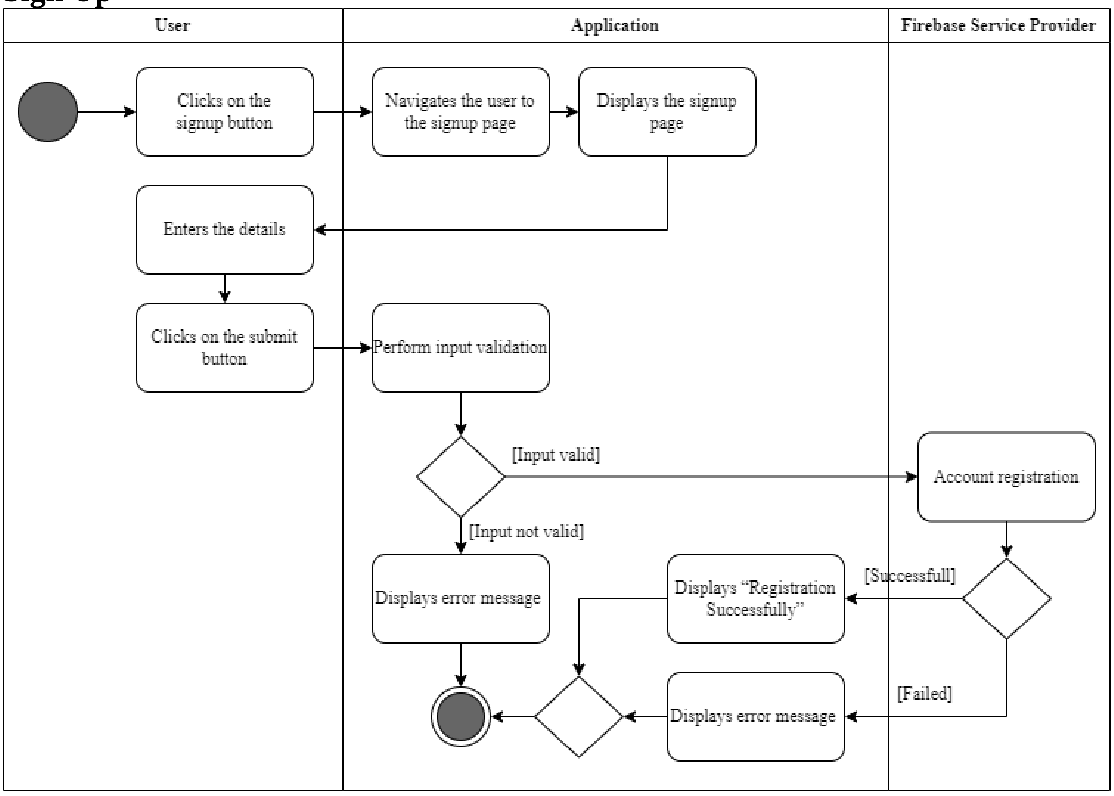

Figure 3.16 Sign Up Activity Diagram.

Sign Out

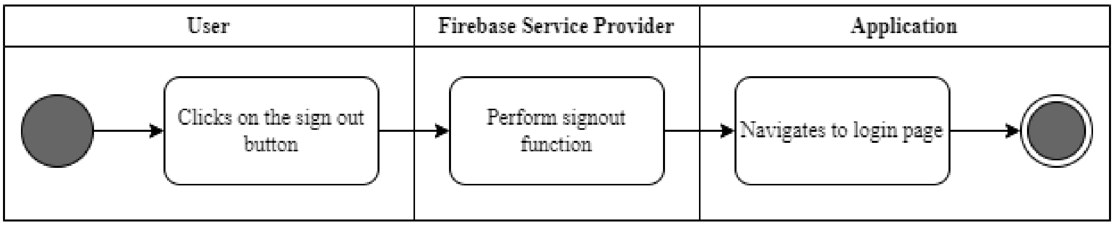

Figure 3.17 Sign Out Activity Diagram.

Change Application Language

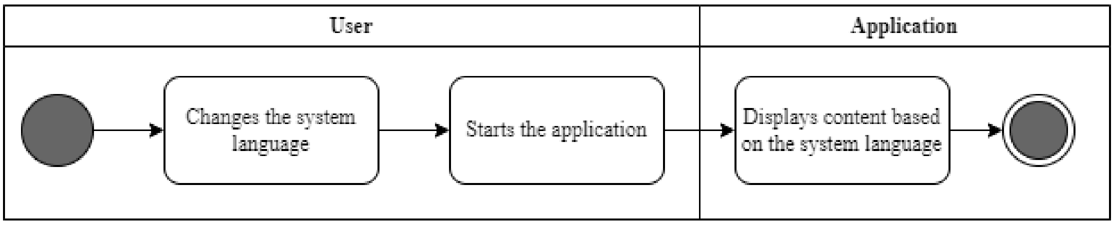

Figure 3.18 Change Application Language Activity Diagram.

Chapter 4
System Design

4.1 System Block Diagram

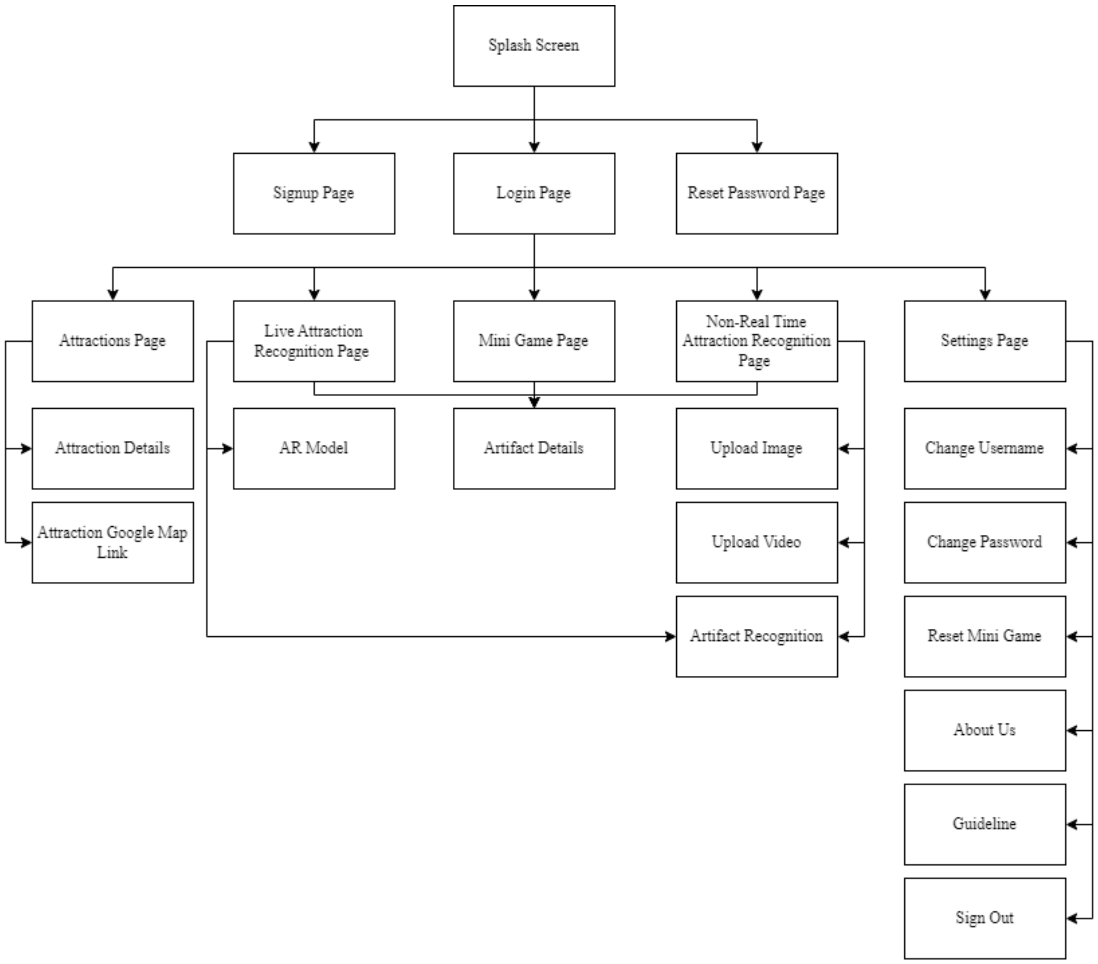

Figure 4.1 System Block Diagram.

4.2 System Flow Chart

Login Module

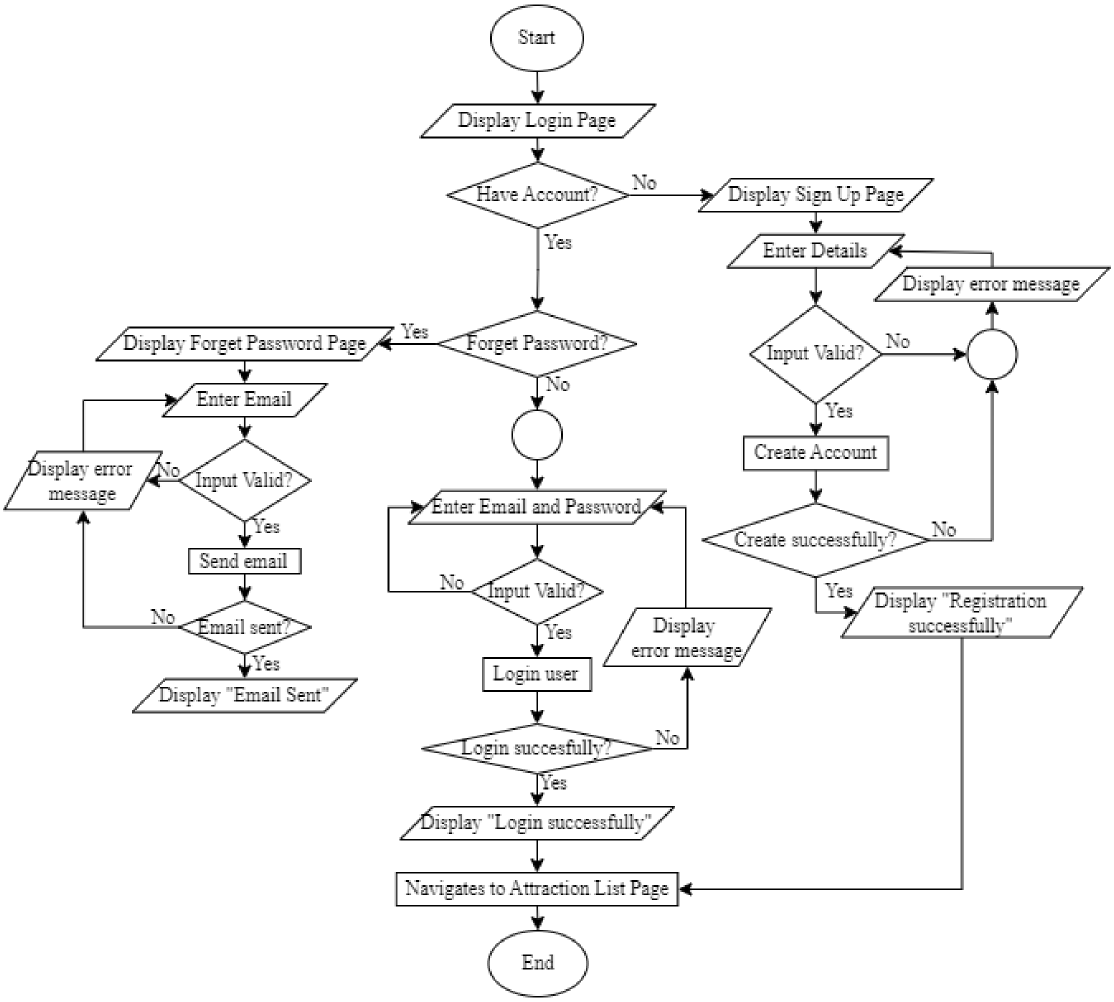

Figure 4.2 Login Module Flowchart.

Attraction List Module

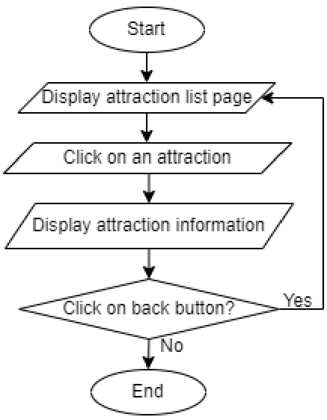

Figure 4.3 Attraction List Module Flowchart.

Live Artifact/Attractions Recognition Module

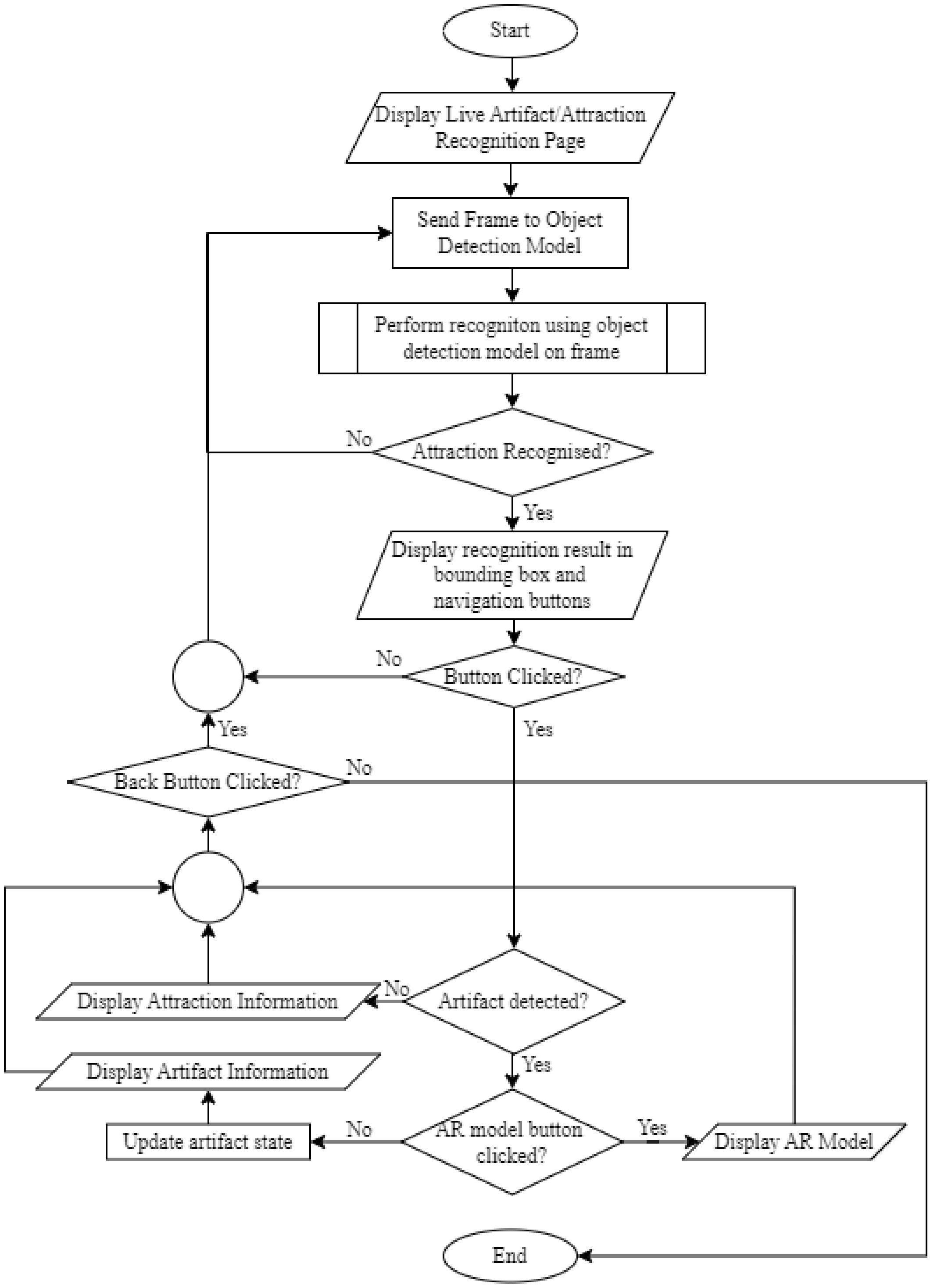

Figure 4.4 Live Artifact/Attractions Recognition Module Flowchart.

