Faculty of Electrical and Electronic Engineering Technology

Development of IoT-Based Smart Pet Feeder Powered by Solar PV

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in partial fulfillment of the requirements for the degree of
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2021

DECLARATION

I declare that this project report entitled "Development of IoT -Based Smart Pet Feeder Powered by Solar PV" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology with Honours.

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DEDICATION

This thesis is dedicated to my loved ones who have meant so much to me. First and foremost, to my parents, who never quit to support me in a variety of ways.

For my father, who has always been there for me in big and small ways.

My mother, who has supported me throughout my studies.

Then there was my wonderful academic adviser, who helped me stay on track and also taught us how to persevere in life. May Allah bestow upon him.

Next, I want to express my gratitude to my dearest best friend, who has inspired me to pursue my dreams and complete the dissertation that I started.

Thank you very much. My affection for you all is unquantifiable. May Allah continue to bless them.

ABSTRACT

Technology is one of the most positive feedback for enhancing the quality of monitoring systems. Since the invention of the Internet of Things (IoT) into human lifestyles, world have developed a wide range of smart services based on IoT. There are some problems encountered in managing regular pet feeding. Among these problems it is the difficulty of getting the pet care nutrient in their health.Sometime, owners are not available at home because of their work.However, not every pet are good in taking care of diet. One of the best health concerns of pet is overeating to prevent obesity.Therefore, this paper introduces to develop smart pet feeder system to help feeding dry food diet to pet such as cat and dogs.The objectives of this project is to develop smart pet feeder wih Internet of Things (IoT), to develop a device that can automatically feed pets without the owner's presence using smart phone,to raise their pet in healthy life with complete nutrient needed and to design the project with solar powered.This smart pet feeder used weight sensor and WiFi module to control input and output of the system.The used of Wi-Fi module via Blynk Mobile app is to trigger a measure of dry food and for setting time in output.Solar energy is for powered system.This project is easy to use and monitoring a pet, other word this project is user-friendly as it introduced the best improvement to smart pet feeder system besides save energy.

ABSTRAK

Teknologi adalah salah satu maklum balas yang paling positif untuk meningkatkan kualiti sistem pemantauan. Sejak penemuan Internet of Things (IoT) ke dalam gaya hidup manusia,dunia telah mengembangkan pelbagai perkhidmatan pintar berdasarkan IoT.Terdapat beberapa masalah yang dihadapi dalam menguruskan pemberian makanan haiwan kesayangan secara berkala.Antara masalah ini adalah kesukaran mengawal nutrisi penjagaan haiwan kesayangan dalam kesihatan mereka. Kadang-kadang, penjaga tidak ada di rumah kerana bekerja. Walau bagaimanapun, tidak setiap haiwan peliharaan pandai mengurus diet. Salah satu yang terbaik masalah kesihatan haiwan peliharaan ialah makan berlebihan untuk mencegah kegemukan.Oleh itu, laporan ini memperkenalkan untuk mengembangkan sistem pintar pemakanan haiwan peliharaan untuk membantu memberi makanan kering kepada haiwan kesayangan seperti kucing dan anjing. Objektif projek ini adalah untuk mengembangkan penyuap haiwan peliharaan dengan Internet of Things (IoT), untuk mengembangkan peranti yang dapat memberi makan haiwan peliharaan secara automatik tanpa kehadiran pemilik dengan menggunakan telefon pintar, untuk membesarkan haiwan kesayangan mereka dalam kehidupan yang sihat dengan nutrien lengkap yang diperlukan dan merancang projek dengan tenaga suria. Pengumpan haiwan peliharaan pintar ini menggunakan sensor berat,modul WiFi untuk mengawal input dan output sistem. Penggunaan modul Wi-Fi melalui aplikasi *Blynk* adalah untuk mencetuskan ukuran makanan kering dan untuk menetapkan masa dalam output.Tenaga suria adalah untuk bekalan kuasa. Projek ini mudah digunakan dan memantau haiwan kesayangan, dengan kata lain projek ini mesra pengguna kerana memperkenalkan penambahbaikan terbaik untuk sistem pintar pemberi makanan haiwan selain menjimatkan tenaga.

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I would like to express my heartfelt gratitude to all of my beloved friends, classmates BEEY, and faculty members who stood by me and supported me through deep and small. May Allah grant the aforementioned individual success and honour in their lives. At last, I would like to bless as well as other individuals who are not mentioned here for being co-operative and supportive.

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^{o}C	-	Temperature
%	-	Percentage

LIST OF ABBREVIATIONS

V	-	Voltage
IoT	-	Internet of Things
PV	-	Photovoltaics
MQTT	-	MQ Telemetry Transport
GPIO	-	General-purpose input/output
LPWAN	-	Low Power Wide Area (LPWA) network
EREV	-	Extended Range Electric Vehicle
Ah	-	Amp-hours
Wh	-	Watt-hour
Amps	-	Ampere
SRAM	-	Static random access memory
RPM	-	Revolutions per minute
g	-	Grams
I	-	Current
P	-	Power
DC	-	Direct Current

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CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, we live in a technologically driven society, and technology is an integral component of every individual's everyday existence. Furthermore, technology is employed in our daily lives as an essential tool and machine to make life simpler by simplifying human chores and developing toward a developed society. Everything used to be done manually in ancient times, such as maintaining a plant, feeding a pet, travelling to the library to locate a reference, shopping at the supermarket, and asking people on the street for directions. Everything is now at your discretion. You can water plants by creating a smart system to monitor them using the Internet of Things (IoT), creating a smart pet feeder system using the Internet of Things (IoT), using a search engine to find references, and installing mobile applications to buy groceries such as Food Panda and finding directions using Waze.

The Internet of Things (IoT) is a common trend among consumers to utilise and construct smart digital systems. This enables users to oversee their work from a remote location, eliminating the requirement for on-site monitoring and inspection. The Internet of Things (IoT) is a new technological concept that includes a worldwide network of interconnected devices. Aside from that, industries have been paying serious attention to the IoT as a critical future technology. Monitoring and control systems are one example of an IoT application. This programme collects data on equipment performance, energy usage, and environmental factors, enabling managers and automated controllers to track performance in real time from any location and at any time. [1]

Our country is presently undergoing a fourth-industry revolution (Industry 4.0). By improving real-time connection, data collection, and analytics capabilities, the Internet of Things (IoT) transforms traditional business into a digital paradigm. Since the early 2010s, when IoT initially gained steam, the home appliance business has been a pioneer in incorporating cutting-edge technologies like IoT and the Cloud. With the advent of the Business 4.0 era, the home appliance industry has embraced technologies such as IoT and

big data, which enable the collection of incremental data from consumers and smart devices. [2]

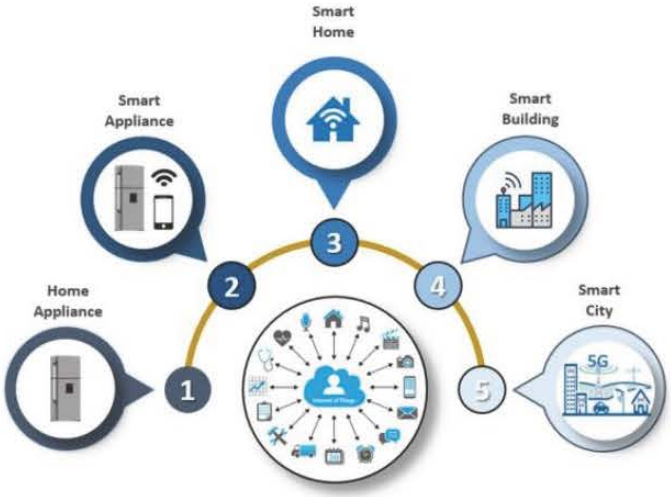


Figure 1.1 IoT enabled portfolio toward digital transformation

Source: [2]

1.2 Problem Statement

Pets can help us cope with loneliness and depression by providing companionship. Pet care should be enjoyable and not taxing. All pet must be cared, and the owner must be present to do so.

However, it is completely obvious that pet care is a burden for pet owners. A certain pet must be cared for, and the owner must be available to do it. Pet owners, on the other hand, cannot leave their pets alone .In order to rectify this problem, the *Blynk* platform was introduced in this project for connecting to the development board and providing a server or collecting IoT feeding data. By using IoT, the project can manage time for feeding the cat.

Other than that, some pets will certainly eat some type of food. Therefore, to solve it, a system that can be prepared first using chosen food and can instantly feed without the owner's presence is required to ensure the pet's health.

In addition, some pets are unable to limit their diet and will eat as long as food is available. For fully monitor the pet's diet it is essential for the owner to ensure that the pet is in healthy living. Therefore, this project is designed by using weight sensor for the scale. It

can be used to monitor the amount of food feed to the pet at each meal in order to be cautious and reduce the risk of illness[3]

Additionally, pet owners will also be upset if there is a blackout when leaving the house for a long time. So this project is designed using a solar system. The use of solar energy can not only facilitate if the electricity is cut off, but can also save on electricity bills.

According to that, in this project the system functions in two ways. The first is to feed the pet. After eating the pet, the system will stop interacting for a short period of time to ensure that the pet does not eat too much.

1.3 Project Objective

At the end of this project, there are a few necessary objectives that need to be achieved. For the project title, "Development of IoT based Smart Pet Feeder Powered by Solar PV", this project is able to:

a) To implement the Internet of Things (IoT) for a smart pet feeder system
b) To develop a device that can automatically feed pets without the owner's presence by using a microcontroller-based system
c) To provide their pet with the necessary nutrition for a healthy life.
d) To design the solar powered for feeder system.

