Wireless Dispenser System: Pet Care

BY

LEE WEI QI

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfillment of the requirements

for the degree of

BACHELOR OF INFORMATION TECHNOLOGY (HONS)

COMMUNICATION AND NETWORKING

Faculty of Information and Communication Technology
(Kampar Campus)

MAY 2019

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I would like to express my special thanks of gratitude to my supervisor Dr. Lau Phooi Yee who gave me the opportunity to develop this Wireless Dispenser System. She gave me a lot of useful advices and guided me to make the project become more useful and convenience. Next, is my family and friends who help me a lot with the design ideas in the project. Thanks for all their support in my project so that I can complete and implement this project. Thank you very much.

Abstract

Nowadays, people would like to adopt a pet not only because of its functionality, but also its cuteness, safety and ornamental purpose. However, people may not be able to maintain their reponsibility when they are having other important thing to do such as having a business trip assigned by the company. The adopted pet unlike other strays animal, its already have no or less survival skill to looks for food outside. Therefore, pet owner will can only ask for their friend to take care of them or looks for a feeder system that can provide the automatic feeding function. However, their friend might not be able to help them all the time. Hence the automatic feeder system is one of the most suitable way for them. The dispenser system proposed in this paper provide several useful functions to help the pet owner not only in feeding their pet automatically. The proposed dispenser system developed using Raspberry Pi interconnected with several subsystem such as real-time monitoring subsystem and door managing subsystem with software support help to ease the burden. The wireless dispensing system that allow the user to feed their pet automatic according to the time or manually according to the owner's preference. The real-time monitoring subsystem allows the owner to monitor their beloved pet anytime. Besides, the door managing subsystem can control the door by using the apps to give their pet some freedom time and another calling pet function to call the pet back to the cage during the feeding period. Moreover, if an unrecognized pet tried to enter the cage, an alarm will be triggered and inform the pet owner via the apps.

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LIST OF ABBREVIATIONS

SoC	System-On-Chip
GSM	Global System for Mobile communication
CPU	Central Processing Unit
IR	Infra-Red
AT	Abbreviation of ATtention
RFID	Radio-frequency identification
GUI	Graphical user interface
LED	Light-emitting diode
SDLC	System Development Life Cycle
GPU	Graphics Processing Unit
VNC	Virtual Network Computing

CHAPTER 1: Introduction

1.1 Problem statement

Nowadays, we can easily find someone who owned at least a pet in their house. The pet can be usual like cat and dog, or unusual such as hedgehog, lizard, and so on. However, most of the pet need to be extra care but sometimes, their pet owner may have other things to do such as traveling, working, or any other unexpected thing to do. In a traditional way most of the people will do is asking a friend to help taking care of their pet. However, it may not only cause trouble to others, but also may not know how to take care of your pet in the correct way. Hence, some of the people will use a more modern way such as a pet feeder that will feed their pet according to the time scheduled by the user or a system with automatic feeding when their pet standing on a designed area.

However, most of the owner will still feel worry as they do not know how was their pet in the house. Sometime, the pet may eat only a little amount of food or sometime the food is not enough for their pet. Furthermore, the pet owner would like to see what their pet will do when they are not around.

There might have a system that can take care of the pet separately in the market, but the pet owner will still have to buy all the products in order to take care of the pet more easily. For example, they have to buy a pet feeder, an automatic door for pet, pet tracking system, and a monitoring system. All the separate components will not only used up all the empty space in the house, but also it will increase the work for the user to set up everything by themselves. For example, user have to design their main door for the pet to pass by, find someone to set up the wiring of the camera to monitor their pet, and so on. All of this will increase the cost for the user to adopt a pet in their house. Hence, the proposed dispenser system can solve the current problem encounter by the pet owner.

1.2 Background and motivation

From the past to now, pet can be found easily in a family, such as a cat to catch the mice, a dog act as a doorkeeper, a bird to fulfil the room with natural background music. Moreover, it is usual to see a family owned more than a pet in their house. It could be a normal pet like cat or dog, or some special pets like a hedgehog, lizard, or even small snake. A survey done by GFK company (GFK company 2016) in figure 1.1 shows that, among 27,000 internet users in 22 countries, the percentage of pet owners is 57% while 33% of them are dog's owner. This shows that more than a half people have owned a pet. Therefore, a system that focusing on pet care can help people to increase their time on other work.

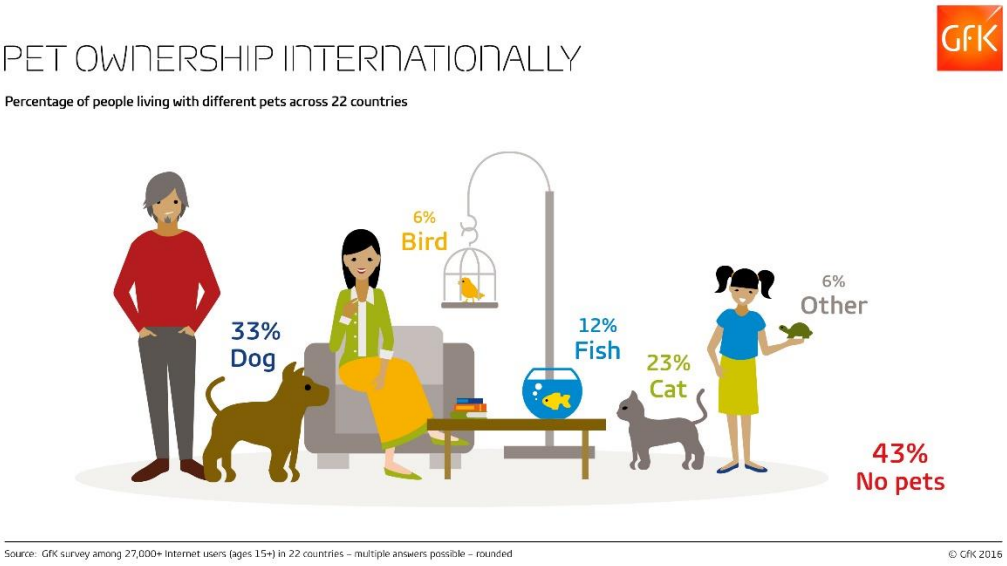


Figure 1.1: Statistic of pet ownership internationally in 2016

According to a consumer survey done by Pet Industry leadership conference 2016 (Lindsay Beaton 2016) in figure 1.2, 46% of pet owner are from age of 18 to 34 in 2015. More of the pet owner in the range of age will be a student or a worker. Most of them will not have a flexible time to feed their pet on time. Secondly, from the age from 35 to 49 are having 42% person are pet owner who are mainly a worker. Usually worker need to arrive at the company before 8 am and can only back to their home after 5pm. Their pet in the house can only eat an extra-large meal in the morning and their owner will not know the lunch for their pet is full enough or not.

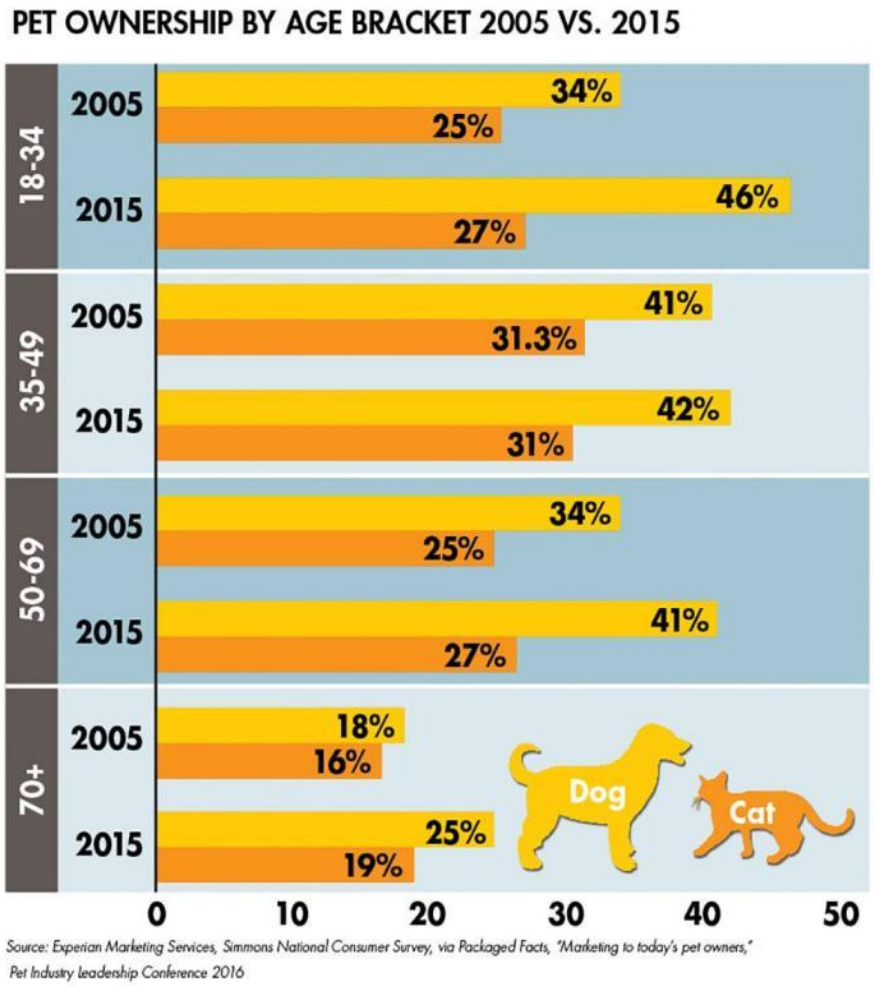


Figure 1.2: Survey of pet ownership by age bracket 2005 vs 2015

With a regularly-scheduled feeding times, it allows their owner to monitor the healthiness of their pet. For example, if the dog normally finished their meal immediately at the right time, pet owner will observe something different when their pet is lacking of appetite. It could be the pet not feeling well or sickness as so the pet owner can pay more attention with their pet whether to bring them to look for a veterinary or not.

1.3 Project Objectives

The main objective of the project is to develop a system with wireless interaction between the dispenser system, pet and the user so that the user can still take care of their pet even when they are not around with their pet for several days. Hence, the project will focus on the wireless connection between the user and the dispenser system. In order to achieve step-by-step, it can be divided into several sub-objectives:

a) Proposed the framework of the wireless dispenser system.

   Firstly, design a basic framework of the wireless dispenser system such as preparing a cage that set up with the suitable placement of Raspberry Pi, dispenser system, and camera module.

b) Develop the hardware system for the basic dispenser function to work on the Raspberry Pi platform.

   Secondly, develop the Raspberry Pi system with the basic function like dispensing food when the button is pressed by the user. Besides, ensure the door can be managed by another button.

c) Develop the software system to control the hardware system.

   Thirdly, develop the basic user interface of an Android app such as a button to set the feeding schedule directly in the Raspberry Pi system, another button that used to call the pet with the recorded sound set by the user. Moreover, button to show the real time monitoring display and to manage the door system.

d) Enhance the system with wireless interaction between software and hardware.

   Fourthly, enhance the Android app so that all buttons can work successfully to control the Raspberry Pi system wirelessly.

e) Further enhance the system with pet recognition function by implementing an extra camera module.

   Lastly, enhance the camera module with the pet recognition so that the system will recognize certain pet of the user to get rid of any unauthorized pet from coming nearby the cage to eat the food.

1.4 Proposed Approach

In order to solve the limitation in the current dispenser system for pet, besides of the basic function like scheduled and automatic feeding features in the dispenser system with using Raspberry Pi.

For the basic function, user can click on a physical button attached with it. For the automatic feeding function, user will have to input with a number of time, the Raspberry Pi with the synchronization of time will feed the pet once it reached. Another software apps requires to be developed in order to produce a dispenser system that can be control wirelessly. The apps with be available on Android platform with several functional buttons.

Moreover, another camera module to be installed in the system to achieve real time monitoring. User can monitor their pet on the apps. The apps will also store the recorded video for 5 days to reduce the storage usage. Besides that, user will have an option to save the video they like.

Furthermore, some other functions like alarm triggering to get rid of other pet. When any other pet tries to eat the food, the alarm will trigger to scare them. Door managing to manage when to open and close the door. When the user is not around, the pet may still need some time to go for a walk.

Lastly a calling for pet function that will play a recorded sound to attract the pet when reach the feeding period. User can record their voice in the apps by clicking on a record button.

1.5 Achievement

The achievement that successfully achieved in this project is stated below:

- Hardware design of the system successfully implemented.
- Dispense button can proceed successfully in the food dispensing sub-system.
- Door open/close button in the door managing sub-system is working successfully.
- Camera module in the real-time monitoring sub-system can successfully retrieved the environment inside.
- An android apps successfully designed.
- Successfully communicate with the hardware system by using the android apps.
- Successfully use the android apps to send the scheduled time to the hardware for automation function.

1.6 Report Organization

This project is organized in few chapters. Chapter 1 contain an introduction to introduce some information about the project such as the problem statement, background and some of the motivation to proposed this project. Besides that, in this chapter also stated the achievement and the flowchart of the system. In chapter 2 contain the literature review regarding the project that proposed by the other scholars and some of the discussion about the strength and weakness compare to the proposed system. In chapter 3 contain the system design information like the system flow diagram, block diagram to describe the project in details. In chapter 4 contain the system requirement and the methodology used in the system. In chapter 5 contain a more detailed system design which to mention that the protocol used in the proposed system, the software and hardware setup, the implementation and explain the result for each module. In chapter 6 contain the overall conclusion for the final project.

CHAPTER 2: LITERATURE REVIEW

2.1 Existing researches with respect to the problems of dispenser system

Back in 1939 year ago, the first automatic dispenser system had already been proposed (Kcgrier 2015), shown in Figure 2.1.

Figure 2.1: Automatic pet feeder in 1939.

From that time, people already realized that a dispenser system should be worked automatically. However, in 1939, the number of pet owner are still very little. Nowadays, a pet can be found easily in a family. People can have more than a pet in their house and the type of pet can be common like cat, dog, bird, and fish, or other species like lizard, hedgehog, hamster, and snake. The time spent to feed their pets are increasing over years. In order to take care of their pet with full of love, a dispenser system that can only be used to feed their pet for only a meal is far insufficient. Hence, there are several existing researchers proposed several dispenser systems in order to maximize the system with extra pet care functions.

2.2 Solutions proposed by researchers

In order to make the dispenser system to be more efficiently and useful, researcher proposed several solutions to overcome the problem.

2.2.1 Weight controlled pet feeding system

Anke Schumann and Yildiray Sager proposed a pet feeding system (Anke Schumann, Yildiray Sager 2009) in 2009 that can feed the pet with different amount of food according to the weight of the pet as shown in Figure 2.2.