Non-Real Time Artifact/Attractions Recognition Module

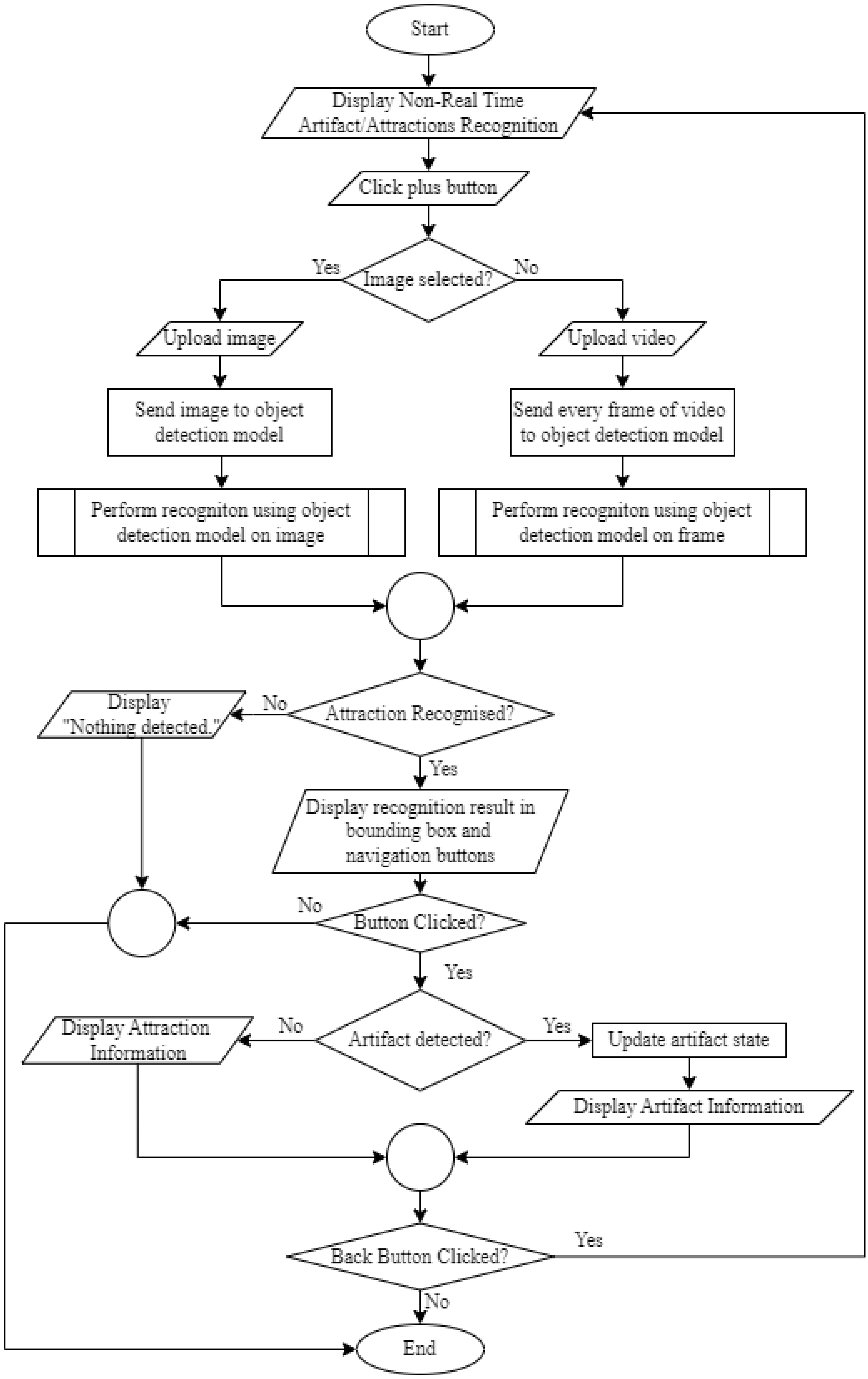

Figure 4.5 Non-Real Time Artifact/Attractions Recognition Module Flowchart.

Mini Game Module

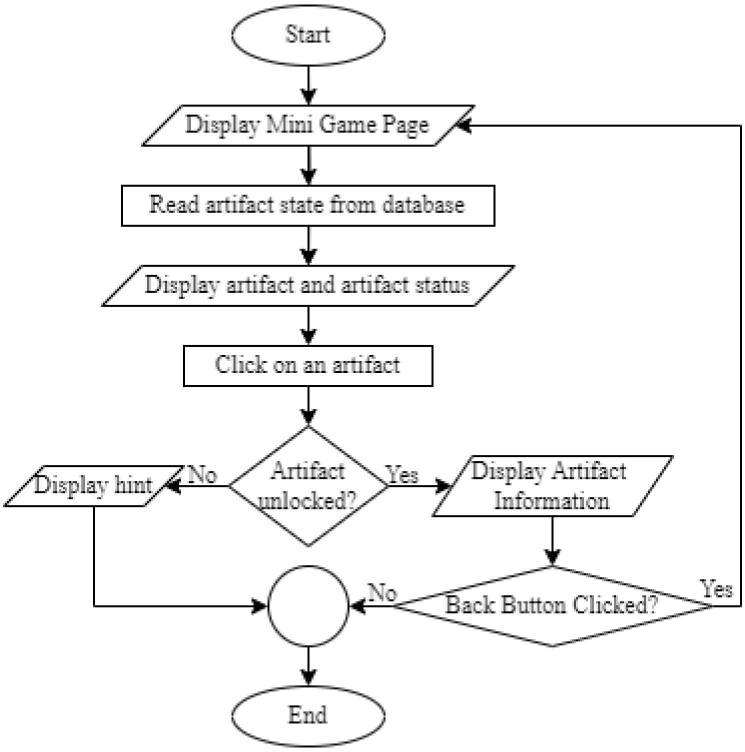

Figure 4.6 Mini Game Module Flowchart.

Settings Module

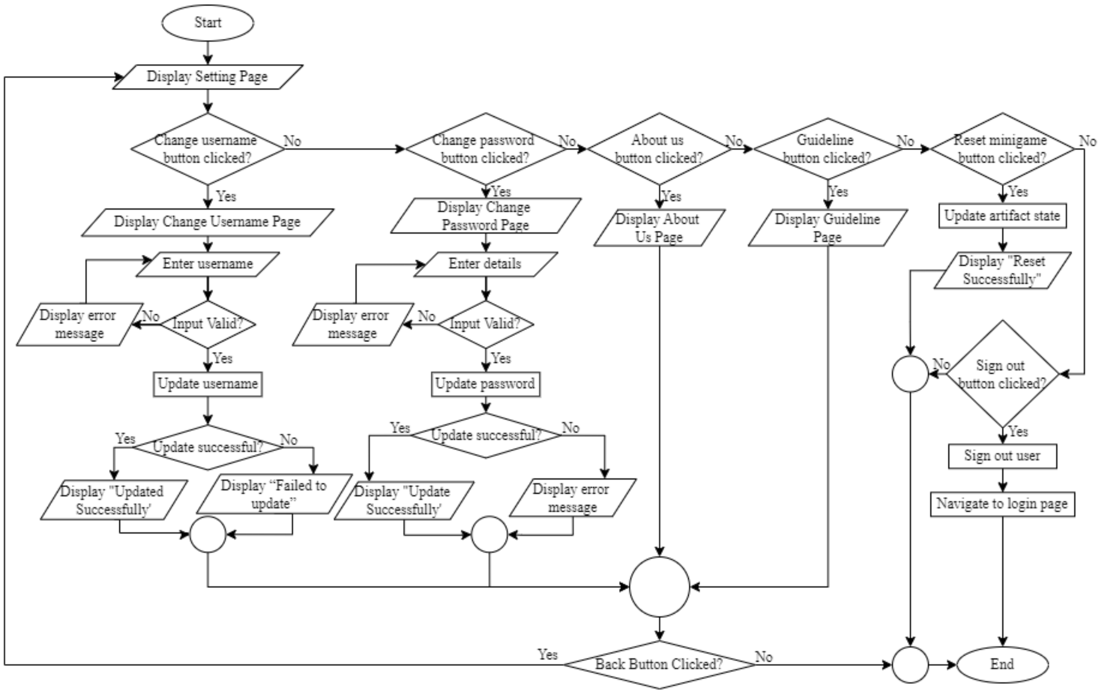

Figure 4.7 Settings Module Flowchart.

4.3 Tools and Technology

4.3.1 Hardware

Laptop

Description	Specifications
Model	Huawei Honor MagicBook 2019 Ryzen Edition (KPR-W19)
Processor	AMD Ryzen 5 3500U with Radeon Vega Mobile Gfx 2.10 GHz
Operating System	Windows 11 Home Single Language
Graphic	Radeon Vega 8 Graphics
Memory	8GB DDR4 RAM
Storage	512GB SSD

Table 4.1 Specifications of laptop.

Smartphone

Description	Specification
Model	Xiaomi Mi 11 Lite
Processor	Qualcomm SM7150 Snapdragon 732G (8 nm)
Operating System	Android 11, MIUI 12
Graphic	Adreno 618
Memory	8GB RAM UFS 2.2
Storage	128GB
Main Camera	64 MP, f/1.8, 26mm (wide), 1/1.97", 0.7µm, PDAF 8 MP, f/2.2, 119˚ (ultrawide), 1/4.0", 1.12µm 5 MP, f/2.4, (macro), AF

Table 4.2 Specifications of smartphone.

4.3.2 Software

Software	Description
Android Studio	It is the official IDE for Android app development. Code editing and developer tools are available in IntelliJ IDEA, a Java IDE for application development. Using the Gradle-based build system, the Android Emulator, the code templates, and the GitHub integration, Android Studio facilitates the creation of Android applications. Each project in Android Studio comes with the source code and resource file types. Modules for Android, libraries, and Google App Engine all fall under this category [14].
Jupyter Notebook	Jupyter Notebook is an open-source web application that allows you to create and share documents containing live code, equations, visualizations, and narrative text. It supports various programming languages, including Python, R, and Julia, among others. It's widely used in data science, research, and education for interactive computing and collaborative work. With Jupyter Notebook, you can write and execute code in individual cells, view the output immediately, and combine code with explanatory text to create rich, interactive documents [33].
Google Colab	The term "Colab" refers to the Google Research product "Colaboratory." Colab's ability to write and run Python code in the browser makes it well suited for usage in education, research, and machine learning. For those who want free GPU access with zero configuration, Colab is a hosted Jupyter Notebook service [15].
LabelImg	LabelImg labels pictures using graphs for free and open-source. Tzutalin published the Python-based programme in 2015 with QT for its GI. LabelImg is a simple tool for labelling a few hundred images for computer vision model training. The annotations can be stored as PASCAL VOC XML files. Human-readable Pascal VOC is a standard XML annotation format used by ImageNet, although no object identification models support it [16].
Blender	Blender stands out as a free, open-source 3D creation suite, offering a comprehensive range of tools for every stage of the 3D workflow. From modelling to animation, simulation to rendering, and even video editing and game creation, Blender covers it all. Its

	flexibility extends further with Python scripting for customization, often resulting in new features integrated into future releases. Ideal for individuals and small studios, Blender boasts a unified pipeline and active development process, evident in its showcase of diverse projects. It operates seamlessly across Linux, Windows, and Macintosh platforms, and Blender's OpenGL-based interface ensures consistency [26].

Table 4.3 Software needed.

4.3.3 Software Development Kit

Software Development Kit	**Description**
AR Core	Google's ARCore is a platform to develop augmented reality (AR) experiences. Using the camera on the device enables devices to see and interact with their surroundings and to incorporate virtual items into the physical world. Motion Tracking, Environmental Understanding, and Light Estimation make this feasible. These features improve the overall augmented reality experience by allowing ARCore to seamlessly place virtual components inside the user's actual environment.
Firebase	Google launched Firebase, a mobile and internet app platform, in 2014. It provides developers with tools and services to create high-quality apps quickly and easily. Firebase offers real-time databases, cloud storage, authentication, hosting, and messaging. The SDKs for popular programming languages like JavaScript, iOS, and Android are also provided. It is also scalability and stable.

Table 4.4 Software Development Kit needed.

4.3.4 Programming Language

Programming Language	**Description**
Java	Programming languages like Java are frequently used to create web apps. Millions of Java programmes are currently in use, making it a popular choice among developers for more than 20 years. Java may be used as a platform unto itself and is an object-oriented, network-centric, multi-platform language. Big data applications, server-side technologies, corporate software, mobile apps, and enterprise software may all be coded using this quick, safe, and dependable programming language [27].
Kotlin	Kotlin is a contemporary programming language that may be converted to native code or JavaScript and operates on the Java Virtual Machine (JVM). It was created by JetBrains and made available to the public in 2016. Because Kotlin and Java are meant to work together seamlessly, developers may utilise both languages in the same project. By providing functional programming capabilities, null safety, succinct syntax, and other contemporary language structures, it seeks to improve upon Java. Because of its smooth interaction with the Android platform, Kotlin has become more and more popular among Android developers. Google has officially recognised Kotlin as a first-class language for Android development [28].
Python	Python adapts to its surroundings and is interpreted, dynamic, and object-oriented. Due to its high-level, in-built data structures, dynamic type, and dynamic binding, it's suited for Rapid Application Development and scripting or glueing existing components. Easy to understand and use Python's syntax prioritises readability and reduces code maintenance. Module and package systems in Python promote code reuse and concern separation. Python is an interpreted programming

	language with a huge standard library that may be freely published as source code or binaries on any major platform. This project trains its object detection model in Python [18].

Table 4.5 Programming language needed.

4.3.5 Libraries

Library	**Description**
TensorFlow	TensorFlow is a free library for doing numerical computations and doing big machine learning. TensorFlow integrates machine learning and deep learning models and algorithms (neural networks) through the use of programming metaphors. Applications written in Python or JavaScript, which provide a simple front-end API, are run in high-performance C++ [19].
Mediapipe Model Maker	MediaPipe Model Maker customises ML models for your data and applications. This tool is faster than constructing and training ML models. Transfer learning is used by Model Maker to retrain models using new data. This method reuses a lot of model code; therefore, it requires less time and data to train than a fresh model. The tool retrains models by deleting the last few layers that categorise data into categories and rebuilding them with the data provided by the user. Model Maker also allows users to fine-tune model layers for accuracy and performance [24].

Table 4.6 Libraries needed.

4.4 User Requirements

- As a user, I can log in to the application with my email address and password.
- As a user, I can reset my password through my email account.
- As a user, I can create an account using my email.
- As a user, I can browse through a list of attractions.
- As a user, I can select an attraction to view its detailed information.
- As a user, I can click on the map to navigate to Google Maps for more information.
- As a user, I can use my phone camera to scan through the artifacts or attractions and perform live artifact/attractions recognition.
- As a user, I can view the detection result with its percentage by scanning through the artifacts or attractions.
- As a user, I can view the artifact 3D model in AR.
- As a user, I can view the detailed information of the artifact after performing artifact/attractions recognition.
- As a user, I can upload an image to perform artifact/attractions recognition.
- As a user, I can upload a video to perform artifact/attraction recognition.
- As a user, I can view the detection result by uploading an image.
- As a user, I can view the detection result by uploading a video.
- As a user, I can view the detailed information of the unlocked artifact.
- As a user, I can view both locked and unlocked artifacts.
- As a user, I can view the hint of the locked artifact when I click on it.
- As a user, I can change my username.
- As a user, I can change my password.
- As a user, I can reset the mini game to its initial state.
- As a user, I can view the information about us.
- As a user, I can view the guidelines of the application.
- As a user, I can skip the guideline directly.
- As a user, I can change the application language by changing the system language.
- As a user, I can sign out my account.

4.5 Database Design

The database chosen to use in this project is Firebase Firestore. It is a versatile, scalable NoSQL cloud database and JSON-compatible document database, which is hosted on Google Cloud infrastructure, to manage and synchronize data for both client and server-side applications [29]. Cloud Firestore, developed by Firebase and Google Cloud, provides a flexible and scalable solution for mobile, web, and server development. Similar to Firebase Realtime Database, it ensures that your data remains synchronized across client applications through real-time listeners and supports offline functionality for mobile and web platforms [29]. This enables you to create responsive applications that function seamlessly regardless of network conditions or internet connectivity. Since Firestore is mostly used for mini game module, thus there are some fields are required in order to let the module work:

Field	Data Type
I	Boolean
II	Boolean
III	Boolean
IV	Boolean
V	Boolean
VI	Boolean
VII	Boolean
VII	Boolean
IX	Boolean
X	Boolean
XI	Boolean
XII	Boolean
XIII	Boolean
XIV	Boolean
congratsDialog	Boolean
email	Text string
username	Text string

Table 4.7 Database Structure.

4.6 Timeline

Figure 4.8 Project Timeline.

Chapter 5
System Implementation

5.1 Hardware Setup

To enable the downloading of our application via Android Studio, several steps must be followed. Firstly, access the "About Phone" section within the system settings of the Xiaomi Mi 11 Lite, which serves as the primary device for testing the application. Locate the "MIUI version" and tap it seven times until the "You are now a developer" notification appears. Return to the main settings menu and scroll down to locate "Additional Settings." From there, navigate to "Developer Options" and activate it to enable the necessary developer settings [30].

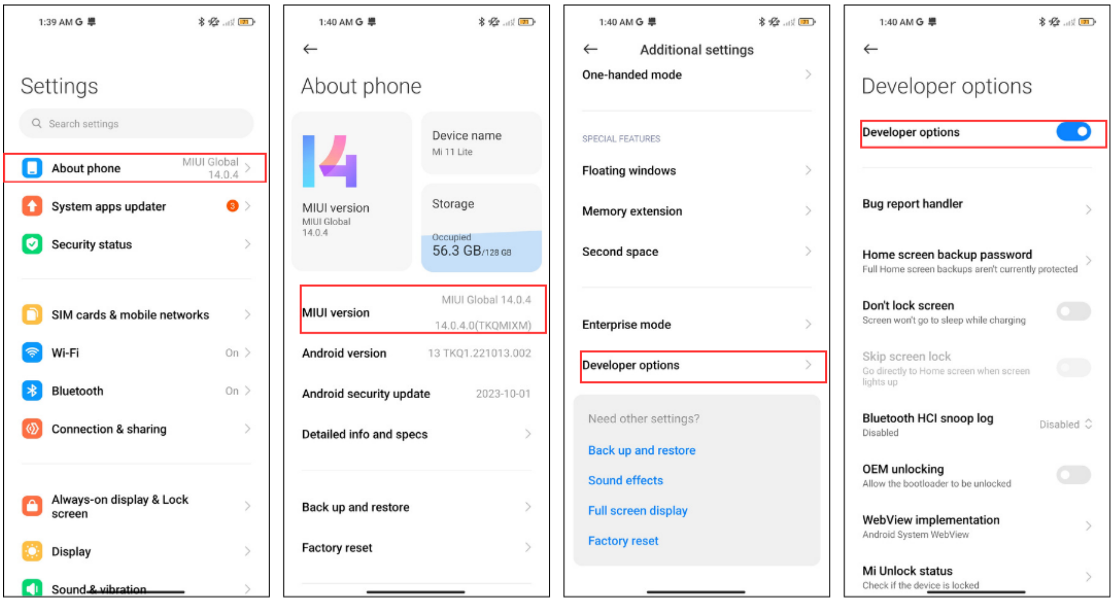

Figure 5.1 Hardware Setup.