1.4 Scope of Project

To avoid any uncertainty about this project due to some limitations and constraints, the scope of the project are defined as follows:

a) The IoT that was developed for smart pet feeders covers the monitoring system in technology.
b) Solar powered supply with battery charging and controller system.
c) Investigation of powered supply that support from solar, time setting for pet feed and weighing measurement were considered in analytical models.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

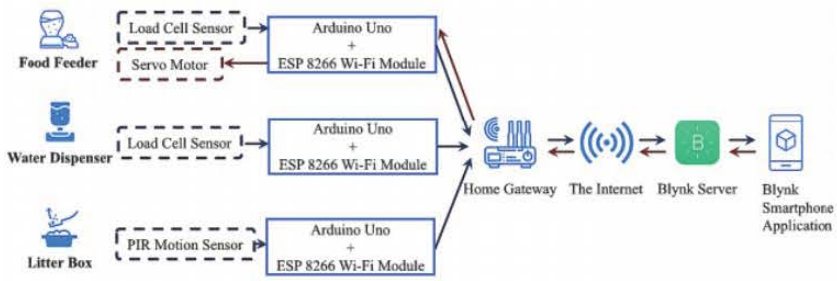
In today's modern society, the world has seen technological advancements grow in various forms, capable of supporting humans in their daily lives. For some animal-loving humans, pets are now considered part of their owner's role in human activities and lifestyles. The increase in the number of pets has correlated with an increase in the elderly population. Pets are usually treated as if they were family members. The most common pets are dogs and cats. Every year, the pet care industry and businesses continue to grow, and the need for products with innovative technologies is critical to supporting seniors in caring for their pets.

2.2 IoT in Smart Pet Feeder

When the owner is not available, the automatic pet feeding system ensures that pets are fed on time, enabling the owner to focus on other responsibilities. The Automatic Pet Feeding System features a nice design and a nice model. The Arduino and IoT bring automation to the system. [3]

Aside from that, smart pet feeder customers may utilise an Android phone to send MQTT publish messages to a MQTT server via an APP. The microcomputer acts as an MQTT server, receiving MQTT messages delivered by mobile phones. The GPIO signals are then sent to the motor hardware by the microprocessor through its PINs.[4]

To allow all components to connect with the same project in Blynk, the authors used the feeder's authentication token, which is received when the Blynk project is formed. [5]



Source:[5]

Figure 2.1 Block diagram of pet care system

Smart pet feeder is mostly produced a basic function same as the product that we can find in the market. The designed with the weight sensor and timer can measured the amount of the food and check the time interval and it can act on time basis with timer set. With the good design, it can be done by using user smart phones. User can receive the status of smart pet feeder through the specific smart phone applications. Many result shown that smart pet feeder can be design by IoT. [6]

Furthermore, with the advent of Internet of Things (IoT) technology, there has been a substantial shift in people's lives, and we have entered an era in which a greater range of items, rather than simply computers or mobile phones, are linked. The IoT has enabled us to perceive and manage the physical world by making items smarter and linking them via an intelligent network, hence "connecting the disconnected." [5]

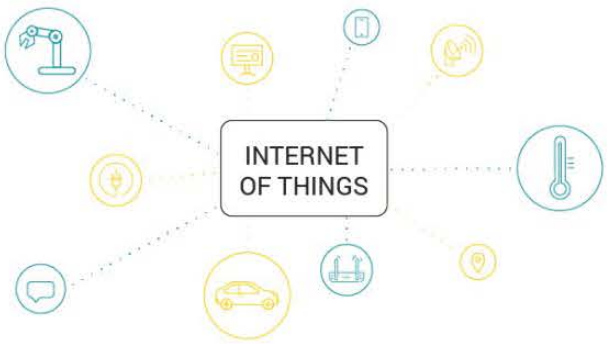
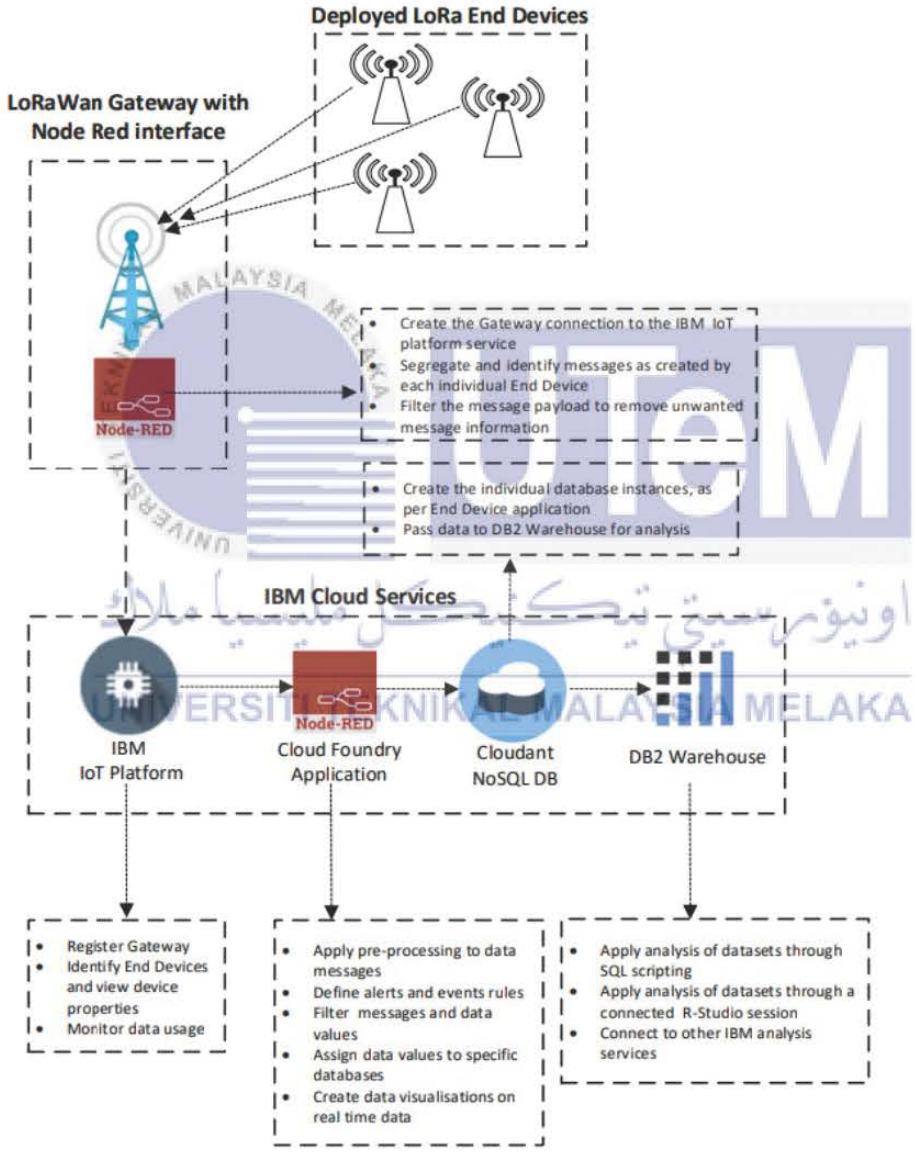


Figure 2.2 Internet of things technology

2.3 Important of using IoT

IoT has a significant impact on the lives of millions of people around the world. It is used in a variety of societal contexts to reduce human interaction and directions and provide highest automation.Other than that,with the help of vibration-based condition monitoring, IoT enabled industrial condition monitoring solutions for Industry 4.0 can be quantified.Over time, LoRaWan has primarily been used to focus on its operation and performance as an LPWAN technology, with fewer specific application deployments. [7]



Source:[7]

Figure 2.3 IoT System: Design architecture and methodology

The fundamental core of the IoT area is connected to intelligent objects, and their behaviour is dependent on an interoperable modelling system. Furthermore, the IoT communication protocol provides a lightweight way to deal with intelligent devices. Furthermore, there are two types of nodes in the IoT: active and passive. A passive node is a backup node that will take over immediately if the active node fails. [8]

Table 2. 1 The similarities and differences between IoT, Internet and WSN

Characteristic	IoT	WSN	Internet
Communication Protocol	Lightweight	Lightweight	TCP/IP
Scale of Area	Cover wide area	Cover wide area	Cover local area
Type of Nodes	Active and Passive	Active	Active
Identifying Object	Must	Disable	Enable

(Source: [8])

Due to the general industrial IoT, the integration of IoT cross-industry will develop in the future, and IoT implementation will become widespread in human lives. [9]

Hence, the use of IoT is appropriate in the design of this project. This project aims to create a system that allows owners to monitor their pets automatically at any time and from any distance without having to physically inspect the pet food on site, as well as a detection system that will notify the user via an installed application when it is time for the pet to eat.

2.4 Solar as power supply

Solar energy is the most important and renewable source of energy known to humans. As a solution, solar trackers are being added to improve the efficiency of solar energy systems at the expense of system complexity and cost. When solar cells are at the proper angle with the sun, which means solar radiation falls vertically on the solar cell, they produce greater energy and efficiency. A sun tracking system is used to do this.[10]

Besides that, when the sun's rays strike a solar photovoltaic module (SPV) at a right angle, it collects the most solar radiation. This can be accomplished using either a continuous tracking system or module mounts with an optimal tilt angle. However, for ideal tilts, a small deviation (75°) is permissible. The best orientation for a solar energy system is determined by the site's latitude, date, and time of year. [11]

With that, as renewable energy sources gain popularity, there is a trend toward the use of small-scale standalone PV systems as an autonomous power supply for charging laptops, mobile devices, routers, and other consumer gadgets. [12]

Figure 2.4 Solar power plant

2.5 Solar battery charging

The energy from the PV panel is undetermined, and the battery's working condition is critical. The battery is a vital component that influences the longevity of the solar PV power producing unit. The suggested controller for charging the battery should be designed in such a way that it increases the battery's lifetime and efficiency [13]

The greatest power from the solar panel is harvested using perturb, depending on irradiance and temperature variations[14]. MPPT algorithms are utilised in the charging of solar PV-powered batteries. Excess power flows into the battery when the battery's state of charge (SoC) is high and the device is idle. Until the battery voltage falls below the gassing voltage, MPPT is employed. When this condition is broken, the power provided by solar PV is decreased to a battery voltage lower than the gassing voltage. This guarantees that the battery will last for an extended period of time[15]

In additional,the MPPT algorithm is used to charge the battery. Thereby, extra energy is harvested by operating at the PV peak power point rather than the PV output voltage at any given time. The charge controller is powered by a battery. [16]

Aside from mobility, solar energy in order to offer a clean, renewable source of electrical energy for charging future EREVs such as the Chevrolet Volt's Li-ion batteries.