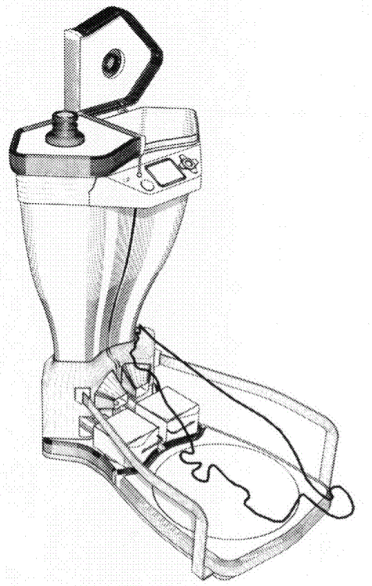


Figure 2.2: Weight controlled pet feeding system.

There is a weight management system to record down the current weight, target weight, and information of the pet. The pet owner calculated the amount of the food for the respective weight and key in to the storage. The system will always update the current weight while the pet stepped on a weight scale.

Strength of the system

The strengths of this proposed system is it can always monitor with the weight of the pet every day. The pet owner can change the training progress for different weight of their pet.

Limitation of the system

However, the limitation of this proposed system is it can be used for only one pet every time. If more than a pets are using the same feeding

system, it will not be recognized by the system and thus the weight recorded in the storage system may not be accurate enough.

Solution to improve from the limitation of the system

One of the solution can used to resolve the problem is adding a camera module on the feeder system with image processing skill to identify which pet stepped on the weight scale and record the weight of the respective pet in the storage system.

2.2.2 IoT in Pet Systems

Chung-Ming Own, Haw-Yun Shin, and Chen-Ya Teng proposed a study and application of the IoT in Pet Systems in 2013 (Chung-Ming Own, Haw-Yun Shin, Chen-Ya Teng 2013). The pet system consists of a smart pet door and a smart pet feeder. The smart pet door can help the pet owner to monitor the activity of their pet. The pets will wear a sensing tag on its collar as showed in Figure 2.3.

Figure 2.3 Collar with sensing tag

The tag will broadcast the pet ID to the system every 20 seconds continuously. The pet door detects the location and periodically requests the pet activity list from the server. A led light can indicate the pet owner where their pet located in. For example, if the pet is far away from the system, the colour of the LED light will be darker. The

control system can set different passage permission for their pet respectively. Sick pet can be forbidden to go out from the room. Besides, pet owner can set the weather rules in the control system. The sensor will sense the weather for every 10 minutes and pets are not allowed to go out when raining outside. Figure 2.4 below shows the diagram of the smart pet door system.

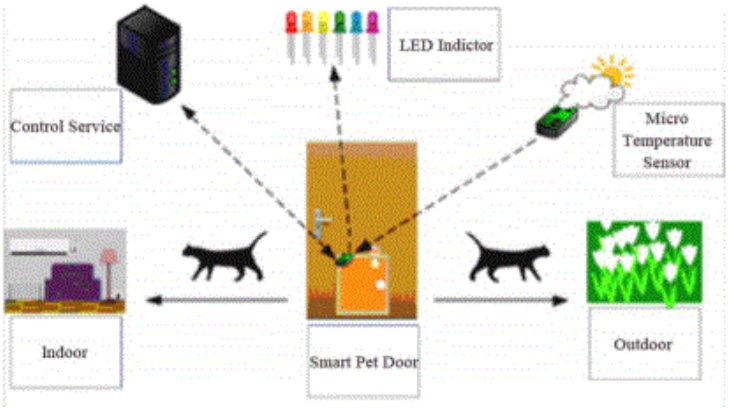


Figure 2.4 Diagram of smart pet door system

Next is the smart feeder system in the IoT pet system shows below in Figure 2.5.

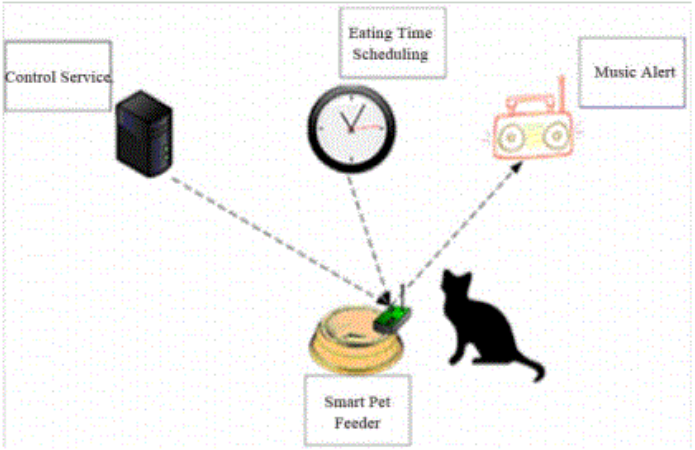


Figure 2.5 Diagram of Smart Pet Feeder system

The Smart Pet Feeder system allow the pet owner to set the eating scheduling remotely. Besides, a greeting voice can be recorded in the system to alert the pet for the eating time.

Strength of the system

The system allows the pet owner to limit the moving range of their pet when it was sick or the bad weather outside the room. Besides, the system can identify their pet with the sensing collar to control the permission of passage from the smart pet door or the eating permission from the smart feeder system.

Limitation of the system

The proposed system must use a sensing collar on the pet in order to identify each pet. The pet owner must always remember to replace the battery power supply in the collar to make sure the collar can work in the right way. Pet owner must always remember for the battery replacement for every pet.

Solution to improve from the limitation of the system

One of the solution is to change the pet identification method to another way. A camera can be installed in both smart pet door and smart pet feeder system so that the power supply replacement can be focus on the system only.

2.2.3 Remote controlled and GSM based automated pet feeder

In 2015, Prashant Singh, Amit Kumar Sharma, Payal Sood, and Paramdeep Singh proposed a remote controlled and GSM based automated pet feeder system (Prashant Singh, Amit Kumar Sharma, Payal Sood, Paramdeep Singh 2015) as shown in Figure 2.6 below.

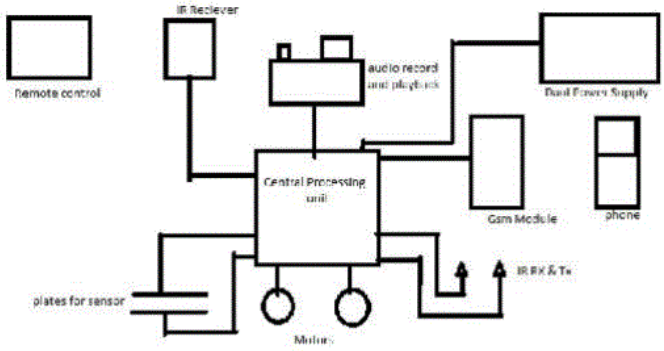


Figure 2.6 Remote controlled and GSM based automated pet feeder

The pet system can be controlled remotely by interactive remote controller, infra-red remote control and a phone. There is a CPU to control the signal received by IR receiver or GSM module. The GSM module is used for data transmission to send AT commands from the device.

Strength of the system

The particular strength of the system is dual power supply with battery charger and left feed alert. Dual power supply can help the system to process continuously in case of power cut or power failure. The system will use the battery to operate and switch back to ac source when it's available. Next, the left feed alert will inform the pet owner by the GSM module if there are any food left. The system will then reduce the feeding amount for the next feeding time.

Limitation of the system

The system is only suitable for only a pet without any identification method. If the pet owner like to feed more than a pet, it will cause some issues like for example, the pet may eat the food from other pet.

Solution to improve from the limitation of the system

One of the way to resolve the problem is to install a camera module in the pet feeder system for identification. Besides, add another feeding bowl beside it and record the different voice to inform the feeding time of their pet so that the other pet will not came to grab the food.

2.2.4 Intelligent water dispensing system for pets

Christopher NERO and Stephen M. Baquet proposed an intelligent water dispensing system for pets in 2018 (Christopher Nero, Stephen M. Baquet 2018). It's a system to provide water and nutritional supplements for the pet. Most of the system only allow the water to remain in a bowl. It will cause the water to stagnate in high humidity environments conversely, continually evaporate and be replaced which

result in wastage of water. This proposed system will supply water unrestrictedly to the pet.

Strength of the system

The proposed system can keep tracking the water in the bowl to know how much water is being consumed. Moreover, it will only supply with certain amount of water to the pet to prevent the wastage of water.

Limitation of the system

One of the limitation of the system is it cannot differentiate which pet are consuming the water and how many pets are consuming the water at the same time. Thus, the tracking features in the system might not be accurate enough.

Solution to improve the limitation of the system

One of the solution is a camera module can be install to differentiate the pet. Besides, a collar with RFID can be used for identification of the pets.

2.2.5 Pet Feeding Control System

Andy H. Gibbs proposed a pet feeding control system in 2018 (Andy H. Gibbs 2018) as shown in Figure 2.7 below.

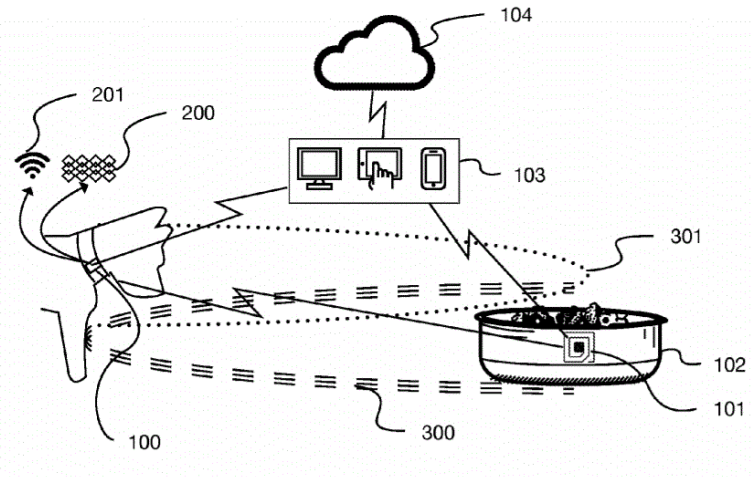


Figure 2.7 Pet Feeding Control System

The pet feeding control system will ensure that one or more pets consuming the specific food paired to them with a RFID collar or a wireless transceiver device to identify the pet. The specific food for respective pet will be stored on a network server. If an unauthorized pet is eating the food, the system will alert the alarm as shown in Figure 2.8 below.

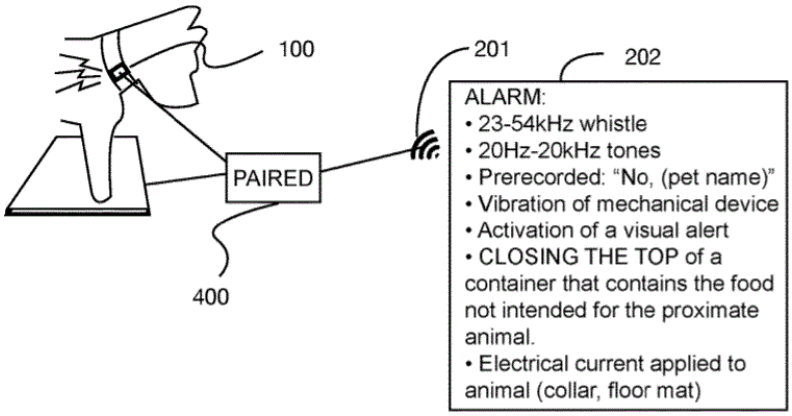


Figure 2.8 Alarm system of the pet feeding control system

Strength of the system

The system can identify each of the pet to provide their respective food stored on the network server and can be modified with their smartphone. Besides, the alarm system is a good method to prevent the other unauthorized pet to eat the food provided.

Limitation of the system

However, the system is too reliance on the network like the storage data and the command are all required a network to make the system working in good condition.

Solution to improve from the limitation of the system

Use a physical storage to store the important data such as the specified feeding foot for respective pet to reduce the possible error in the future.

2.2.6 Embedded Target Detection System Based on Raspberry Pi System

Bahaa Eldin Gamal, Ahmed Nasr Ouda, Yehia Zakaria Elhalwagy, and Gamal Ahmed Elnashar proposed an embedded target detection system that based on Raspberry Pi System in 2016 (Embedded Target Detection System 2016). With the implementation of target detecting and tracking system, it can extract required information from image without other external processing unit. Real time tracking can be achieved by using simple and fast colour detection procedures based on frame differencing and camera motion compensation to estimate the motion vector for controlling the pan tilt DC motors, which will drive the camera to track the moving target in real-time. The Figure 2.9 below shows the diagram of standalone slow motion target tracker setup system.

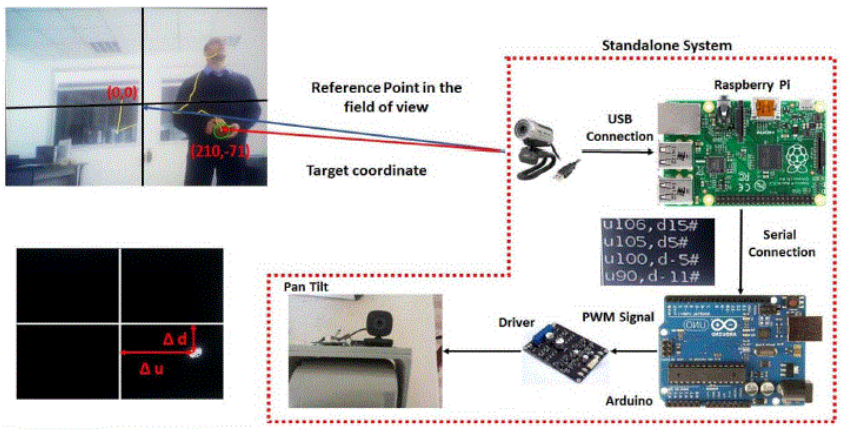


Figure 2.9 Standalone Slow Motion Target Tracker Setup System

Strength of the system

With the use of target tracking system in real-time, the wireless dispenser system can be improved to allow the pet owner to monitor their pet in the other room.

Limitation of the system

One of the limitation of the system is the system is working without the network. The pet owner can only check and monitor their pet in a specific location.

Solution to improve from the limitation of the system

The system can be improved by allowing it to broadcast the image to the network so that the pet owner can monitor their pet every time with any devices that connected to the internet.

2.2.7 Developing fish feeder system using Raspberry Pi

Hidayatul Nur Binti Hasim, Mriitha Ramalingam, and Ferda Ernawan proposed to develop a fish feeder system using Raspberry Pi in 2017 (Fish feeder system 2017). Food starvation and overfeeding may risk the health of the fish and leads to bad water quality in the aquarium. The system will use microcontroller and Raspberry Pi based web application to feed the fish on time. As shown in the Figure 2.10 below, the main function of the system is view and edit schedule, feed and view the fish.