5.2 Software Setup

5.2.1 Software

There is some software that needs to be installed and downloaded:

1. Android Studio (version 2023.1.1)
2. Jupyter Notebook (version)
3. LabelImg (version 1.5.0)
4. Blender (version 4.1)

5.2.2 Software Development Kit

There is also a software development kit (SDK) needs to be included:

1. AR Core (version 3.10.6)
2. Firebase (version 3.10.6)

5.2.3 Libraries

There are 2 libraries that need to be installed in Google Colab:

1. TensorFlow (version 2.13.0)
2. Mediapipe Model Maker (version 0.10.11)

5.3 Setting and Configuration

5.3.1 Object Detection Model Creation

Dataset Preparation

For this project, images of the Sacred Heart Church and its artifacts were taken for the dataset. A total of 3333 images with different angles and lighting conditions were taken using an Android phone stated in part 4.3.1. The images are then classified into 15 classes and stored in their respective folder.

IX	5/9/2023 3:35 AM	File folder
Church_BLDG	12/8/2023 11:01 PM	File folder

Figure 5.2 Dataset for Object Detection.

Labelling Installation and Configuration

To enable the drawing of bounding boxes around each image and produce annotations, it is essential to install and configure Labelimg correctly. Once Labelimg is set up, open the directory containing all the images. Then, proceed with drawing bounding boxes around the artifacts or attractions in the images.

```
import os
!pip install --upgrade pyqt5 lxml
LABELIMG_PATH = os.path.join('Tensorflow', 'labelimg')
if not os.path.exists(LABELIMG_PATH):
    !mkdir {LABELIMG_PATH}
    !git clone https://github.com/tzutalin/labelImg {LABELIMG_PATH}
if os.name == 'posix':
    !make qt5py3
if os.name =='nt':
    !cd {LABELIMG_PATH} && pyrcc5 -o libs/resources.py resources.qrc
!cd {LABELIMG_PATH} && python labelImg.py
```

Figure 5.3 Coding for Labelimg installation

Figure 5.4 Labeling software

Image Annotations

Next, the Annotation of these images is then produced using Labelimg. The images and their respective annotations are then further classified into train folder and test folder, and stored into a folder that contains all of the classes. Then, uploaded to Google Drive.

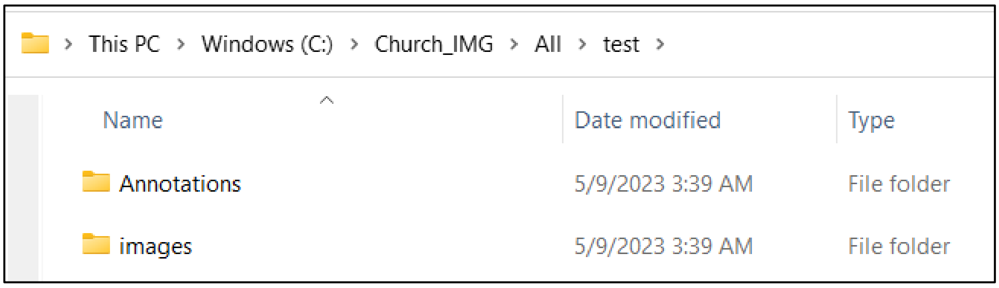

Figure 5.5 Images and Annotations for Object Detection.

Install and Import Libraries for Training Model

Subsequently, it is necessary to install and import a select number of libraries before starting the training of the object detection model. The libraries required for this task include Mediapipe model maker, TensorFlow, OS and files. The utilisation of Tensorflow, Mediapipe model maker is important for the training of the model due to their presence of predefined functions that facilitate a more efficient and fast training process. The OS library facilitates the exporting of models to local computer systems, while the files library offered by Google Colab enables the reading of files from Google Drive.

```
!pip install wheel setuptools pip --upgrade
!pip install mediapipe-model-maker
```

```
[ ] import os
    import tensorflow as tf
    assert tf.__version__.startswith('2')
    from google.colab import files
    from mediapipe_model_maker import object_detector
```

Figure 5.6 Coding for importing libraries for model training.

Loading Dataset

The process of manually splitting the train data and test data is first performed, followed by using the Dataset function to facilitate the import of the dataset from the files in Google Colab, which are read from Google Drive. The function "from_pascal_voc_folder" is utilised to determine whether the annotation format is the same as the Pascal VOC format. This determination can facilitate the training process of the model by extracting significant information from the annotation file. In order to accurately locate the file, it is important to know the folder's path. Finally, the sizes of the training data and test data are outputted to verify the correctness of the number of imported and received data by the system.

```
[ ] train_data = object_detector.Dataset.from_pascal_voc_folder('/content/drive/MyDrive/All/train')

[ ] val_data = object_detector.Dataset.from_pascal_voc_folder('/content/drive/MyDrive/All/test')

[ ] print("train_data size: ", train_data.size)
    print("validation_data size: ", val_data.size)
```

Figure 5.7 Coding for loading dataset for training and validation.

Object Detection Model Selection

The Mediapipe model maker offers a limited selection of four predefined models, namely MobileNetV2, MobileNetV2 I320, MobileNet MultiHW AVG, and MobileNet MultiHW AVG I384. These models have been specifically created and optimised for use on mobile and embedded devices. The selection process eventually involves choosing between MobileNetV2 and MobileNet MultiHW AVG. At last, MobileNet V2 is selected because of its significantly lower latency compared to MobileNet MultiHW AVG but having a little lower average precision (AP) of only 0.1%. MobileNetV2 is a convolutional neural network architecture designed with the objective of achieving optimal performance on mobile computing devices. The architecture is founded upon an inverted residual structure, wherein the bottleneck layers establish the residual connections [20]. Lightweight depthwise convolutions are used in the intermediate expansion layer to efficiently filter features and introduce non-linearity to the model. The design of MobileNetV2 has an initial fully convolutional layer consisting of 32 filters, which is subsequently followed by 19 residual bottleneck layers [20].

Model architecture	Input Image Size	Test AP		CPU Latency		Model Size	
		float32	QAT int8	float32	QAT int8	float32	QAT int8
MobileNetV2	256x256	88.4%	73.5%	48ms	16ms	11MB	3.2MB
MobileNetV2 I320	320x320	89.1%	75.5%	75ms	33.38ms	10MB	3.3MB
MobileNet MultiHW AVG	256x256	88.5%	70.0%	56ms	19ms	13MB	3.6MB
MobileNet MultiHW AVG I384	384x384	92.7%	73.4%	238ms	41ms	13MB	3.6MB

Figure 5.8 Comparison between Mediapipe model maker supported model.

Object Detection Model Training

The model is then trained with the parameters of batch_size=8, learning_rate=0.3, and epochs=20 [22].

```
hparams = object_detector.HParams(batch_size=8, learning_rate=0.3, epochs=20, export_dir='exported_model')
options = object_detector.ObjectDetectorOptions(
    supported_model=object_detector.SupportedModels.MOBILENET_V2,
    hparams=hparams
)
model = object_detector.ObjectDetector.create(
    train_data=train_data,
    validation_data=val_data,
    options=options)
```

Figure 5.9 Coding for training the model.

Object Detection Model Evaluation

Once the model has undergone training, it is subsequently evaluated using a statistic known as average precision, using the validation dataset. The model achieved an average precision of 90.07%, indicating a good level of performance. The average precision metric is an important performance measure that seeks to reduce the reliance on a single confidence threshold value [21]. It is quantified by calculating the area under the precision-recall curve. The PR Curve is condensed into a single scalar value by AP. The average precision metric exhibits a positive correlation with both precision and recall, indicating that it is high when both precision and recall are high, and low when either precision or recall is low, as shown across various confidence threshold values [21].

```
[ ]  model.evaluate(val_data)

     756/756 [==============================] - 47s 59ms/step - total_loss: 0.1499 - cl
     /usr/local/lib/python3.10/dist-packages/keras/src/engine/functional.py:642: UserWa
       inputs = self._flatten_to_reference_inputs(inputs)
     creating index...
     index created!
     creating index...
     index created!
     Running per image evaluation...
     Evaluate annotation type *bbox*
     DONE (t=2.07s).
     Accumulating evaluation results...
     DONE (t=0.63s).
      Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.901
      Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.998
      Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.998
      Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = -1.000
      Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = -1.000
      Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.901
      Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.923
      Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.923
      Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.923
      Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = -1.000
      Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = -1.000
      Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.923
     ([0.1499052345752716,
       0.08082995563745499,
       0.0003109858662355691,
       0.09637926518917084],
      {'AP': 0.90079594,
```

Figure 5.10 Coding for model evaluation.

Exporting Object Detection Model

The model is then exported and downloaded in the format of tflite to further implement it in mobile devices.

```
model.export_model('Church.tflite')
!ls exported_model
files.download('exported_model/Church.tflite')
```

Figure 5.11 Coding for exporting model.

5.3.2 Firebase Service

Firebase Project Creation

To utilize Firebase services, users must first register an account on the Firebase platform. Upon registration, users can proceed to create a new project and fill up the information needed. Once the project is created, it will appear in the Firebase dashboard.

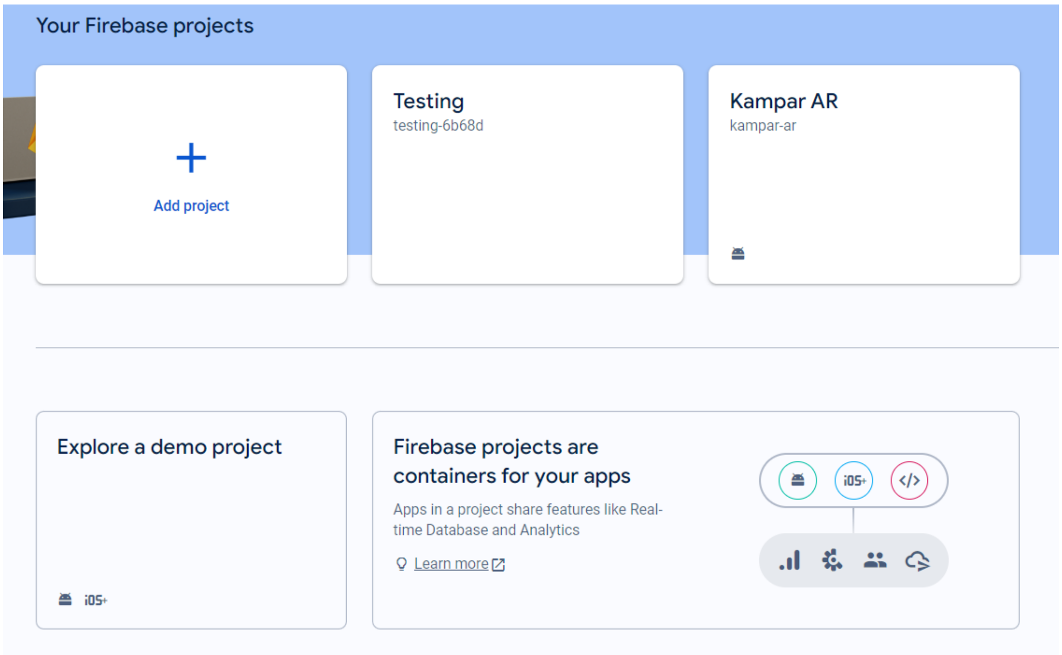

Figure 5.12 Firebase Console.

Firebase Authentication

To utilize Firebase authentication services for tasks such as account creation and login, users must first select and enable the desired sign-in method within the Firebase console. In this case, the chosen sign-in method is email and password authentication.

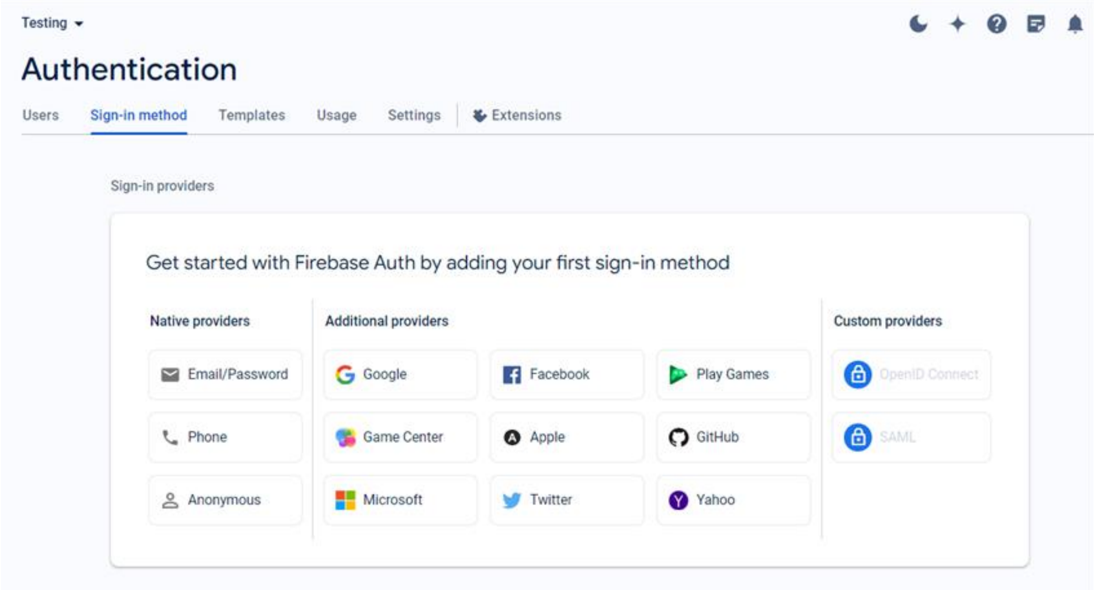

Figure 5.13 Firebase Authentication Method.

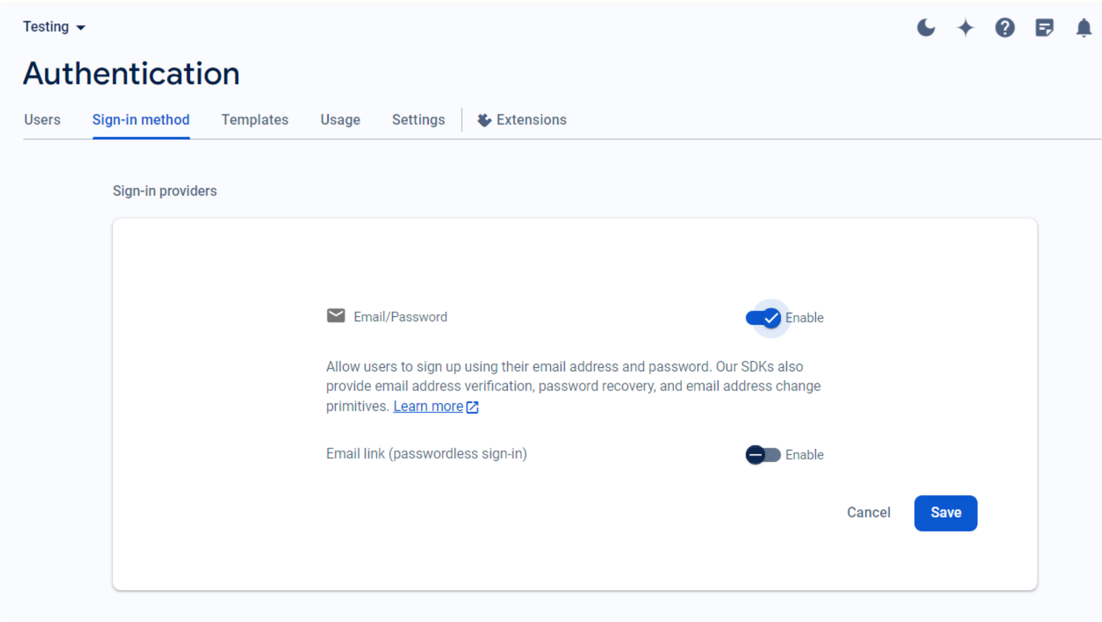

Figure 5.14 Firebase Email Password Authentication.

After adding the authentication method and some data, the user's tab will look like this.

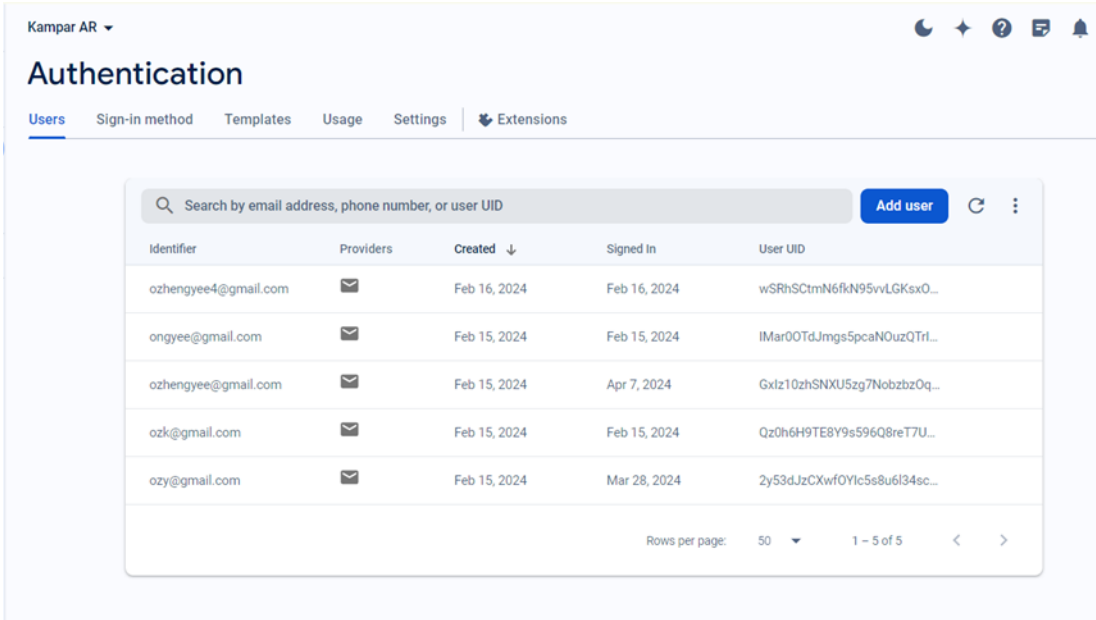

Figure 5.15 Firebase Authentication Users Table.