Solar Li-ion battery charging is roughly three times as effective as solar hydrogen for generating electricity to move an EREV as solar hydrogen is for FCEV propulsion. [17]

Solar battery charging system can be designed with non-inverter asynchronous buck-boost dc- to- dc converter. The goal of a charging circuits is to keep the converter's output voltage above the battery voltage so that the state of charge may be regulated. Asynchronous dc-to-dc buck-boost converter which does not modify the polarisation of the input voltage at the load and uses just two transistors, two diodes, a capacitor, and an inductor. It is a basic module that considers the fluctuation of the solar panel voltage with the variability of the load current, as is achieved when installing the circuit in an existing solar MPPT for recharging. [14]

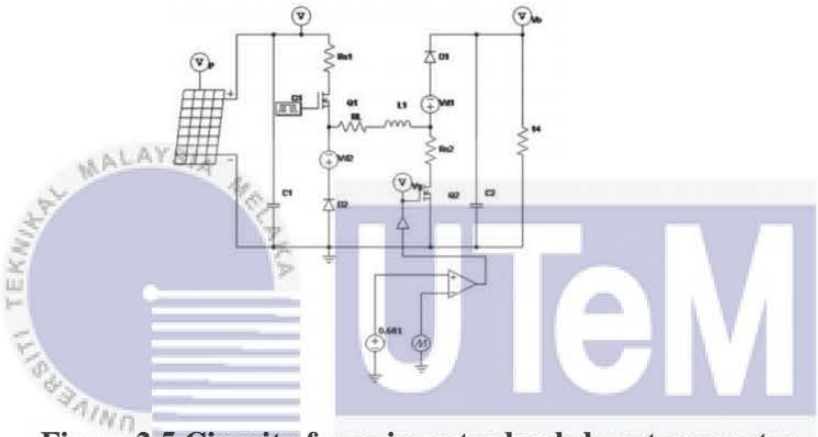


Figure 2.5 Circuit of non-inverter buck-boost converter

As a pet owner, it will be a troublesome to use the pet feeder when the house blackout. Therefore, solar battery charging is suitable power supply because can save the energy when leave house for a long time.

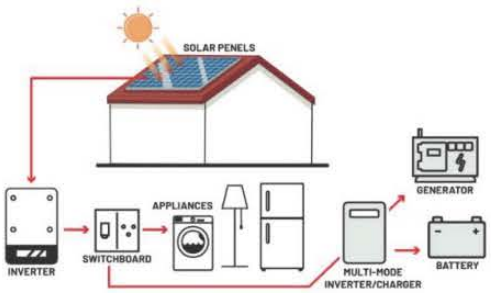


Figure 2.6 Solar battery system

As conclude, this project will use solar as the main power supply. Direct supply will be using during daily and secondary battery during night or when there is no sunlight or no current in house.

2.6 Battery Sizing

The battery is used to store electrical energy for the system. The entire power required determines the criteria for selecting a battery. The computation of battery capacity in Ah and Wh is shown below.

$$Battery\ Capacity\ (Ah) = \frac{Battery\ Capacity\ (Wh)}{Battery\ Voltage}$$

$$Battery\ Capacity(Wh) = Total\ Power\ Demand \times Storage\ Days \times \frac{100}{Battery\ DOD}$$

2.7 Types of solar panel

A photovoltaic (PV) module is a combination of PV cells, often known as solar cells. To get the desired voltage and current, a collection of PV modules (also known as PV panels) is linked together in a huge array known as a PV array. A PV module is a fundamental component of any PV system that converts sunlight into direct current (DC) power. PV modules can be linked in either series or parallel configurations.

2.7.1 Polycrystalline

Polycrystalline solar panels are more environmentally friendly than monocrystalline solar panels.It eliminates the need for each crystal to be individually shaped and placed, and the bulk of the silicon is utilised during the production process. For this reason, there is relatively little waste produced.

Figure 2.7 Polycrystalline module

2.7.2 Monocrystalline

Monocrystalline solar panels are more efficient. These panels can generate more electricity in the same amount of space as panels made of other materials. These panels are highly advised for larger-scale solar applications. These panels can be connected in an array to power rural homes. As standalone panels, these panels are ideal for street lighting.

Figure 2.8 Monocrystalline module

2.7.3 Thin Film

Thin-film panels are frequently thinner than other panel types. This is due to the fact that the cells within the panels are approximately 350 times thinner than the crystalline wafers used.

Figure 2.9 Thin-film

2.7.4 HIT

A HIT solar cell is made up of a single thin crystalline silicon wafer that is bordered by ultra-thin amorphous silicon layers. HIT is an abbreviation for "heterojunction with intrinsic thin layer."

Figure 2.10 HIT Solar Panel

2.8 Types of PV system

A photovoltaic (PV) system consists of one or more solar panels, an inverter, and other electrical and mechanical equipment that create electricity from the sun's radiation.

2.8.1 Hybrid system

Hybrid system is system that commbine solar and battery storage in one. Since the cost of battery storage is decreasing, systems that are already connected to the power grid can begin to benefit from battery storage as well. This entails storing solar energy generated

during the day and using it at night. When the stored energy runs out, the grid serves as a backup, giving users the best of both worlds.

Figure 2.11 Hybrid system

2.8.2 Gried-Tied system

On-grid or grid-tie solar systems are the most popular and frequently used by homes and businesses.This system using either solar inverters or microinverter to connect with public electricity grid and does not used batteries. Energy export from any excess power will receive credits.

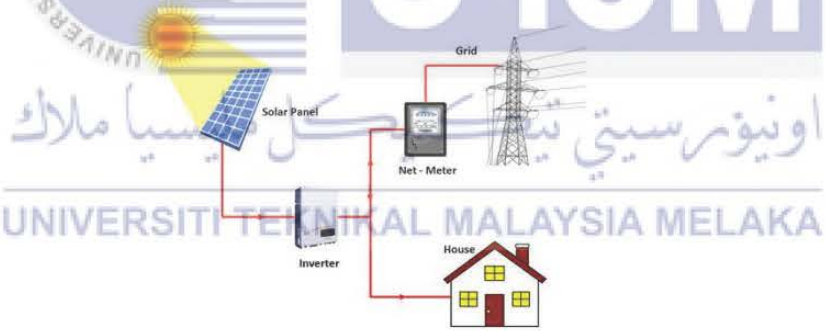


Figure 2.12 Gried-tied of solar system

2.8.3 Off-grid system

This technology required battery storage and was not linked to the power grid. As a result, it is referred to as a stand-alone system. A proper design is required to generate adequate power and fulfil the capacity requirements of the battery. When more costly batteries and an off-grid inverter are employed, the system becomes more expensive.

Figure 2.13 Off-grid of solar system

2.9 Solar charge controller

The solar charge controller acts as a regulator, distributing electricity from the PV array according to load conditions and the battery bank. When the battery bank is nearing capacity, the controller cuts the charging current to maintain a steady voltage in order to fully charge and maintain the battery. By adjusting the voltage, the solar controller protects the battery.

$$Solar\ Charger\ (Amps) = \frac{Panel\ Wattage}{Battery\ Voltage}$$

2.9.1 Types of solar charge controller

2.9.1.1 Pulse-width modulation (PWM)

When employing a switch between the PV array and the battery, PWM types are simple. The switch can swiftly open and close, allowing it to pulse, or "throttle back", the power coming from a solar panel in order to cut down the charge current as the batteries fill up.

Figure 2.14 Pulse-width modulation (PWM)

2.9.1.2 Maximum power point tracking (MPPT)

MPPT controllers are more practical in comparison. They can modify (or track) the PV array's input voltage and current to obtain the best operating voltage that will create the most power at any given time.

Figure 2.15 Maximum power point tracking (MPPT)

2.9.2 Comparison between PWM and MPPT

PWM charge controllers are frequently used for small-scale systems due to their lower cost when compared to MPPT charge controllers. This is also due to the fact that for installed powers of up to a few hundred watts, the yield difference between PWM and MPPT charge controllers is not significant (in the range of 10-15 %)[12]

Table 2.2 Efficiency of the charge controllers versus the average radiation and temperature

Controller	Temperature (°C)	Radiation (W/m^2)	Efficiency (%)
PWM	39.35	812.95	71.42
MPPT	41.9	743.86	86.82

From table 1,Regardless of the fact that the environmental conditions were more favourable in the PWM controller's tests, the MPPT controller's average efficiency was 14.9 percent higher than PWM controller's.

2.10 Comparison components

2.10.1 Microcontroller

A microcontroller is a compact microcomputer designed to control the operations of embedded systems in office equipment, robotic systems, small appliances, motor vehicles, and a variety of other devices.

Table 2.3 Comparison between Arduino and Rasberi Pi

	Arduino Uno	Rasberi Pi
Model Tested	 R3	 Model B
RAM	2KB	256MB
Storage	32kB flash	Depends on size of SD card
Speed	16MHz	1.2GHz
Networking	None	Ethernet,Wi-Fi , Bluetooth
Suite for	Hardware	Software

Arduino microcontrollers are destined for hardware design, whereas Raspberry Pi models are planned for software design. However, it also has a slight advantage in terms of software development due to the ability to be mobile-programmed. [18]

2.10.2 WiFi Module

Wifi module is a full WiFi network that can be directly attached as a serving Wi-Fi adapter and wireless internet connectivity interface to any microcontroller-based design due to its simple connectivity via Serial Communication.