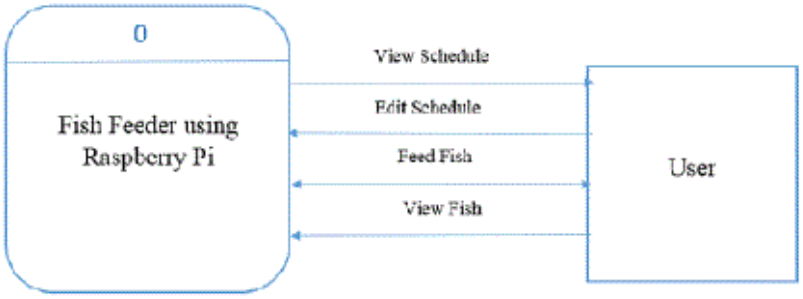


Figure 2.10 Context Diagram of Fish Feeder using Raspberry Pi Application

Strength of the system

The fish feeder system can be used online to monitor the environment of the fish tank so that the pet owner can observe their pet with their smartphone in any place that can connect to a network.

Limitation of the system

The limitation is the fish feeder system can be only installed in a small aquarium size. If the size is bigger like a pond, it will not be able to check and monitor the environment under the water.

Solution to improve from the limitation of the system

Install more camera module to interact with each other so that it can still allow the pet owner to monitor the environment in a larger aquarium size.

2.2.8 Smart Pet House

Ahmed Mandy, Hassan Qazweeni, Mohammed Noureddine, Talal Al-Radhwan, and Mohammed El-Abd proposed a smart pet house system in 2016 (Smart Pet House 2016). The proposed system consists of several subsystems such as monitoring system, smart ventilation system, and smart illumination system.

Monitoring system composed of a rotatable webcam. Besides, there is also an IR sensor to detect the presence of the pet in the smart house. The camera will display the live feeds of the pet as shown in Figure 2.11 below.

Figure 2.11 GUI for the monitoring system

Smart ventilation subsystem composed of two temperature sensors and a fan. Pet owner can control the fan manually or automatically according to the pre-programmed temperature value set in the system. Figure 2.12 below shows the interface of the ventilation system.

Figure 2.12 Interface of the Ventilation Subsystem

Smart illumination subsystem composed of a light sensor and 3 LEDs. The light can switch on manually or automatically when the level of the light goes below the pre-programmed value and switch off when the level goes above the pre-programmed value. Figure 2.13 below shows the interface of the smart illumination subsystem.

Figure 2.13 Interface of the Smart Illumination Subsystem

Strength of the system

The system consists of several subsystems that can interact with each other is convenience for the pet owner to control all of them by using a single application.

Limitation of the system

The proposed system can only interact with smart pet house with the computer that connected with the controlling system. If the pet owner is not staying around the area, the system cannot be able to control manually and the pet owner will not be able to monitor their pet while travelling or working outside.

Solution to improve from the limitation of the system

The system can further improve by adding a network module so that the control system can be used wirelessly from the smartphone that connected to the internet.

2.2.9 Internet of Things for Human – Pet Interaction

Yung-Sheng Shih, Hooman Samani, Chan-Yun Yang proposed an IoT pet interaction system for human in 2016 (Internet of Things for Human 2016). The Figure 2.14 shows the overall system architecture design of the proposed system.

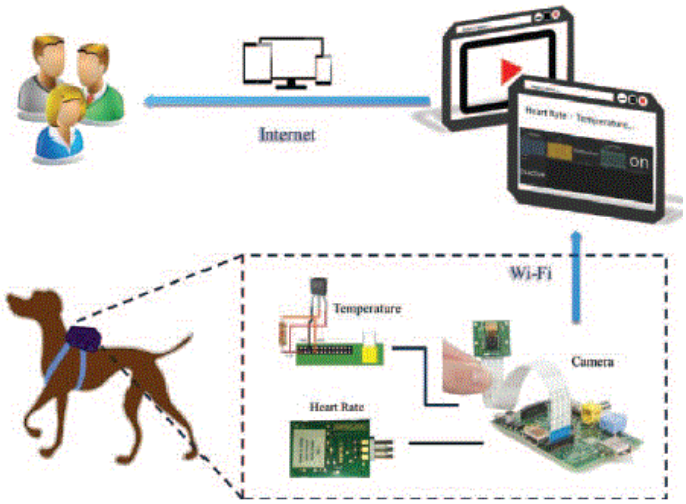


Figure 2.14 Diagram of overall system architecture design

The main hardware component used to design the system is Raspberry Pi 2 Model B for receiving and processing the sensor data. A camera module attached on the Raspberry Pi to retrieve the image on the devices. The temperature sensor and heart rate sensor will get the current physiological data of the pet for monitoring purpose. Figure 2.15 below shows the actual system deployed on a real pet.

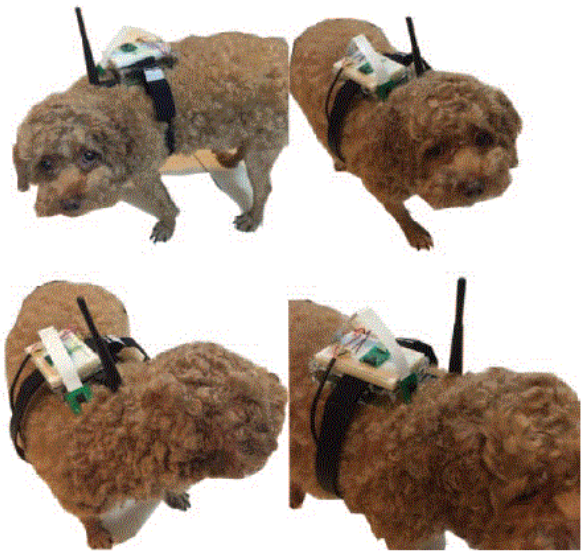


Figure 2.15 Diagram of the actual system deployed on a real pet

Strength of the system

The system can be maintenanced easily as the hardware component on the pet can be replaced without any extra knowledge about the technologies. Besides, the system allowed the pet to have more freedom to move around compared to the smart pet house system for monitoring purpose.

Limitation of the system

The system required a pet to wear a bulky thing around with them which may caused the pet to feel uncomfortable and try to remove them from their body. It may caused the lifespan of the sensing system to be drastically reduced.

Solution to improve from the limitation of the system

One of the solution is to redesign the sensing system to another smaller size that can be fit inside the pet's collar which can reduce the uncomfortableness of the pet.

2.3 Pet identity detection system

2.3.1 Directional Edge-Based Detection Method

Akihiko Yamada, Kazuhiro Kojima, Jun Kiyama, Masayoshi Okamoto, and Haruhiko Murata from Japan proposed a detection method based on directional edge in 2011 (Directional Edge-Based Detection Method). The Figure 2.16 shows the overview of the detection method.

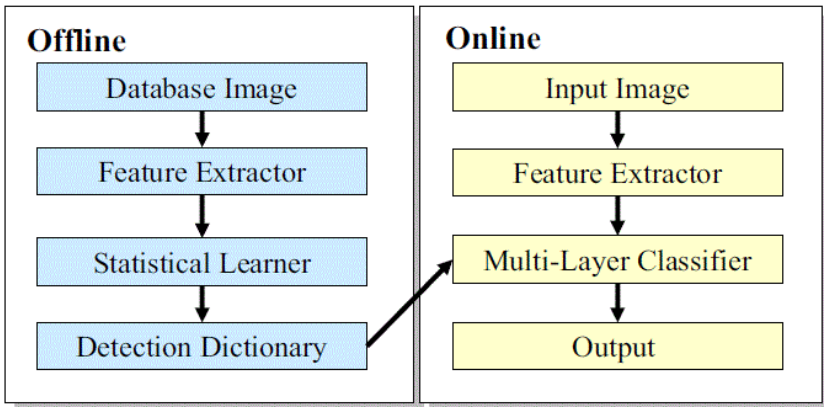


Figure 2.16 Overview of the detection method

Their method consists of offline and online process. Offline part is the image will be first save in the database system. The image you saved will be further extract and another system will learn the statistical detail. Then, the image will be stored inside the detection dictionary. Next, the system will retrieve the detail of the input image classified in multi-layer. Then, the classified image will compare with the detection dictionary to produce the output.

The multi-layer classifier will not only four directional features but also a classifier to judge a face efficiently as shown in Figure 2.17 below.

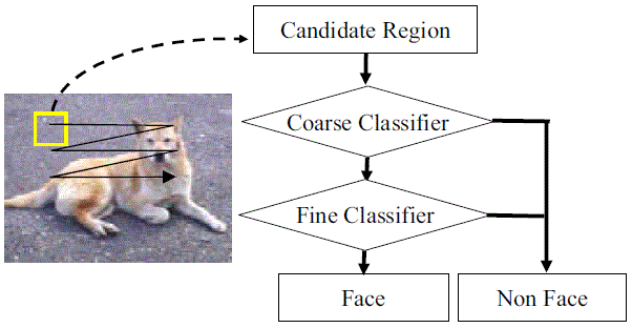


Figure 2.17 Overview of Multi-Layer Classifier

1.3.2 Cat's Nose Recognition

Rifka Widyastuti and Chuan-Kai Yang from Taiwan proposed a recognition method that can be used to recognize the cat with their nose in 2018 (cat's nose recognition). The system can be divided into two part which is cat nose detection and recognition part as shown in Figure 2.18 below.

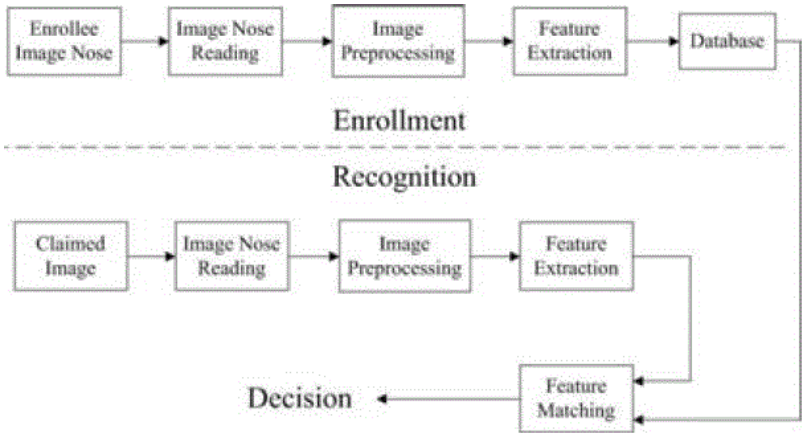


Figure 2.18 Overview of recognition scheme

The detection part will first enrol a nose image. The image will be processed and feature extracted before storing in the database. Next, the recognition part will compare the cat nose image's feature with the one stored inside the database.

CHAPTER 3: System Design

3.1 Description of the project

This project contains both hardware and software part. The main component in the hardware part is the Raspberry Pi 3 model B+. The usage is to act as a controller to control all the subsystem such as the servo motor in the dispensing system and door managing system, and the camera module. The Raspberry Pi will receive the signal from either physical button or android apps. If the signal received is from the dispensing button, then the raspberry pi will forward the signal to the servo motor inside the dispenser to rotate 45 degree. Once the servo motor rotated, the food will drop down from the hole inside to dispense the food. If the signal received is from the door open/close button, it will forward the signal to the servo motor at the door to rotate for 90 degree to open and close the door. Besides that, 2 camera modules will be attached with the raspberry pi for the real-time monitoring subsystem.

Next is the software part which is an android app to communicate with the Raspberry pi. The android app will have several functions such as normal feed button, extra feed button, schedule feed button, open door button, close door button, schedule door button, and monitoring button. When the user clicks on the button, it will send the signal wirelessly to the raspberry pi. Once it received the signal sent from the mobile phone, it will complete the task given accordingly.

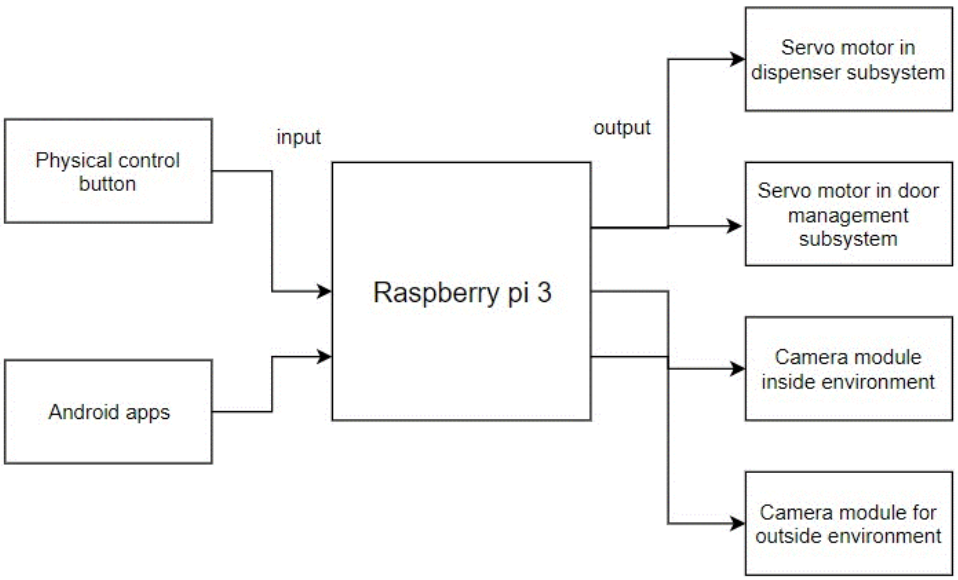


Figure 3.1 System Design Diagram

3.2 System Block Diagram

The block diagram in figure 3.2 below shows the physical connection of the raspberry pi 3 model B+.