Firebase Firestore

To utilize the Firebase Firestore service, the initial step involves creating a database and configuring its location. Additionally, setting the security rules to production mode ensures that data remains private by default, with access only granted based on specified security rules.

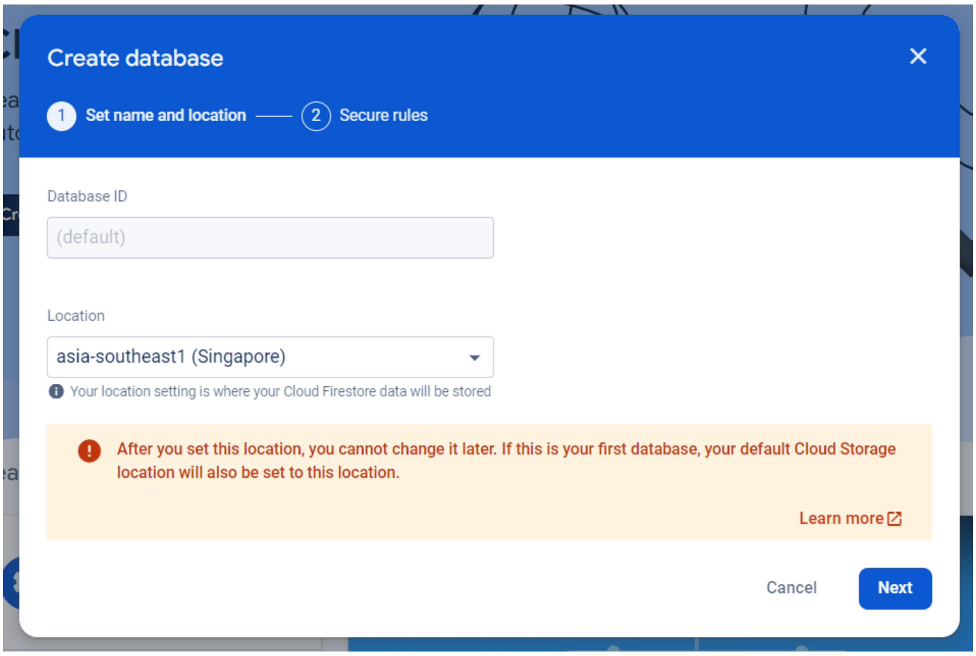

Figure 5.16 Firebase Firestore Name and Location Declaration.

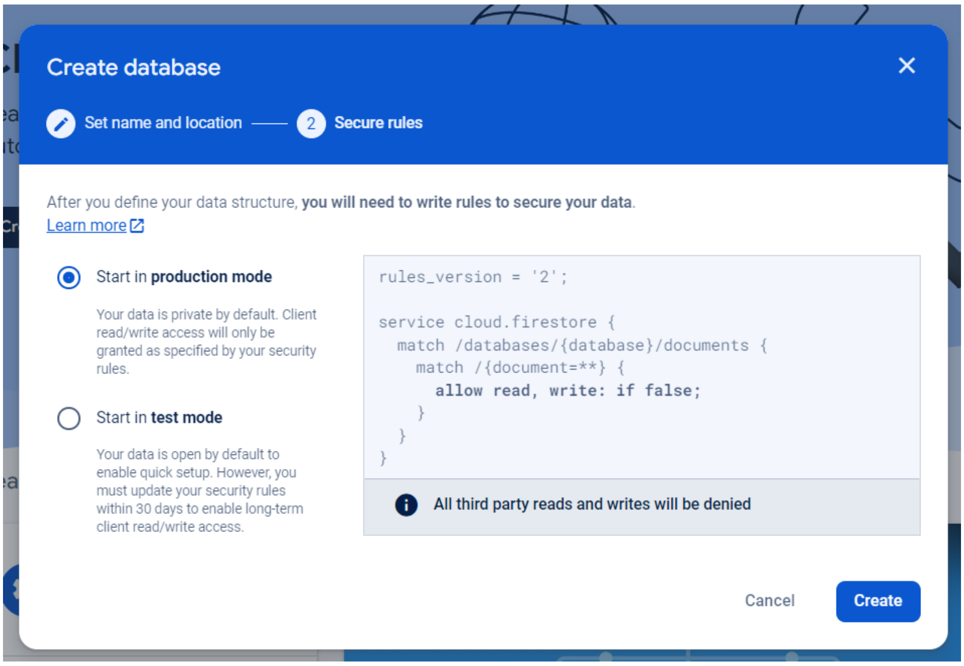

Figure 5.17 Firebase Firestore Secure Rules Selection.

Next, the security rules are adjusted to permit user reading and writing privileges only if a user is logged in.

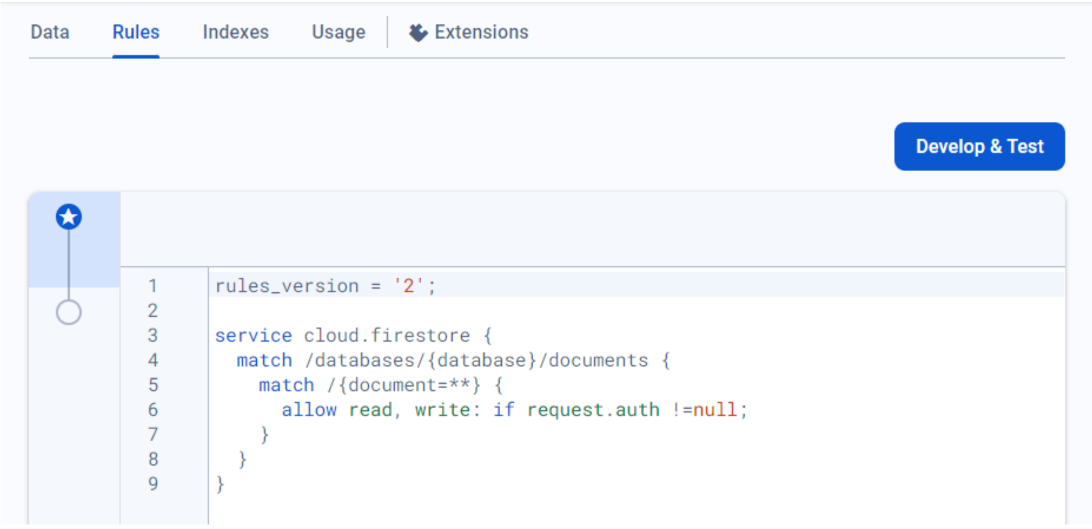

Figure 5.18 Firebase Firestore Secure Rules Declaration.

Adding Firebase to Android Studio Project

To integrate the Firebase Authentication Service and Firebase Firestore Service into Android Studio, access the "Tools" tab within the Android Studio interface. From there, select "Firebase" and choose to add a service, such as authentication and cloud Firestore in this instance. Subsequently, establish a connection between the application and Firebase, and incorporate the SDK into the application.

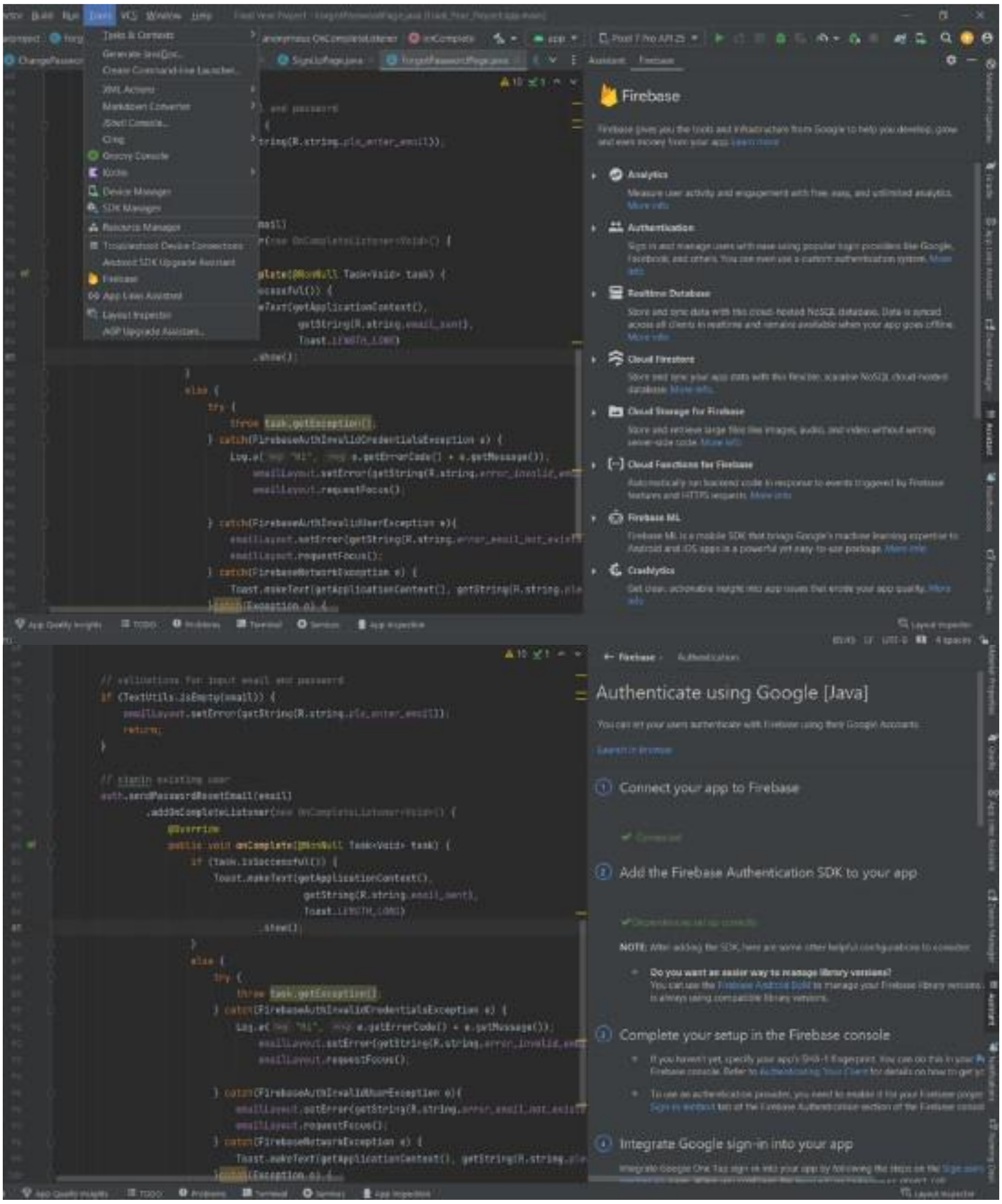

Figure 5.19 Setting up Firebase in Android Studio.

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5.4 System Operation

Splash Screen

Figure 5.20 Splash Screen.

A simple splash screen contains the logo of the application.

Login Page

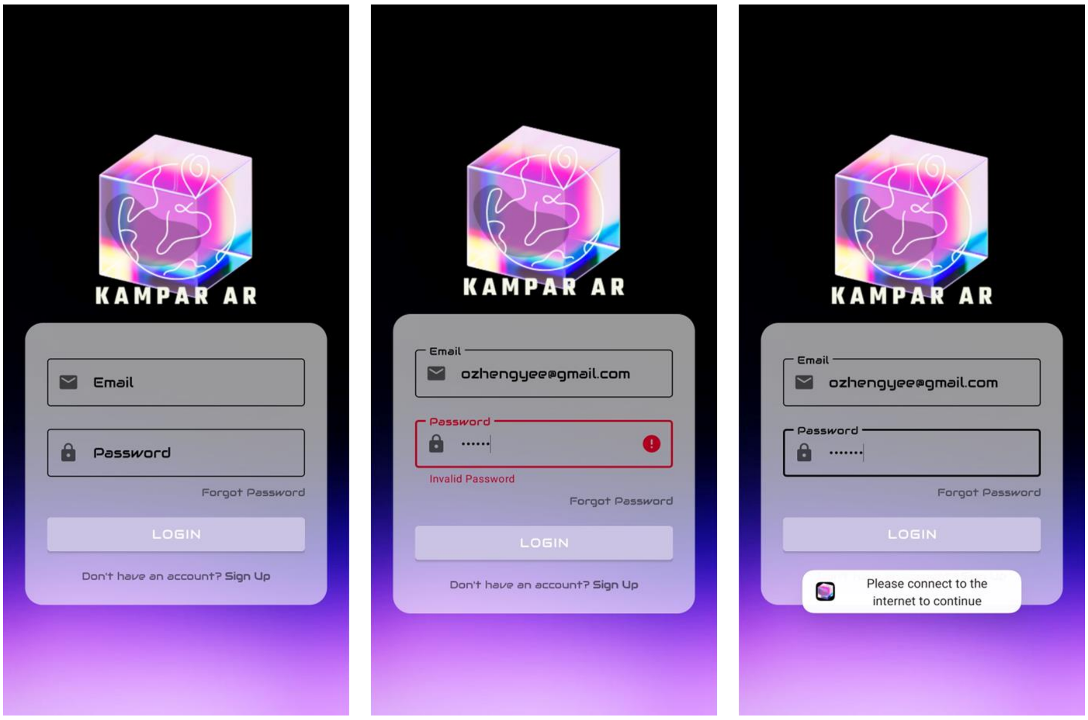


Figure 5.21 Login Page.

The login page enables users to access their accounts by entering their email and password. Upon clicking the login button, the application conducts input validation to ensure the accuracy of the provided information. In case of any invalid inputs, corresponding error messages appear beneath the respective input fields. If the input is deemed valid, the application proceeds to authenticate the user. Upon successful authentication, a "Login Successfully" message is displayed. Conversely, if authentication fails, an error message is presented either through a toast notification or displayed beneath the relevant text box.

Sign Up Page

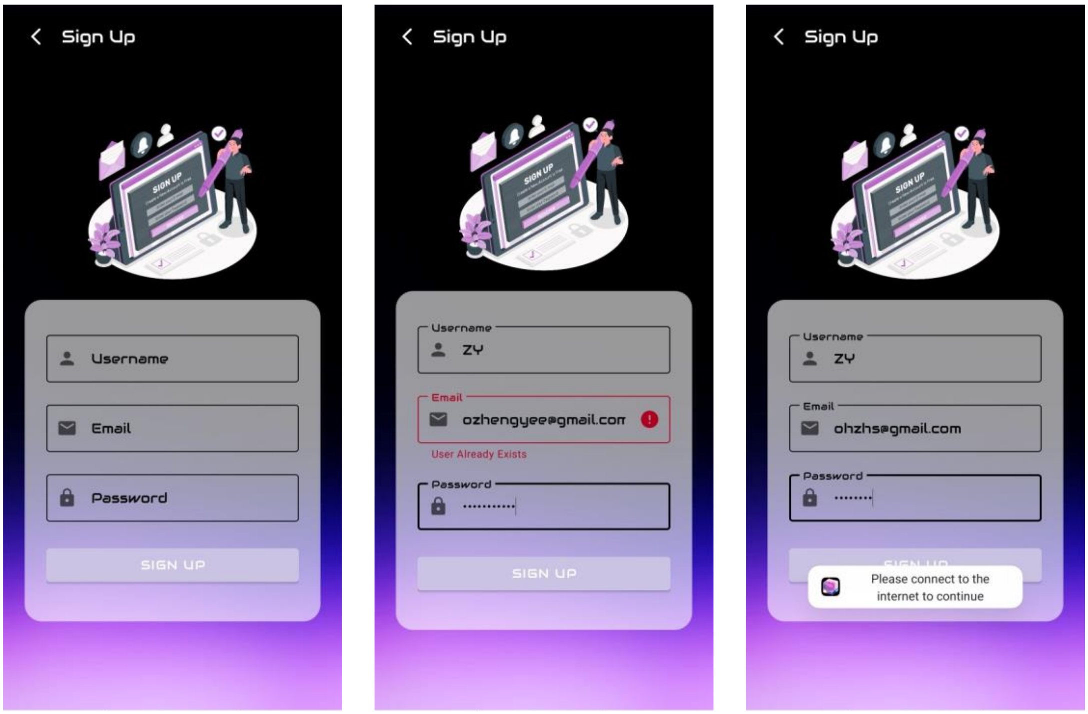


Figure 5.22 Sign Up Page.

The sign-up page enables users to create their accounts by using their email and password. Upon clicking the sign-up button, the application conducts input validation to ensure the accuracy of the provided information. In case of any invalid inputs, corresponding error messages appear beneath the respective input fields. If the input is deemed valid, the application proceeds to account registration for the user. Upon successful registration, a "Registration Successful" message is displayed. Conversely, if registration fails, an error message is presented either through a toast notification or displayed beneath the relevant text box.