Table 2.4 Comparison between ESP32 and ESP8266

	ESP32	ESP 8266
		
Bluetooth	Yes	-
Typical Frequency	160MHz	80MHz
SRAM	Yes	-
Flash	yes	-
GPIO	34	17
802.11 b/g/n Wi-Fi	HT40	HT20
Touch Sensor	Yes	-
Working Temperature	-40°C to 125°C	-40°C to 125°C

2.11 Summary of Literature Review

Table 2.5 Summary of Literature Review

Author	Year	Title	Objective	Findings
M. S. Tiwari, S. M. Hawal, N. N. Mhatre, and A. R. Bhosale	3March 2018	Automatic Pet Feeder Using Arduino	Feeding pet without of its owner by using Arduino	The Arduino circuit used in this project is used to manage the device's function. The ESP8266 Wi-Fi module is reasonably priced which is used to receive signals from mobile devices and transmit to an Arduino.
W. C. Wu, K. C. Cheng, and P. Y. Lin,	2018	A Remote Pet Feeder Control System via MQTT Protocol	Build a pet monitor and pet feeder in one.	A remote car with IP camera is used to control either to fill food or water using 4 buttons (forward, backward, turn right and turn left). The microcomputer (Rasberry Pi) is to transmits GPIO signal through PIN and uses for receiving MQTT messages. Remote control system is for monitor pet and also feed pet.
M. YixingChen	2020	Implementation of an IoT based Pet Care System.	Uses many sensors and actuators on the food feeder, water dispenser, and litter box to create an IoT-based pet care system.	• To connect the Blynk with project, authentication token will send for each device when add new devices. Network is a big issue to get failure because Arduino Uno and ESP8266 could not have a stable connection. • Food feeder, Tower Pro SG90 Micro Servo as actuator for 90-degree opening. Failure of this project caused by the network disconnection. The crosstalk of pins problems has solved by changing the connection from software serial to hardware serial. • When connected with food feeder, water dispenser is displayed as “Online”. This part is to make sure how much water consumed. • Litter Box, PIR motion sensor, HC-SR501 sensor

				outputs as movement senses is used.
K. Seungcheon	2016	Smart Pet Care System using Internet of Things	Automatic feeding remote controlled and a smart phone APP	Each component has its own platform with various sensors. The devices design is linked with home network based on WiFi WLAN. The smart phone can be used as monitoring system through mobile network.
S. A. Goswami	2019	Internet of Things: Applications, Challenges and Research Issues.	Important of IoT in application.	The Internet of Things is being utilised in a variety of areas of society to decrease human contact and orders and achieve maximum automation. The issues is number of connected devices is increses, data storage increase, privacy and security
Z. H., H. A., and M. M	October 2015	Internet of Things (IoT): Definitions, Challenges and Recent Research Directions	Reviewing the main challenges of the IoT environment by focusing on the recent research directions.	• IoT has been one of the primary strategies used to convey the ubiquitous computing paradigm, however it is not as widely utilised as cloud computing technologies. • The major equation to represent the IoT environment is " IoT environment= Internet + WSN " • IoT= Internet + WSN+ Smart Items surrounded by Intelligent environment.
S. Liu, L. Guo, H. Webb, X. Ya, and X. Chang,	March 2019	Internet of Things Monitoring System of Modern Eco-Agriculture Based on Cloud Computing	To focus on how China can increase IoT in their agricultural industry and rely less on humans.	Since an IoT platform requires significant computer resources, cloud computing technology is used to create an IoT service platform.The IoT gateway is primarily in charge of sensor data collecting and device control.
Mustafa, Falah I. Shakir, Sarmid Mustafa, Faiz F. Naiyf, Athmar thamer	2018	Simple Design and Implementation of Solar tracking System Two Axis with Four Sensors for Baghdad city	To design and implementation simple and cheap price solar tracker system with two axes (azimuth angle as well as altitude angle) using Light Dependent Resistor (LDR)	• When solar cells are at the right point in relation to the sun, they produce more energy and have a higher efficiency. • The dual tracker solar tracking system is more effective than the fixed solar panel for generating electricity from the sun. The energy gained from the solar panel with the dual tracker exceeds 35% of the

			with real dimensions the project composed of solar panel, two-motor satellite di	energy gained by the fixed photovoltaic solar panel.
Kalaiselvan Narasimman n Iniyan Selvarasan	2016	Design construction and analysis of solar ridge concentrator photovoltaic (PV) system to improve battery charging performance	To concentrate light on solar cells, reducing the required cell area for a given output power	• When the sun's rays reach a solar photovoltaic module (SPV) at a straight angle, it captures the most solar radiation. • The optimal orientation for a solar energy system depends on the site latitude, date, and time of the year. A sun tracking mechanism is not cost-effective, but an adjustable (tilt angle) solar photovoltaic module mount will be more cost-effective in the long term.
Ivomir Antonov, Hristiyan Kanchev and Nikolay Hinov	2020	Study of PWM Solar Charge Controller Operation Modes in Autonomous DC System	To understand about solar charge controller.	PWM are frequently used in small-scale devices. A solar charge controller is designed to control the battery charging from the photovoltaic array and ensure power supply to the load. It also splits the current drawn from the PV array between the battery and the load, and preventing the battery from overcharging.
Digi K Dileep, Bharath K R	2018	Conditional Battery Charging in Solar PV Based System	To include control into the maximum power point tracking (MPPT) control so that the power received from the solar panel may be changed to charge the battery using the usual charging technique.	• An MPPT charge controller or a control system is needed to maintain the converter input voltage constant. The requirement of a MPPT controller is to keep the output voltage constant regardless of changes in other parameters such as output voltage, load current, etc. A charge controller is necessary to get the maximum power output from the PV panels. • The storage battery is the most expensive component of a solar system since it needs to be replaced more frequently than PV panels. However, the battery's lifetime may be extended by using a controller made specifically for solar systems.

Carlos Lozano Espinosa	2017	Asynchronous non-inverter buck-boost DC to DC converter for battery charging in a solar MPPT system,	The objective is to build a non-inverter asynchronous buck-boost dc-to-dc converter that will function as a rechargeable battery for an MPPT solar system.	• Analysis of buck and boost converters combined with practical considerations such as voltage drops on diodes, conduction resistance on MOSFETs, and parasitic resistance on inductance provides an understanding of the changing current in the load and its impact on the voltage of the solar panel.
Sandeep Anand, Rajesh Singh Farswan, Bhukya Mangu, B.G. Fernandes	-	Optimal Charging Of Battery Using Solar PV in Standalone DC Systems.	To detect the optimal effectiveness of the solar pv scheme and battery capacity without affects battery life.	When the battery's state of charge (SoC) is high and the system is inactive, extra power flows into the battery. The battery charging technique proposed in this paper utilises both the MPPT algorithm and charge conditioning of the battery. When the battery voltage is less than its gassing voltage, MPPT is used. When this condition is violated, power from solar PV is reduced to maintain battery voltage less than that of the battery.
Tarlochan Kaur, Jaimala Gambhir, Sanjay Kumar	2016	Arduino Based Solar Powered Battery Charging System For Rural SHS,	The development of a low cost, microcontroller based, solar powered battery charging system.	• The MPPT algorithm is used to charge the battery. • The charger can also be used for remote surveillance of battery connected to PV standalone systems. • The ESP8266 may host or offload an application from another application processor that is responsible for all Wi-Fi networking capabilities.
Thomas L. Gibson, Nelson A. Kelly	2010	Solar photovoltaic charging of lithium-ion batteries,	To proof of concept for solar PV charging of batteries for electrically powered vehicles	Solar energy can offer a clean, sustainable source of electricity to charge the Li-ion batteries in future EREVs like the Chevrolet Volt. This research includes a proof of concept for an efficient and safe PV-battery charging system for residential and commercial applications.
N.Qamarina,M. Noor,A. Azwady, J. Azizul,and A. Hafiza	2018	Arduino vs Raspberry Pi vs Micro Bit : Platforms for Fast IoT Systems Prototyping,	To understand the IoT applications development, few examples of IoT systems that are implemented on each platform are demonstrated.	The Arduino was selected for its built-in libraries, while the Raspberry Pi was chosen for its processing and networking features that allow it to connect to the internet wirelessly. Microbit has the benefit of being excellent for the creation of wearable systems. It can support software development via mobile apps. It also offers a large number of sensor interface libraries, which are equivalent to those found on Arduino microcontrollers.

2.12 Summary

Since some pet owners need help for giving their cats food, the mission for this project is to build a pet feeder that can feed at anywhere without limiting distance for the owners that leave their home for a while. This smart pet can be controlled using a smartphone by the development of IoT. In addition, the power coming is from solar. It is built with a solar charge controller to avoid overcharging for charging batteries that can be a problem when the house blacks out or there is no current.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, we will go over the method and description that were used to complete the project successfully. It would also explain the equipment used in this project, as well as how each phase of the experiment should be carried out from beginning to end. Therefore, methodology is defined as a topic that includes an explanation of the project material, methods, and data collection. This were included the completion of the objective project, the software equipment, and the variety of raw materials that can be used for this project. This chapter will demonstrate the progress and clearly explain the overall component from the beginning to the end of the project.

3.2 Project Architecture

3.2.1 Block Diagram

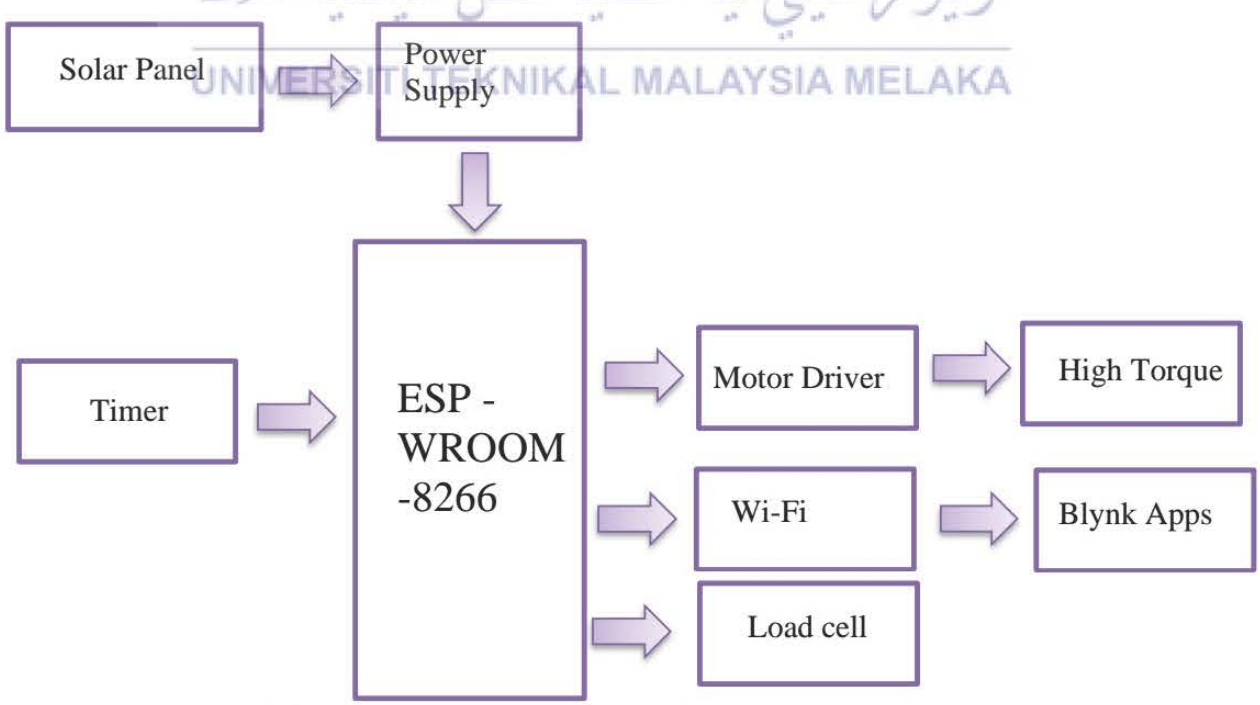


Figure 3.1 Block Diagram of the systems

3.2.1.1 Explanation of Block Diagram

The inputs timer in this Smart Pet Feeder sends the measured data to the ESP8266, which interfaces all of the data before exporting it to the outputs. The ESP8266 is a low-cost chip microcontroller that can interface the system's inputs and outputs.