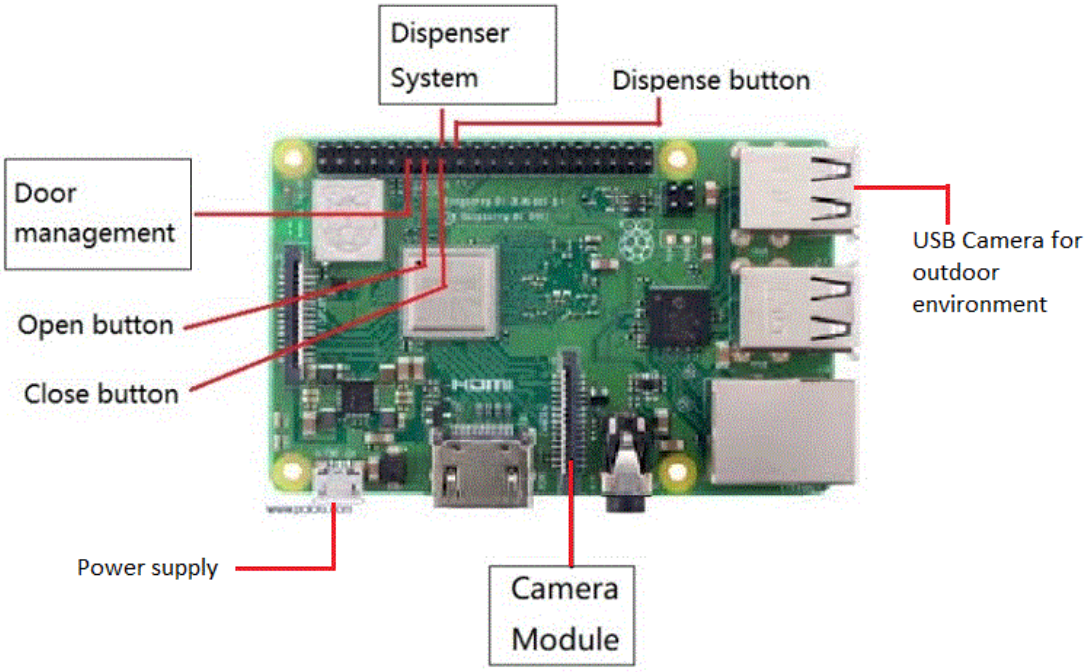


Figure 3.2 Block diagram for the system

Two servo motor will be connected to the port 23 for dispensing and port 17 for the door management. Dispensing button will connect to port 24, door open button will connect to port 27 and close button will connect to port 22. A USB camera will connect to the USB port to capture the outside environment and a camera module will use the dedicated camera port for capturing indoor environment. The power supply used in the system is a 20k mah power bank to ensure the portability of the system.