Forget Password Page

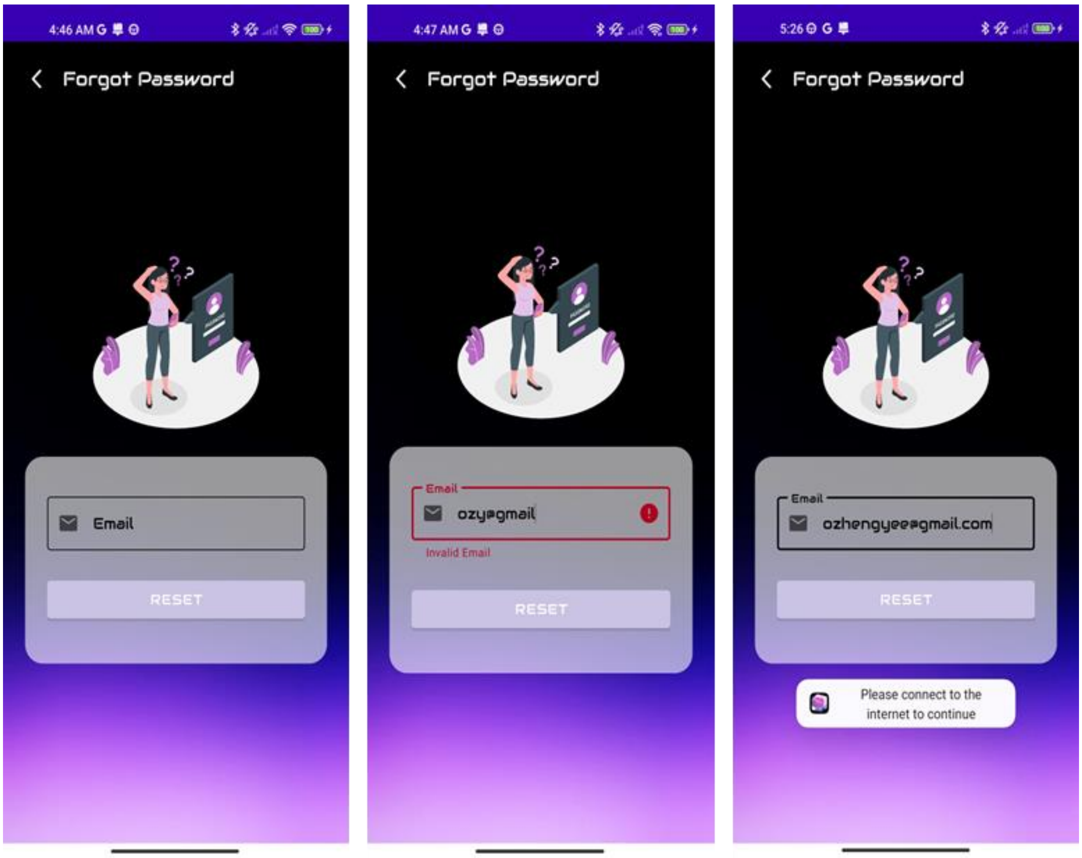


Figure 5.23 Forget Password Page.

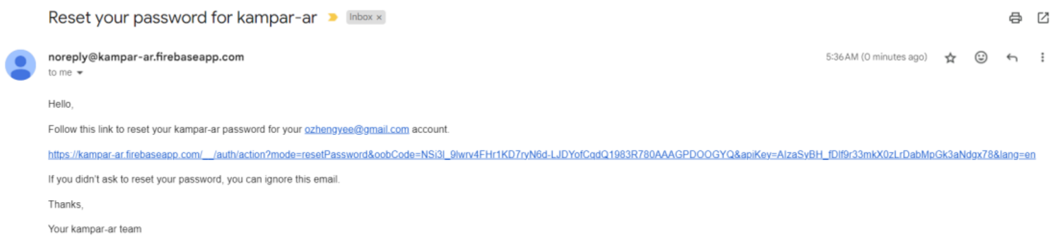


Figure 5.24 Forget Password Email.

The forget password page enables users to reset their password by using their email if they forgot their password. Upon clicking the reset button, the application conducts input validation to ensure the accuracy of the provided information. In case of any invalid inputs, corresponding error messages appear beneath the respective input fields. If the input is deemed valid, the application proceeds to send a reset password email to the user. Upon successfully sending, an "Email Sent" message is displayed. Conversely, if fails to send the email, an error message is presented either through a toast notification or displayed beneath the relevant text box.

Attraction List Page

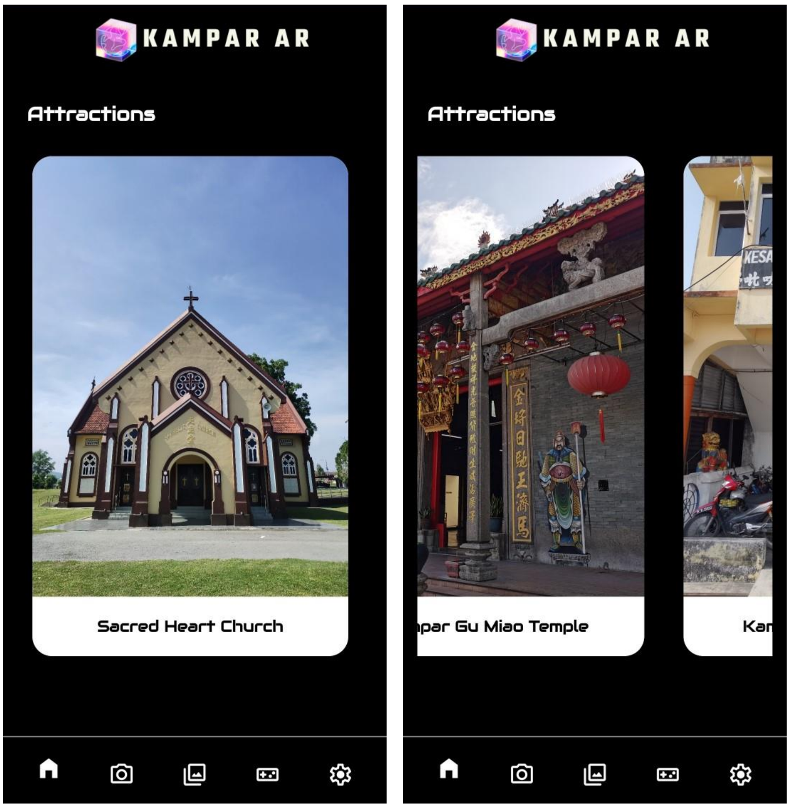


Figure 5.25 Attraction List Page.

The attraction list page provides users with access to browse all available attractions. Users can navigate through the list and click on individual attractions to view detailed information about each one.

Attraction Details Page

Figure 5.26 Attraction Details Page.

On the attraction details page, users can access comprehensive information about the selected attraction. Additionally, users have the option to click on a map feature, which will redirect them to Google Maps for further details not provided within the application.

Live Artifact/Attractions Recognition Page

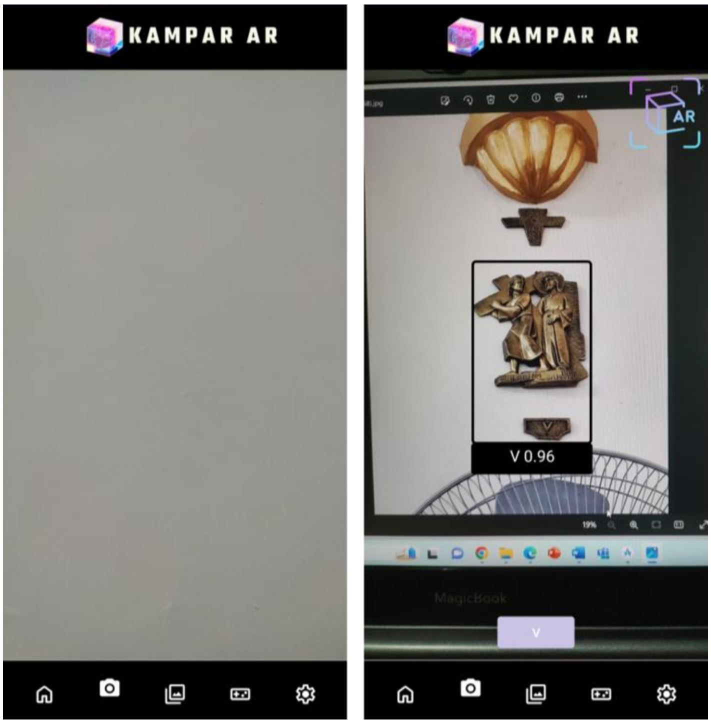


Figure 5.27 Live Artifact/Attractions Recognition Page.

On the live artifact/attraction recognition page, users can utilize their phone camera to scan their surroundings. When an artifact/attraction is detected, one or two navigation buttons will appear: the artifact/attraction details button and the AR model button. The artifact/attraction details button allows users to access detailed information about the detected result. The AR model button, on the other hand, is exclusively displayed when the detected result is an artifact. Upon clicking this button, the application redirects users to the AR model page, where they can view the artifact in 3D and augmented reality (AR).

AR Model Page

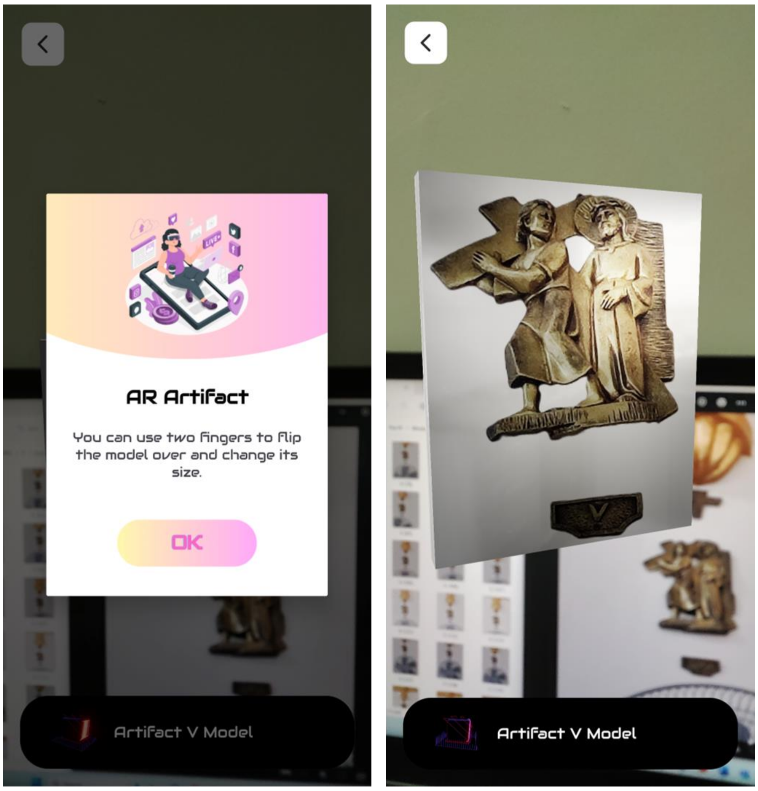


Figure 5.28 AR Model Page.

On the AR Model page, users are provided with a brief tutorial on interacting with the 3D model. Following this, users can proceed to view the 3D model of the detected artifact. The 3D model can be rotated horizontally using a simple gesture: swiping with two fingers across the screen.

Non-Real Time Artifact/Attractions Recognition Page

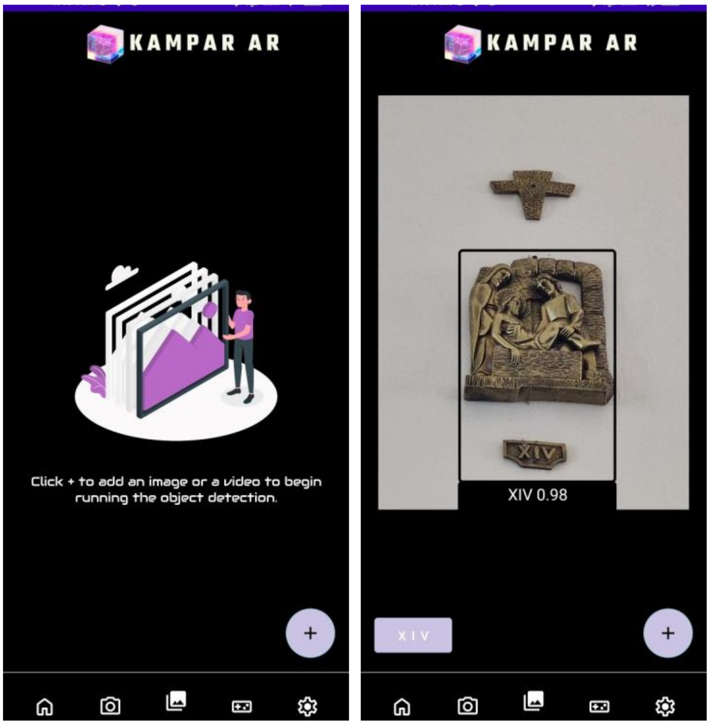


Figure 5.29 Non-Real Time Artifact/Attractions Recognition Page.

On the non-real time artifact/attraction recognition page, users can either upload an image or a video to perform artifact/attraction recognition. When an artifact/attraction is detected, one navigation button will appear: the artifact/attraction details button. The artifact/attraction details button allows users to access detailed information about the detected result.

Artifact Details Page

Figure 5.30 Artifact Details Page.

On the artifact details page, users can access comprehensive information about the selected artifact.

Mini Game Page

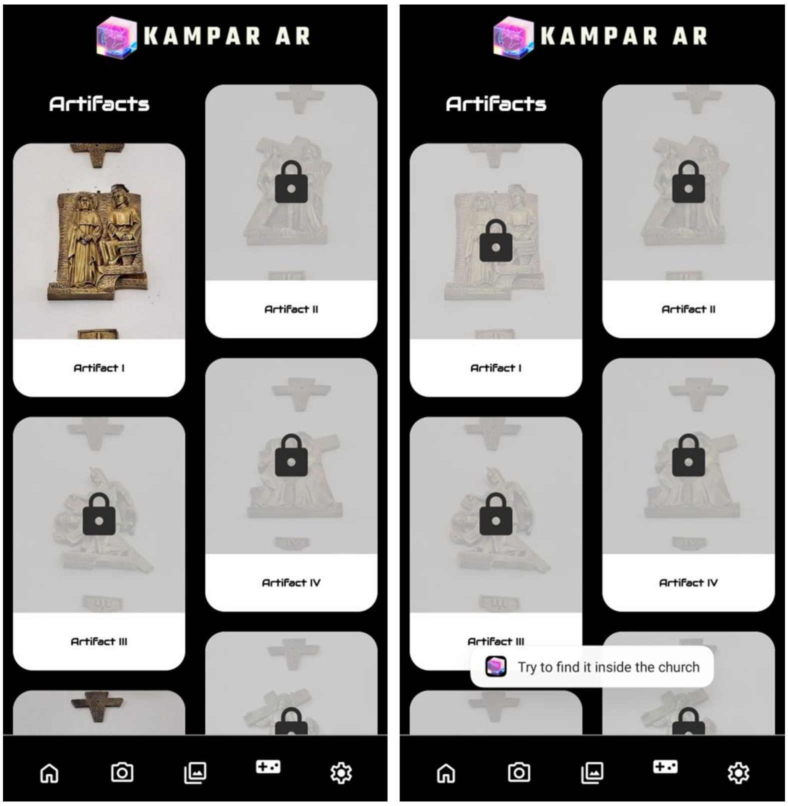


Figure 5.31 Mini Game Page.

On the mini-game page, users can browse through a list of artifacts and view their mini game status, including both locked and unlocked artifacts. If a user clicks on an unlocked artifact, the application will navigate them to the artifact details page. However, if the user clicks on a locked artifact, the application will display a hint associated with that artifact. These hints can assist users in locating the locked artifact within the game.

Settings Page

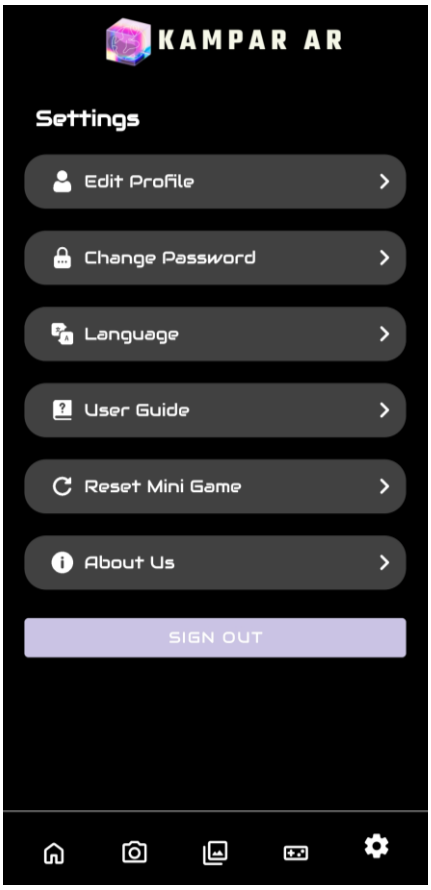


Figure 5.32 Settings Page.

On the settings page, users can access various useful functions and view additional information about the application.

Change Username Page

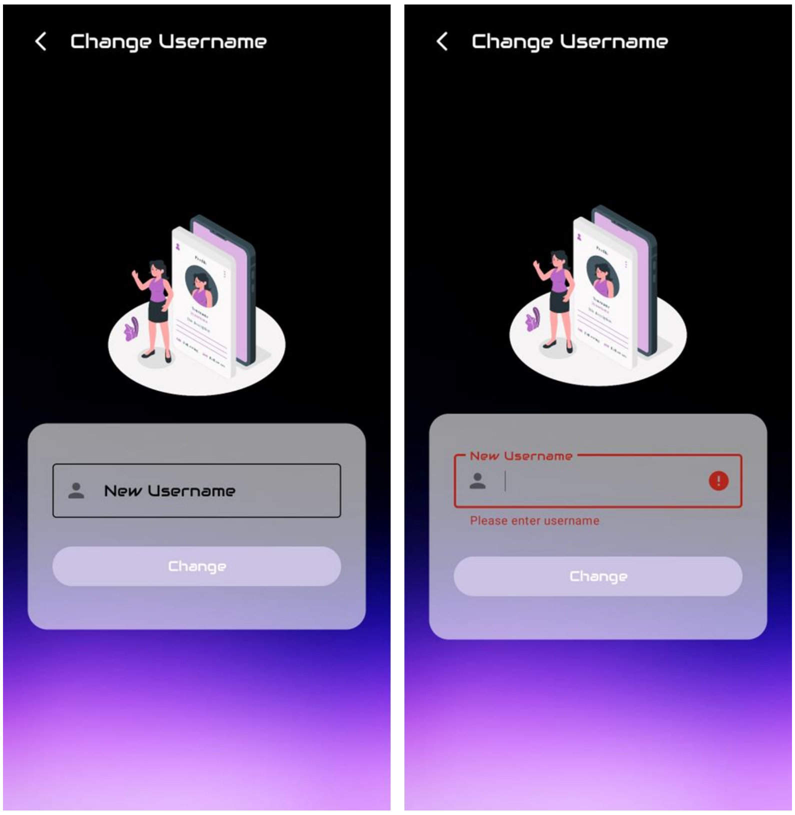


Figure 5.33 Change Username Page.