The outputs of this system are Load cell, Motor driver and wireless module. The function of the load cell is to detect the weight of the pet food. When the weight that has been set is correct, high torque will stop the operation.However, feeding pet schedule can be adjusted based on the actual condition of the pet at that time.

The ESP8266 has Wi-Fi capability and can transfer data to the created smartphone application. All parameter data monitored and timer control are shown in the smartphone apps, allowing users to monitor their pet based on the data acquired. To avoid obesity, the user may make immediate modifications to the pet's nutrition based on the data obtained.

3.2.2 Project Flowchart

This smart pet feeder system feeds the pet at a specified time and sends a notification to the user via smartphone or other device that supports Blynk Apps. The amount of pet food will be measured by another sensor, the weight sensor. The power source is solar, which is built with a solar charge controller. The Sealed Lead Acid battery was utilised in this project because it has a longer lifespan and lower operating costs than traditional battery technologies. The Wi-Fi Module is utilised to process data for the motor to turn and to detect the load cell. Following that, Figure 3.2 depicts the thesis's research design.

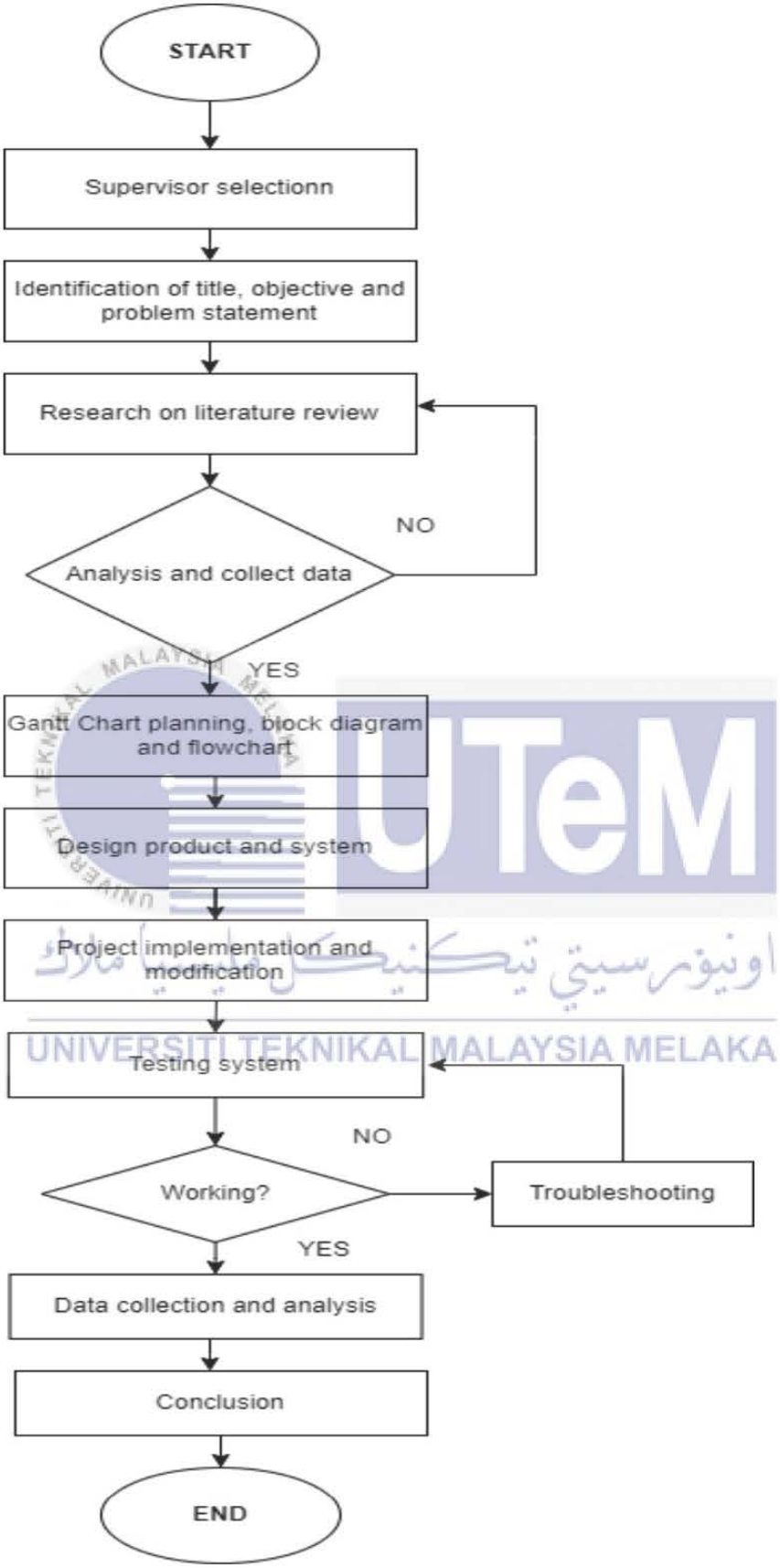


Figure 3.2 Smart pet feeder general process flow

3.2.2.1 Explenation of Flowchart

Firstly,the aim of brainstorming ideas is to produce ideas, determine the objectives of this project's planning, and develop solutions based on the challenges discovered.

Following that, it is critical to do research on relevant current projects in order to obtain a deeper grasp of the topic of study. It contributes to the development of the project by providing a foundation of information, theories, and concepts. Finding articles, books, encyclopaedias, and dictionaries that give overall views of the topic of study might help in research. First, the findings of the research must be analysed.

Furthermore, Gantt Charts are used to help plan the schedule of a project by providing start and end deadlines as well as the method necessary to finish the project. Furthermore, the block diagram and flowchart depict the overall workflow and procedure of the system.

Furthermore, before beginning the project, a mockup and system form should be designed. Creating hardware by selecting appropriate hardware for the system and creating code for the entire system. When the coding is complete, it is passed to the hardware. Only then can the testing procedure begin. If an error occurs during testing, the problem must be resolved before the product is finished. Finally, data from the entire system may be collected and used for some discussion.

3.2.3 Experimental setup

The first element that needs to be done to complete this project successful is the literature review. Literature review is the part of the important that process of the study from previous projector and similar project that must be carried out. This part also included research into history, uses and the important of the Internet of think (IoT), powered energy from solar charging battery, and the application that are used to make the project complete.

However, for this part, it will discuss about the project background researh that used to run successfully. The research that related with this project is about the how IoT work, the server that used when using IoT, power generation by solar energy and the charging battery system. In addition, the analysis of find the best components to be used for this project will be the one that important before complete in hardware sections.The number of solar modules,maximum power and voltage at Pmax must be right to ensure that the power of project is suitable for charging battery in project field.

After that, Arduino IDE software also needed for coding system, powered supply and connect with Blynk apps. Then the coding had uploaded into the hardware section with the correct component.

Finally, The design of this project needs to be analysed to make sure the connection for the hardware components is connected each other.

3.2.4 System Flowchart

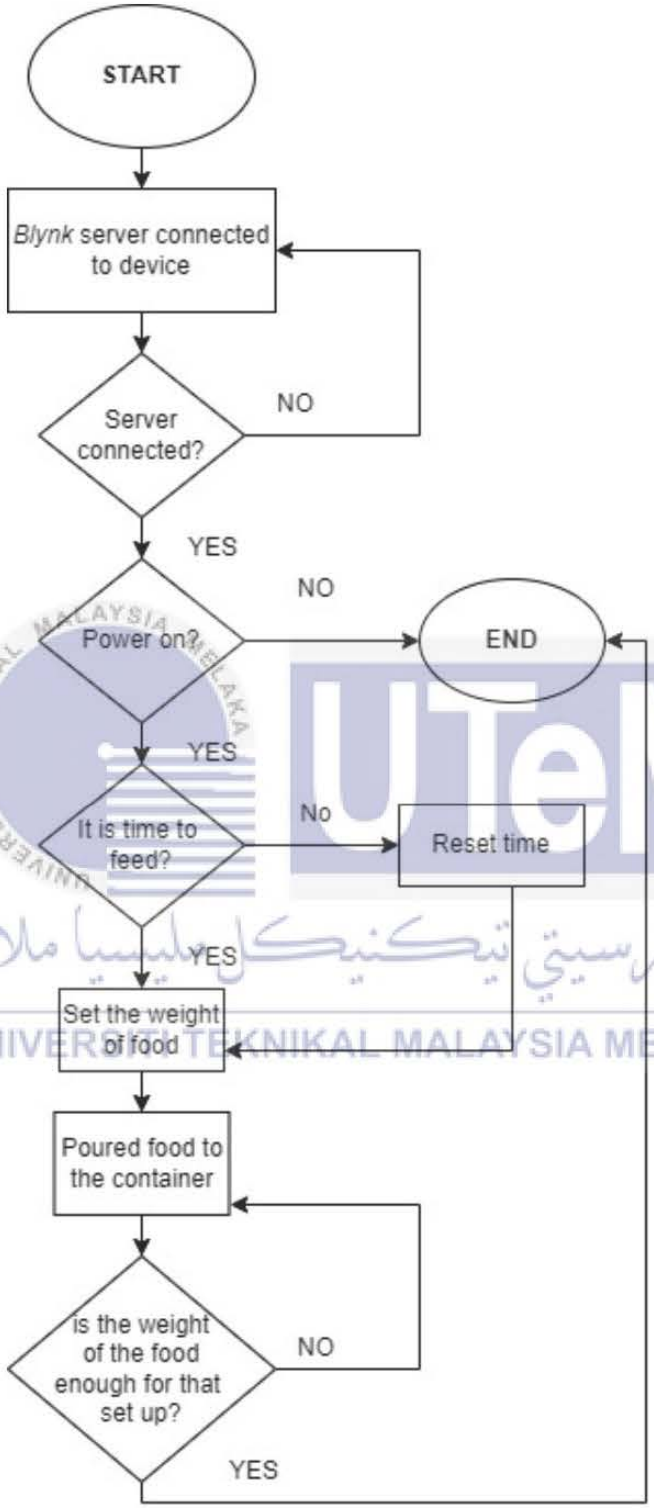


Figure 3.3 Flowchart of the system

3.3 Parameters

In this system, the parameters observed is load cell. The load cell is used for measuring the weight of pet food. All the hardware equipment used for measuring the parameter are listed in this part.