3.3 Flow Chart

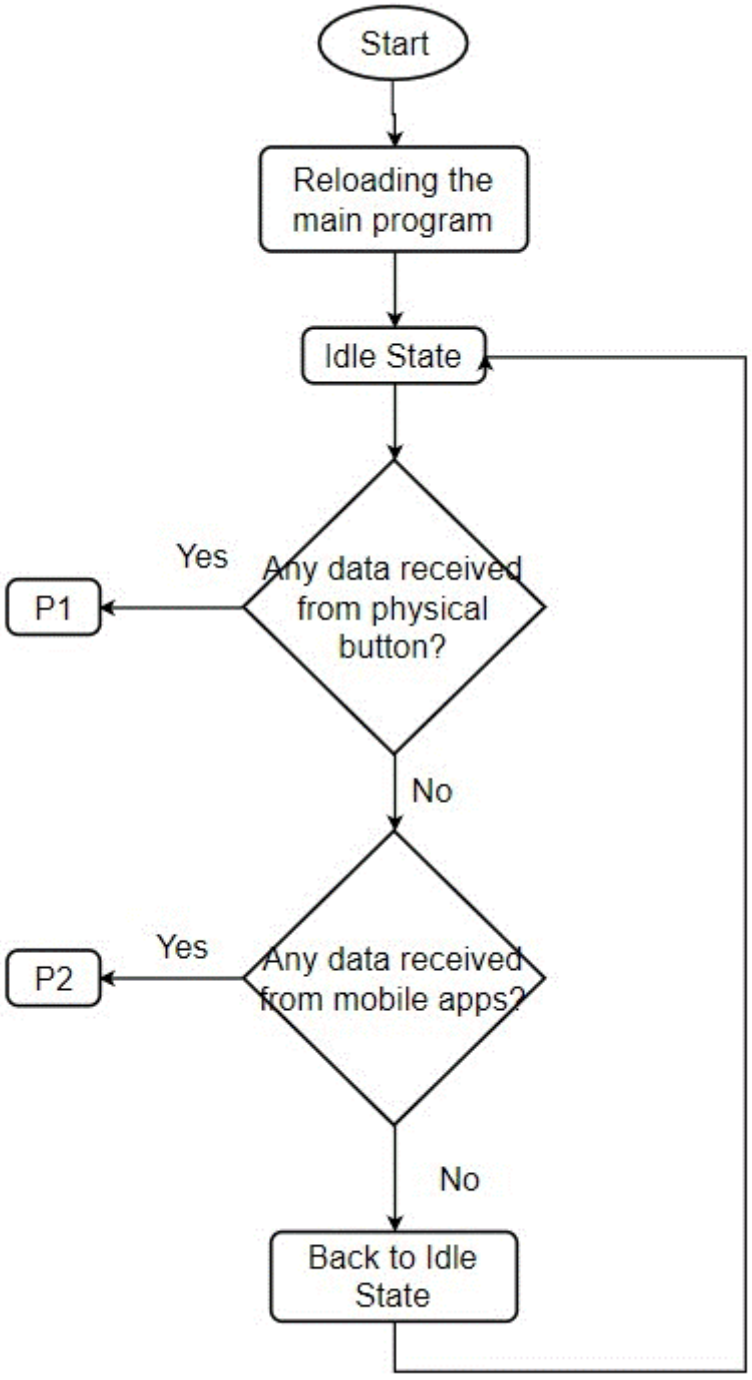


Figure 3.3 Flowchart for the overall system

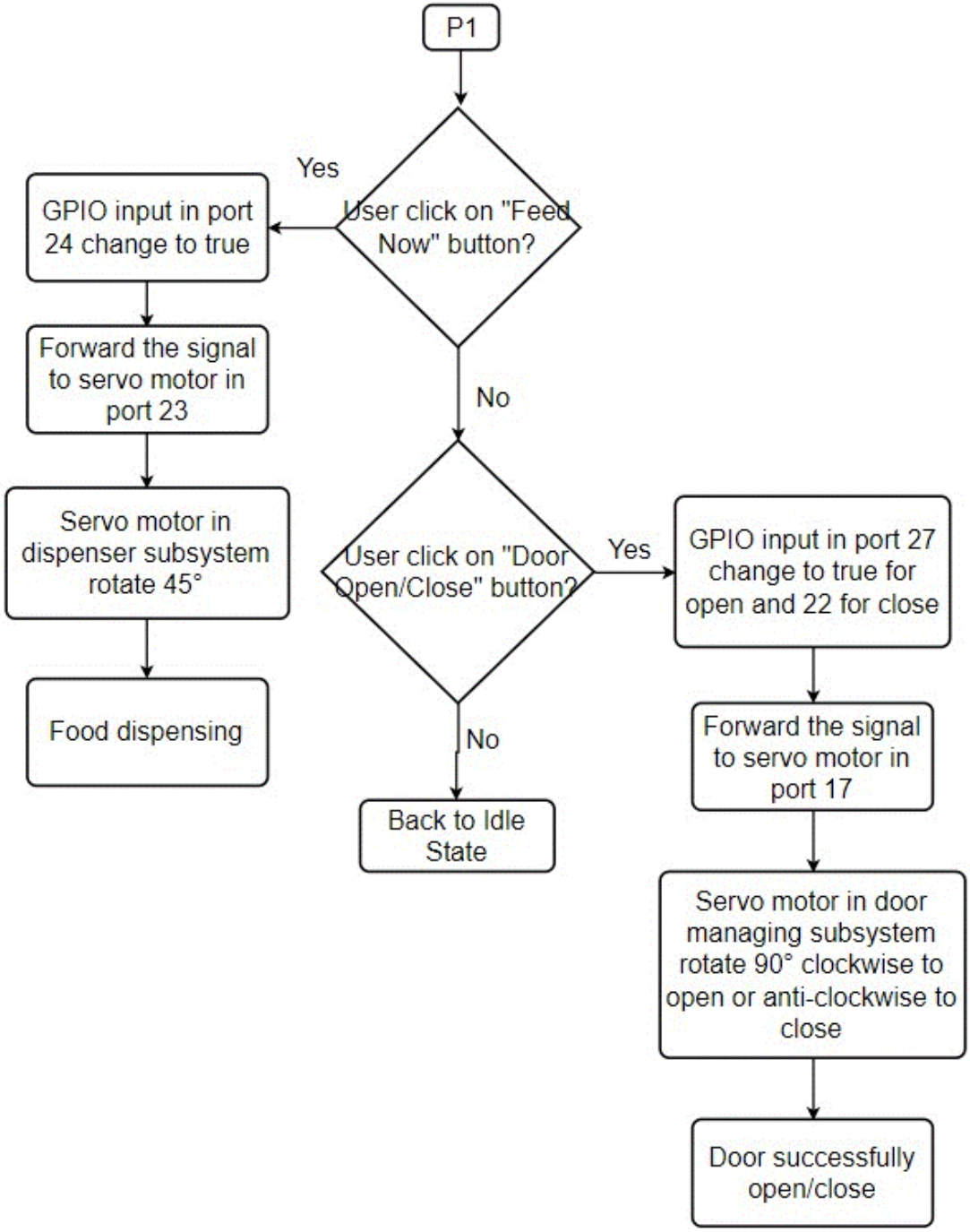


Figure 3.4 Flowchart for the physical button interaction

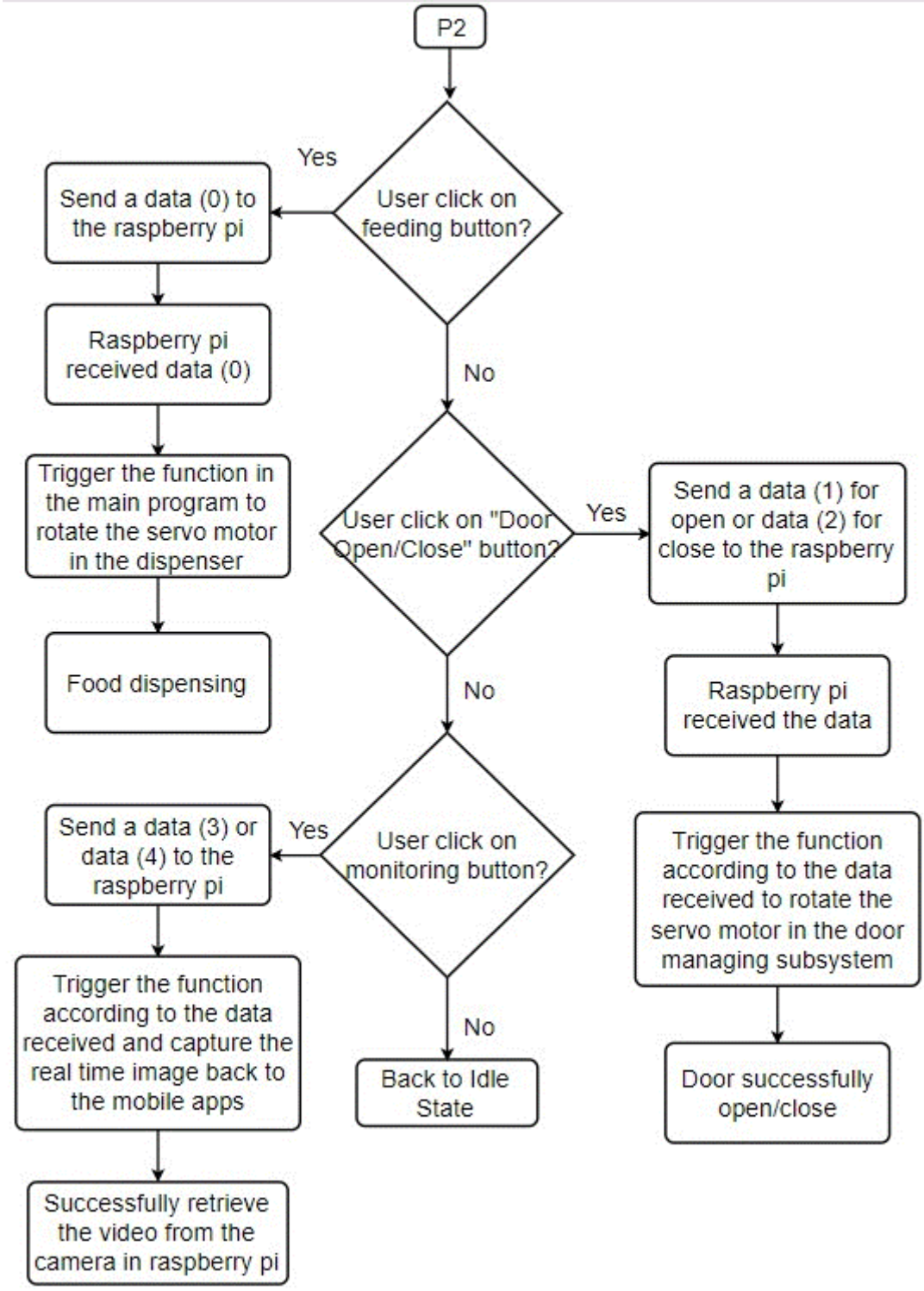


Figure 3.5 Flowchart for the mobile app interaction

3.4 Schematic Diagram

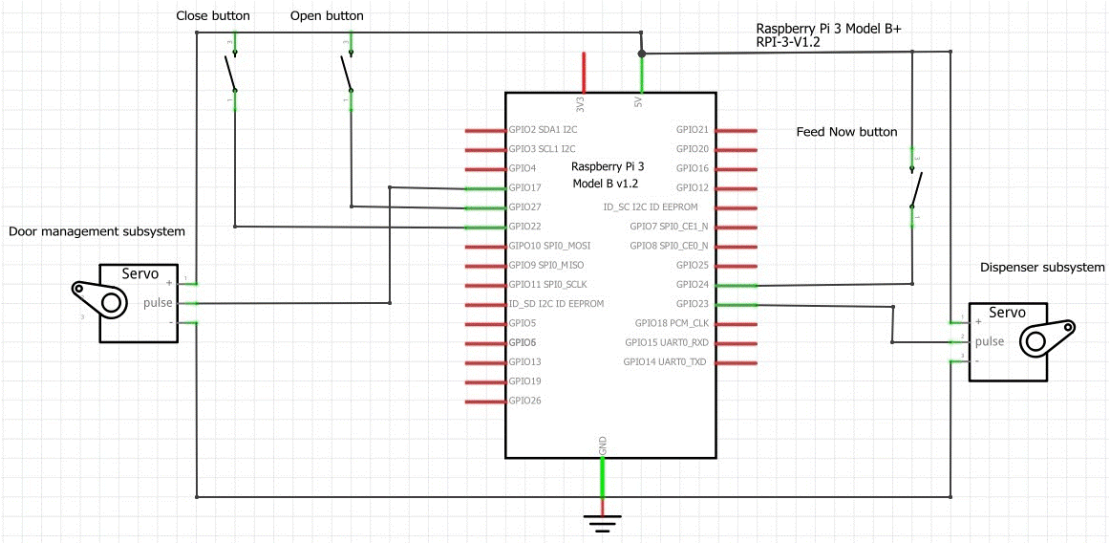


Figure 3.6 Schematic Diagram for the hardware system

3.5 Hardware Development

3.5.1 Connection of Raspberry Pi 3 Model B+ to the components

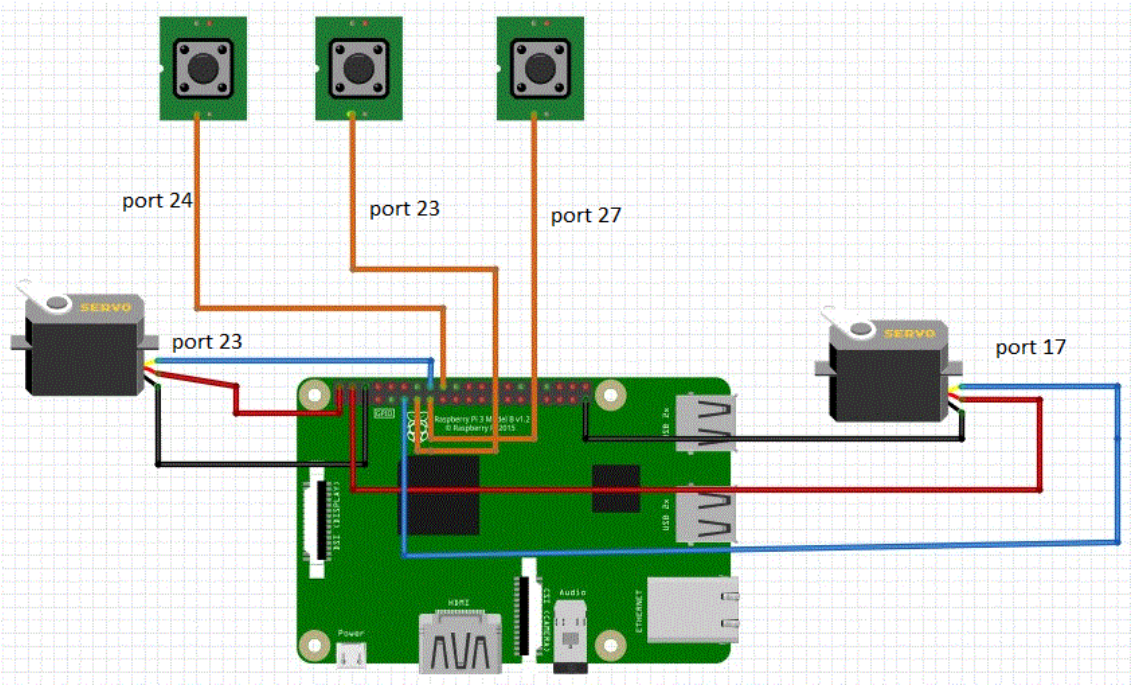


Figure 3.7 Connection of the Raspberry pi 3 Model B+ to the components

The main component required to build the project is a Raspberry Pi as the main hardware device which will used to control all the other components. A servo motor used to control the dispenser subsystem connect to the GPIO port 23 as an output, a

button switch connects to GPIO port 24 as an input. When the user clicks on the button, a signal will be sent to the Raspberry Pi to trigger the servo motor in port 23. Then it will rotate for 90° as shown in figure below.

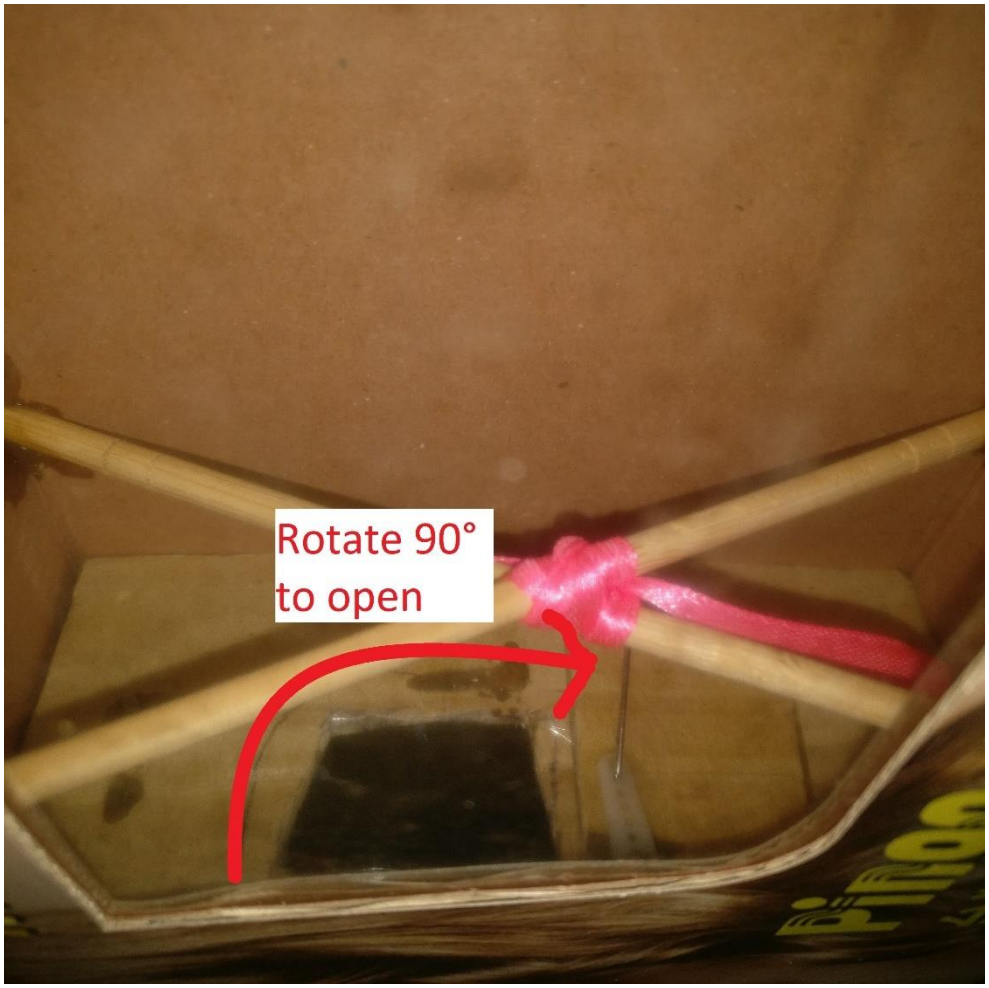


Figure 3.8 Servo motor in dispenser subsystem

Next, the other servo motor used to control the door managing subsystem connect to the GPIO port 17 as an output. Two button switches connect to GPIO port 22 and port 27 as the input for opening and closing the door. When the user clicks on the open button in port 22, a signal will send back to Raspberry Pi and trigger the servo motor to rotate 90° anticlockwise to open the door. When the user clicks on the close button in port 27, the signal will trigger the servo motor to rotate 90° clockwise back to the starting point as shown in figure below.

Figure 3.9 Servo motor in door managing subsystem

After all the hardware setting is completed, then we have to write some python code to control all the servo motors and the switches.

```
def setup():
    GPIO.setmode(GPIO.BCM)
    GPIO.setwarnings(False)
    GPIO.setup(17,GPIO.OUT) #door servo
    GPIO.setup(27,GPIO.IN,pull_up_down=GPIO.PUD_UP) #button open
    GPIO.setup(22,GPIO.IN,pull_up_down=GPIO.PUD_UP) #button close
    GPIO.setup(23,GPIO.OUT) #dispenser servo
    GPIO.setup(24,GPIO.IN,pull_up_down=GPIO.PUD_UP) #button feed now
    global p
    p = GPIO.PWM(17,50) #GPIO17 for PWM with 50Hz
    p.start(8) #initialization
    global p2
    p2 = GPIO.PWM(23,50) #GPIO23 for PWM with 50Hz
    p2.start(10) #initialization
    return
```

Figure 3.10 Setup command for GPIO port

Firstly, we have to set both GPIO port 17 and 23 as output by writing the command: GPIO.setup (17, GPIO.OUT) and GPIO.setup (23, GPIO.OUT). Next, set the port for button switches as input by writing the command: GPIO.setup (27, GPIO.IN,

pull_up_down = GPIO.PUD_UP), : GPIO.setup (22, GPIO.IN, pull_up_down = GPIO.PUD_UP), : GPIO.setup (24, GPIO.IN, pull_up_down = GPIO.PUD_UP). This command is to tell the system that the port will be used to read the input data. After that define the PWM value for both output port in port 17 and port 23 and start with a starting value as the default position.

```
def Dispense():
    p2.ChangeDutyCycle(10)
    time.sleep(0.5)
    p2.ChangeDutyCycle(5)
    time.sleep(0.5)
    p2.ChangeDutyCycle(10)
    time.sleep(0.5)
```

Figure 3.11 Command to control the servo motor in dispenser

Secondly, we have to change the duty cycle in the servo motor to rotate 90° by typing p2.ChangeDutyCycle. the servo motor will rotate to 90° and stop for half second to dispense the food and return back to the default position to stop dispensing.

```
def Dopen():
    p.ChangeDutyCycle(8)
    time.sleep(0.5)
    p.ChangeDutyCycle(7)
    time.sleep(0.5)
    p.ChangeDutyCycle(6)
    time.sleep(0.5)
    p.ChangeDutyCycle(5)
    time.sleep(0.5)
    p.ChangeDutyCycle(4)
    time.sleep(0.5)
    p.ChangeDutyCycle(3)
    time.sleep(0.5)

def Dclose():
    p.ChangeDutyCycle(3)
    time.sleep(0.5)
    p.ChangeDutyCycle(4)
    time.sleep(0.5)
    p.ChangeDutyCycle(5)
    time.sleep(0.5)
```

Figure 3.12 Command to control the door's servo motor

Thirdly, we have to do the same thing for the servo motor in door managing subsystem. However, we cannot do the same to straight rotate 90° at once as if we do so, the servo motor will open and close the door rapidly. It may reduce the lifespan of the servo motor and also it will scare the pet staying inside. Therefore, the rotation will be completed by stopping in every cycle to slow down the rotation speed.

```
def close():
    p.stop()
    p2.stop()
    GPIO.cleanup()
```

Figure 3.13 Command to close and clean up the program

Lastly, we have to stop the servo motor and clear all the thing we set in GPIO to prevent any possible damage to the Raspberry Pi.

3.5.2 Connection of Raspberry pi 3 model B+ to the Pi Camera

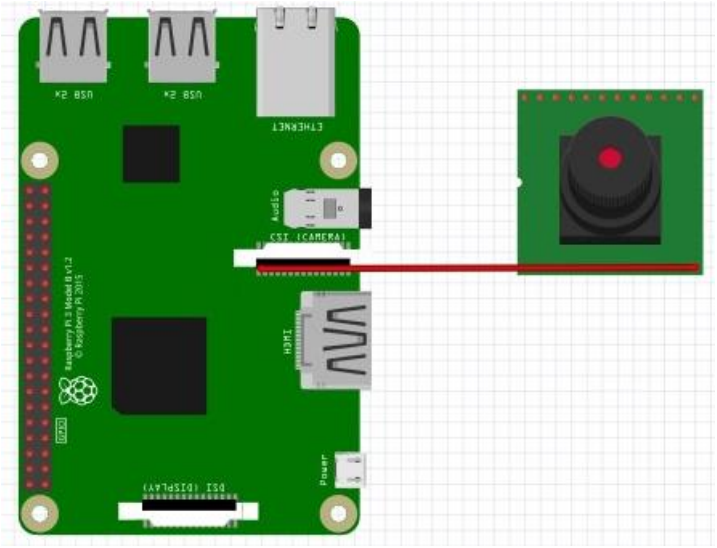


Figure 3.14 Connection to Pi Camera

A camera module will connect to the CSI port in Raspberry Pi via a flex cable. The main purpose of the camera module is to capture the environment inside the cage and send back to the user. In order to use the camera, first we have to enable the camera interface by typing “sudo raspi-config” and select the camera option.

3.5.3 Setting up the Bluetooth connection in Raspberry Pi

Bluetooth is one of a way to create the connection between mobile phone and raspberry pi wirelessly. Since that Bluetooth is an inbuilt function in raspberry pi, we do not have to purchase any other Bluetooth dongles.

To set up the Bluetooth in raspberry pi, first we have to open the terminal and type “sudo apt-get install Bluetooth bluez blueman” to download the relevant packages and install it in the raspberry pi. Next, reboot the system using “sudo reboot”.

Next, click on the Bluetooth icon at the top right side in the home screen as shown in figure below.

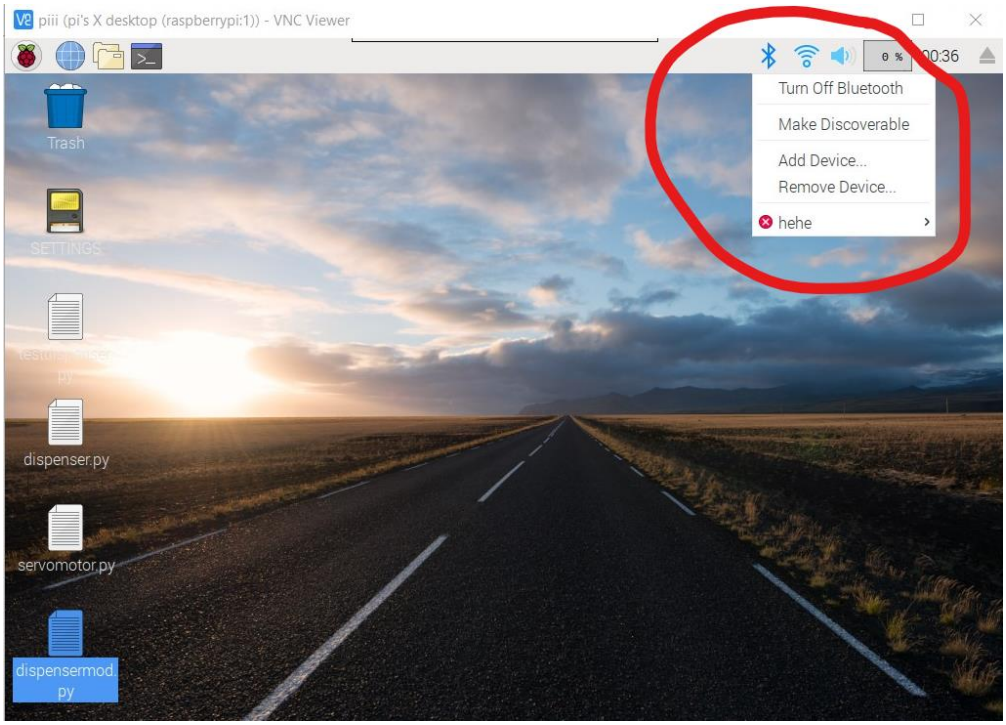


Figure 3.15 Setting up Bluetooth connection

Then, click on the “Add Device” selection and choose your own Bluetooth device in the list. After a 6-digit passcode confirmation, your device will now successfully connect with the raspberry pi system.