The change username page enables users to change their username. Upon clicking the change button, the application conducts input validation to ensure the accuracy of the provided information. In case of any invalid inputs, corresponding error messages appear beneath the respective input fields. If the input is deemed valid, the application proceeds to update the username for the user. Upon successful update, an "Update Successfully" message is displayed. Conversely, if the update fails, an error message is presented either through a toast notification or displayed beneath the relevant text box.

Change Password Page

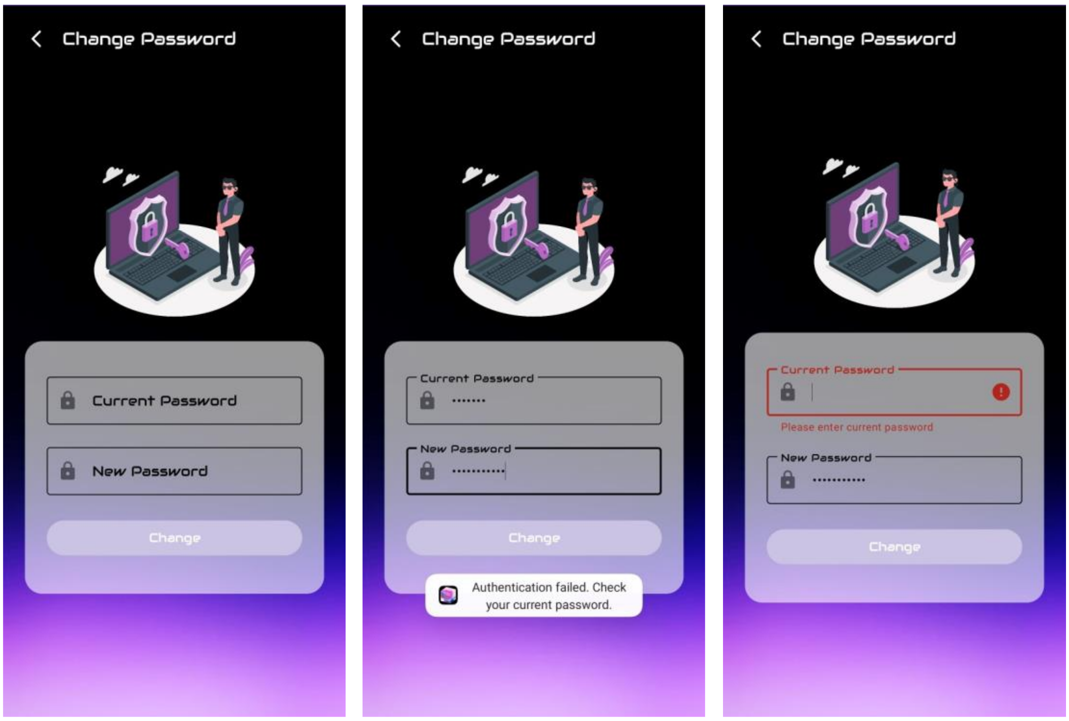


Figure 5.34 Change Password Page.

The change password page enables users to change their password. Upon clicking the change button, the application conducts input validation to ensure the accuracy of the provided information. In case of any invalid inputs, corresponding error messages appear beneath the respective input fields. If the input is deemed valid, the application proceeds to authenticate the user. Upon successful authentication, an "Update Successfully" message is displayed. Conversely, if the update fails, an error message is presented either through a toast notification or displayed beneath the relevant text box.

Guideline Page

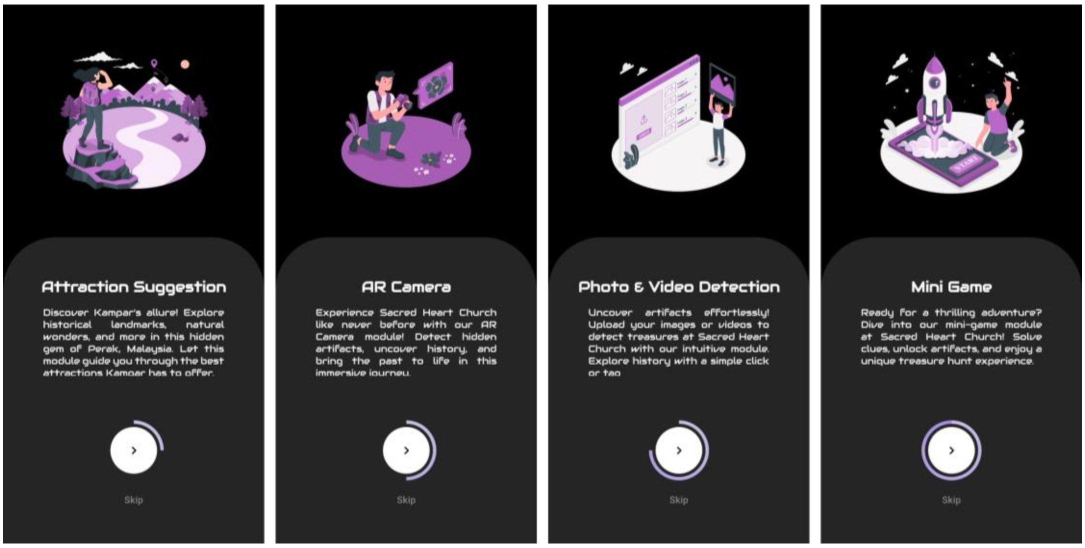


Figure 5.35 Guideline Page.

The guideline page provides users with information on how to effectively use the application.

About Us Page

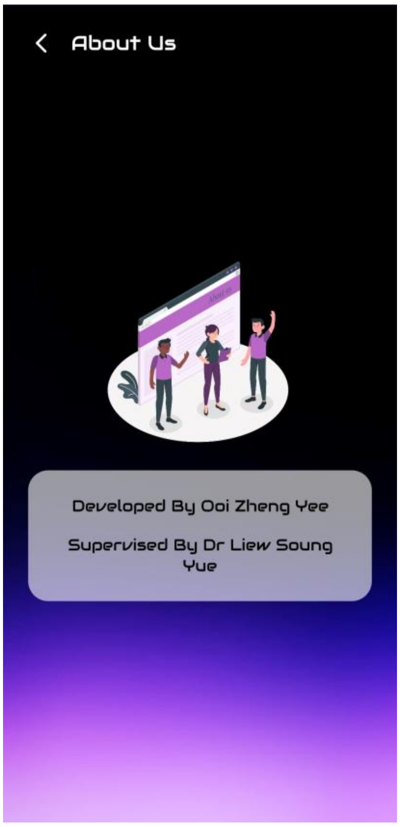


Figure 5.36 About Us Page.

The About Us page provides users with information about the developer.

Application Language

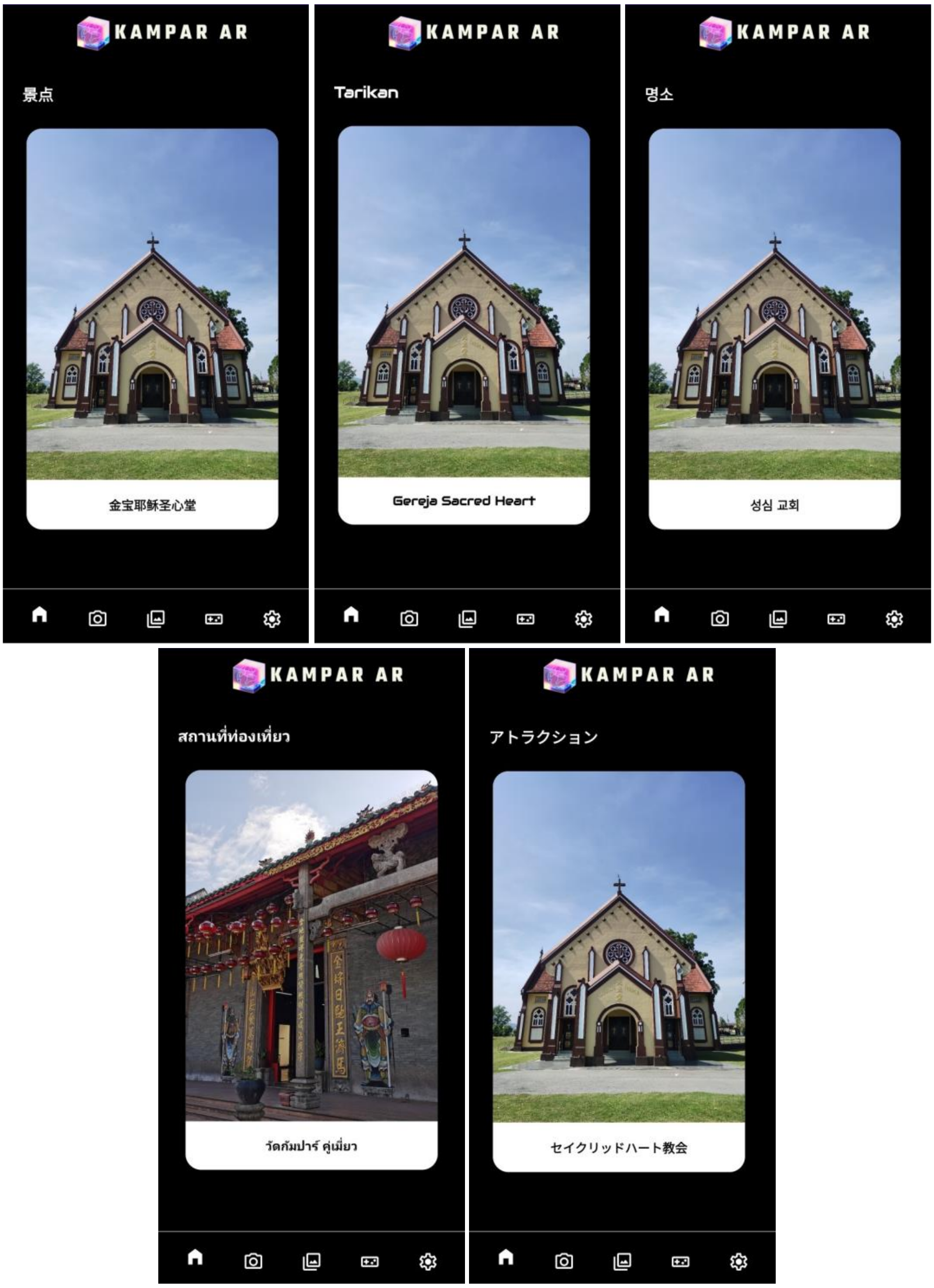


Figure 5.37 Application in Different Language.

The application supports 6 languages including English, Chinese, Malay, Korean, Japanese and Thai. The application language is determined by the system language. If the user system language is Chinese, the application will be in Chinese automatically.

5.5 Implementation Issues and Challenges

1. **Model Selection**

   The process of selecting an appropriate model architecture will unavoidably include complexity. Several factors must be taken into consideration about this matter. For instance, the parameters that can be considered are the dimensions of the model, the time delay in processing, and the level of accuracy achieved. Initially, the use of a Tensorflow model maker is being considered for training the model with a customised dataset in this project. This choice is driven by the fact that the Tensorflow model maker simplifies the training process, hence reducing the time required. Consequently, this enables the project team to allocate more attention to other project-related tasks. Additionally, the Tensorflow model maker offers a wider range of models that can be employed in the project. However, an issue arises during the installation of the model maker, where the dependencies fail to align. After conducting careful research, a proposal was made to develop a virtual environment with specific requirements for the installation of the model maker. Yet, despite these efforts, the implementation was ultimately unsuccessful. Then, an alternative method showed up such as the utilisation of the Mediapipe model maker. The Mediapipe model maker offers a limited selection of four models for utilisation: MobileNetV2, MobileNetV2 I320, MobileNet MultiHW AVG, and MobileNet MultiHW AVG I384. As the accuracy of the model increases, there is a corresponding increase in both the latency and size of the model. Hence, the consideration of many conditions is necessary when utilising the application, thereby providing a potential obstacle. This issue also presents a challenge in the process of selecting models for object detection, especially real-time detection.

2. **Image Collection**

   Obtaining images of churches and their associated artefacts may be a challenging task, particularly when certain artefacts are positioned in high locations that are difficult to reach. Therefore, capturing photos of these artefacts requires the use of high-resolution cameras capable of zooming in to precisely capture them. Additionally, the initial method used for image acquisition involved the use of the iPhone 13 and iPhone 13 Pro Max devices. During the training process, it was observed that there exists an error between the dimensions of the input photos provided to the model and the dimensions of the images received by the model. The occurrence of this circumstance can be due to the difference in picture formatting between images captured using an iPhone and those taken using standard techniques, despite both formats sharing identical names. Finally, the process involves using an Android phone to gather the previously mentioned images once again. When acquiring photos, it is important to take into account capturing them under various conditions, including diverse angles and lighting settings. This approach is crucial for achieving enhanced accuracy during the model training process.

Chapter 6
System Evaluation and Discussion

6.1 System Testing and Performance Metrics

6.1.1 Object Detection Model Testing and Performance Metrics

There are a few metrics used to determine the performance of the object detection model:

IOU (Intersection over Union)

In the context of object detection, IOU is used to determine how well a predicted bounding box aligns with a ground-truth bounding box. If the IOU value is high (close to 1), it indicates a good alignment, meaning the predicted box accurately captures the object. If the IOU value is low (close to 0), it means there's little overlap between the predicted and ground-truth boxes, suggesting poor detection [31].

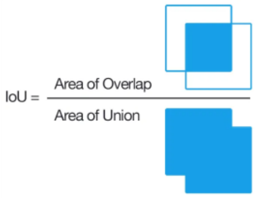


Figure 6.1 Formula of IoU.

AP (Average Precision)

This metric measures the area under the precision-recall curve. It's a single number that summarizes the model's performance across all recall levels. Higher AP indicates better performance [31].

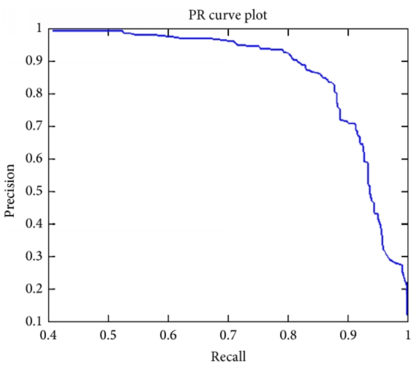


Figure 6.2 Precision-Recall Curve.

AP50 (Average Precision at IoU 50%)

This is the average precision computed with a threshold of 50% Intersection over Union (IoU) between the predicted and ground-truth bounding boxes. IoU measures the overlap between two bounding boxes [31].

AP75 (Average Precision at IoU 75%)

Similar to AP50 but computed with a higher IoU threshold of 75%. This means the predicted bounding box must have at least 75% overlap with the ground-truth bounding box to be considered a correct detection [31].

6.1.2 Mobile Application Testing and Performance Metrics

Test cases will be used to perform testing for the mobile application. A test case refers to a series of actions executed on a system to assess whether it meets software requirements and operates accurately. It aims to ascertain whether various features within the system function correctly and adhere to relevant standards, guidelines, and customer specifications. Writing test cases also serves to uncover any errors or defects present in the system [32].

6.2 Testing Setup and Result

6.2.1 Object Detection Model Testing Setup and Result

Object Detection Model Evaluation

Once the model has undergone training, it is subsequently evaluated using the code model.evaluate(val_data), using the validation dataset. The model achieved an average precision of 90.07%, indicating a good level of performance.

```
model.evaluate(val_data)
```

```
756/756 [==============================] - 47s 59ms/step - total_loss: 0.1499 - c
/usr/local/lib/python3.10/dist-packages/keras/src/engine/functional.py:642: UserW
  inputs = self._flatten_to_reference_inputs(inputs)
creating index...
index created!
creating index...
index created!
Running per image evaluation...
Evaluate annotation type *bbox*
DONE (t=2.07s).
Accumulating evaluation results...
DONE (t=0.63s).
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.901
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.998
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.998
```

Figure 6.3 Model evaluation result.

Importing Libraries for Object Detection Model Testing

The primary purpose of importing libraries like as TensorFlow, NumPy, MediaPipe, and OpenCV (cv2) is to facilitate the implementation of object detection algorithms on an input image.

```
# STEP 1: Import the necessary modules.
import tensorflow as tf
import numpy as np
import mediapipe as mp
from mediapipe.tasks import python
from mediapipe.tasks.python import vision
import cv2
from google.colab.patches import cv2_imshow
```

Figure 6.4 Coding for importing libraries for model testing.

Create Function for Drawing Bounding Box, Label and Score

Next, a function is then created to draw a bounding box on the object being detected with its corresponding label and result. NumPy libraries and OpenCV are mainly used in this function [23].

```
MARGIN = 10  # pixels
ROW_SIZE = 10  # pixels
FONT_SIZE = 1
FONT_THICKNESS = 2
TEXT_COLOR = (255, 0, 0)  # red


def visualize(
    image,
    detection_result
) -> np.ndarray:

  for detection in detection_result.detections:
    # Draw bounding_box
    bbox = detection.bounding_box
    start_point = bbox.origin_x, bbox.origin_y
    end_point = bbox.origin_x + bbox.width, bbox.origin_y + bbox.height
    cv2.rectangle(image, start_point, end_point, TEXT_COLOR, 3)

    # Draw label and score
    category = detection.categories[0]
    category_name = category.category_name
    probability = round(category.score, 2)
    result_text = category_name + ' (' + str(probability) + ')'
    text_location = (MARGIN + bbox.origin_x,
                     MARGIN + ROW_SIZE + bbox.origin_y)
    cv2.putText(image, result_text, text_location, cv2.FONT_HERSHEY_PLAIN,
                FONT_SIZE, TEXT_COLOR, FONT_THICKNESS)

  return image
```

Figure 6.5 Coding for drawing bounding box, label and score.