3.3.1 Microcontroller and Driver

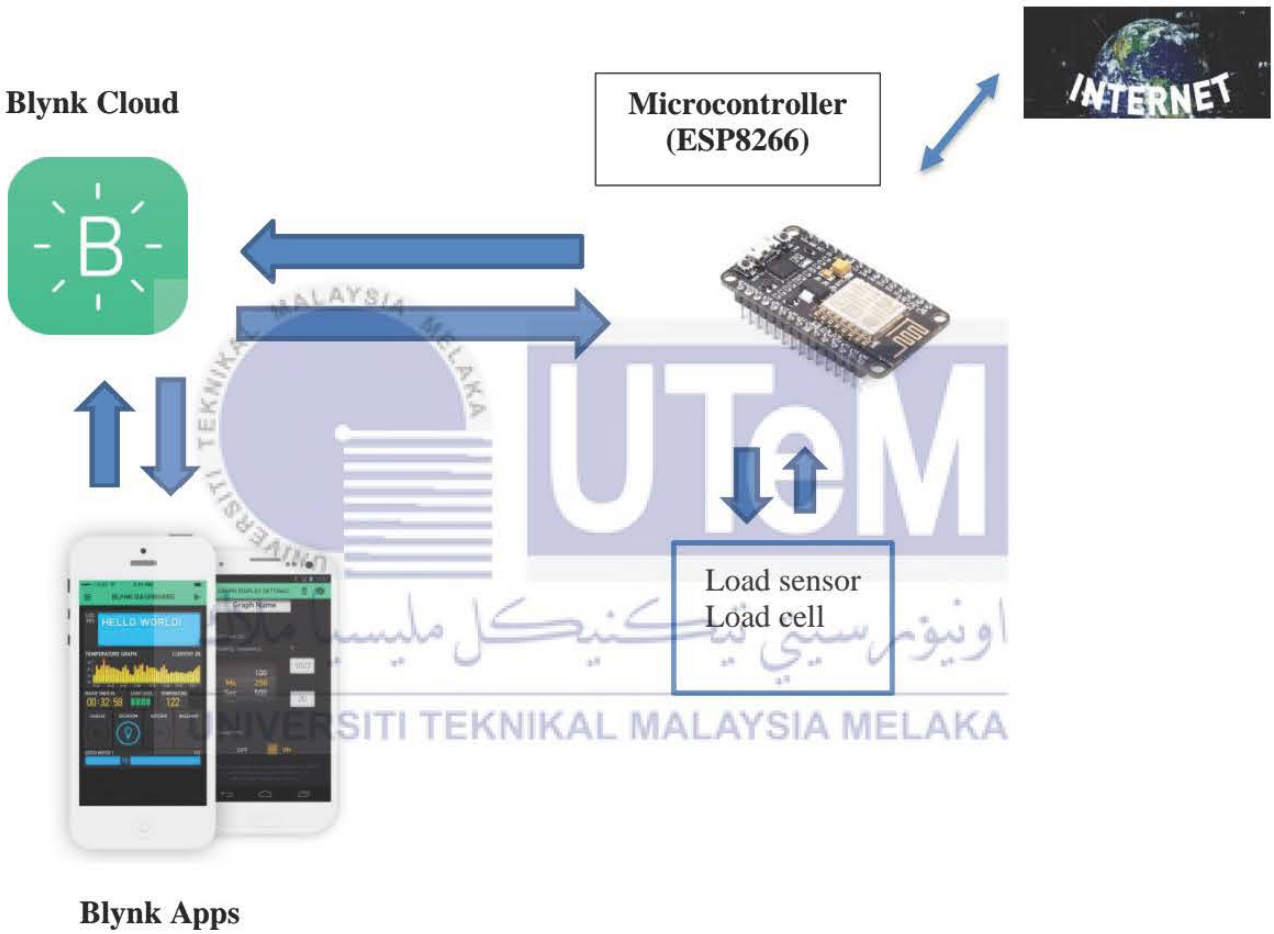


Figure 3.4 Data flow of Blynk Cloud

Figure below show the ESP8266 microcontroller will be prommed by Arduino IDE by adding the name template ID, device name, auth token on the coding along with the password and the internet acces.

3.3.1.1 Wi-Fi Based NodeMCU ESP8266

The ESP8266 is one of the industry's most comprehensive WiFi chips. It can host the application or offloading WiFi networking functionality. The ESP8266 also has an upgraded version of Tensilica's L106 Diamond series 32-bit CPU and on-chip SRAM..

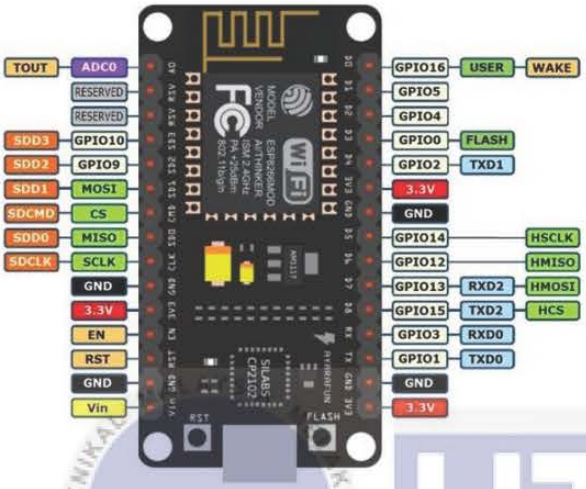


Figure 3.5 Pinout NodeMCU ESP8266

3.3.2 Load Cell Amplifier HX711

This chip is intended for high-precision electrical scaling and design, and it features two analogue input channels as well as a programmable value of 128 inbuilt amplifiers. The input circuit may be adjusted to produce a bridge voltage electrical bridge sensor model (such as pressure or load) that is an excellent high-precision, low-cost sampling front-end module.

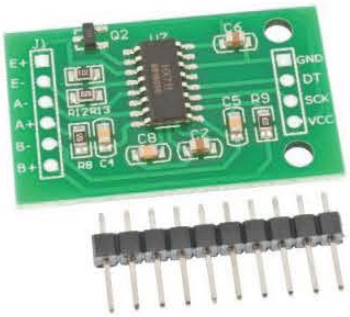


Figure 3.6 HX711

3.3.3 DC 12V Worm Gear Motor

The motor shaft's output shaft is positioned vertically in the gearbox, resulting in low noise and great torque. The worm gear motor with self-locking, in the absence of electric motors, the output shaft does not move, indicating that it is self-locking.

Figure 3.7 DC 12V Motor

Table 3.1 Features of DC 12V Motor

Motor Specification	
Voltage	12VDC
Speed (RPM)	101 - 200
Torque (kgf.cm)	1.01 - 2.00
Encoder	No

3.3.4 Motor Driver L298N

Motor is controlled by this motor driver. The motor driver in this system is responsible for controlling the rubber blade that is used to dispense the pet food. When the output is less than or equal to 12V, the 5V pin can be used as an output pin to power the microcontroller. A 12V battery powers this system.

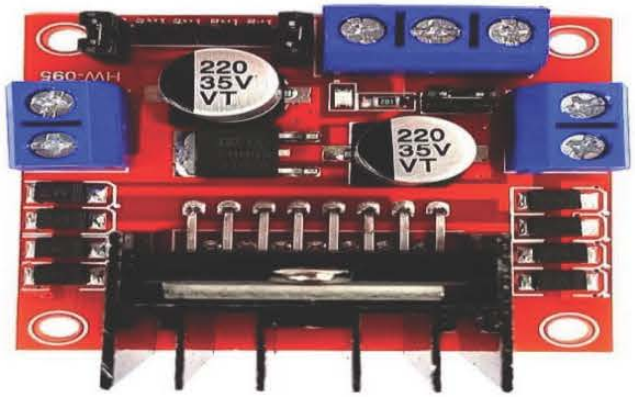


Figure 3.8 Motor Driver

Table 3.2 Features of Motor Driver

Motor Voltage	**7V to 12V**
Peak Current	2A
Controller	1 stepper or 2 DC motor
Driver	Dual H bridge Motor Driver