After the basic Bluetooth set up, we have to write the python code to use the Bluetooth to control the hardware system. Firstly, we have to set up the Bluetooth server as shown in figure below.

```
server_socket=BluetoothSocket(RFCOMM)
server_socket.bind(("",PORT_ANY))
server_socket.listen(1)
port=server_socket.getsockname()[1]
service_id = str(uuid.uuid4())

advertise_service(server_socket, "PetCareServer",
                  service_id=service_id,
                  service_classes = [service_id, SERIAL_PORT_CLASS],
                  profiles=[SERIAL_PORT_PROFILE])

try:
    while True:
        print ('Waiting for RFCOMM connection'.format(port))
        client_socket, client_info = server_socket.accept()
        print ('...connected from :'.format(client_info))
        try:
            while True:
                data = client_socket.recv(1024).decode().lower()
                if len(data)==0:
```

Figure 3.16 Use Bluetooth as the wireless server

To use the Bluetooth in our command, we have to set the RFCOMM as the Bluetooth socket by typing "server_socket=BluetoothSocket(RFCOMM)". Then mention to only listen to one Bluetooth device using "server_socket.listen(1)". After we advertise the Bluetooth service, we will try to get the connection from the Bluetooth device. Once we get the connection, it will print "connected from: device name". then the program will read the data receive from the android app as shown in figure below.

```
if data == 'dispense':
    servomotor.Dispense()

if data == 'open':
    servomotor.Dopen()

if data == 'close':
    servomotor.Dclose()

if GPIO.input(27)==False: #open button clicked
        servomotor.Dopen()

if GPIO.input(22)==False: #close button clicked
        servomotor.Dclose()

if GPIO.input(24)==False: #feed now button clicked
        servomotor.Dispense()
```

Figure 3.17 Command to read the Bluetooth data

When the data receive is "dispense", it will call the Dispense() function in servomotor.py. the Dispense() function will then rotate the servo motor and dispense

the food. Besides that, when the user clicked on the button switches, the GPIO port will be change to false and call the function accordingly.

3.6 Software Development

3.6.1 Android Studio to make the mobile app

The software part of the project is the android app to control the hardware system. In order to create an android app, android studio is a good choice.

```
public void sendBtMsg(String msg2send){
//UUID uuid = UUID.fromString("00001101-0000-1000-8000-00805f9b34fb");
UUID uuid = UUID.fromString("94f39d29-7d6d-437d-973b-fba39e49d4ee"); /
try {

        mmSocket = mmDevice.createRfcommSocketToServiceRecord(uuid);
        if (!mmSocket.isConnected()){
                mmSocket.connect();
        }

                String msg = msg2send;
        //msg += "\n";
        OutputStream mmOutputStream = mmSocket.getOutputStream();
        mmOutputStream.write(msg.getBytes());

} catch (IOException e) {
                // TODO Auto-generated catch block
                e.printStackTrace();
        }

}
```

Figure 3.18 Command to send Bluetooth message from mobile app

To send the Bluetooth message back to the raspberry pi, we will need to check whether the socket is connected or not. If the mmSocket is not connected, then it will call the mmSocket.connect() function to create the connection. Else it will create a string type message and use the OutputStream.write to send the data back to the raspberry pi.

Next, is to configure the button and set what data will be send back to the raspberry pi. For the dispensing button, we have to create an action listener to monitor whether the button being clicked or not by using the Dispensebutton.setOnClickListener(new View.OnClickListener()). The code inside this function is: new Thread(new workerThread("Dispense")).start(); to create a new thread and send the thread with the data we want back to the system. Then, do the same for the rest button in the app to send back different type of data via Bluetooth connection.

Figure 3.19 User interface of the android app

3.6.2 Real time monitoring on webpage

To monitor the inside environment from the webpage using the camera module attached in raspberry pi, we have to set up the motion software by following the steps below:

1. Sudo apt-get install motion
2. Sudo modprobe bcm2835-v4l2
3. Sudo nano /etc/modules
4. Sudo nano /etc/default/motion
5. Sudo cp /etc/motion/motion.conf /etc/motion/motion.conf.bak
6. Sudo nano /etc/motion/motion.conf
7. Sudo service motion start

The first and second step is to install the motion and get the driver needed in the raspberry pi. Next, we have to type the command in the third step to add the bcm2835-v4l2 driver at the end of the file to allow the driver be activated after any reboot to ensure the camera is always available. After typing the command in step 4, change the start_motion_daemon to yes in order to run the camera server process at the background. In step 6, create a backup for the camera configuration file and start to change some configuration after the command in step 7. Some of the main configuration have to change is to allow daemon, adjust the framerate, height, and width of the video and webcontrol_port to 8081. Finally, the configuration for the motion is completed and run the motion service. To test the camera server on the webpage, simply key in the ip address of raspberry pi with the port 8081. For example, http:// <raspberry pi's ip address>:8081.

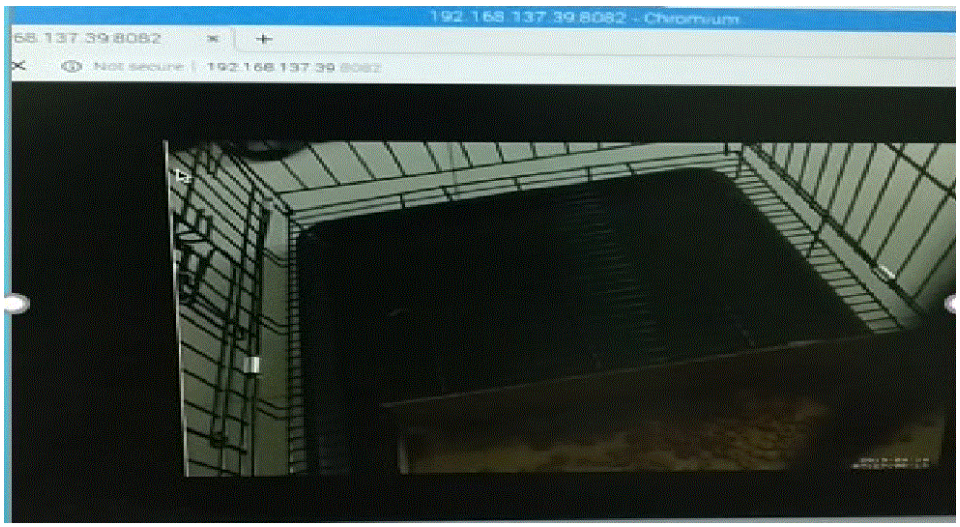


Figure 3.20 Sample real time monitoring on a webpage

CHAPTER 4: Methodology and Tools

4.1 Methodology

The final outcome of this project it to develop a wireless dispenser system for pet with several functions to resolve the limitation of the existing system using Raspberry Pi. Some of the function included is apps interaction with Raspberry Pi, real-time monitoring, door management, calling for pet, and automated feeding system. In order to ensure the proposed system can complete in the limited time, SDLC methodologies will be applied as shown in Figure 3.1 below.

Figure 4.1 Diagram of SDLC model

- Planning: To plan and identify the problem of the existing dispenser system, find a solution, and estimate the time required for the following system.
- Analysis: To analyse the software and hardware requirement of the proposed system like Raspberry Pi, a camera module, familiar with Python language, and so on.
- Design: To design the hardware and software system such as designing the framework that interacted with Raspberry Pi for the hardware part and designing the app interface and function for the software part.
- Implementation: To implement a system that connect the hardware and software part completed in the design phase so that both of the part can communicate and exchange the data between each other.
- Maintenance: To fix the bugs or defects that found in the system.

4.2 Development tools

The development tools that used in the proposed system for the hardware part is mainly the Raspberry Pi 3 model B+ development board that loaded with Raspbian OS. The Python programming language will be the language that used to program the Raspberry Pi. For the software part, android studio is the main software to write the android app using java programming language.

4.2.1 Raspberry Pi

Raspberry Pi (What is Raspberry Pi) is a small sized, low cost computer that can be operated using Linux OS. There are several different models of Raspberry Pi.

Table 1.1: Comparison between different model of Raspberry Pi

Raspberry Pi Models Comparison	Raspberry Pi Model A+	Raspberry Pi Model B+	Raspberry Pi 2 Model B	Raspberry Pi 3 Model B+
SoC	BCM2835	BCM2835	BCM2836	BCM2837
Instruction Set	ARMv6 32-bit	ARMv6 32-bit Single Core	ARMv7-A 32-bit	ARMv8-A 64-bit
CPU&Speed	ARM11@700Mhz	ARM11@700Mhz	Quad Coretex A7@800Mhz	Quad Coretex A53@1.4Ghz
RAM	512MB	512MB	1GB	1GB
GPU	-	Broadcom 250MHz VideoCore IV	Broadcom 250MHz VideoCore IV	Broadcom 400MHz VideoCore IV
Wi-Fi	No	No	No	802.11 b/g/n/ac
Bluetooth	No	No	No	Version 4.2
Ethernet	No	10/100 Mbps	10/100 Mbps	10/100 Mbps
USB port	1 x USB 2.0 port	4 x USB 2.0 port	4 x USB 2.0 Port	4 x USB 2.0 Port

The version used in the proposed system is Raspberry Pi 3 Model B+. The advantage of this model is having a higher version of SoC, faster CPU & Speed, larger RAM,

more number of USB port, and a better GPU. Moreover, in this model it attached with a Wi-Fi and Bluetooth module in the Raspberry Pi so that it can use the Wi-Fi and Bluetooth function without any other component needed. With the Wi-Fi connectivity on Raspberry Pi, the controlling data sent from the apps can be received and perform the task requested by the user.

To setup a Raspberry Pi from the beginning, it can be done by following the steps bellow:

1. Prepare a SD card with at least 8GB storage.
2. Format the SD card and install NOOBS. It's an OS installer which contain Raspbian and LibreELEC for raspberry pi.
3. Prepare and connect a monitor, keyboard and mouse to the raspberry pi.
4. Insert the SD card with NOOBS folder to the raspberry pi and power on the device.
5. Select and install the Raspbian OS from the selection after boot up.
6. Wait for a few minutes after the installation completed, the raspberry pi will be ready to use with the Raspbian OS.

4.2.2 Python Language

Python is one of the most famous language and widely used in worldwide (x). It is mainly used as a scripting and automation language. Python runs on almost every major OS and platform including the Raspbian OS in Raspberry Pi because of its binding or wrappers with major libraries and API-powered services. Python consists of two versions which is version 2 and version 3. However, Python version 2 will only get official updates until 2020. Fortunately, Raspberry Pi support both Python version 2 and version 3. The main difference in both of the version is the concurrency controls and more efficient interpreter on version 3.

4.2.3 VNC viewer

Virtual Network Computing (VNC) viewer is a software that allow the user to remote control another computer over a network connection such as ethernet and Wi-Fi. VNC works on a client/server model. Raspberry pi will act as a server to be remote controlled by the laptop as a client. A server will forward the display to the client and

client can control the server remotely. VNC compatible with most of the operating system.

There are some steps to follow in order to setup raspberry pi as a VNC server:

1. Enable VNC from the setting in raspberry pi
2. Open the terminal and type sudo apt-get install tightvncserver in the terminal to install the VNC server.
3. Type vncserver:1 to start the VNC server using port 1
4. Enter and confirm a password
5. Type “ifconfig” to get the ip address which will be used in the client side.
6. Successfully setup VNC server on raspberry pi

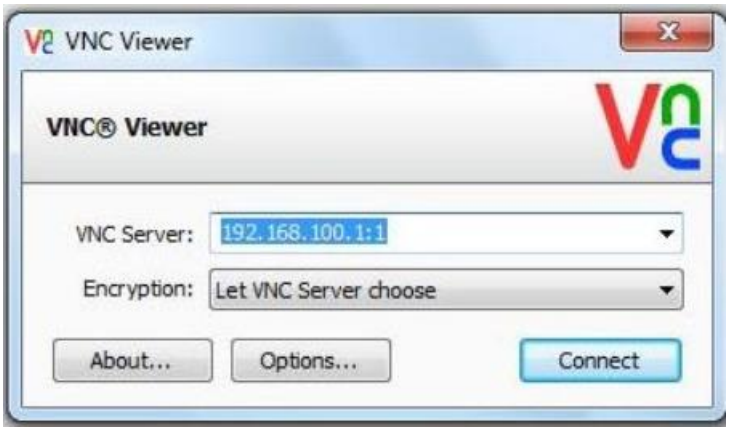
To allow the VNC server start automatic after any reboot:

1. Create a folder “autostart” in .config folder from the Pi’s user folder.
2. Create a file “tightvnc.desktop” in the folder.
3. Type “gnome tightvnc.desktop” to edit the file.
4. Type the following command in the file to allow VNC server to start automatic.

```
[Desktop Entry]
Type=Application
Name=TightVNC
Exec=vncserver :1
StartupNotify=false
```

To setup the client side:

1. Download and install VNC Viewer in your laptop.
2. Enter your raspberry pi’s ip address with :1 behind to connect the server.



3. Enter the password you set from step 4 earlier above.

4. Press OK and connect to your raspberry pi remotely using your laptop.

4.2.4 Android Studio

Android studio is an official IDE for android app development. Some of the main features to enhance your productivity when developing your android apps are:

- Gradle-based build system.
- Faster emulator.
- Unified environment to develop for all android devices.
- Allow changes to code and resource to your running app without any reboot.
- Hugh code templates and GitHub integration supported.
- Great testing tools and framework.
- Lint tools
- C++ and NDK support
- Built-in support for Google Cloud Platform.

4.2.5 Other tools

Camera module

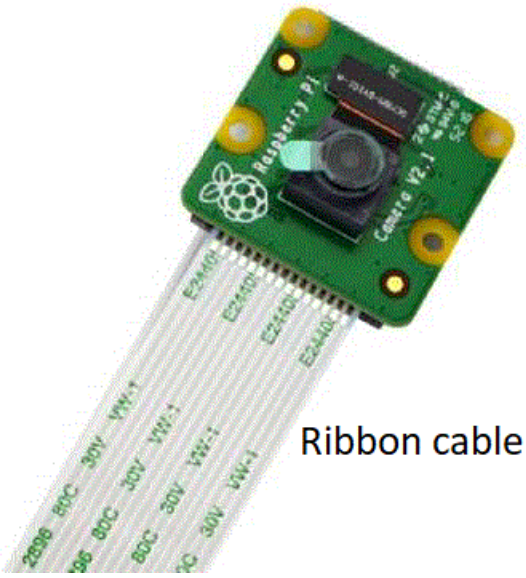


Figure 4.2 Camera module v2 for raspberry pi

The sensor used in the camera module is a Sony IMX219 8-megapixel sensor which enhance the quality from the 5-megapixel sensor in camera module v1. The camera module supports all the raspberry pi version from raspberry pi 1 to 3. The maximum framerate supported in 1080p is 30 fps and 60fps in 720p. It used a ribbon cable to connect from the camera module to CSI port on raspberry pi.

Still Resolution	8 Megapixels
Video Modes	1080p30, 720p60 and 640 x 480p60/90
Linux Integration	V4L2 driver available
C programming API	OpenMAX IL
Sensor	Sony IMX219
Sensor Resolution	3280 x 2464 pixels
Focal length	3.04mm
Size	15 x 24 x 9 mm
Weight	3g

Table 4.2.1 Specification for camera module v2

Remax power bank (RPL-58) 20,000 mAh

Figure 4.3 Remax Power bank 20,000 mAh

Remax power bank model RPL-58 will be used in the project as a power supply for the raspberry pi. The maximum output supported is 5v 2.4a which sufficient the needs for raspberry pi. The battery used in the power bank is a huge 20,000 mAh Polymer Li-ion battery and this is one of the reasons to choose this power bank, to ensure the battery life can last for more days.

Capacity	20,000 mAh
Input	5V 2A (Micro USB)
Output	5V 2.4A (max)
Battery Type	Polymer Li-ion battery
Working Temperature	-10°C to 45°C
Indicator light	Yes
Dimension	160 x 80.2 x 22.15 mm
Weight	460g

Table 4.2.2 Specification of power bank

TowerPro SG-90 Servo Motor

Figure 4.4 Sg90 Servo motor

TowerPro SG-90 servo motor is a basic servo motor to be used in many projects. It can be operated from 4.8v to 6.5v. the rotation angle is only from 0° to maximum 180° which do not allow a full cycle rotation. This servo motor can pull a maximum weight of 2.5kg object if the load distance is 1cm as shown in figure below.

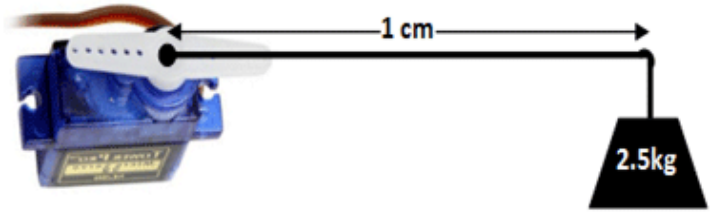


Figure 4.5 maximum pulling weight of Sg90 servo motor

The pulling weight will change accordingly when the distance of the load being changed. For example, if the load distance is 0.5cm, the servo motor will be able to have the pulling weight at maximum 5kg, and 2cm load distance can only support maximum 1.25kg.

Wire Colour	**Description**
Brown	Ground wire connected to the ground
Red	Power supply for the servo motor
Orange	PWM signal received using this wire

Table 4.2.3 Wire configuration for servo motor

Operating Voltage	4.8V to 6.5V
Torque	2.5kg/cm
Operating speed	0.1s/60°
Gear Type	Plastic
Rotation	0° to 180°
Net weight	9g

Table 4.2.4 Specification of the servo motor

KY04 Switch push button

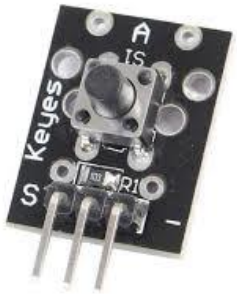


Figure 4.6 KY04 switch push button

Key switch module KY-004 is a standard push button module which is suitable for many projects. It has a pull down to ground on the signal pin.

Rating	12v DC 50mA
Size	2.5 x 1.5 x 0.6 cm
Net Weight	6g
Electrically life	100,000 cycles
Environment temperature	-25°C to 105°C

Python idle 2.7.9

Python IDLE 2.7.9 is the main idle used in raspberry pi to write the code in python programming language. It is a built-in idle after the Raspbian OS is successfully installed in the raspberry pi.

4.3 Requirement

4.3.1 Hardware requirement

- 1 Raspberry Pi 3 model B+
- 1 SD card with minimum 8GB memory
- 1 USB keyboard
- 1 USB mouse
- 1 monitor
- 1 power bank as a power supply with minimum 5V 2A output
- 1 pet cage
- 2 servo motors
- 3 button switches
- 1 breadboard
- 1 camera module for inside environment
- 1 USB camera for outside environment
- Several jumpers to connect from the raspberry pi to the servo and button switches

4.3.2 Software requirement

- Raspbian OS
- Android Studio
- VNC Viewer

CHAPTER 5: Specification

5.1 Analysis Plan

To ensure that the durability of the system is good enough to operate for several days, some analysis plan such as:

- Analyse the minimum battery to supply the power for the raspberry pi.
  One of the aims for this proposed system is to allow the user to leave their pet in their house for several days. Therefore, the capacity of the battery is the main concern point.

- Check the maximum food that can be filled in the dispenser.
  In order to leave the pet for several days, the maximum food storage should be enough for more than a day, and to have almost the same lasting duration as the battery.

- To analyse whether the temperature will affect the system.
  Temperature is also one of the points to concern about as if the whether is too hot or too cold, will it affect the functionality of the hardware system.

5.2 Design Plan

The plan to design the system is a shown in the figure below:

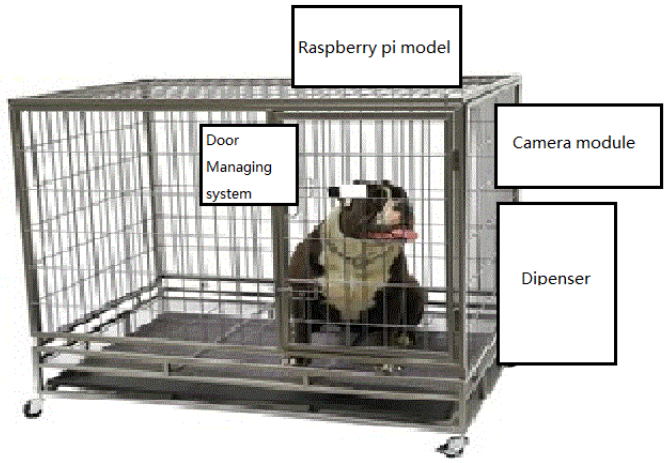


Figure 5.1 Design plan for the system

The Raspberry Pi will be placed on the top of a cage and connected to all the subsystems. The camera module will be placed on the dispenser for real-time monitoring. The dispenser will be installed beside the cage and the door managing system will be at the corner of the door.

5.3 Verification Plan

The verification technique that will be used to test the system is the Black Box testing. Black box testing is a testing technique that will check the input and output of the system as such in the Figure 3.2 below.

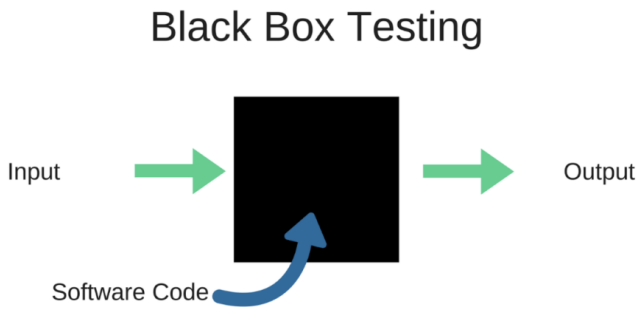


Figure 3.2 Black Box Testing

If the system can produce the output correctly according to the input, then the system is ready. For example, when the user click feeding now button as an input, the output should be the dispenser will dispense some food immediately. The test should cover all of the sub-system like Dispenser system, Door managing system, and real-time monitoring system.

CHAPTER 6: Implementation and Testing

6.1 Implementation

Top down design view of the actual system

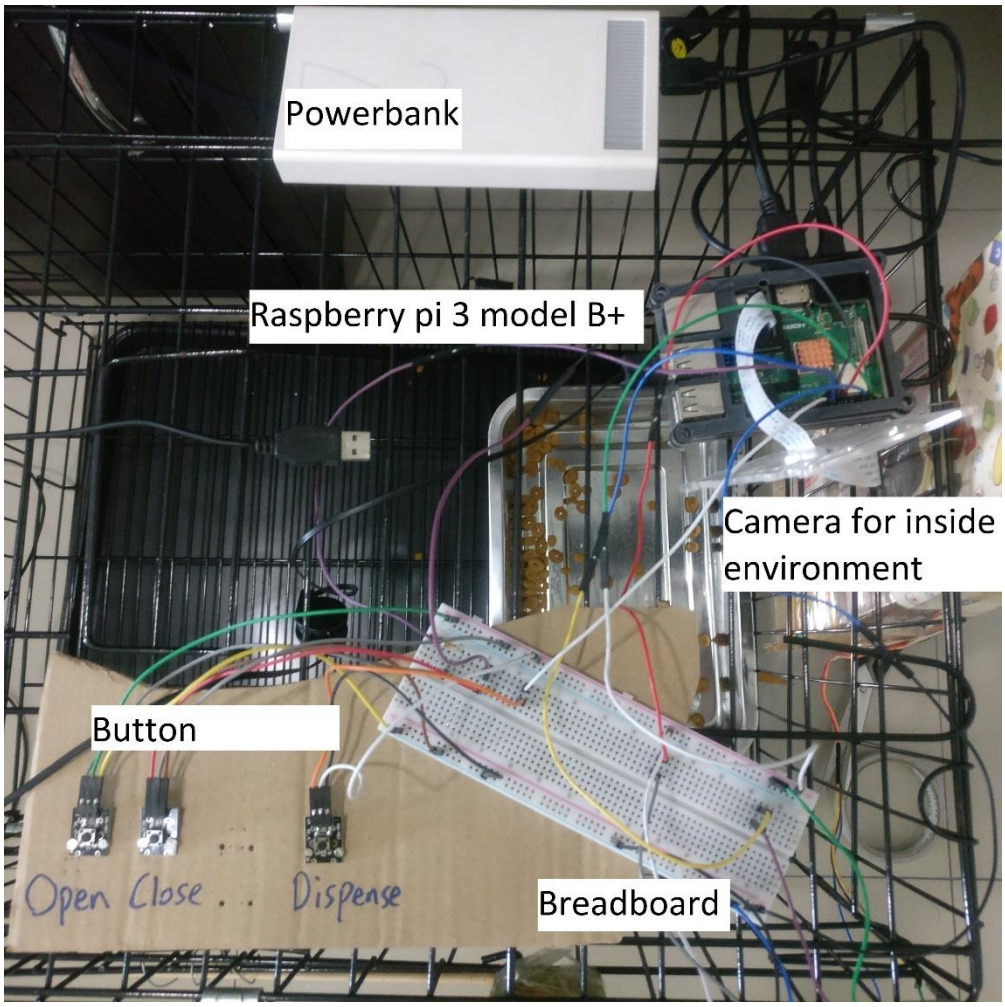


Figure 6.1 Top down design view of the actual system

Most of the components placed on the cage such as the power bank, 3 switch buttons, 1 breadboard, 1 raspberry pi 3 model B+, and the camera module for inside environment. 1 jumper used to connect to the breadboard for each of the switch button and 2 jumpers used to connect from breadboard to the raspberry pi.

Front view of the actual system

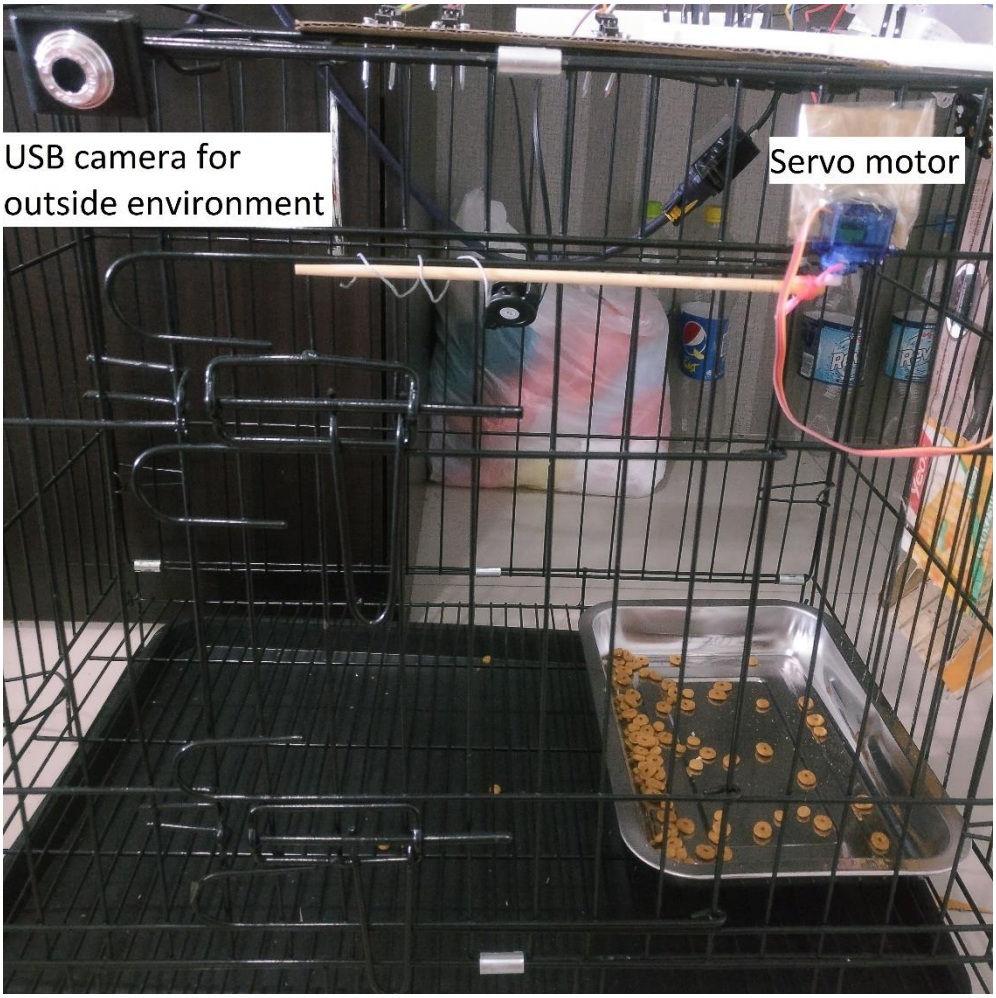


Figure 6.2 Front view of the actual system

Front view contains a servo motor use to control the door to open and close. A USB camera installed on the top left corner of the door to monitor the environment outside the cage. 2 jumpers to connect the servo motor to the breadboard and back to raspberry pi.

Side view of the actual system

Figure 6.3 Side view of the actual system

The dispenser with a transparent cover will let the user check whether the food is sufficient or have to be refilled. The servo motor inside the dispenser used 2 jumpers to connect with the raspberry pi.

Inside environment of the actual system

Figure 6.4 Inside environment of the actual system

The environment inside only placed with a food container below the dispenser to get the dispensed food. The size of the container is 30 x 18 x 10 cm which is large enough to receive more food and reduce the chance that the pet will flip over the container.

User interface of the app

Figure 6.5 User interface of the android app

The user interface of the android app consists of 8 buttons. The buttons are categorized by using different colour. Green colour for the dispenser system, yellow colour for the door managing system, and red colour for the monitoring system.

The extra feed button is to feed the pet with double amount of food. Schedule feed and schedule door is to implement the automatic function. Inside camera and outside camera function is used to check the inside and outside environment.

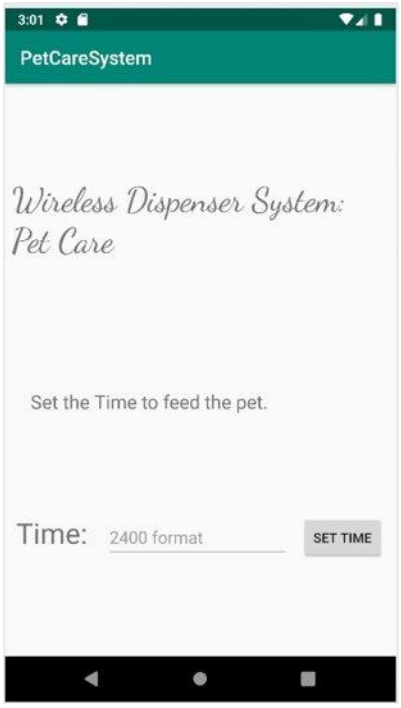


Figure 6.6 Schedule feed function

The schedule feed function allows the user to set the time in 2400 format in the app. The time data will be sent to the raspberry pi to trigger the dispensing function every day once the time is reached.

Figure 6.7 Schedule door function

Schedule door function allows the user to set the opening and closing time so that the door will be operated automatic.

6.2 Testing

The tests conducted in the system are:

i. Functionality of the physical button switch.

The physical button can be operated successfully to trigger their respective function such as the dispense button can dispense the food without any error.

Test	**Result**
Dispense button	Success
Open button	Success
Close button	Success

Table 6.1 Test result for the physical button

ii. The actual working hour of the system.

The working hour by connecting with a 20,000 mAh power bank can be lasts for maximum 6 days for 2 feed, 1 open/close door, and 1 monitoring from both inside and outside cameras, which will be acceptable for a user to go for a short excursion.

Test	**Result**
Day 1	100% battery
Day 2	82% battery
Day 3	64% battery
Day 4	45% battery
Day 5	25% battery
Day 6	6% battery

Table 6.2 Test result of the battery

iii. Maximum weight can be obtained by the dispenser.

The maximum weight to obtained can be up to 1.8kg which can already fill up all the space inside the dispenser.

Test	**Result**
0.5 kg	The dispenser is working well.
1kg	The dispenser is working well.
1.5kg	The dispenser is working well.
1.8kg	The dispenser is full and still working well.

iv. The working temperature range of the system.

The temperature value used to test is according to the weather in Malaysia. In a room with lowest air-conditioner open which is around 16°C and up to 40°C in the afternoon without any cooling method. The test result is showed in the table below:

Test	**Result**
16°C	All the hardware functions able to work normally.
20°C	The system is working in good condition.

30°C	The system is working in good condition.
35°C	The temperature of the raspberry pi increased but still in good condition.
40°C	Hardware function is still working. However, the processor of the raspberry pi is very hot.

Table 6.3 Testing result according to the different temperature

v. Wireless control from the android app to the raspberry pi.
The android app can send the data successfully to the raspberry pi in less than 2 second delay.

vi. Wireless monitoring function from the android app.
Wireless monitoring function is working successfully as shown in the figure below:

Figure 6.5 Sample image captured from the camera module

vii. Food leakage rate from the dispenser

The food usually will leak out from the dispenser after every feed. The leakage rate is around 5%.

No	Test	Result
1	118 g	112g (5% leak)
2	120 g	114g (5% leak)
3	117g	112g (4% leak)
4	118g	112g (5% leak)
5	120g	112g (6% leak)
6	115g	112g (3% leak)
7	116g	110g (5% leak)
8	118g	112g (5% leak)
9	118g	112g (5% leak)
10	122g	115g (4% leak)

Table 6.4 Testing result of the leakage rate

viii. Leftover food in the container

The cat in the cage can always finish the food in the container after every feed. The food dispensed usually not sufficient for the cat and extra feed is needed.

No	Test	Result
1	Normal feed (118g)	Finished
2	Extra feed (120g)	Finished
3	Normal feed (117g)	Finished
4	Extra feed (118g)	Finished
5	Normal feed (120g)	Finished
6	Extra feed (115g)	Finished
7	Normal feed (116g)	Finished
8	Extra feed (118g)	Finished
9	Normal feed (118g)	Finished
10	Extra feed (122g)	Finished

Table 6.5 Testing result of the leftover food in the container

CHAPTER 7: Conclusion

7.1 Project Achievement

The system has been designed and developed successfully with all the basic functionality. All the physical button switches are working and able to control the dispense and door managing features. Next, an Android app has been successfully developed and able to control the hardware system remotely. The user can successfully control all the subsystems such as dispenser subsystem, door management subsystem, and real time monitoring subsystem. However, the last objective to further enhance the system with recognition function is not still not working as the difficulty of categorized every pet with their own speciality. Unlike the human face recognition, a pet will not show their face to the camera and stay quiet in front of the door for a few second to let the system to recognize them. Therefore, the recognition part will be a big issue when the target is a living pet.

7.2 Problem Encountered

The problem encountered is the security for the door managing subsystem. As in the developed system, the door will not be able to be locked even if the door can be closed successfully. A bigger pet such as a dog will have the strength to break the door easily. In order to enhance the door with an automatic door lock, another subsystem have to be implemented which will need more time to develop and set up the hardware and software environment to create a lock system. Besides that, if the door lock subsystem did not implement correctly, when the user clicks on the open button accidentally, not only the servo motor in the door managing subsystem will be spoiled, the raspberry pi will also get damage.

7.3 Personal insight into the total research experience

Overall the research experience is useful as a communication and networking student. Usually we will learn the knowledge mainly in networking field. Most of the time we will only use virtual device to configure the network. With the opportunity to develop this final year project, many extra knowledges in physical hardware and software such as mobile app development being learnt. These knowledges will be very useful in the future as networking is not only focus on the virtual device, but also the

physical devices such as a router and switch. After this project, some basic hardware configuration such as how to connect different modules together correctly in order not to spoil the component, the way to use a breadboard and the design something from available resources like using only the cardboard and a servo motor to create a dispenser for a pet. Most of the thing will not be teach by the teacher in the school if you are not studying in the relevant subject. However, this knowledge is still very useful for your daily life in the future. You can easily create many IoT devices for your house to improve the living environment. Moreover, the mobile app development skill is also an important skill to obtain during this final year project session. Usually networking student will not have the mobile app development as their compulsory subject to be taken. Because of the hardware and software related in this project, a networking student with extra knowledges will be more competitive.

7.4 Novelties and Contributions

After completed this project, the main purpose of this system is to reduce the stray dogs or cats in the street. Not only because of the disease carried by the stray animals, but also to ensure that all the life born in the earth should be treated equally. If there is a system to help the user to take care of the pet, the chance of the pet being abandon will be reduced.

7.5 Future Improvement

There are still having several things can be improved in the future:

- Fully automated feeding system without any human interaction.

  The system can be operated without any human interaction. For example, a weight measuring tool to measure the food container. Once the weight is reduced to a certain value, it will automatic dispense the food, so that user will not have to set the schedule to feed manually.

- Self-cleaning sub-system

  A cleaning function can be implemented as when the user is leaving for several days, the environment inside the cage will be very dirty.

- Automatic refill function

  A function that allow the system to track the level of the food inside the dispenser system. When the foods are running out, it will refill it automatic.

- Sensor implementation

  Several sensors such as light sensor and temperature sensor can be implemented in the system. For example, when the environment is too dark during the day time, the light will switch on automatic and when the temperature is too hot, the fan will be switched on to reduce the temperature in the environment to ensure the raspberry pi will not overheated.

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Poster

UNIVERSITI TUNKU ABDUL RAHMAN

Faculty of Information Technology

Wireless Dispenser System: Pet Care

By Lee Wei Qi

Introduction

People nowadays like to adopt a pet not only because of their cuteness, but also the security and ornamental. However, they will not always have a fixed schedule to take care of them everyday. Once they have something else to do, no one can take care of them when their friends or neighbors are not around at the same time. Therefore, their only helper is the technology nowadays. With the use of Raspberry Pi to connect with several subsystems such as dispenser subsystem, door management subsystem, real-time monitoring subsystem, the user will not have to worry too much with their pets while they are away for several days.

Objectives

- Proposed the framework..
- Develop the hardware system.
- Develop the software system.
- Enhance the system with wireless interaction between software and hardware.
- Further enhance the system with pet recognition.

Discussion

Outdated dispenser system with only schedule feeding:

- User have no idea whether the amount of food is enough for the pet or not.
- User cannot monitor their pet condition.
- User cannot dispenser more foods other than scheduled time.

Proposed dispenser system:

- User can monitor their pet in real-time.
- User can feed their pet wirelessly using the app.
- User can record their voice to have more interaction with their pet.
- User can manage the door to allow their pet to have some free time outside the desired cage.

Result

- The dispenser system can last for 6 days by using a 20k mAh power bank.
- Feeding for two times a day is sufficient for a cat.
- User need to monitor the inside environment before closing the door manually.
- The dispenser system is not suitable for outdoor environment.
- 2 second delay when controlling the hardware using the app.
- The cat will usually finish the food dispensed in the container.

Methodology

- Develop using the Raspberry Pi 3 model B+ in the hardware system.
- Develop using the Android Studio for the software system.
- A camera module to achieve real-time monitoring function.
- Flowchart of the system:

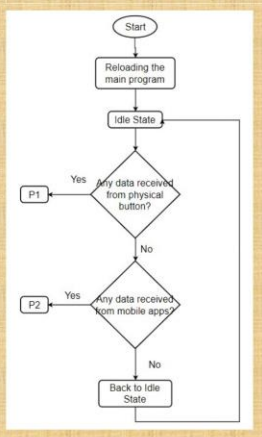

Figure 1: Flowchart of the main program

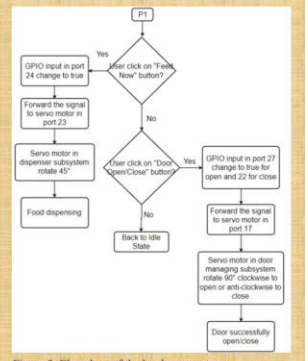

Figure 2: Flowchart of the hardware system

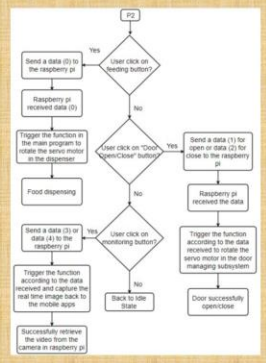

Figure 3: Flowchart of the software system

Figure 4: Framework of the system design

Conclusion

The existing dispenser system need to be improve with more features that regarding the pet caring aspect. With several enhancement in the proposed system, the pet owner can have more time for themselves when they need to busy with their own stuff. With several useful functions in the proposed system, the pet owner can finally reduce their workload and reduce the loneliness of their pet while they are away. Moreover, this proposed system can still further enhance with other subsystems such as self-cleaning system, fully automatic function, more IoT concepts item, and so on.

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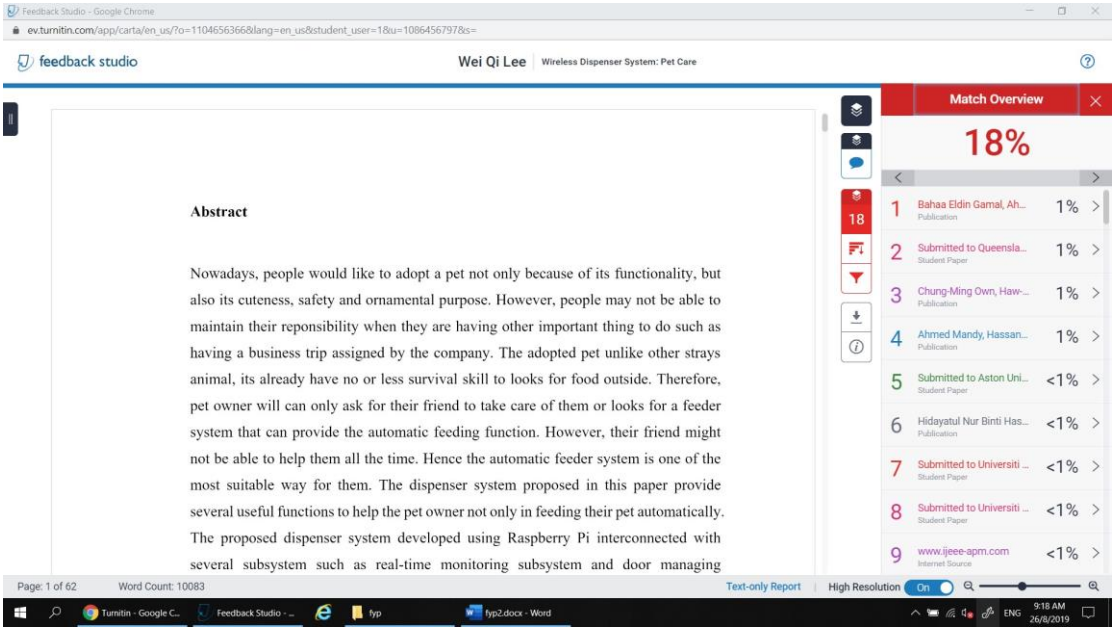

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