Testing External Image on Object Detection Model

The ObjectDetector object is created using the specified model and a threshold parameter of 0.5. Subsequently, a selection of photos that were not included in the model training process, including photographs sourced from the internet, were included. Finally, the result will be presented [23].

```
# STEP 2: Create an ObjectDetector object.
base_options = python.BaseOptions(model_asset_path=model_path)
options = vision.ObjectDetectorOptions(base_options=base_options,
                                       score_threshold=0.5)
detector = vision.ObjectDetector.create_from_options(options)

# STEP 3: Load the input image.
image = mp.Image.create_from_file('/content/drive/MyDrive/maxresdefault.jpg')

# STEP 4: Detect objects in the input image.
detection_result = detector.detect(image)

# STEP 5: Process the detection result. In this case, visualize it.
image_copy = np.copy(image.numpy_view())
annotated_image = visualize(image_copy, detection_result)
rgb_annotated_image = cv2.cvtColor(annotated_image, cv2.COLOR_BGR2RGB)
cv2_imshow(rgb_annotated_image)
```

Figure 6.6 Coding for testing model on external image.

Object Detection Model Testing Results

Result on an object that passes into the process of training the model:

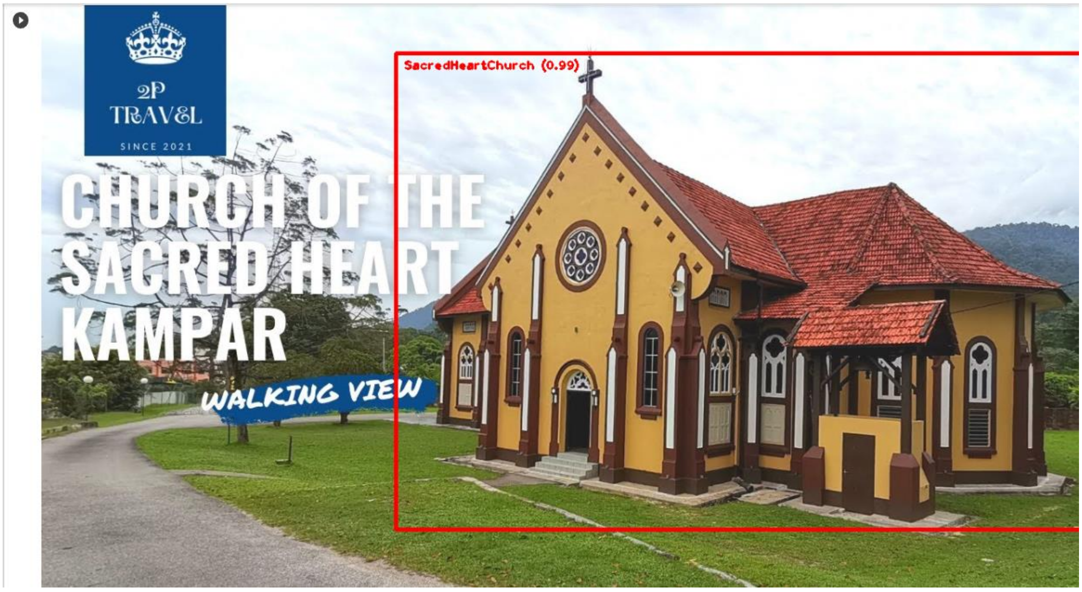


Figure 6.7 Detection results for Sacred Heart Church.

Figure 6.8 Detection results for Artifact IX.

Result on an object that does not pass into the process of training the model:

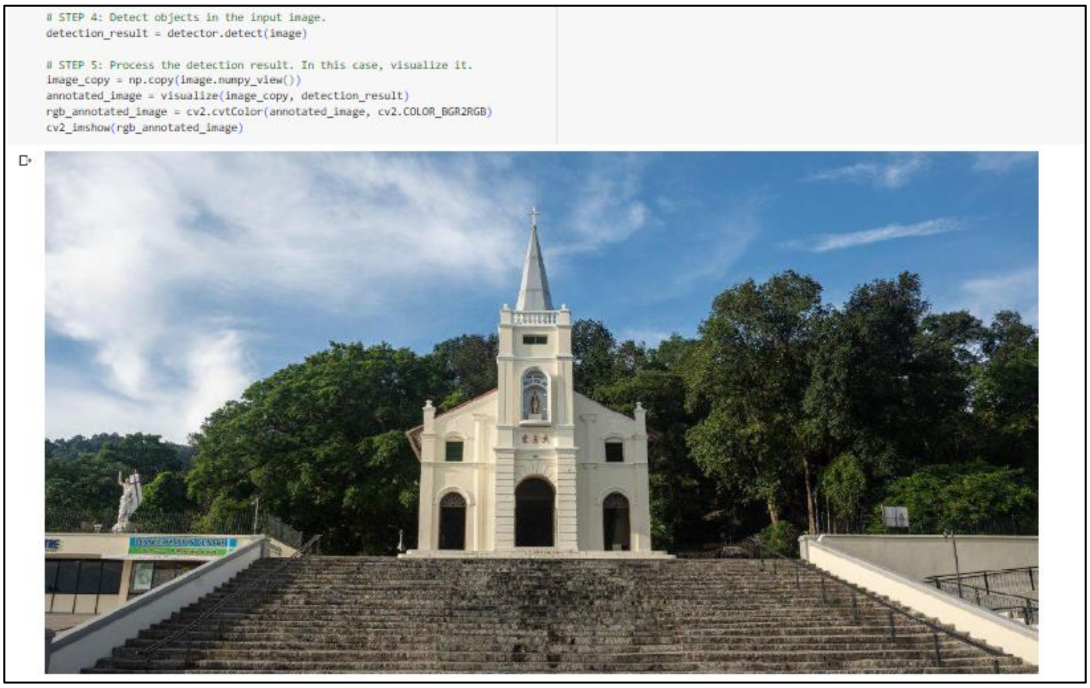


Figure 6.9 Detection results for random church.

Detected results using mobile phone:

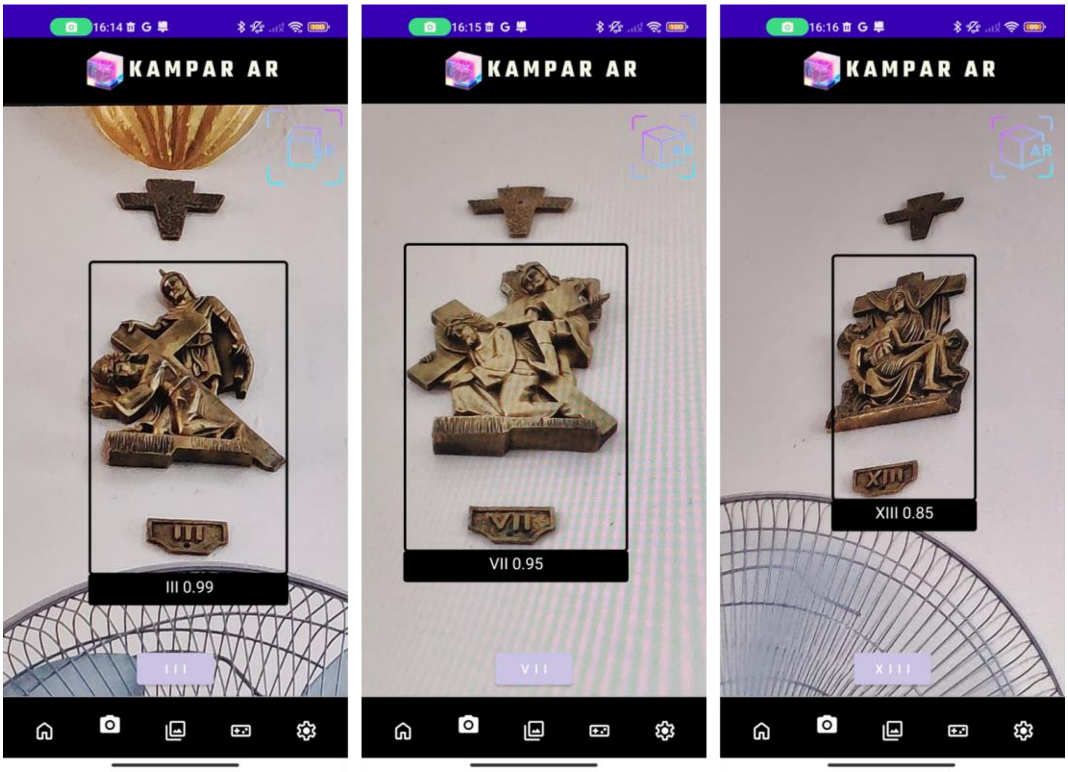


Figure 6.10 Detection result using mobile phone.

6.2.2 Mobile Application Testing Setup and Result

Use Case	Test Case	Expected Result	Actual Result	Pass/Fail
Browse Attractions	Clicks on an attraction in the list.	Navigates user to an attraction details page with correct information.	Navigates user to attraction details page with correct information.	pass
	Clicks on the map.	Navigates user to attraction's location in Google Maps.	Navigates user to attraction's location in Google Maps.	pass
	Clicks on the back icon button.	Close the attraction details page.	Close the attraction details page.	Pass
Perform Live Artifact/Attraction Recognition	Clicks on the camera button in the navigation bar.	Navigates user to live artifact/attraction recognition page.	Navigates user to live artifact/attraction recognition page.	Pass
	Moving the phone around to scan through things.	Sends a frame to object detection model to perform detection.	Sends a frame to object detection model to perform detection.	Pass
	Result detected.	Displays a bounding box which contains the detected result along with its navigation buttons.	Displays a bounding box which contains the detected result along with its navigation buttons.	Pass
	Clicks on the artifact/attraction details button.	Navigates the user to the artifact/attraction details page.	Navigates the user to the artifact/attraction details page.	Pass

	Clicks on the AR model button.	Navigates the user to the AR model page.	Navigates the user to the AR model page.	Pass
	Moves AR model with 2 fingers.	AR model turns horizontally.	AR model turns horizontally.	Pass
	Clicks on the back icon button on the artifact/attraction details page.	Close the artifact/attraction details page.	Close the artifact/attraction details page.	Pass
	Clicks on the back icon button on the AR model page.	Close the AR model page.	Close the AR model page.	Pass
Upload Image	Clicks on the gallery button in the navigation bar.	Navigates user to non-real time artifact/attraction recognition page.	Navigates user to non-real time artifact/attraction recognition page.	Pass
	Clicks on the plus button.	Navigates user to the gallery.	Navigates user to the gallery.	Pass
	Select an image.	Sends the image to perform object detection.	Sends the image to perform object detection.	Pass
	Result detected	Displays a bounding box which contains the detected result along with its navigation buttons.	Displays a bounding box which contains the detected result along with its navigation buttons.	Pass
	No result detected	Displays the message “Nothing Detected”.	Displays the message “Nothing Detected”.	Pass
	Clicks on the artifact/attraction details button.	Navigates the user to the artifact/attraction details page.	Navigates the user to the artifact/attraction details page.	Pass

	Clicks on the back icon button on the artifact/attraction details page.	Close the artifact/attraction details page.	Close the artifact/attraction details page.	Pass
Upload Video	Clicks on the gallery button in the navigation bar.	Navigates user to non-real time artifact/attraction recognition page.	Navigates user to non-real time artifact/attraction recognition page.	Pass
	Clicks on the plus button.	Navigates user to the gallery.	Navigates user to the gallery.	Pass
	Select a video.	Sends every frame of video to perform object detection.	Sends every frame of video to perform object detection.	Pass
	Result detected	Displays a bounding box which contains the detected result along with its navigation buttons.	Displays a bounding box which contains the detected result along with its navigation buttons.	Pass
	No result detected	Displays the message “Nothing Detected”.	Displays the message “Nothing Detected”.	Pass
	Clicks on the artifact/attraction details button.	Navigates the user to the artifact/attraction details page.	Navigates the user to the artifact/attraction details page.	Pass
	Clicks on the back icon button on the artifact/attraction details page.	Close the artifact/attraction details page.	Close the artifact/attraction details page.	Pass
Browse Artifacts	Clicks on the game button on the navigation bar.	Navigates user to mini game page.	Navigates user to mini game page.	Pass

	Clicks on the locked artifact.	Display a hint for the selected artifact.	Display a hint for the selected artifact.	Pass
	Clicks on the unlocked artifact.	Navigates the user to the artifact details page.	Navigates the user to the artifact details page.	Pass
	Clicks on the back icon button on the artifact details page.	Close the artifact details page.	Close the artifact details page.	Pass
Reset Mini Game	Clicks on the reset mini game button.	Update artifact info to the initial state.	Update artifact info to the initial state.	Pass
Change Username	Clicks on the change username button	Navigates the user to the change username page.	Navigates the user to the change username page.	Pass
	Submit empty username	Display “Please enter username”.	Display “Please enter username”.	Pass
	Submit a username longer than 15 characters.	Display “Username too long”.	Display “Username too long”.	Pass
	Submit valid username	Display “Update Successfully”.	Display “Update Successfully”.	Pass
	Username fails to update	Display “Failed to update”	Display “Failed to update”	Pass
	Clicks on the back icon button	Close the change username page.	Close the change username page.	Pass
Login	Submit an empty email.	Display “Please enter email”.	Display “Please enter email”.	Pass
	Submit empty password	Display “Please enter password”.	Display “Please enter password”.	Pass
	Submit invalid email	Display “Invalid Email”.	Display “Invalid Email”.	Pass

	Submit invalid password	Display “Invalid Password”.	Display “Invalid Password”.	Pass
	No internet connection	Display “Please connect to the internet to continue”	Display “Please connect to the internet to continue”	Pass
	Submit a valid email and password	Display “Login successfully”	Display “Login successfully”	Pass
Reset Password	Clicks on forget password button	Navigates the user to the forget password page.	Navigates the user to the forget password page.	Pass
	Submit an empty email.	Display “Please enter email”.	Display “Please enter email”.	Pass
	Submit invalid email	Display “Invalid Email”.	Display “Invalid Email”.	Pass
	Submit an email that has not been registered	Display “Email does not exist”.	Display “Email does not exist”.	Pass
	No internet connection	Display “Please connect to the internet to continue”	Display “Please connect to the internet to continue”	Pass
	Submit valid email	Display “Email sent”.	Display “Email sent”.	Pass
Change Password	Clicks on the change password button	Navigates the user to the change password page.	Navigates the user to the change password page.	Pass
	Submit an empty current password.	Display “Please enter current password”.	Display “Please enter current password”.	Pass
	Submit an empty new password.	Display “Please enter new password”.	Display “Please enter new password”.	Pass

	Submit an invalid current password	Display “Authentication failed. Please check your current password”.	Display “Authentication failed. Please check your current password”.	Pass
	Submit a valid current password	Display “Update Successfully”.	Display “Update Successfully”.	Pass
	No internet connection	Display “Please connect to the internet to continue”	Display “Please connect to the internet to continue”	Pass
Sign Up	Clicks on the sign-up button.	Navigates the user to the sign-up page.	Navigates the user to the sign-up page.	Pass
	Submit an empty username.	Display “Please enter username”.	Display “Please enter username”.	Pass
	Submit an empty email.	Display “Please enter email”.	Display “Please enter email”.	Pass
	Submit an empty password.	Display “Please enter password”.	Display “Please enter password”.	Pass
	Submit a username longer than 15 characters.	Display “Username too long”.	Display “Username too long”.	Pass
	Submit registered email.	Display “User Already Exists”.	Display “User Already Exists”.	Pass
	Submit a weak password.	Display “Password is too weak”.	Display “Password is too weak”.	Pass
	No internet connection.	Display “Please connect to the internet to continue”.	Display “Please connect to the internet to continue”.	Pass

	Submit a valid username, email and password.	Display "Registration Successful".	Display "Registration Successful".	Pass
View Guideline	Clicks on the guideline button.	Navigates the user to the guideline page.	Navigates the user to the guideline page.	Pass
	Clicks on the next arrow icon button.	Navigates the user to the next guideline.	Navigates the user to the next guideline.	Pass
	Clicks on the skip button.	Close the guideline page.	Close the guideline page.	Pass
View About Us	Clicks on about us button.	Navigates to the About Us page.	Navigates to the About Us page.	Pass
	Clicks on the back icon button.	Close the About Us page.	Close the About Us page.	Pass
Change Application Language	Changes system language.	Application language change.	Application language change.	Pass
Sign Out	Clicks on the sign out button.	Navigates to the login page.	Navigates to the login page.	Pass

Table 6.1 Test Cases.

6.3 Objectives Evaluation

This project is an on-site AR tourism mobile application developed specifically for Android mobiles, aiming to offer users a range of functions they require. The attraction list allows users to browse attractions in Kampar, while live attraction/artifact recognition enables users to scan their surroundings to discover and learn about attractions or artifacts. The AR model feature allows users to view artifacts more clearly, which may not be easily visible to the naked eye. Additionally, a mini-game similar to a treasure hunt enhances the immersive and engaging experience for tourists. The object detection model used for recognition is not only fast but also boasts a high precision of 90.07%. Consistent design, ease of learning, ease of use, and the availability of guidelines make the mobile application more user-friendly. Lastly, this project took two semesters, approximately six months, to complete development. It successfully achieved all objectives, offering users a comprehensive and enjoyable tourism experience.

Chapter 7
Conclusion and Recommendation

7.1 Conclusion

The Mobile Tour Guide Application with On-Site Augmented Reality for Kampar Churches has successfully reached its development goals, marking the completion of the project. These days conventional tourism activities such as guided tours often suffer from drawbacks like large crowds and a lack of personalised experiences, leading to visitor dissatisfaction. In less frequented tourist spots like Kampar, valuable cultural and historical sites remain overlooked, impacting local businesses and communities dependent on tourism revenue. Thus, the newly developed application addresses these challenges by employing multilingual, object detection techniques and augmented reality, albeit not the most advanced ones, with an accuracy rate of 90.07%. While there may be superior models available, this one adequately serves users' needs, especially those seeking information on specific attractions or artifacts. Overall, the project's feasibility is demonstrated, offering the potential to bolster tourism in Kampar by enriching visitors' on-site experiences and disseminating historical and cultural insights. By engaging users in a more interactive and captivating manner, the application also aids in preserving and transmitting Kampar's heritage, potentially bridging generational gaps in historical awareness. This endeavour holds promise for fostering tourism growth and advancing Kampar's development.