3.4 Circuit Connection

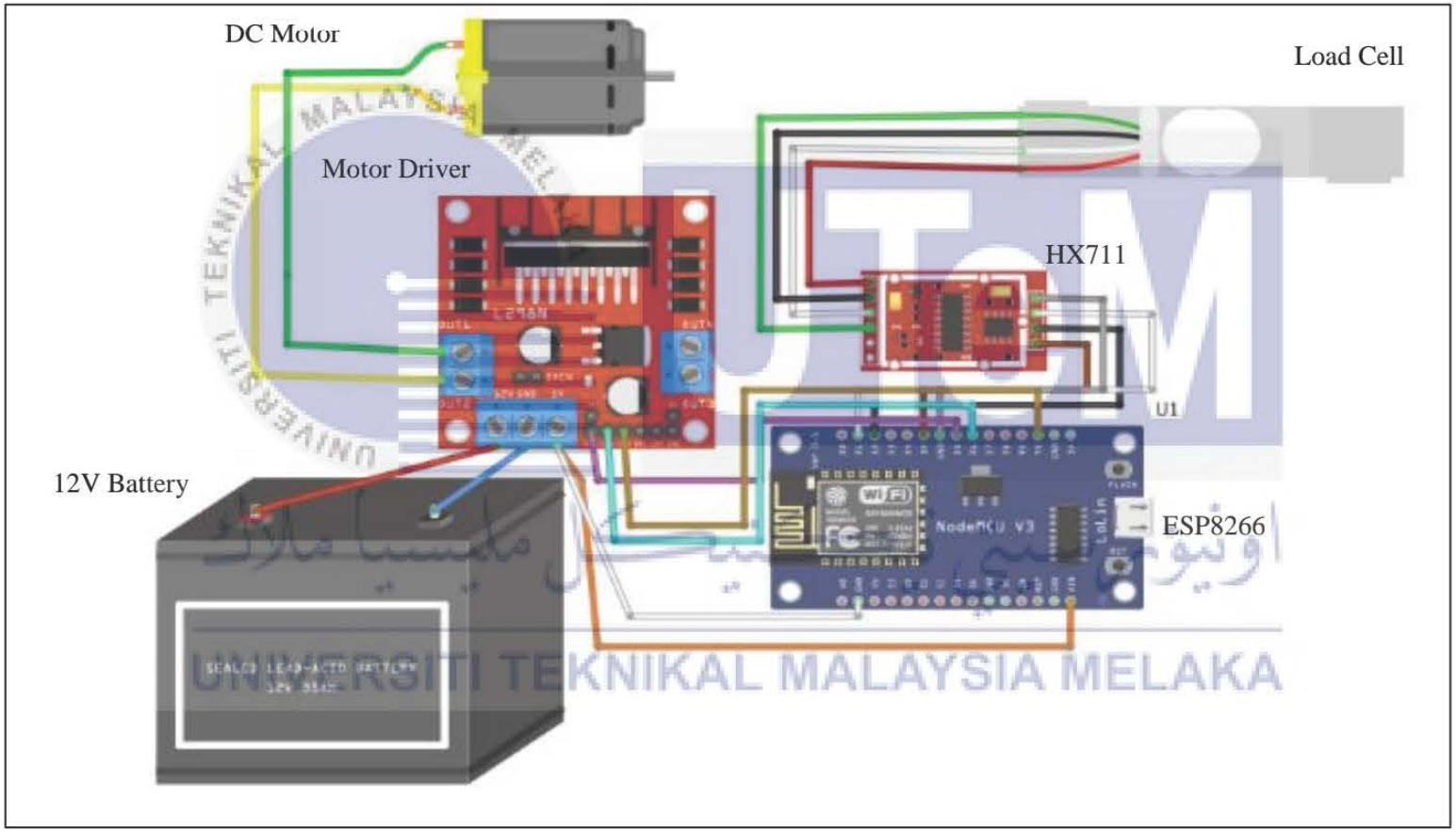


Figure 3.9 Circuit connection of system

3.5 Electrical Hardware Connection with Solar Panel

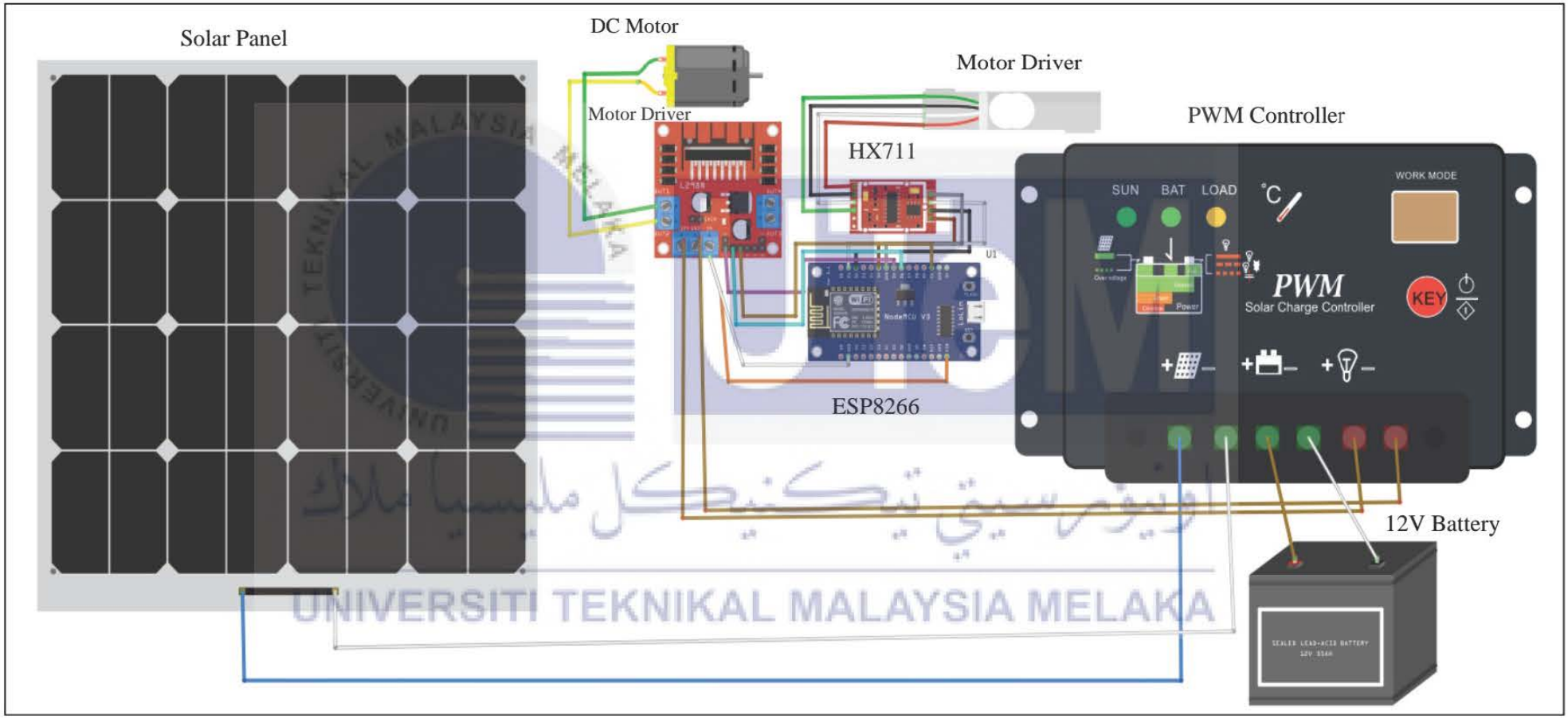
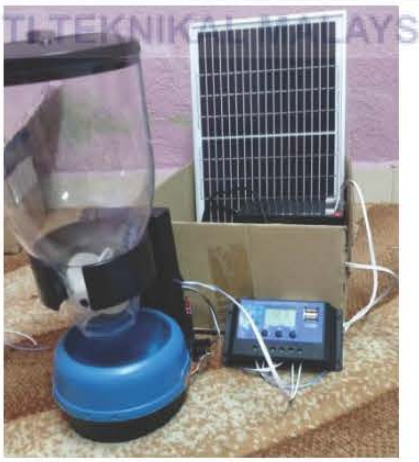


Figure 3.10 Electrical Hardware Connection with Solar Panel

3.6 The Evolution of Pet Feeder Casing

a) Others Design

b) Paper Box



c) Final Product Food Dispenser

Figure 3.11 Product Case of Food Dispenser

3.7 Cost of production

The operating costs have been analysed and are listed in the table below. Rm169.15 is the total price. Compared to the current market pricing for wholesale automatic pet feeders, the price is cheaper.

Table 3.3 Price of Project Hardware

No	Item	Quantity	Price
1	NodeMCU ESP8266	1	RM 15.50
2	12V High Torque Worm	1	RM35.90
3	Female to Male Jumper Wire (40pcs)	1	RM3.90
4	Motor Driver	1	RM6.90
5	Mini Breadboard	1	RM2.50
6	Load Cell Amplifier HX711	1	RM4.90
7	Load Cell Straight Bar	1	RM7.90
8	Polycrystalline Solar Panel	1	RM51.75
9	12V Rechargeable Seal Lead Acid Battery	1	RM27.90
10	PWM Solar Panel Controller	1	RM12.00
		Total	RM169.15

3.8 PSM2 Gantt Chart

Table 3.4 PSM2 Gantt Chart

No.	Activity / Week	WEEK														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Start create programming for feeding time and buy compenents for hardware															
2	Start create circuit for powered supply															
3	Compile all the initial circuits from PSM1															
4	Test and run the simulation															
5	Arrange and combine wiring															
6	Design a project body for pet food storage															
7	Combine project with wiring circuit															
8	Run the system with the successful hardware															
9	Collect the data result															
10	Drafting result and discussion															
11	Preparation for final PSM2 report															
12	Preparation for powerpoint slide and final report															
13	Presentation and submission report															

3.9 Summary

This chapter discusses the methodology proposed to develop a new, useful, and comprehensive approach in smart pet feeders. The primary aim of this proposed methodology is to make a simple, less precise, and useful prediction in a way that does not result in a large loss of validity of the results. The methods were also designed to take advantage of commonly accessible but limited network and solar data. The ultimate goal of the method is not to achieve the highest level of accuracy, but to make it feasible to use on new projects

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter describes the results and discussion of developing pet food dispenser systems using IoT from top to bottom. The project's results were focus on performance and accuracy of project. The complete testing process is intended to produce the outcome described in the project's aim and scope.

4.2 Results and Analysis

4.2.1 Pet Food Dispenser

In five days, the experiment was tested for a real-world application for the work. Since the Blynk application was used for IoT implementation, relying heavily on the precise NodeMCU ESP8266 module, which includes Wi-Fi connectivity. The data has been uploaded to a server and may be accessed using the Blynk app.Using Blynk apps on mobile, the precision of time serving and kibble weight can be easily checked and displayed in the form of a display gauge.At first, the owner may decide when to feed the pet and how much kibble to treat it with. Once the key board inputs are completed, the timing value and fixed number of kibbles are released to the pet. If there are a few kibbles left, ongoing food distribution should be limited.