7.2 Recommendation

While the application has been successfully developed, there are several areas where enhancements can be made. Firstly, due to time constraints, the project was limited to recognising only one church in Kampar. Thus, expanding the scope of attractions recognised by the app beyond a single church to include various landmarks, historical sites, cultural points of interest, and natural wonders in Kampar would offer tourists a more comprehensive experience of the area. Additionally, efforts should be directed towards improving the accuracy of object recognition models, considering factors such as variations in lighting, camera quality, and the physical environment. This could involve refining existing algorithms, diversifying training data, or exploring new machine-learning techniques to ensure reliable performance under diverse conditions. Moreover, investing in the enhancement of AR features is crucial to providing users with immersive experiences. This may entail refining AR models by scanning artifacts from multiple angles and creating detailed 3D models or engaging skilled 3D modellers to enhance the quality, as well as integrating interactive elements that allow users to engage more deeply with the virtual environment. Furthermore, introducing supplementary features such as audio guides, virtual tours, or gamification elements can add depth and interactivity to the app, enhancing its overall appeal and user engagement. Collaboration with local businesses and attractions is another essential aspect to consider. By partnering with local establishments, the app can promote tourism in Kampar more effectively, featuring sponsored content or special offers within the app and providing opportunities for businesses to showcase their offerings to users. Additionally, ensuring that the application provides accurate and up-to-date information about attractions, events, and other tourist-related activities in Kampar is vital. This may involve integrating real-time data feeds or establishing partnerships with local authorities to ensure the timely updating of information. Lastly, actively soliciting feedback from users through in-app surveys, user reviews, or focus groups can provide valuable insights into areas for improvement and user preferences. This feedback can guide future development efforts, ensuring that the AR tourism application continues to evolve and meet the needs of its users effectively.

REFERENCES

[1] L. Jasenovcova, “What is augmented reality and how does ar work?.” Resco.net. https://www.resco.net/blog/what-is-augmented-reality-and-how-does-ar-work/#:~:text=Augmented%20reality%2C%20or%20AR%2C%20is,with%20the%20device's%20camera%20input. (accessed Apr. 25,2023).

[2] M. Shah, “How augmented reality (AR) is changing the Travel & Tourism Industry.” Medium. https://towardsdatascience.com/how-augmented-reality-ar-is-changing-the-travel-tourism-industry-239931f3120c. (accessed Apr. 25,2023).

[3] B.K. Seo, K. Kim, and J.I. Park, “Augmented reality-based on-site tour guide: A study in Gyeongbokgung,” in Computer Vision – ACCV 2010 Workshops, 2010, pp. 276–285, doi: 10.1007/978-3-642-22819-3_28.

[4] H. Zhang, P.-C. Chang, and M.-F. Tsai, “How physical environment impacts visitors’ behavior in learning-based tourism—the example of Technology Museum,” in Sustainability, 2018, pp. 3880, doi: 10.3390/su10113880.

[5] W. T. T. C. Staff, “8 ways responsible tourism benefits local communities.” WTTC Travel Hub. https://travelhub.wttc.org/blog/8-ways-responsible-tourism-benefits-local-communities. (accessed Apr. 25,2023).

[6] V. Parikh, M. Keskar, D. Dharia and P. Gotmare, "A Tourist Place Recommendation and Recognition System," in 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT), (Coimbatore, India), 2018, pp. 218-222, doi: 10.1109/ICICCT.2018.8473077.

[7] L. Xinyu, L. Xiaochun, C. Rongfeng, F. Yizhou, X. Tianmin and C. Junyan, "Application of the Faster R-CNN Algorithm in Scene Recognition Function Design," in 2019 15th International Conference on Computational Intelligence and Security (CIS), (Macao, China), 2019, pp. 16-19, doi: 10.1109/CIS.2019.00012.

[8] Y. Chen, K. Yu, T. Kao and H. Hsieh, “Deep learning based real-time tourist spots detection and recognition mechanism,” in Conference Collection IMETI 2020, 2021, pp. 1-19, doi: 10.1177/00368504211044228.

[9] M.N. Razali, E. Owens, N. Tony et al, “Landmark Recognition Model for Smart Tourism using Lightweight Deep Learning and Linear Discriminant Analysis,” in International Journal of Advanced Computer Science and Applications, 2023, pp. 198-213, doi: 10.14569/IJACSA.2023.0140225.

[10] Y. Li, X. Li, and C. Yue, “Recognition of Tourist Attractions,” Nov. 24, 2021.

[11] “Search what you see.” Google Lens. https://lens.google/howlensworks/#:~:text=What%20is%20Google%20Lens%3F,and%20take%20other%20useful%20actions (accessed Sep. 7, 2023).

[12] “Software engineering: Prototyping model.” GeeksforGeeks. https://www.geeksforgeeks.org/software-engineering-prototyping-model/ (accessed Sep. 7, 2023).

[13] E. Durand, F. Merienne, P. Callet, “Ray-on, an On-Site Photometric Augmented Reality Device,” Journal on Computing and Cultural Heritage, vol. 7, no. 2, pp. A1-A9, Jul. 2017.

[14] T. Contributor. “What is Android Studio?: Definition from TechTarget.” Mobile Computing. https://www.techtarget.com/searchmobilecomputing/definition/Android-Studio (accessed Sep. 7, 2023).

[15] “Frequently Asked Questions.” Google colab. https://research.google.com/colaboratory/faq.html (accessed Sep. 7, 2023).

[16] G. Boesch. “LabelImg for image annotation.” viso.ai. https://viso.ai/computer-vision/labelimg-for-image-annotation/#:~:text=LabelImg%20is%20a%20free%2C%20open,its%20GI%20(graphical%20interface) (accessed Sep. 7, 2023).

[17] A. Damala, E. Hornecker, M. Vaart, D. Dick, I. Ruthven, “The Loupe: Tangible Augmented Reality for Learning to Look at Ancient Greek Art,” Mediterranean Archaeology and Archaeometry, vol. 16, no. 5, pp. (In Press), May. 2016.

[18] “What is python? executive summary.” Python.org. https://www.python.org/doc/essays/blurb/ (accessed Sep. 7, 2023).

[19] S. Yegulalp. “What is tensorflow? The Machine Learning Library explained.” InfoWorld. https://www.infoworld.com/article/3278008/what-is-

tensorflow-the-machine-learning-library-explained.html (accessed Sep. 7, 2023).

[20] “Papers with code - mobilenetv2 explained.” Explained | Papers With Code. https://paperswithcode.com/method/mobilenetv2 (accessed Sep. 7, 2023).

[21] A. Anwar. “What is average precision in object detection & localization algorithms and how to calculate it?.” Medium. https://towardsdatascience.com/what-is-average-precision-in-object-detection-localization-algorithms-and-how-to-calculate-it-3f330efe697b (accessed Sep. 7, 2023).

[22] “Object detection model customization guide | mediapipe | google for developers.” Google. https://developers.google.com/mediapipe/solutions/customization/object_detector (accessed Sep. 7, 2023).

[23] “Object detection guide for python | mediapipe | google for developers.” Google. https://developers.google.com/mediapipe/solutions/vision/object_detector/python (accessed Sep. 7, 2023).

[24] “MediaPipe model maker | google for developers.” Google. https://developers.google.com/mediapipe/solutions/model_maker (accessed Sep. 7, 2023).

[25] “5 types of AR and how they improve online shopping.” Shopify. https://www.shopify.com/blog/types-of-ar#2 (accessed Sep. 7, 2023).

[26] J. Charnas. “What is blender (Software)? – simply explained.” All3DP. Mar. 27, 2023. https://all3dp.com/2/what-is-blender-software-simply-explained/ (accessed Apr. 11, 2024).

[27] “What is Java? - Java Programming Language Explained – AWS.” Amazon Web Services, Inc. https://aws.amazon.com/what-is/java/#:~:text=Java%20is%20a%20widely%2Dused,as%20a%20platform%20in%20itself (accessed Apr. 11, 2024).

[28] B. Lutkevich, “Kotlin.” WhatIs. Dec. 28, 2022. https://www.techtarget.com/whatis/definition/Kotlin (accessed Apr. 11, 2024).

[29] "Firestore | Firebase," Firebase. https://firebase.google.com/docs/firestore (accessed Apr. 11, 2024).

[30] L. Stanton, "How to enable MIUI developer Options," Alphr, Jun. 26, 2023. https://www.alphr.com/miui-developer-options/ (accessed Apr. 11, 2024).

[31] Y. Liu, "The confusing metrics of AP and MAP for object detection / instance segmentation," Medium, May 18, 2020. [Online]. Available: https://yanfengliux.medium.com/the-confusing-metrics-of-ap-and-map-for-object-detection-3113ba0386ef (accessed Apr. 11, 2024).

[32] K. Brush, "test case," Software Quality, Mar. 06, 2020. https://www.techtarget.com/searchsoftwarequality/definition/test-case (accessed Apr. 11, 2024).

[33] R. Python, "Jupyter Notebook: An Introduction," Nov. 20, 2023. https://realpython.com/jupyter-notebook-introduction/ (accessed Apr. 11, 2024).

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3,Y3	**Study week no.:** 1
Student Name & ID: Ooi Zheng Yee (20ACB02227)	
Supervisor: Dr Liew Soung Yue	
Project Title: Mobile Tour Guide Application with On-Site Augmented Reality - Kampar Churches	

1. WORK DONE [Please write the details of the work done in the last fortnight.] • Review the FYP1 report. • Review the model and application developed in FYP1.
2. WORK TO BE DONE • Start developing login module for mobile application.
3. PROBLEMS ENCOUNTERED No
4. SELF EVALUATION OF THE PROGRESS Good

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3,Y3	**Study week no.:** 2
Student Name & ID: Ooi Zheng Yee (20ACB02227)	
Supervisor: Dr Liew Soung Yue	
Project Title: Mobile Tour Guide Application with On-Site Augmented Reality - Kampar Churches	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Successfully developed login module for mobile application.

2. WORK TO BE DONE

- Start developing attraction list module for mobile application.

3. PROBLEMS ENCOUNTERED

No

4. SELF EVALUATION OF THE PROGRESS

Good

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3,Y3	**Study week no.:** 3
Student Name & ID: Ooi Zheng Yee (20ACB02227)	
Supervisor: Dr Liew Soung Yue	
Project Title: Mobile Tour Guide Application with On-Site Augmented Reality - Kampar Churches	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Successfully developed attraction list module for mobile application.

2. WORK TO BE DONE

- Start developing live attraction recognition module for mobile application.

3. PROBLEMS ENCOUNTERED

No

4. SELF EVALUATION OF THE PROGRESS

Good

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3,Y3	**Study week no.: 4**
Student Name & ID: Ooi Zheng Yee (20ACB02227)	
Supervisor: Dr Liew Soung Yue	
Project Title: Mobile Tour Guide Application with On-Site Augmented Reality - Kampar Churches	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Successfully developed live attraction recognition module for mobile application.

2. WORK TO BE DONE

- Start developing non real time attraction recognition module for mobile application.

3. PROBLEMS ENCOUNTERED

No

4. SELF EVALUATION OF THE PROGRESS

Good

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT
(Project II)

Trimester, Year: T3,Y3	**Study week no.: 5**
Student Name & ID: Ooi Zheng Yee (20ACB02227)	
Supervisor: Dr Liew Soung Yue	
Project Title: Mobile Tour Guide Application with On-Site Augmented Reality - Kampar Churches	

1. WORK DONE
[Please write the details of the work done in the last fortnight.]

- Successfully developed non real time attraction recognition module for mobile application.

2. WORK TO BE DONE

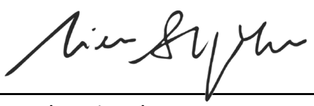
- Start developing mini game module for mobile application.

3. PROBLEMS ENCOUNTERED

No

4. SELF EVALUATION OF THE PROGRESS

Good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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3,Y3	**Study week no.: 6**
Student Name & ID: Ooi Zheng Yee (20ACB02227)	
Supervisor: Dr Liew Soung Yue	
Project Title: Mobile Tour Guide Application with On-Site Augmented Reality - Kampar Churches	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Successfully developed mini game module for mobile application.

2. WORK TO BE DONE

- Start developing settings module for mobile application.

3. PROBLEMS ENCOUNTERED

No

4. SELF EVALUATION OF THE PROGRESS

Good

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3,Y3	**Study week no.: 7**
Student Name & ID: Ooi Zheng Yee (20ACB02227)	
Supervisor: Dr Liew Soung Yue	
Project Title: Mobile Tour Guide Application with On-Site Augmented Reality - Kampar Churches	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Successfully developed settings module for mobile application.

2. WORK TO BE DONE

- Collect rest of the images to train the model.
- Draw bounding box for every images.

3. PROBLEMS ENCOUNTERED

No

4. SELF EVALUATION OF THE PROGRESS

Good

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3,Y3	**Study week no.: 8**
Student Name & ID: Ooi Zheng Yee (20ACB02227)	
Supervisor: Dr Liew Soung Yue	
Project Title: Mobile Tour Guide Application with On-Site Augmented Reality - Kampar Churches	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Collected rest of the images to train the model.
- Draw bounding box for every images.

2. WORK TO BE DONE

- Start to retrain the object detection model.

3. PROBLEMS ENCOUNTERED

No

4. SELF EVALUATION OF THE PROGRESS

Good

Supervisor's signature

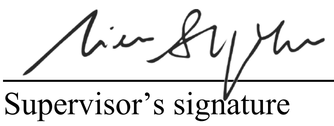
Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3,Y3	**Study week no.: 9**
Student Name & ID: Ooi Zheng Yee (20ACB02227)	
Supervisor: Dr Liew Soung Yue	
Project Title: Mobile Tour Guide Application with On-Site Augmented Reality - Kampar Churches	

1. WORK DONE [Please write the details of the work done in the last fortnight.] • Successfully train the object detection model.
2. WORK TO BE DONE • Perform testing of every single function and fix bug if needed.
3. PROBLEMS ENCOUNTERED No
4. SELF EVALUATION OF THE PROGRESS Good



Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3,Y3	**Study week no.: 10**
Student Name & ID: Ooi Zheng Yee (20ACB02227)	
Supervisor: Dr Liew Soung Yue	
Project Title: Mobile Tour Guide Application with On-Site Augmented Reality - Kampar Churches	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Perform testing of some function and fixed some bug.

2. WORK TO BE DONE

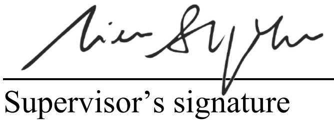
- Perform testing for the rest of all function and fix bug if needed.

3. PROBLEMS ENCOUNTERED

No

4. SELF EVALUATION OF THE PROGRESS

Good



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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3,Y3	**Study week no.: 11**
Student Name & ID: Ooi Zheng Yee (20ACB02227)	
Supervisor: Dr Liew Soung Yue	
Project Title: Mobile Tour Guide Application with On-Site Augmented Reality - Kampar Churches	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Fix all the bugs found.
- Ensure that the application is 95% no bugs.

2. WORK TO BE DONE

- Start writing report and prepare presentation slides.

3. PROBLEMS ENCOUNTERED

No

4. SELF EVALUATION OF THE PROGRESS

Good

Supervisor's signature

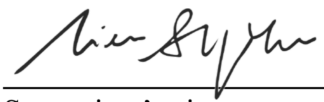
Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3,Y3	**Study week no.: 12**
Student Name & ID: Ooi Zheng Yee (20ACB02227)	
Supervisor: Dr Liew Soung Yue	
Project Title: Mobile Tour Guide Application with On-Site Augmented Reality - Kampar Churches	

1. WORK DONE [Please write the details of the work done in the last fortnight.] • Part of the report is done.
2. WORK TO BE DONE • Continue writing report. • Perform testing in the church.
3. PROBLEMS ENCOUNTERED No
4. SELF EVALUATION OF THE PROGRESS Good



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POSTER


UTAR
UNIVERSITI TUNKU ABDUL RAHMAN
Mobile Tour Guide Application
with
On-Site AR
KAMPAR
KAMPAR AR
Attractions
Sacred Heart Church
Introduction
This mobile app retrieves historical info by scanning buildings or artifacts in Kampar, enhancing immersion and attracting tourists to its rich historical and cultural sites.
• Methods
Detect
View AR
Play
Read
• Discussion
These are crucial, as traditional tour guides lack the allure of modern mobile tour applications. Without a knowledgeable guide to shed light on the area for the uninitiated, the situation will only worsen.
• Conclusion
The concept is feasible, and the application could enhance tourists' on-site experience in Kampar by offering an interactive way to explore the area. Overall, it's hoped this project will contribute positively to tourism in Kampar.
Project Developer: Ooi Zheng Yee
Project Supervisor: Dr. Liew Soung Yue

PLAGIARISM CHECK RESULT

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ORIGINALITY REPORT

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Universiti Tunku Abdul Rahman			
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FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	Ooi Zheng Yee
ID Number(s)	20ACB02227
Programme / Course	Bachelor of Computer Science (Honours)
Title of Final Year Project	Mobile Tour Guide Application with On-Site Augmented Reality - Kampar Churches

Similarity	**Supervisor's Comments (Compulsory if parameters of originality exceeds the limits approved by UTAR)**
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Note Supervisor/Candidate(s) is/are required to provide softcopy of full set of the originality report to Faculty/Institute

Based on the above results, I hereby declare that I am satisfied with the originality of the Final Year Project Report submitted by my student(s) as named above.

Signature of Supervisor	Signature of Co-Supervisor
Name: Dr Liew Soung Yue	Name:
Date: 26/4/2024	Date:

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF INFORMATION & COMMUNICATION TECHNOLOGY (KAMPAR CAMPUS)

CHECKLIST FOR FYP2 THESIS SUBMISSION

Student Id	20ACB02227
Student Name	Ooi Zheng Yee
Supervisor Name	Dr Liew Soung Yue

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✓	Signed FYP Thesis Submission Form
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✓	All references in bibliography are cited in the thesis, especially in the chapter of literature review
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✓	Poster
✓	Signed Turnitin Report (Plagiarism Check Result - Form Number: FM-IAD-005)
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I, the author, have checked and confirmed all the items listed in the table are included in my report.

____

(Signature of Student)
Date: 25/04/2024