Figure 4.1 Hardware circuit

Figure 4.2 Result project hardware

Table 4.1 Test Result of Weight Measurement Food Dispenser

No	Date	Time	Actual Weight (g)	Display Weight (g)	Accuracy Weight
1	7/12/2021	8.00 am	45	45	100%
2	7/12/2021	1.20pm	39	failed	0
3	8/12/2021	9.30 am	54	40	74.07%
4	8/12/2021	1.18pm	15	17	88.24%
5	9/12/2021	8.30am	65	68	95.59%
6	9/12/2021	12.47pm	36	37	97.29%
7	10/12/2021	10.00am	39	37	94.87
8	10/12/2021	2.30pm	52	20	38.46%
9	11/12/2021	8.00pm	89	failed	0
10	11/12/2021	11.50pm	59	56	94.91%

Figure 4.3 Data actual weight of kibbles releasing

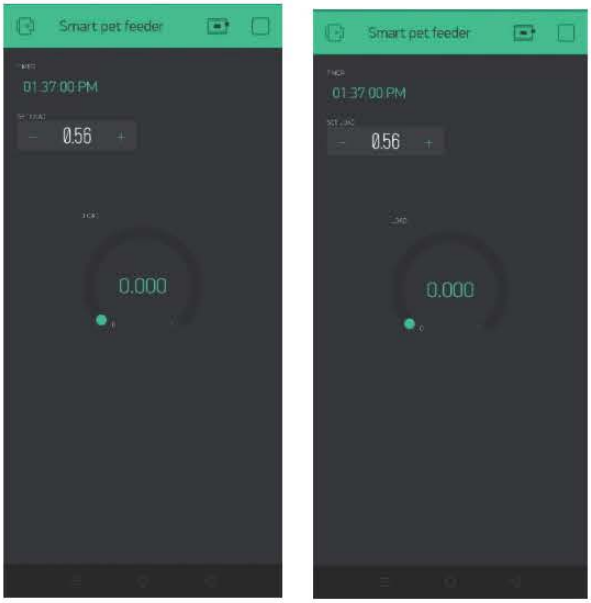
Figure 4.4 Data display weight of kibbles releasing

The "Actual weight" module indicates the number of grams that have been set based on the last time it was activated. The "Time" button serves as a quick food dispenser. When pushed, the food dispenser will start rotating and removing food until an appropriate quantity of weight is established.

As we can see from the data, the result got twice execution failed caused by the network disconnection. On 10 disember 2021, the result shown the lowest accuracy which is 38.46%. This is due to the problem with the internet network. The motor that rotates to release food stops with an amount of food that is not equal to that specified.The total weight of kibbles for a cat is determined by the cat's weight and activity level, as well as the type of food.

The total percentage of accuracy is not very accurate due to problems with the external shape of the project on the part of the scales that require a balanced and robust design.

Figure 4.5 Shows the number of pet food serving



(a) (b)

Figure 4.6 Smart pet feeder data including actual weight and display weight in display gauge (kilogram)

4.2.2 Solar Charging experiment

4.2.2.1 Calculation on Load analysis

Load analysis is calculation for the load used for the Smart Pet Feeder system.. In this calculation, the average usage of the solar charging system is 24 hour per day as the system is 100% powered by solar and the load has DC system voltage of 12V for DC motor and 10A for solar charge controller. The power requirement for the load is calculated by using equation:

$$Power = Voltage\ (V)\ x\ Current\ (I)$$

Table 4.2 Load Parameter

Items	Voltage (V)	Current (I)	Power (P)	Total Watt	Hours/day	Watt-Hour/Day
Load	12	10	120	120	24	2880
Total						2880

Total amp-hours per day used by loads per day:

$$\frac{2880Watt - Hour/Day}{12V} = 240A - Hour/Day$$

4.3 Summary

The results and analyzes taken are all shown in this confirmed chapter. The actual time and weight present can be determined based on the results of the analysis which is at 36g minimum according to the current situation. Furthermore, the hardware and software i.e. Blynk Apps can be linked together via ESP8266 and both work well.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Every pet owner's schedule is different; some may utilise their residence in the house to feed the pets, while others may not have residence or time to do so. This suggested Smart Pet Feeder solves the problem and makes it easier for pet owners to care for their pets. Utilizing Smart Pet Feeder will be different from the regular way if the owners feed their pets personally, with more accurate feeding on time with the amount of food necessary as we set, could be managed from a distance which the normal approach could not archive.

To sum up, the current project develops an IoT-based Smart Pet Feeder system with a load cell bar parameter. Automatic food dispensing and food intake control are among the features of the Smart Pet Feeder system. A smartphone is used to control and monitor the devices from remote locations; it also displays statistical data.

5.2 Future Works

The accuracy of these development findings might be improved in the future by doing the following:

i) Alarm mechanism to notify pet owners if there any unexpected happen such as food stuck.
ii) Speaker and spy camera for monitoring pet.
iii) Development based on project sizing for large size such as pet shop, hotel, or hospital.
iv) Increase the coneectivity of system connection.

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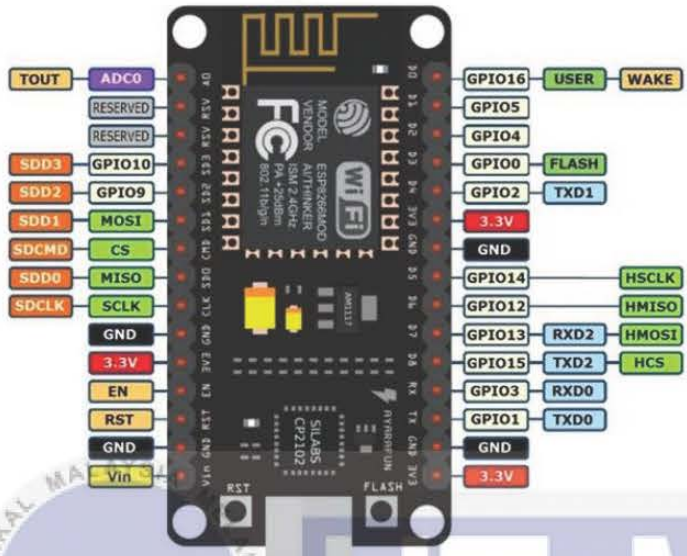
APPENDICES

Appendix A Pin NodeMCU ESP8266



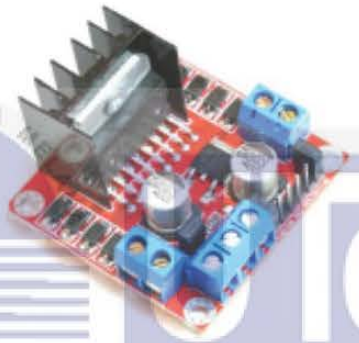
Appendix B Datasheet of L298N

HT **Handson Technology**

User Guide

L298N Dual H-Bridge Motor Driver

This dual bidirectional motor driver, is based on the very popular L298 Dual H-Bridge Motor Driver Integrated Circuit. The circuit will allow you to easily and independently control two motors of up to 2A each in both directions.It is ideal for robotic applications and well suited for connection to a microcontroller requiring just a couple of control lines per motor. It can also be interfaced with simple manual switches, TTL logic gates, relays, etc. This board equipped with power LED indicators, on-board +5V regulator and protection diodes.

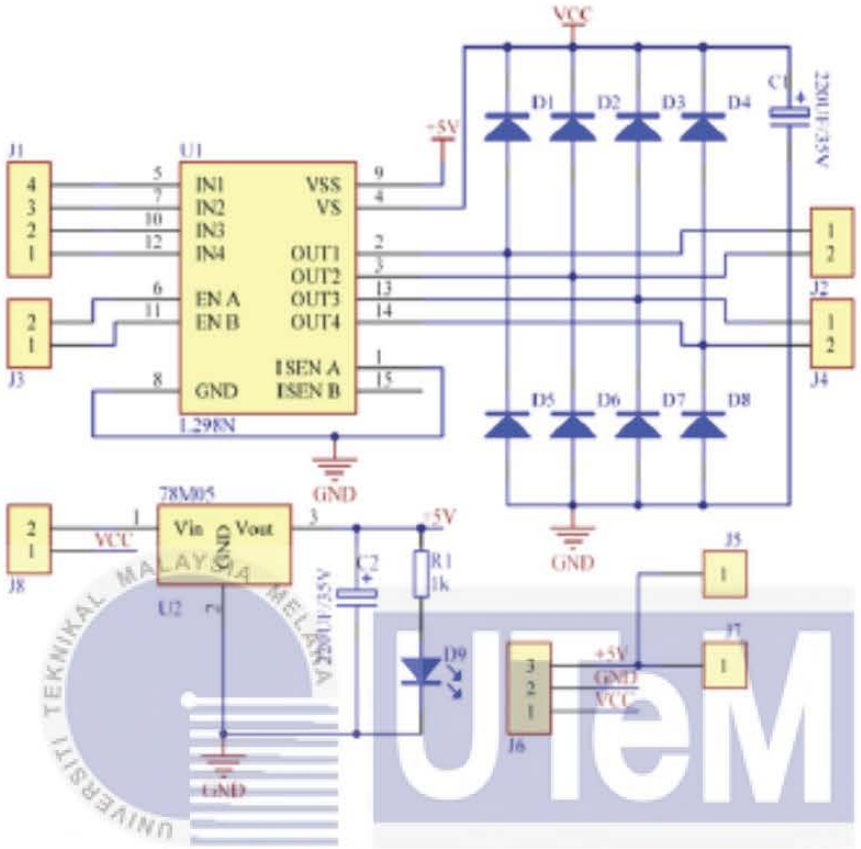


SKU: MDU-1049

Brief Data:

- Input Voltage: 3.2V~40Vdc.
- Driver: L298N Dual H Bridge DC Motor Driver
- Power Supply: DC 5 V - 35 V
- Peak current: 2 Amp
- Operating current range: 0 ~ 36mA
- Control signal input voltage range :
- Low: -0.3V ≤ Vin ≤ 1.5V.
- High: 2.3V ≤ Vin ≤ Vss.
- Enable signal input voltage range :
  - Low: -0.3 ≤ Vin ≤ 1.5V (control signal is invalid).
  - High: 2.3V ≤ Vin ≤ Vss (control signal active).
- Maximum power consumption: 20W (when the temperature T = 75 ℃).
- Storage temperature: -25 ℃ ~ +130 ℃.
- On-board +5V regulated Output supply (supply to controller board i.e. Arduino).
- Size: 3.4cm x 4.3cm x 2.7cm

Schematic Diagram:



Board Dimension & Pins Function: