DESIGN AND FABRICATION OF AN AUTOMATIC FISH FEEDING SYSTEM FOR HOME AQUARIUM

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DESIGN AND FABRICATION OF AN AUTOMATIC FISH FEEDING SYSTEM FOR HOME AQUARIUM

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Report submitted in partial fulfilment of the requirements
for the award of the degree of
Bachelor of Engineering (Hons.) Mechatronics Engineering

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For Abah and Mak –

and everyone else in the back of the truck.

ACKNOWLEDGEMENT

In the name of the Creator, the Most Beneficent and the Most Merciful for only in His oneness and glory we seek guidance and protection. Ameen. Firstly, I would like to express my gratitude to God for giving me the strength and health to accomplish this final year project and also to complete this report. Next, I would like to thank my final year project supervisor, Dr. Noraini binti Mohd Razali; for I successfully made through this valuable journey with her helps, advices and warm words of motivation. In addition, I also would like to thank to the Faculty of Manufacturing Engineering and especially to the faculty's dean, Prof. Dr. Wan Azhar bin Wan Yusoff for the guidance throughout my final year project through all the briefings, seminar events, and especially permission to complete my project using the faculty's facilities which contributed greatly in the progression of my final year project. Finally, an honourable mention goes to my family, friends, seniors and lecturers for their blessing and prayers for me in completing this final year project. Without supports and helps, direct or indirectly; of the particulars that were mentioned above, I would face many difficulties while doing this project. I really am indebted with everyone. Thank you.

ABSTARCT

This project is devoted to design and fabricate an automatic fish feeding system for the application of home aquarium. An automatic fish feeder is a device that will dispenses fish food at a predetermined time and with selected amount. This automatic fish feeder is a solution for aquarist to ensure their pet fishes are fed in healthy way and on schedule. The project implements the integration of mechanical and electrical/electronic system to control fish feeding operation. The controller used for this device Arduino Uno microcontroller board. The controller controls the feeding mechanism and feedback system. This device uses a vertical screw conveyor mechanism to dispense the fish food into the water. The mechanism is actuated by unipolar stepper motor where the amount of dispensed food is controlled by the motor steps input when it is coupled to the screw conveyor. On the other hand, the feedback system is consist of user interface feature using keypad button for aquarist to choose the amount of dispensed food and infrared sensor as a warning system to warn aquarist when fish food level is low. A brief literature review is made on all of the elements involved in this system such as Arduino Uno microcontroller, stepper motor, screw conveyor, sensor and user interface feature. At the end of this project the automatic fish feeding system is successfully designed and fabricated following the specified objectives.

ABSTRAK

Projek ini bertujuan untuk merekabentuk dan menghasilkan sebuah sistem pemberi makanan ikan secara automatik bagi aplikasi kepada akuarium di rumah. Pemberi makanan ikan automatik ini adalah sebuah alat yang akan melepaskan makanan ikan pada masa yang telah ditetapkan dengan kuantiti yang telah dipilih. Pemberi makanan automatik ini merupakan satu jalan penyelesaian kepada akuaris untuk memastikan ikan peliharaan mereka diberi makan secara sihat dan mengikut jadual. Projek ini menggunakan integrasi daripada sistem mekanikal dan elektrik/elektronik untuk mengawal operasi memberi makanan kepada ikan. Pengawal yang digunakan untul alat ini adalah papan mikropengawal Arduino Uno. Pengawal ini bertujuan untuk mengawal mekanisme pemberi makanan dan sistem suapbalik. Alat ini menggunakan mekanisme penghantar skru menegak untuk melepaskan makanan ikan ke dalam air. Mekanisme ini digerakkan oleh motor pelangkah ekakutub dimana kuantiti makanan ikan yang dilepaskan dikawal oleh masukan langkah motor apabila ia digandingkan dengan penghantar skru. Manakala sistem suapbalik pula terdiri daripda ciri antara muka yang menggunakan butang kekunci untuk akuaris memilih kuantiti makanan ikan yang akan dilepaskan dan penderia sinar inframerah sebagai sistem amaran untuk memberi amaran kepada akuaris apabila tahap makanan ikan sudah kurang. Kajian latar belakang juga telah dijalankan kepada semua elemen yang terlibat di dalam sistem ini seperti mikrokawalan Arduino Uno, motor pelangkah, penghantar skru, penderia dan ciri antara muka. Di akhir projek ini, sistem pemberi makanan ikan secara automatik berjaya direkabentuk dan dihasilkan mengikut objektif-objektif yang telah ditetapkan.

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CHAPTER 1:

INTRODUCTION

1.1 Project Background

Fish-keeping in home aquarium is a popular hobby where its history dated back since the ancient times when marine products were kept in an aquarium-like container for later consumption during the Roman Empire and the Chinese also initially kept carp fish for food; then later developed them into modern ornamental forms of Koi and goldfish as we see today. Over the centuries, the modern fish-keeping hobby soon began in the late 1920's as development of the toy industry. The United State- based company, Mattel, was one of the key founders of the "toy" fish hobby. The first tropical fish were sold in toy stores throughout Europe. Fish-keeper is generally called as an aquarist. Since then, many development and inventions were made for aquarist to suit the growing demands in fish-keeping hobby and one of the inventions made was automatic fish feeder.

An automatic fish feeder is an electronic device that has been designed to dispense the right amount of fish food or known as fish pellets at a predetermined time. Normally, it is used to help aquarist to feed their pet fish when he or she is on a vacation or too busy to maintain a regular feeding schedule. The device typically has a set of function for aquarist to set the feeding time and occurrence, feeding amount and also other optional limits. The automatic fish feeder is able to repeat its task daily and accurate, therefore a solution for aquarist to ensure that their pet fishes are fed in healthy way and on schedule.

1.2 Project Problem Statement

There are several problems that have been identified through research study on commercial fish feeder available in market and also through research journal; for this project in order to re-create or if possible, to improve the efficiency of the previous design of automatic fish feeder.

a) Inefficiency of manual feeding.

Manual feeding by using man power requires the aquarist's precise intuition to avoid the waste of pellet that was supplied to the fish. Meanwhile, it is impractical if the aquarist needs to be out of town for many days and leaving the fish unfed. However, nowadays the invention of fish feeder concentrate on inventing a timely, accuracy feeding device which can replace or reduce the use of labour in aquaculture industries which also being adapted into the management in aquarium use. This is one of the main functions that are very important in designing efficient feeding system for this project. The system must be able to be controlled or adjusted by user according to their demand and needs. As referring to "automatic" word itself, the feeder should be able to be operated without supervision of the aquarist at least at certain interval of time.

b) Inaccurate amount of fish pellets.

One of the main concerns in fish feeding is the amount of fish pellets during feeding. This is because if the amount of fish pellets through manual feeding is not accurate, it could severely the affect fish's health. If the fish is fed on small amounts, then there could be significant loss of fish due to starvation. On the other hand, if the amount exceeded from what is required, this can cause overeating, contaminate the water and clog up important filters in the aquarium. Hence, the system should be able to be controlled or adjusted by aquarist according to their desired amount of fish pellets to be fed.

c) Lack of user control interface and warning system in fish feeder design.

The user interface system is the medium where interactions between human and machine occur. The lack of user interface in automatic fish feeder is impractical for aiding aquarist in making operational decisions such as setting the feeding time or feeding amount. For this project, the user interface system should be user-friendly to ensure effective operation and control of the fish feeder on the user’s end, and also a feedback from the fish feeder itself to warn user if the feeder is stuck or the fish pellets container is empty.

1.3 Project Objectives

The following objectives were identified and introduced to address the problems that have been stated from the previous section.

a) To design and fabricate automatic fish feeding system or machine
b) To ensure an accurate amount of fish pellets to be dispensed at predetermined time.
c) To embed a user control interface and warning system to the fish feeding system.

1.4 Project Scope

For this research project, here are the scopes that have been identified to ensure that this project would not be going off the track and only meet its objectives:

a) Study on the implementation of the suitable controller and transducer for the fish feeding system to be function as desired. Analysis on the feeder mechanism to ensure accurate amount of fish pellets to be distributed during each feeding time.
b) The automatic fish-feeder is only appropriate for the application to home aquariums where the type of fish is range from small to medium and the type of fish food is granular or small pellets.
c) The fish feeding system is a prototype only. Hence, there is cost limitation in developing a prototype and its aesthetical value would not be emphasized.

1.5 Project Organization

1.5.1 Project process flow

The project process flow is shown as in the Figure 1.1 below.

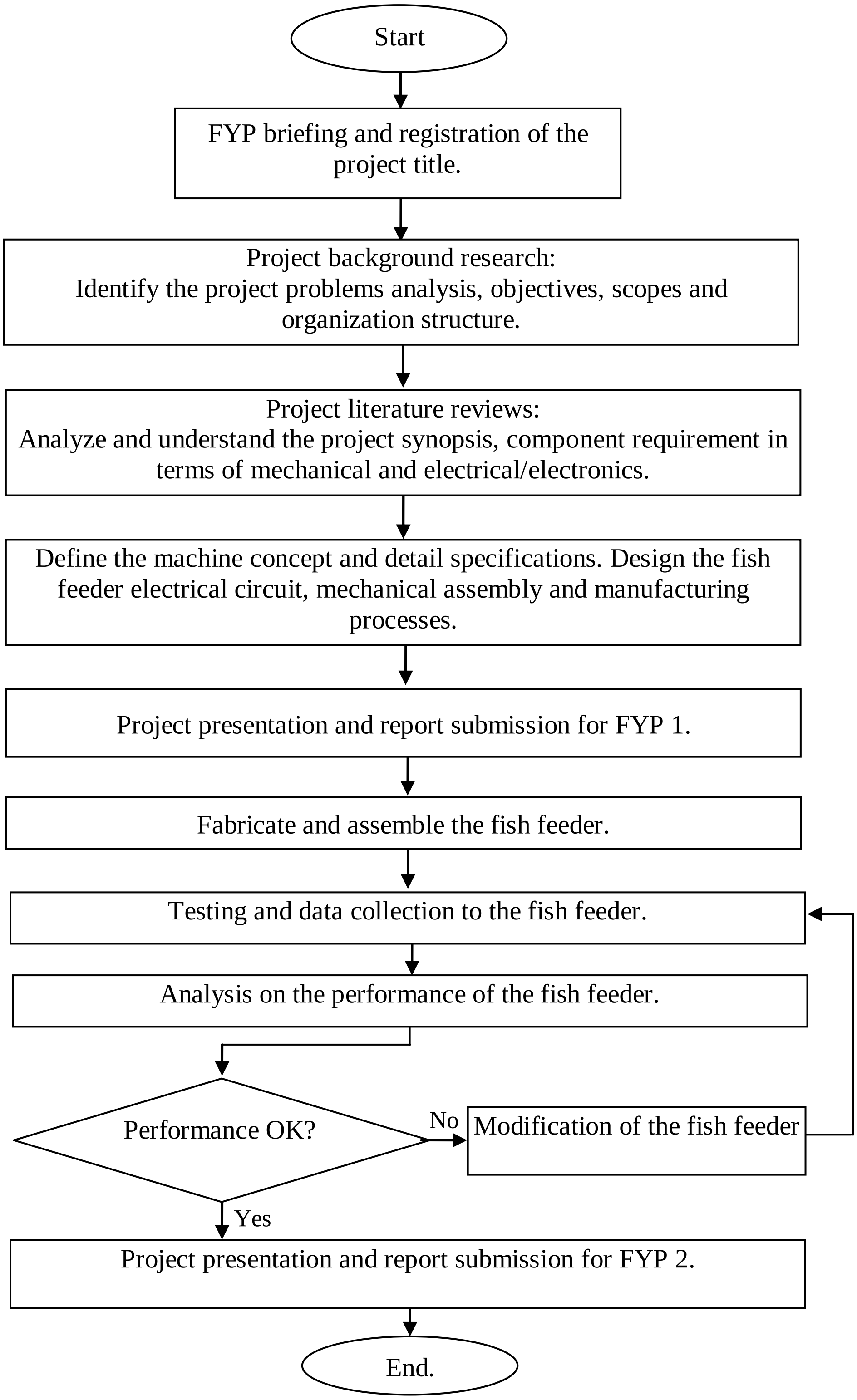


Figure 1.1: *Project process flow*

1.5.2 Chapters Organization

Chapter 1 discusses the introduction of this project which covers project background, problem statement, objectives, scopes and organization.

Chapter 2 discusses literature study on automatic fish feeder. Besides that, it consist the study of the microcontroller and sensor for the warning system.

Chapter 3 discusses the methodology of the project. The hardware development consists of the circuit design and feeder container design. The components used in the project were discussed in details. For the software development, the algorithm and programming the microcontroller were discussed.

Chapter 4 discusses the result and discussion of this project. This chapter also discusses the efficiency of the feeder container mechanism and the application of the warning system.

Chapter 5 discusses the conclusion and recommendation of the project as well as suggestions on the improvements future work.

CHAPTER 2:

LITERATURE REVIEWS

2.1 Introduction

This chapter's intentions are to provide the reviews on previous researches and products for the automatic fish feeder system from various background and references. Besides that, this chapter also presents the discussion on few components that will be implemented in this project with some related studies such as the fish feeder mechanism, system controller, motor, user interface, and feedback system. The content of this chapter mainly focus on the application of fish feeding system for home aquarium.

2.2 Automatic Fish Feeder

For this project to successfully achieve its objectives it is very important to firstly be able to understand the fish feeding system before the design and fabrication process takes place. Through the research on previous journals and products on automatic fish feeder, most of the autonomous systems are invented to serve the purpose of helping aquarist to reduce energy and time in their fish-keeping hobby. Introducing this independent technology also ensure the health and well-being of the pet fishes. Thus, this brings benefits for both sides. Looking through the general components for most automatic fish-feeding system, it's identified that the basic components are the controller, the feeder mechanism and the motor. While, certain automatic fish feeders also introduce sensor as a form of feedback system and also user interface as such display unit, keypad or graphical user interfacing software; as the additional functions and features to the basic automatic fish-feeding system. Sub-sections below are the summary of some previous works that have been analyze.

2.2.1 Prototype of An Automatic Fish Feeder

This project aims to reduce waste fish pellets during feeding time at fish pond due to lack of efficiency of fish pellets distribution to wide surface area.[1] This automatic fish feeder is made up of a pellet tank, pellet distributor and stand. The control system used for this feeder is a timer which at a predetermined time triggers the motor to run the distributor. The pellet distributor has a unique mechanism which is a propeller design that able to distribute the fish pellets through the outlet gap for a wider surface area by differentiating the angle of force applied by a few set of gears of the propeller. Hence, the functional efficiency of the automatic fish feeder would increase as wide surface area is covered during feeding time and waste of fish pellets also is reduced.

2.2.2 An Intelligent Fish Feeder System

This project aims to design an intelligent system of automatic fish feeder that could alerts aquarist via Global System for Mobile Communication (GSM) modem.[2] The mechanical and electrical involved in the system consist of PIC microcontroller, GSM modem, keypad, sensor and geared DC motor. The feeder will dispense fish pellets at predetermined time however if the sensor is triggered, signalling when the fish food level is low, the controller would give instructions to the GSM modem to send a text message to alert the aquarist. This feeder is applied for home aquarium application.

2.2.3 Aerial Fish Feeding System

This project's objective is to design an automatic fish feeding system that includes food dispensing and distribution together where a motor drive unit would control a mobile top hung feeder via a natural fibre cable.[3] The motor is controlled by a *programmable logic control* or PLC which based on the overall feeding operation sequence that includes filling or refilling the feeder then transporting it to the ponds where the fish pellets is dispensed. The mechanism would gives access wide pond feeding area regardless to any fish farm layout while maintaining accurate amount of fish pellets distribution.

2.2.4 Automatic Fish Feeder System Using PIC Microcontroller

This project devoted to design an automatic fish feeder that utilize an efficient fish pellets dispense system depending on the rotational speed of a DC motor.[4] The feeder developed combines pellet storage, feeder stand, former, DC motor and PIC microcontroller. The mechanism of fish pellets distribution is solely controlled by the rotational speed of the DC motor itself which attached to a sphere former. The feeder also includes a keypad as the user interface unit to let the aquarist to determine options for suitable speed range of the motor depends on the size of the aquarium or pond. The higher the speed, the larger the distribution area will be.

2.2.5 Hydor Ekomixo Automatic Feeder

This type of automatic fish feeder by Hydor[5] is a battery operated feeder which can dispense fish pellets with ten different dose settings for up to three times of feeding time per day via an electronic timer control. The feeder also have food capacity of 90ml which according to the supplier, approximately sufficient for 30 days. The feeder consists of a cover, feeding spout and control, food compartment, motor and battery cover. The feeder also includes a special mixing vibration mechanism to prevent fish food clumping from forming.

Based on the findings on previous works and researches, we saw that most of the automatic fish-feeding systems make use of microcontroller as the controller for this type of embedded systems[6][7] due to its adaptability in handling signal processing and compact size. Microcontroller is also used in many available automatic fish-feeder products on the market because of its size and low cost. On the other hand, choosing *programmable logic controller* or PLC is another option for controller because PLC is actually relatively easier to program in designing the automatic fish-feeding system controller than its rival, the microcontroller. However, due to its rather large size, PLCs are usually implemented in large scale automatic fish-feeding system[8][9] the like used in fish ponds or lakes as in aquaculture field.

Meanwhile, the feeding mechanism is also a crucial aspect for the automatic fish-feeding system design. The purpose of a feeding mechanism is ensure that amount of fish food to be dispensed is precise and the mechanism to effectively distribute fish food to the aquarium, ponds or lake. The design of feeding mechanism consist of the feeder container and actuator that peripherals with the controller. The feeding mechanism is unique by itself as to achieve the objective of the automatic fish-feeding system. The actuator that receives the specific instructions from the controller and operates the feeding mechanism is actually the motor. They are many type of motors can be used in designing the automatic fish-feeding system and of course, different types of motor serve different mode of operation to the feeding mechanism.

A certain types of automatic fish feeder system design have a feedback system implemented into them. Infra-red sensor often is favourite choice where it is used to detect if the fish food is empty and triggers a warning alarm to the aquarist. Furthermore, a for battery-driven automatic fish feeder, there is also a feedback system which alerts the aquarist if the battery life is getting low and need to change. Besides that, user interface unit in form of push buttons, keypad, or graphical user interface is also implemented to the automatic fish feeder to give the user to make decision on feeding parameters such as feeding time and frequency. This includes a display unit too.

As for the project on this thesis, the selection of the feeder mechanism, motor, controller, user control interface and feedback system will be further discuss in depth on the next sections in this chapter respectively.

2.3 Feeder Mechanism

Our aquatic pets also needed proper diet so that they can be healthy, stay active and ensuring long lifespan. Aquarist does not need to supply different types of food to meet their pet fish dietary needs as nowadays, development in technology has combine many good nutrition sources to form a well-balanced and proper diet for our pet fish. There are various types of aquarium food which include pellets, dry flakes, brine shrimp, daphnia, algae wafers, tubifex worms, plankton, and bloodworms;[10] and different types of fish have different type of diets. For instance tiger barb, Oscar, and convict cichlid are heavy eaters as to compare guppy, angelfish and cory which considered as the medium eaters. Meanwhile the light eaters are bubble-eyed goldfish, pencil fish and ballon mollies[11] The most common mistake aquarist made is overfeeding fish and sometime vice versa when aquarist is too afraid to overfed the fish however led to starvation and poor health. This is usually due to lack of knowledge in proper nutrition needs for particular fish species. Hence, the amount of fish food is important and that aspect is greatly emphasize for this project in the feeder mechanism.

2.3.1 Screw conveyor mechanism

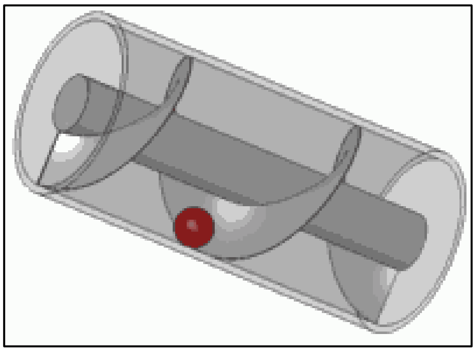


***Figure 2.1**: Screw conveyor*

The screw conveyor or also known as auger conveyor is a type of mechanism which uses a rotating helical screw-like blade and coiled around a shaft, usually within a tube, to transfer granular or liquid materials. Figure 2.1 shows an example of a screw conveyor. Historically, the earliest type of screw conveyor is the Archimedes' screw used to transfer water from low area body of water into irrigation ditch. In modern industries, the screw conveyor are commonly used in agriculture field where it is used to move semi-solid materials such as wood chips, food waste, grains, boiler ash and even animal feed. For this project, the screw conveyor is introduced as the feeder mechanism. Fish food in form of pellets will be inserted in the screw conveyer tube. Meanwhile, a motor will be connected to the centre shaft that holds the helical screw-like blade of the conveyor. During operation, the motor rotates the centre shaft and thus successfully dispensed the fish pellets. As the movement of the conveyor is fully control by the motor, a precise amount of fish pellets will be dispensed each time specific angle of rotation is instructed.

According to Kase Custom Conveyors, a leading engineering company in designing for bulk material handling; there are few considerations must to be taken in designing screw conveyors. Some of considerations for the selection of the type of screw conveyor are[12]:

a) The characteristic of the material to be conveyed (condition, maximum particle size, specific bulk density, etc);
b) Amount of the material to be conveyed;
c) The distance of which the material to be transported.

The type of fish food to be used for this project is the floating, granule type which usually has a diameter size of 1.7mm to 2mm. According to one of the leading fish food manufacturer, Hikari from Japan[13] this type of fish food can be fed to small fishes with the length about 3cm to 5cm, twice or thrice daily.

2.4 Stepper Motor

As mentioned in the previous section, the motor will be use to rotate the screw conveyor of the feeder mechanism. There are many types of motor however the only type that can cooperates with screw conveyor mechanism is the stepper motor. Hence, for this project system design, a stepper motor is to be used.

A stepper motor is a type of brushless DC electric motor that divides a full motor rotation into a number of equal steps where the electrical pulses were converted into discrete mechanical movements. By energizing the multiple organized coils in a sequence, the motor will rotates one step at a time. The motor rotation has some direct relationships with the applied input pulses. The direction of the motor shafts rotation depends on the sequence of the applied pulses. Meanwhile, the frequency of the input pulses will affect the speed of the motor shaft and the length of rotation is depends to the number of input pulses applied to the motor. Table 2.1 below shows some of the advantages and disadvantages of a stepper motor.[14]

Table 2.1*: The advantages and disadvantages of a stepper motor.*

Advantages	**Disadvantages**
The rotation angle of the motor is proportional to the input pulse.	Motor resonances could happen if not properly controlled.
Accurate positioning and repeatability of movement and also the motor error does not accumulate from one step to the next.	Limited high speed torque as it is not easy to control when operates at extremely high speeds.
Very dependable since there is no contact brush in the motor thus the motor life only depends on the bearing life.	Tend to run hot because the current consumption is independent of the load
Able to attain very low speed synchronous rotation with a load that is directly coupled to the motor shaft.	

2.5 Controller

The controller is the most basic part of the automatic fish-feeding system. The controller is basically the substitute for human brain in this system especially in restoring inputs memories and giving out specific instruction for the automatic fish feeding system to dispense fish food at predetermined time with the correct amount of fish food. For this project, the type of controller will be used is the microcontroller and to be specific, the Arduino Uno microcontroller board from Atmel which based on the ATmega328.

2.5.1 Arduino Uno

Arduino Uno is an interactive microcontroller board designed by Arduino Company and manufactured by SmartProjects Company from Italy. This microcontroller board uses ATmega328 microcontroller by Atmel. ATmega328 is a high-performance 8-bit Atmel AVR RISC-based architecture microcontroller having the combination of 32K bytes of ISP flash memory with read-while-write capabilities, 1K bytes EEPROM, 2K bytes SRAM, 23 general purpose input/output lines, 32 general purpose working registers, three flexible timer/counters with comparator modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel of 10-bit A/D converter, programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device able to operates between 1.8V to 5.5V. As mounted in Arduino Uno, the microcontroller board has 14 digital input/output pins (of which six can be used as PWM outputs), six analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. Arduino Uno contains everything needed to support the ATmega328 microcontroller.[15]. Figure 2.2 shows the pin mapping of ATmega328.

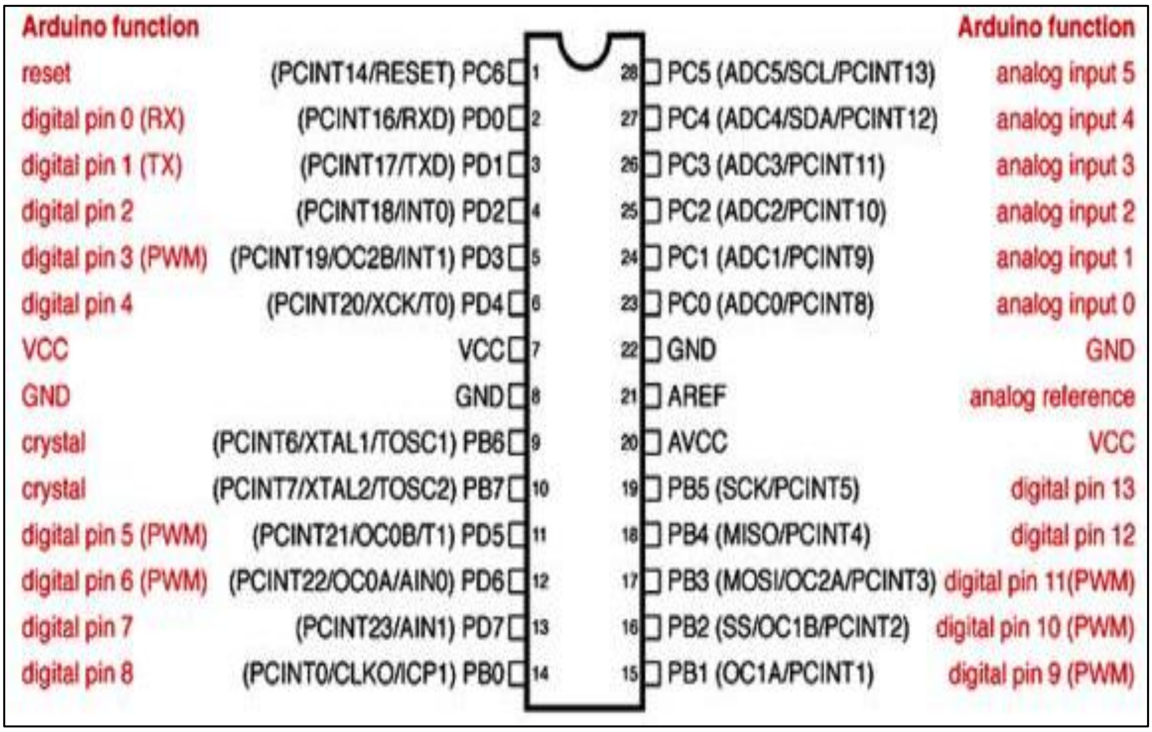


Figure 2.2: *ATmega328 pin mapping.*

2.6 User Control Interface

The user control interface system acts as the aid for aquarist to make operational decisions to the automatic fish-feeding system like setting the feeding time, feeding amount, etc.

2.6.1 Display Unit

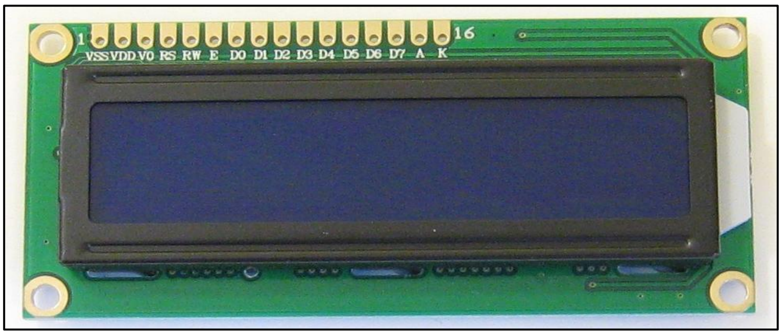


Figure 2.3: *16x02 Liquid-crystal display panel.*

Liquid-crystal display (LCD) is a type of flat panel display used for electronic visual display devices that uses the light modulating properties of liquid system[16]. For each LCD pixel contains a layer of molecules aligned in between of two transparent electrodes and two polarizing parallel and perpendicular filters. The alignment of the electrodes surface determines the liquid-crystal molecules where they twist and untwist at different degrees to allow or block light to pass through. The LCD displays are used in diverse type of application including television, calculator, signage, aircraft cockpit display, computer monitor and panel. For this project, the LCD is used for displaying optional inputs and outputs for user to select as such the number of times to feed per day and feeding amount setting. Figure 2.3 shows the 16x02 liquid-crystal display panel.

2.6.2 Keypad

A set of buttons arranged in a block/pad as user input interface for feeding time, amount and frequency information. A keypad usually has digits, symbols or complete set of alphabetical letters printed on it depends on its functionality and inputs.

2.7 Feedback system

A feedback system is when the outputs of a system are "fed back" again into itself as the inputs, where the chain of reason-and-effect takes place to form a circuit or loop. For this project, there are two feedback systems is to be implement to the automatic fish feeder system design; which are firstly, a feedback system to indicate low fish food level using infrared sensor to warn user if the fish food in the feeder container is empty and secondly, a feedback system to indicate low battery level to warn user if change of battery is needed.

2.7.1 Infra-red Sensor

An infra-red (IR) sensor is a type of electronic device which is used to sense the change in its surrounding's characteristics by either emitting or detecting infra-red waves. The waves have wavelength ranges from 0.75µm to 1000µm in the electromagnetic spectrum and human eyes cannot see these waves.[17] The infra-red technology can be seen in various type of application our daily live from home appliances to industrial field application. For instance, the signals emit from a remote control were interpreted by the infra-red detector embedded in the televisions.

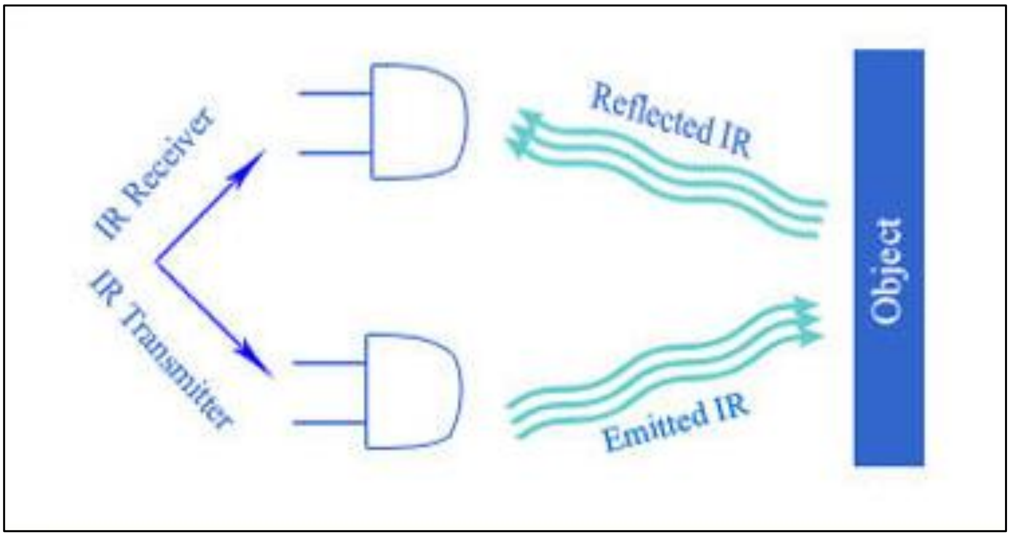


Figure 2.4: *Infra-red sensor working principle.*

A typical IR sensor consists of an IR receiver and an IR transmitter. The IR transmitter will always transmit the infra-red light, while the working concept of the IR receiver is similar to Light Dependent Resistor (LDR) where when there is obstacle, the infra-red light get reflected to the IR receiver changes the voltage across the circuit. Monitoring the change in voltages will gives us an obstacle detection sensor where in the case of this particular automatic fish feeder system, the fish food is the obstacle. When the level of the fish food getting low, the IR receiver will start receiving the infra-red light from the IR transmitter and thus triggers the warning alarm or the warning LED. Figure 2.4 shows the working principle of an infra-red sensor in a simple diagram.

CHAPTER 3:

METHODOLOGY

3.1 Introduction

This chapter highlights the detail explanation of methodology used for the design and fabrication of the automatic fish feeding system. The system consists of the implementation of both mechanical and electrical/electronic elements. The mechanical elements are the screw conveyor feeder mechanism and stepper motor. Meanwhile, the electrical/electronic elements are the system electrical circuit, Arduino Uno controller programming, infra-red sensor and also the LCD. The functionality of this automatic fish feeding system highly depends on the successful integration of both mechanical and electrical/electronic elements. Thus, the integration of both elements also will be discussed in this chapter.

3.2 Methodology Flow Chart

The diagram of Figure 3.1 is the flow chart of this project's methodology.

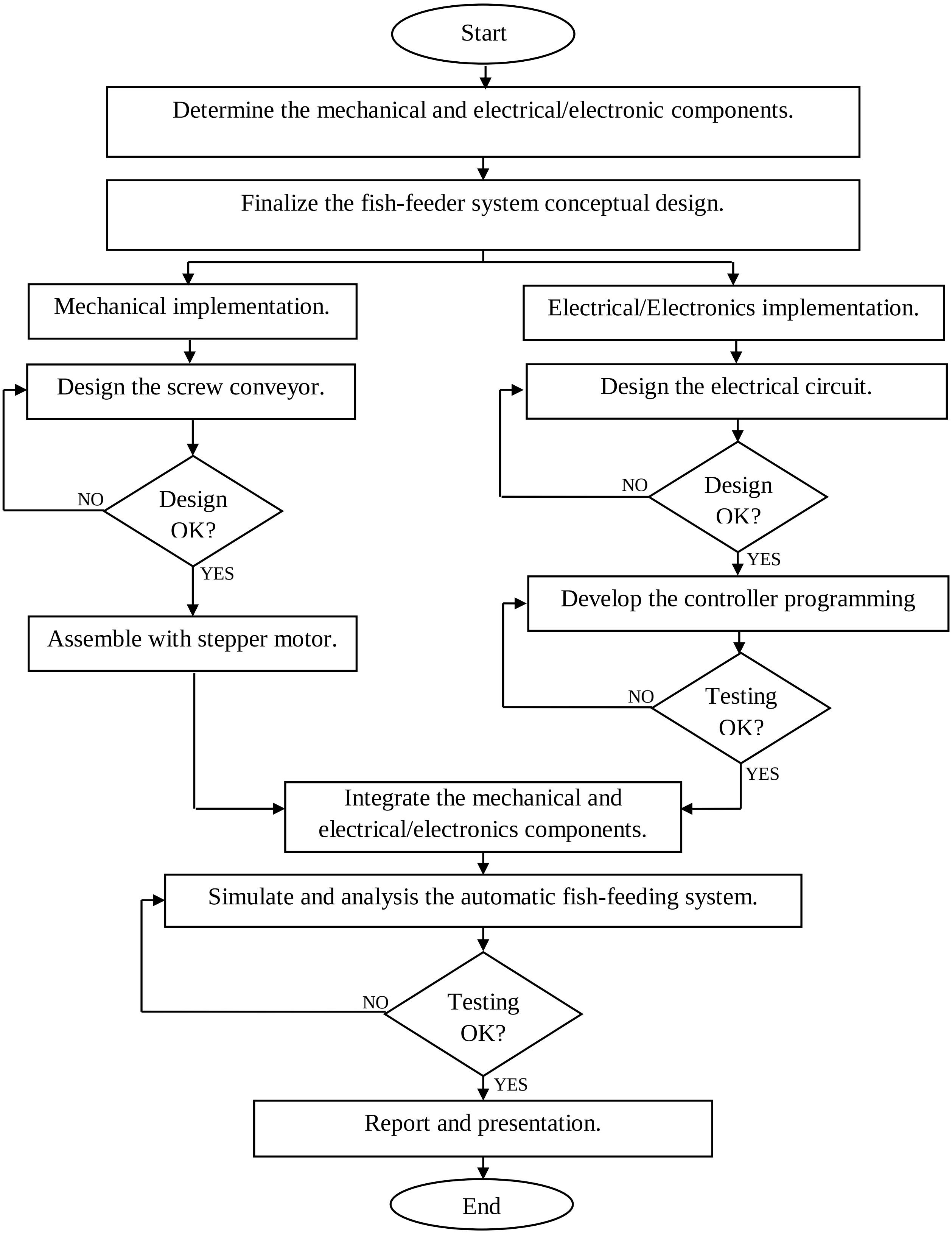


Figure 3.1: *Methodology flowchart*

3.3 Mechanical Implementation

This section will discuss in depth regarding the mechanical implementation to this project of automatic fish feeding system from the conceptual design to the screw conveyor design and selection of motor.

3.3.1 Overview of Conceptual Design

As mentioned in the project scope, this automatic fish-feeding system does not emphasized any aesthetical value. Hence, the main focus is to ensure a successful system as listed in the project objectives. The basic concept of the system is as shown in block diagram in Figure 3.2. The system would be in a continuous loop from the combination of basic mechatronic system which consists of the power supply, controller, transducer and actuator.

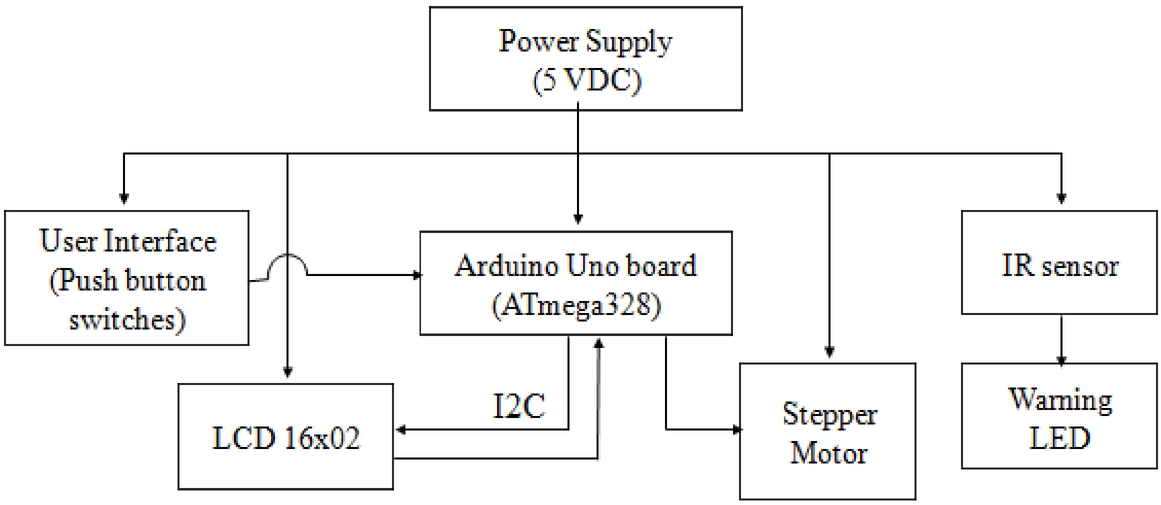


Figure 3.2: *System block diagram.*

The selection for the final design concept is made through based from four type of design. The designs were presented as Table 3.1.

Table 3.1: *Design concepts.*

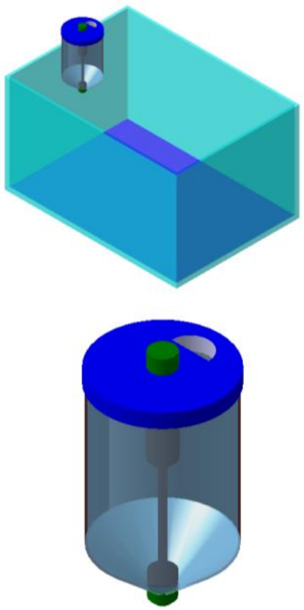
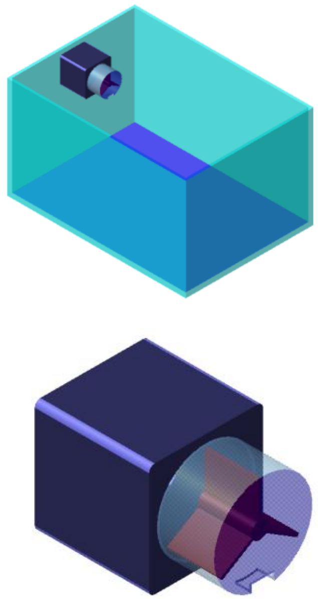
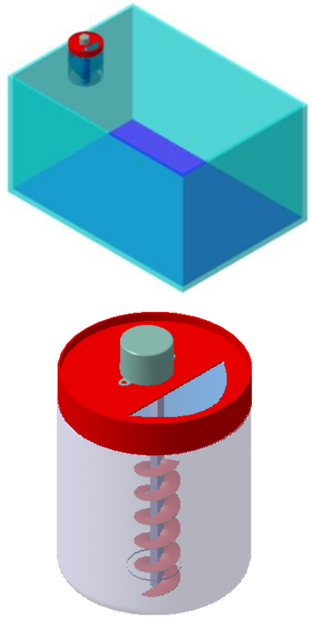
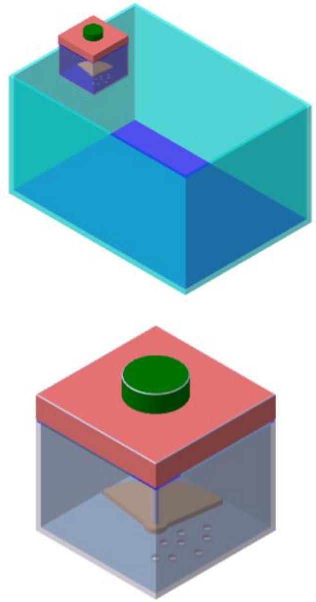
Design Type	DESIGN I	DESIGN II	DESIGN III	DESIGN IV
Drawings of design concept				
Descriptions	Central locking solenoid actuator acts as piston. It opens and releases fish food at predetermined time when the rod is contracted.	Servo motor rotates the blade to specified angle at predetermined time. Fish food in each blade section drops through an opening.	Stepper motor rotates the screw conveyor to specified turns or step angles at predetermined time, releasing fish food through an opening.	Servo motor rotates the trap door to let fish food drops through holes at the predetermined time. Then, trap door rotates back to initial position.

Table 3.2: *Selection of design concepts.*

CRITERIA	DESIGN I	DESIGN II	DESIGN III	DESIGN IV
Easy to fabricate	-	X	X	X
Low fabrication cost	-	X	X	X
Easy to control amount of food	-	X	X	-
Accurate feeding time	X	X	X	X
Durability	X	-	-	-
Low maintenance	X	-	X	-
TOTAL	**3**	**4**	**5**	**3**

Based on Table 3.2, the design concept of Design III is chosen for this project because the design concept fits to most of the desired criteria. The body of this automatic fish feeder will be made from recycled items. For instance, the feeder container is made from a circular plastic bottle. Meanwhile, the stepper motor will be attached on top of the plastic bottle cover lid. A hole will be made through the bottom of the plastic bottle to insert the screw conveyor. The screw conveyor then will be coupled with the stepper motor. The fish food compartment will be made separated from the outer body container. The infrared sensor will be placed inside the outer body container. The stepper motor and infrared sensor will be wired to a control box of which the circuit board, LCD and keypad buttons are located. The control box is made from recycle cardboard box with the dimension of approximately 110mm x 90mm x 60mm. The control box is also the where the circuit board, LCD and keypad are located. The chosen design of the keypad design of the control box and its layout are as shown in Figure 3.3, 3.4 and 3.5 respectively.

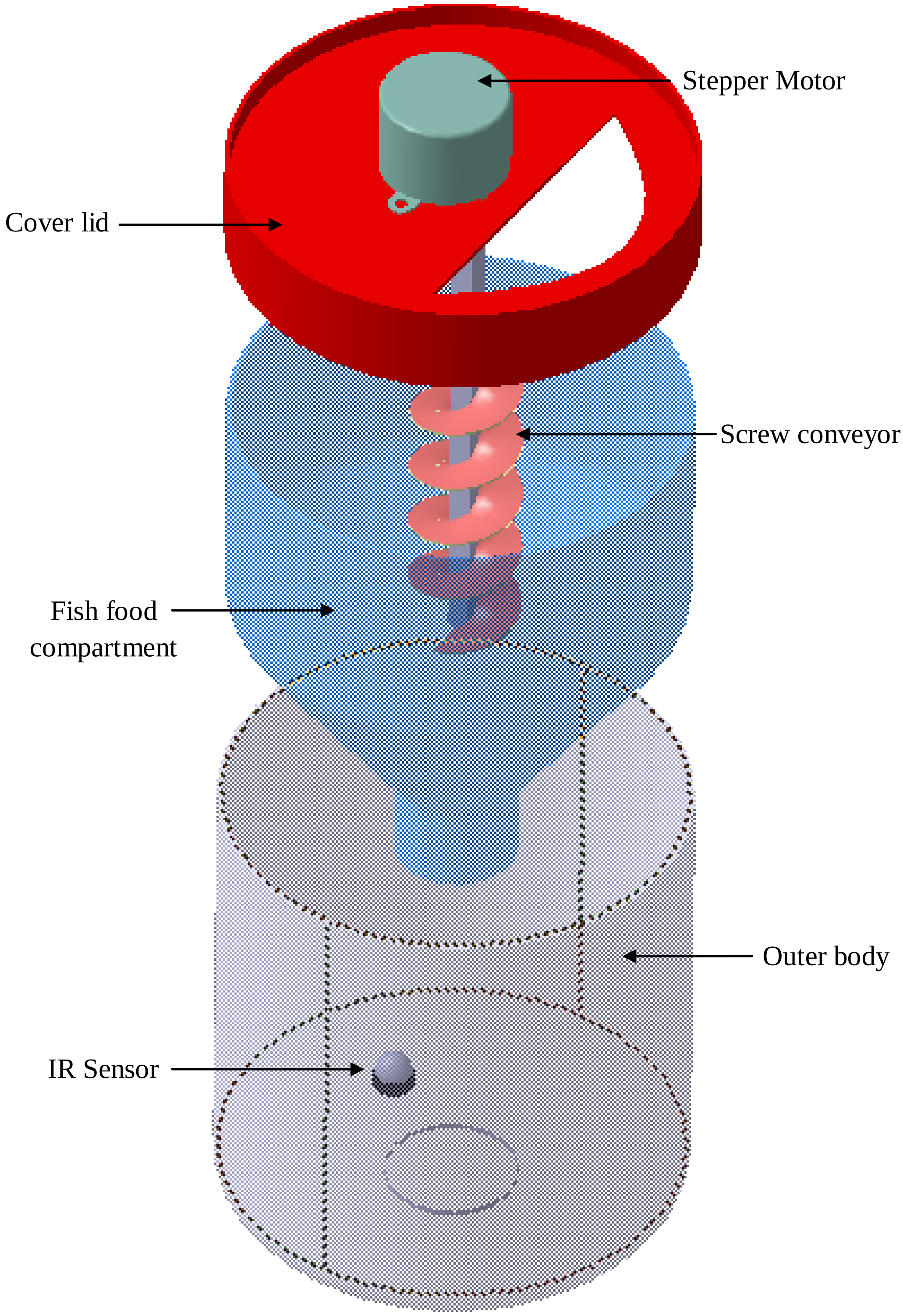


Figure 3.3: *Assembly design of the fish feeder.*

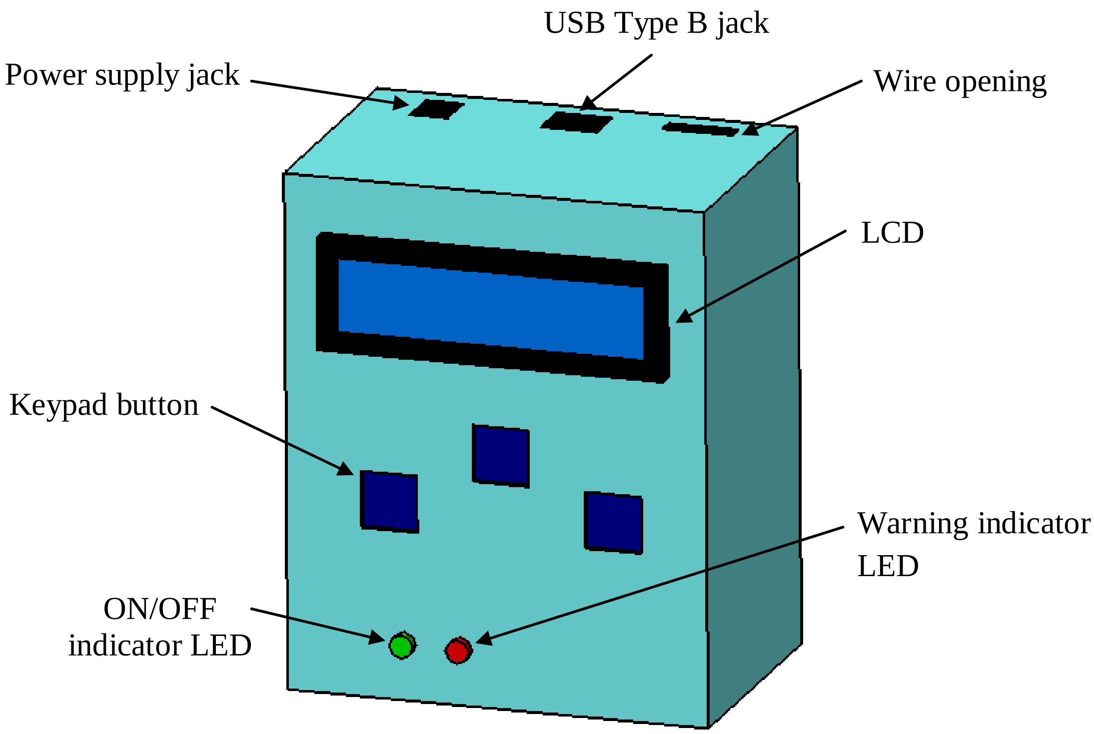


Figure 3.4: *Control box- keypad design.*

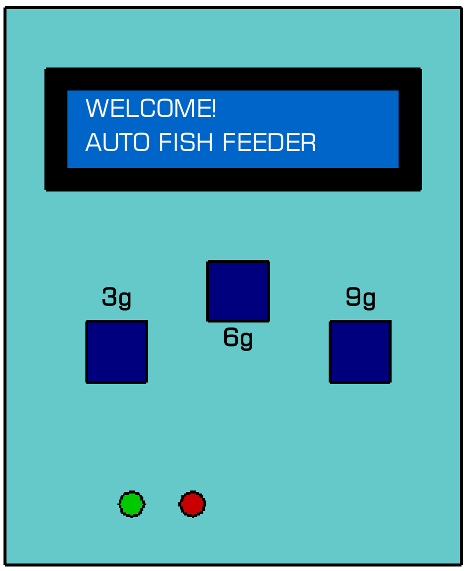


Table 3.5: *Keypad layout.*

3.3.2 Screw Conveyor Design

In designing a screw conveyor system, there are few factors have to be taken into consideration; which are:

- The characteristic of the material to be conveyed (condition, maximum particle size, specific bulk density, etc);
- Amount of the material to be conveyed;
- The distance of which the material to be transported.

For this automatic fish-feeding system, the screw conveyer is designed using CATIA software as shown in Figure 3.6. In the early stage, the planning for the fabrication of screw conveyor is to be done using 3D printing. However, due to the fact that the cost of the 3D printing material is expansive and this automatic fish feeder project is a prototype only, the initial idea is dismissed. As an alternative, the fabrication of the screw conveyor is to be made from recycle material such as plastic sheet and cardboard. The screw conveyor that has been design has the following parameters:

- Spiral outside diameter, *OD*: 24mm
- Centre shaft diameter, *D*: 8mm
- Spiral pitch, *p*: 10mm
- Spiral thickness, *t*: 1mm
- Shaft length, *l*: 124mm
- Type: Double flight full pitch

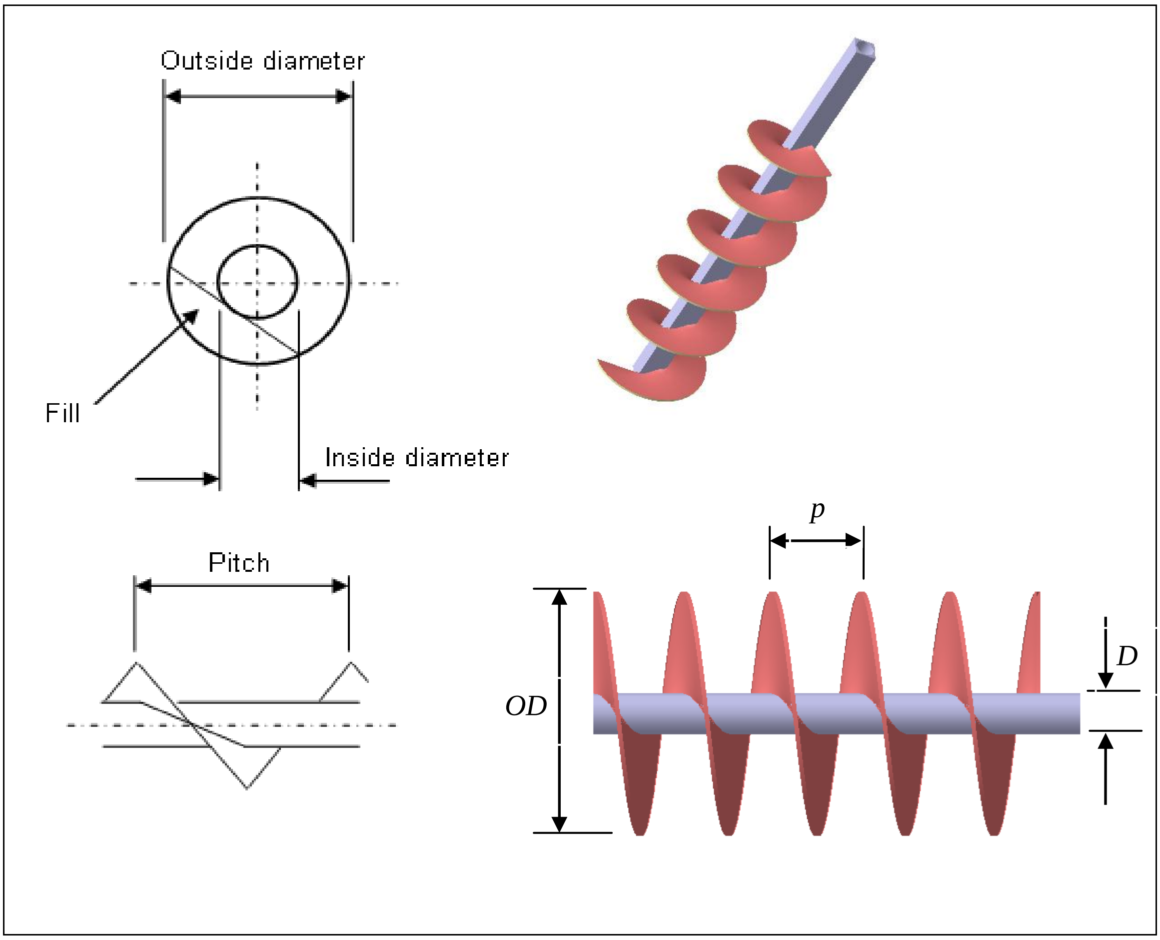


Figure 3.6: *Screw conveyor design.*

3.3.3 Stepper Motor

The stepper motor used for this project is the 28BYJ-48 Stepper Motor. This type of unipolar stepper motor is a small, cheap; 5V geared stepping motors operating 100Hz frequency. It provides a decent torque at speeds of about 15 *rotations per minute* (rpm) because of its gear reduction ratio of approximately about 64:1. The motor has four coils of wire that were magnetized in sequence for the magnetic motor shaft spin. This stepper motor able to move in accurate, fixed angle increments known as steps. For half-step mode which consists of 8-step control signal sequence, we calculated that:

$$Stride\ angle, \theta = \frac{360}{64} = 5.625°$$

$$Number\ of\ step\ per\ revolution, n = \frac{360}{Stride\ angle} \times Gear\ ration = \frac{360}{5.625} \times 64 = 4096\ steps$$

To peripherals the stepper motor with Arduino Uno board, ULN2003 stepper motor driver is needed to easily control the stepper motor from Arduino Uno microcontroller board. A separated 5V 2A power supply is used, as the stepper motor might drain huge current than the Arduino Uno can handle and could potentially damage the microcontroller board itself. Figure 3.7 shows the model of a 28BYJ-48 stepper motor.

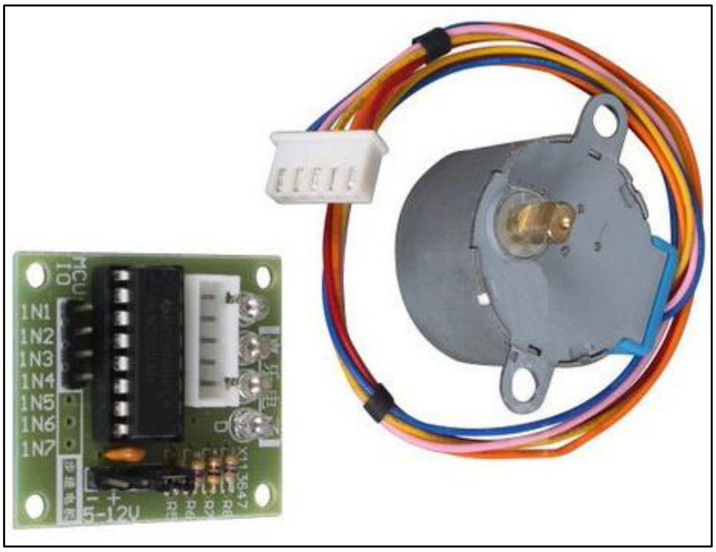


Figure 3.7: *28BYJ-48 Stepper Motor and ULN2803 motor driver.*

3.4 Electrical Implementation

This section will discuss in depth regarding the electrical implementation to this project of automatic fish feeding system, which consist of the explanation regarding the electrical circuit and programming for the microcontroller used.

3.4.1 Electrical circuit

The electrical circuit for this automatic fish feeding system is presented in Figure 3.9. The system uses 12V power supply via 12V adapter before voltage regulator LM7805 regulates to the desired power supply of 5V. D2 is the ON/OFF indicator LED which tells the aquarist that if the machine is turn on or off. Meanwhile, the LCD, push button switches, ULN2003 and stepper motor is directly peripherals to the Arduino Uno board. The ULN2003 and stepper motor uses the pin 13, 12, 11 and 10. The push button switches that serves as the keypad are connected to pin 6, 5 and 4. On the other hand, the infra-red sensor is connected separately from the Arduino Uno. Once triggered, the D1 or warning indicator LED will light up to alert the aquarist if the food level in the feeder container is low. The feedback system flowchart is shown in Figure 3.8.

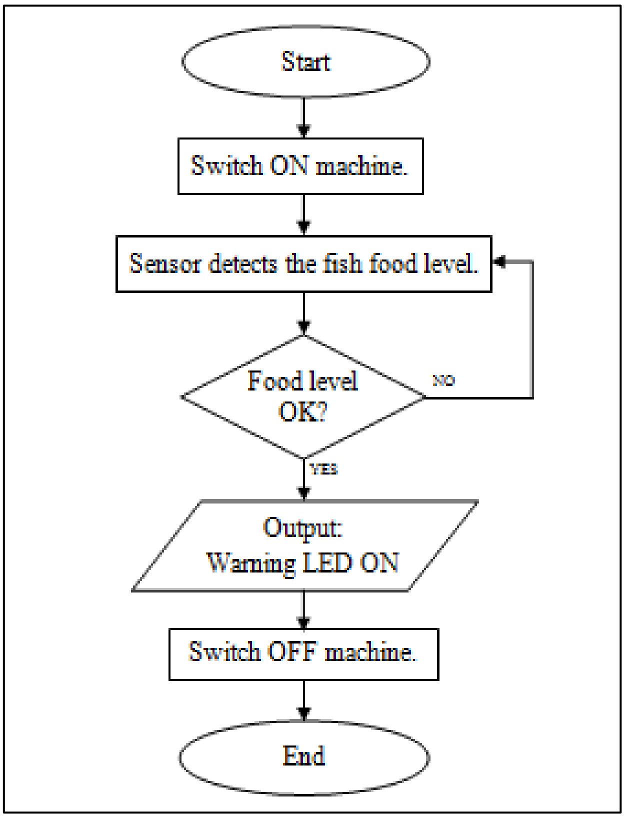
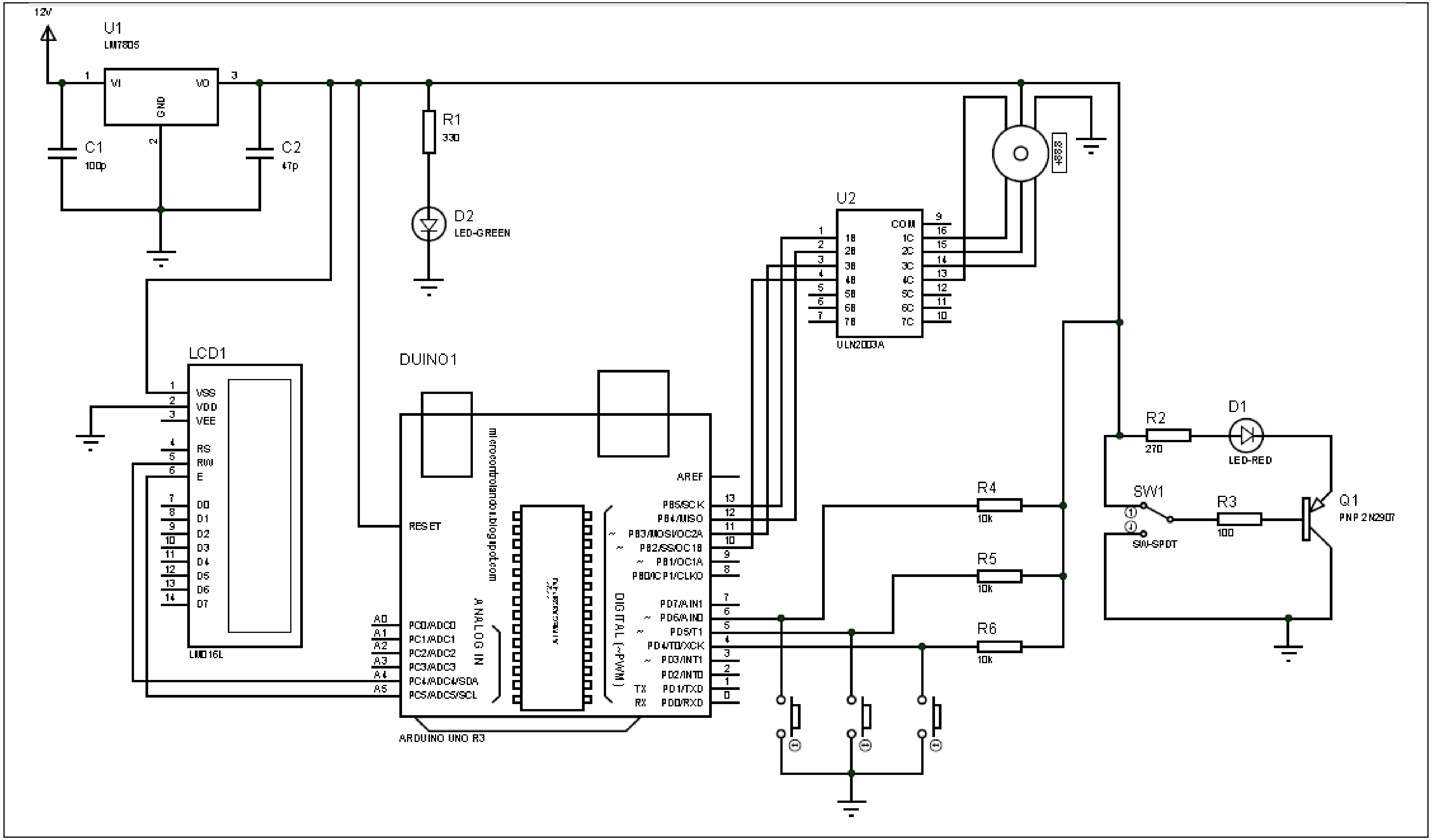


Figure 3.8: *Warning feedback flowchart*

Figure 3.9: *Circuit diagram.*



Because of the limited pin resources of Arduino Uno board, the LCD would be used is not able to connect normally with the microcontroller using the typical LCD shield. However, with *inter-integrated circuit* (I2C) communication, the LCD is able to function perfectly with only 2 wires. The 16x02 LCD panel actually will use the 12C communication interface of the Arduino Uno board through A04 (SDA) and A05 (SCL) pins. However, the LCD actually needs to be connected to a I2C LCD controller module. Figure 3.10 shows the 16x02 I2C LCD with its controller module.

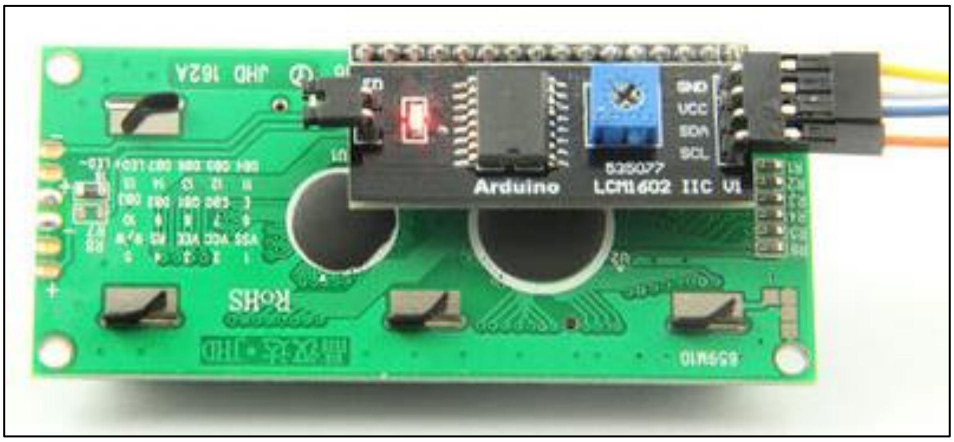


Figure 3.10: *16x02 I2C LCD controller module.*

Table 3.3 describes which pins on the Arduino Uno board need to be connected to the I2C LCD controller module.

Table 3.3*: Pin assignment for LCD controller module.*

I2C LCD controller module	**Arduino Uno**
VCC	5V
GND	GND
SDA	A04
SCL	A05

3.4.2 Arduino IDE

Every Arduino board would come with a simple *integrated development environment* (IDE) that could runs on regular personal computers and allows the users to write programs. It is a cross-platform application written in Java and derives from the IDE for the processing programming language and wiring projects. The software is includes a code editor with features such as syntax highlighting, brace matching and automatic indentation. The software also is able to compile and upload written programs to the Arduino board with just a single click.

A program code written is the work space is called a *sketch*. Meanwhile the programs are written in C or C++. The Arduino IDE comes with a software library, which makes many common input/output operations much easier. Users only need define two functions to make a runnable cyclic executive program. For this project the libraries that were used are:

a) ***AccelStepper.h***: To be interface with 28BYJ-48 stepper motor and its driver. This is because the standard Arduino Stepper library cannot handle the stepper motor if it needs to be operated in half-step mode.

b) ***Wire.h***: To allow Arduino Uno board to communicate with I2C devices.

c) ***LiquidCrystal_I2C.h***: To be interface with the LCD via I2C communication.

d) ***SimpleTimer.h****:* To configure the timer setting for the automatic fish feeder.

After booting, the Arduino first positions the stepper motor into their initial positions and also set the motor to the required acceleration and speed. Meanwhile, the LCD at first blinks three times and then proceeds to the main screen which shows the welcome note, “WELCOME! AUTO FISH FEDEER”. The next screen shows “AMOUNT OF FISH FOOD? 3g/ 6g/ 9g”, where the program would allows user to set the desired amount of fish food per session. After user inserts the input through the keypad button, then the LCD change to the next timing screen where it shows, “NEXT FEEDING TIME: 7:59:59” and the LCD will be counting backward until 0:00:00. The LCD timing will repeat by itself. At the same time when LCD starts counting, a separated timer function will also starts counting for the stepper. When the current time is equal to either of the predetermined feeding time, the stepper motor will starts to rotates the screw conveyor according to the feeding amount so as to dispensed fish food into the water. Then, the final position of the stepper motor is set as the new initial position. Figure 3.11 is the flowchart of the controller.

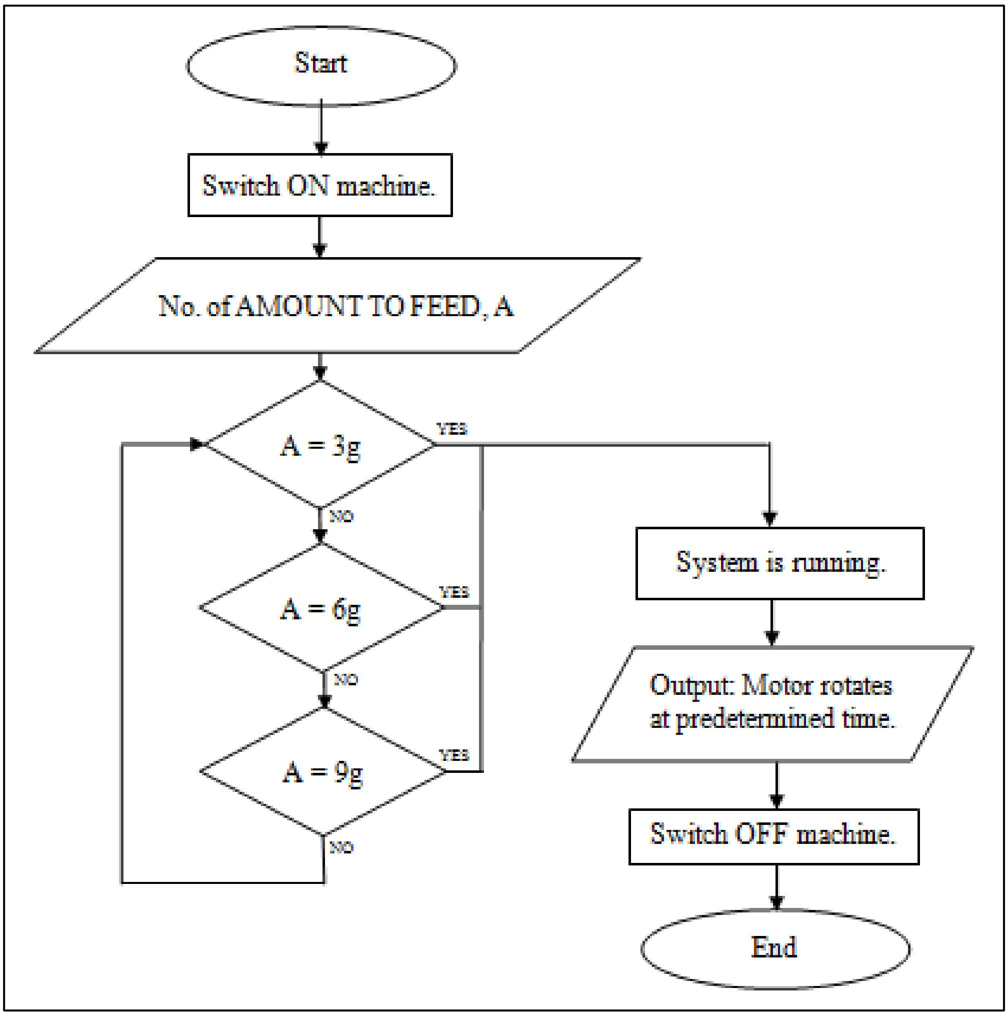


Figure 3.11: *Controller flowchart*

3.5 Fabrication Process of the Automatic Fish Feeder

This section explained the fabrication process of the automatic fish feeder. The fabrication process started with the procuring of material and components needed to fabricate this automatic fish feeder machine. Most of the electrical components are available in the faculty's electric/electronic laboratory; except for Arduino Uno board, I2C LCD and also the stepper motor; which was bought online. Meanwhile, the mechanical components are mostly obtained from recycle items. Table 3.4 presents the procurement checklist.

Table 3.4: *Material procurement checklist.*

NO	PART	MATERIAL	DESCRIPTION	UNIT
1	Adapter 12 V 2A	-	-	1
2	Female DC Jack Type B	-	2.1 mm, Black	1
3	Arduino Uno R3	-	Refer Datasheet	1
4	28BYJ-48 Stepper Motor	-	Refer Datasheet	1
5	I2C LCD 16 x 02	-	Refer Datasheet	1
6	IC ULN2003	-	-	1
7	IC LM7805	-	-	1
8	LED Red	-	-	1
9	LED Green	-	-	1
10	PNP Transitor 2N2907	-	Refer Datasheet	1
11	Push-Button Switch	-	4 pins	4
12	Infrared Sensor	-	w/ socket	1
13	Multilayer Capacitor 47uF	-	-	1
14	Multilayer Capacitor 100uF			1
15	Resistor 0.25W 5% (100Ω)	-	-	1
16	Resistor 0.25W 5% (270Ω)	-	-	1
17	Resistor 0.25W 5% (330Ω)	-	-	1
18	Resistor 0.25 5% (10kΩ)	-	-	4
19	Soldering ProtoBoard	-	-	1
20	Control box	Cardboard box	100 x 100 x 30	1
21	Feeder body (Round shape)	Plastic bottle	70 x 90	1
22	Screw Conveyor Shaft	Cardboard	-	1
23	Screw Conveyor Flight	Cardboard sheet	A4	2
24	Holt-melt Adhesive Gun	-	-	1
25	Holt-melt Adhesive Stick	-	-	5
26	Suction cup	Plastic	Max. 500g	1

The process of fabrication starts with mechanical components. The body of the fish feeder is made by cutting of parts of used plastic bottle to create the fish food container and feeder outer body. Then, any sharp edges is filed using a filer. Next, the parts were fastened by hot-melt adhesive gun. The screw feeder is then constructed by using paper craft technique and is strengthen using lots of PVA glue. The screw feeder is then coupled to the stepper motor using silicone adhesive. Figure 3.12 and 3.13 shows the cutting and filing process.

Figure 3.12: *Cutting the fish food container.*

Figure 3.13: *Filing the fish feeder body.*

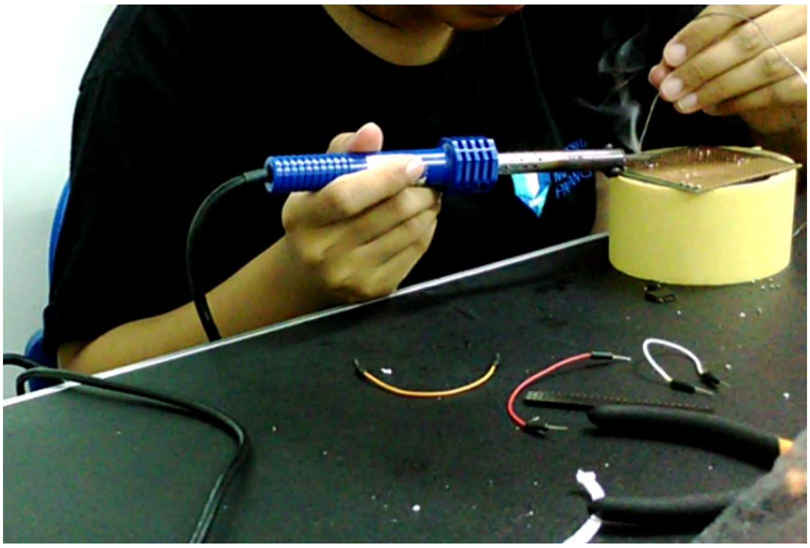


Figure 3.14: *Soldering components to circuit board.*

Meanwhile, the electrical elements actually started off with Arduino Uno programming using Arduino IDE software. And then, the circuit simulation testing is performed via Proteus 8 Professional circuit simulator software. After the circuit is confirmed, the soldering process of electrical components onto the soldering proto board is done and also circuit testing and troubleshooting is executed afterward. Figure 3.14 and 3.15 shows the process of soldering and troubleshooting.

Figure 3.15: *Testing the circuit board.*

After the circuit board is done, then all the electrical elements were assembled neatly into the control box. The electrical elements were then integrated with the mechanical elements. Finally, the automatic fish feeder is ready to be analysed for its functionality. Figure 3.16 shows the finished automatic fish feeder.

Figure 3.16: *Finished automatic fish feeder.*

CHAPTER 4:

RESULT AND ANALYSIS

4.1 Introduction

In this chapter, we would look upon the conducted analysis and experiment to the automatic fish feeder system and the cost analysis for this project. The analysis and experiments made were very important to evaluate whether objectives of this project can be achieved or not. Besides that, this chapter also presents the procedure and discussion of results based on the conducted analysis through the respective sections and sub-sections.

4.2 Fish Feeder Fabrication Analysis

Firstly, this section would discuss on the analysis of the fabrication process of the automatic fish feeder. This analysis is made to ensure that the implementation of mechanical and electrical and electronics elements are compatible and made the fish feeding system working out together. Throughout the process of fabrication, a continuous modification and improvement is done to ensure that the objectives of this project are met. One of the modifications made is the fabrication of fish food compartment to the final design. The design of the fish food compartment improves the conveying process to become more efficient. However, the setback is the storage of fish food become limited to approximately 150g at full storage. By using the equation below,

$$\frac{Amount\ of\ fish\ food\ at\ full\ storage}{Amount\ of\ food\ per\ session\ \times Session\ per\ day} = Days\ in\ operation$$

Since the automatic fish feeding system is set with three sessions per day, for 3g per session, the machine can lasted enough for approximately 17 days. Meanwhile, it would be 8 days and 6 days for 6g per session and 9g per session respectively. Table 4.1 shows the overall machine specifications of this automatic fish feeder.

Table 4.1: *Automatic fish feeder machine's specifications.*

Power Supply	5 VDC, 2.0A, 50Hz
Feeder Mechanism	Screw conveyor
Microcontroller	Arduino Uno R3
Motor	28BYJ-48 Stepper motor,
Sensor	Infra red sensor
User Interface	Liquid-crystal display and keypad buttons
Feeding Time	3 session per day (every 8 hours)
Feeding Rate	3/6/9 gram per session 9/18/27 gram per day
Material	Feeder body: plastic Control box: paper box
Dimensions	Feeder body 100 x 125 Control box
Food capacity storage	150g
Weight	500g (with full food capacity) 350g (without food capacity)

4.3 Analysis A: To determine the amount of dispensed fish food.

Analysis A is an experiment to determine the amount of dispensed food by the automatic fish feeder machine. This experiment is conducted based on the second objective of this project of which, to ensure accurate amount of dispensed food by the automatic fish feeder. Since the available equation to calculate screw capacity does not suitable for the proposed screw conveyor design, this experiment is done by trial and error to relate between the stepper motor steps input and amount of dispensed fish food.

4.3.1 Procedures of Analysis A

The procedure of Analysis A is given by the steps below:

1. The apparatus of the experiment is prepared, which is the automatic fish feeder, plastic container and an electronic weighing balance.
2. Then, the automatic fish feeder is set to rotate according to its step input revolution. The first step input is one revolution.
3. The empty plastic container is weighed and recorded.
4. The amount of dispensed fish food is weighed using the electronic weighing scale.
5. The experiment is repeated by setting different values of step input revolutions as shown in Figure 4.1.
6. The recorded mass of the actual amount of dispensed fish food is subtracted from the recorded mass of plastic container.
7. The average mass of actual amount of dispensed fish food, Ma is calculated.
8. The curve of mass of actual amount dispensed fish food against the step input revolution is plotted.

Figure 4.1: *Electronic weighing scale with an empty and filled container.*

4.3.2 Result & Discussion of Analysis A

Table 4.2: *Results from Analysis A*

Stepper Revolution, Rev	Actual Amount, M_a (g)					M_{avg} (g)
	I	II	III	IV	V	
1	1.970	1.980	1.304	1.127	1.456	1.56
$1\,^1/_2$	2.970	2.980	3.034	3.127	3.086	3.03
2	4.360	4.523	4.607	4.324	4.611	4.48
$2\,^1/_2$	5.962	6.052	5.955	6.122	5.941	6.01
3	7.324	7.467	7.511	7.561	7.256	7.42
$3\,^1/_2$	8.959	8.973	9.061	8.947	9.164	9.02

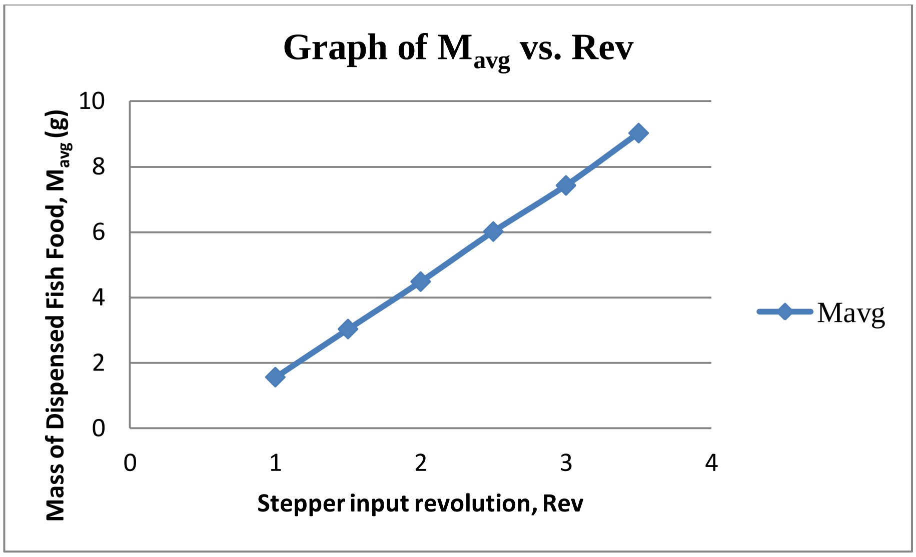


Figure 4.2: *Graph of mass of dispensed fish food, (M_{avg}) against stepper input revolution, (Rev).*

From Table 4.2 and Figure 4.2, the mass of dispensed fish food is directly proportional to the stepper input revolution. The result obtained from this experiment showed that as the stepper input revolution increases, the mass of dispensed fish food also increases. This information is important because we want to ensure that the screw conveyor did its task accordingly. Besides that, it is revealed that the suitable stepper input revolution for 3g, 6g, 9g is 1.5 rev, 2.5 rev and 3.5 rev respectively. Even though, the exact amount during each reading is fluctuated, but the after calculating the average, the actual amount of dispensed fish food is nearly equal to the desired amount for this fish feeding system.

4.3.3 Sample of calculations

$Mass\ of\ plastic\ container, M_c\ : 4.068\ g$

$Recorded\ mass\ of\ dispensed\ fish\ food, M_{rec}:\ 13.041\ g$

$Actual\ mass\ is\ dispensed\ fish\ food, M_a:$

$$13.041 - 4.068 = 8.973\ g$$

$$Average\ mass\ of\ dispensed\ fish\ food, M_{avg}:$$

$$\frac{8.959\ g + 8.973\ g + 9.061\ g + 8.947\ g + 9.164\ g}{5} = 9.0208\ g$$

4.4 Analysis B: To investigate the screw conveyor design.

On the other hand, Analysis B is an experiment to investigate the relationship between the angles of inclination of screw feeder and the fish food capacity. For this experiment, the inclined plane is made using a protractor, cardboard and Styrofoam. Using the protractor, Styrofoam block is cut according to the angle of inclination to be tested and a cardboard is attached to the cut Styrofoam. According to Kase Custom Coveyors Company, when the angle of inclination of a screw conveyor increases, the allowable capacity of a given unit decreases. Thus, the statement became this experiment initial hypothesis.

4.4.1 Procedure of Analysis B

The procedure of Analysis B is given by the steps below:

1. The apparatus of the experiment is prepared, which is the automatic fish feeder, an electronic weighing balance and a set of inclined plane (0^o, 15^o, 30^o, 60^o, 90^o) as shown in Figure 4.3.
2. Then, the automatic fish feeder is set for 10 seconds interval of feeding time and for 3 grams per interval.
3. The fish feeder is placed on 0^o inclined plane and the feeder is switched on.
4. The amount of dispensed fish food is weighed using the electronic weighing scale.
5. The experiment is repeated by setting different degree values of inclined plane.
6. The mass of dispensed fish food is observed and analysed.

7. The curve of mass of actual amount dispensed fish food against the step input revolution is plotted.

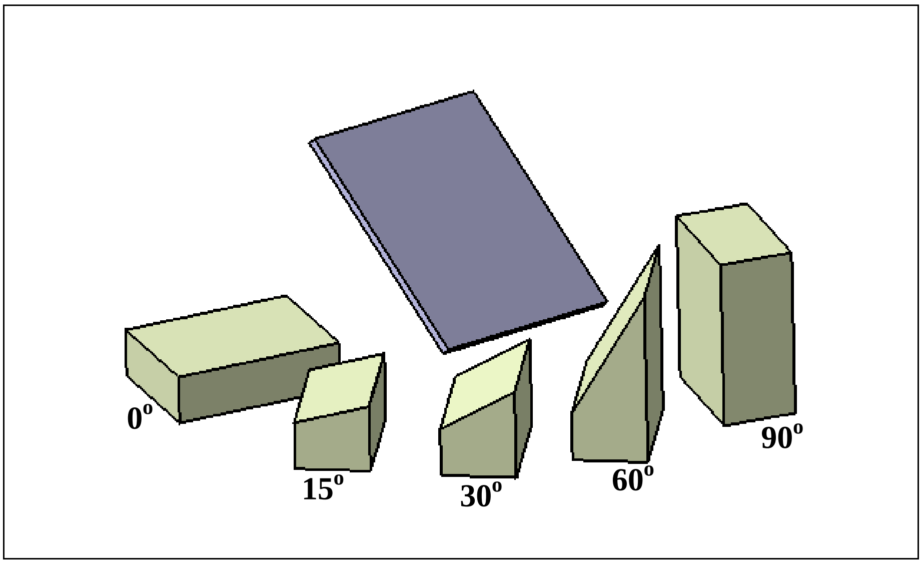


Figure 4.3: *Apparatus for Analysis B*

4.4.2 Result and Discussion of Analysis B

Table 4.3: *Results of Analysis B*

Readings		Angle of inclination, θ				
		0°	**15°**	**30°**	**60°**	**90°**
Amount of dispensed fish food, M (g)	**I**	4.011	3.997	3.645	3.095	3.117
	II	3.634	4.011	3.633	3.102	3.110
	III	3.781	3.972	3.519	2.932	2.981
	IV	2.891	2.778	3.071	3.020	3.086
	V	2.430	2.682	2.831	2.997	3.023

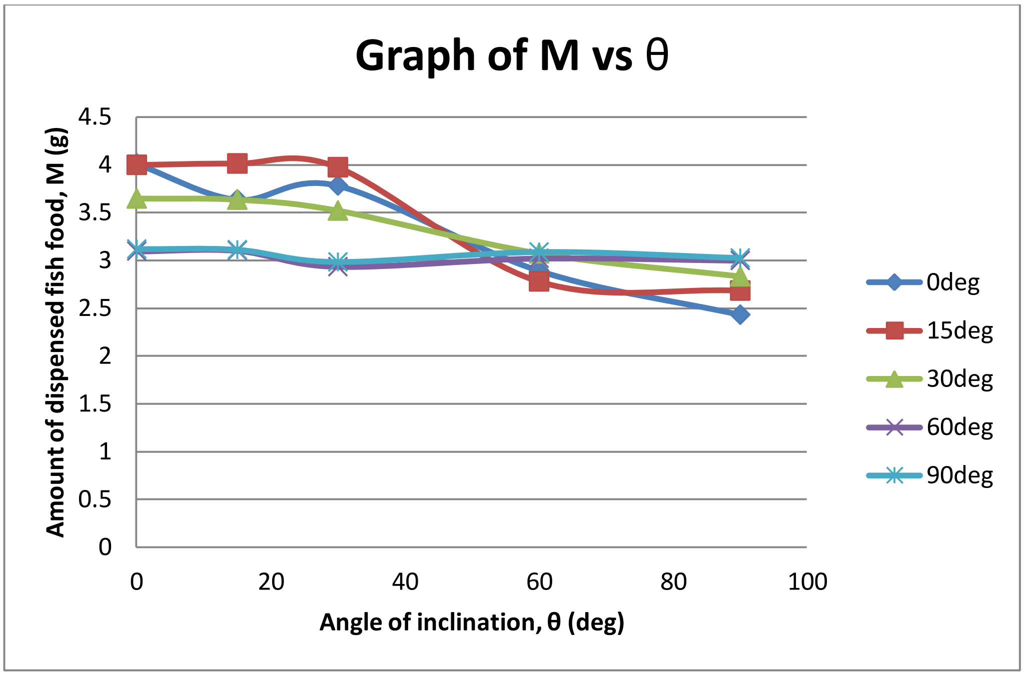


Figure 4.5: *Graph of amount of dispensed fish food, (M) against angle of inclination of screw conveyor,(θ) .*

Based on the tabulated result of Table 4.3 and Figure 4.5, for 0^o and 15^o inclination the amount of dispensed fish food is rather stable even though fluctuated. However, for 30^o, 60^o and 90^o of inclination, the amount of dispensed fish food starts to decrease after third reading. This information did not agrees with the initial hypothesis. There are few factors that may contribute to this condition. Firstly, the hypothesis maybe only refers for material elevation by screw conveyor. In this situation, the allowable capacity is affected by the angle of inclination because the Earth gravity and material density must taken into consideration when elevating material using the screw conveyor. The Kase Custom Conveyer Company also mentioned that "a standard screw conveyor will often operate normally horizontally or at angles up to 15^o with only a small loss in capacity". By theory, more power also is required for an inclined screw conveyor but this project does not require lifting the fish food. Besides that, maybe due to the initial proposed fish feeding design that were used when this experiment is conducted and the fish food is fully filled.

However, the initial proposed design is still acceptable and quite successful because the screw conveyor able to control the dispensed amount of fish food precisely. One of the ways to overcome this problem is by introducing the fish food compartment which is made by taking the neck part of a recycled bottle. As mentioned before, the bottle neck design of the fish food compartment generally helps to aid the conveying process.

4.5 Cost Analysis

The cost analysis is done to calculate the feeding cost needed for the operation of the automatic fish feeder. Table 4.4 shows the cost of feeding per day according to the amount of dispensed fish food.

$$Cost\ of\ fish\ food\ per\ 100g = RM1.60$$

$$Cost\ of\ fish\ food\ per\ 1g = \frac{RM1.60}{100g} = RM0.016$$

$$Cost\ of\ fish\ food\ at\ full\ storage = RM0.016 \times 150g = RM2.40$$

$$Cost\ of\ feeding\ per\ day = Feeding\ amount\ per\ day \times RM0.016$$

Table 4.4: *Cost analysis*

Designated amount of fish food	Amount of fish food per day	Cost of feeding per day
3g	6g	RM 0.10
6g	18g	RM 0.29
9g	27g	RM 0.43

CHAPTER 5:

CONCLUSION AND RECOMMENDATION

5.1 Introduction

In this final chapter, the overall conclusion based on the design and fabrication of automatic fish feeding system for home aquarium project is elaborated in detail. Furthermore, a few recommendations for future work or research were also listed, in terms of electrical and electronics; and mechanical.

5.2 Conclusion

From the result of the analysis made in previous chapter, it is found that with full storage capacity of 150gram, the automatic fish feeder machine can be operated approximately for 17, 8 or 6 days for 3g, 6g, 9g designated amount option respectively. This means that users have to be aware of how many days it takes before the fish feeder need to be refill with fish food. The machine specification can be read from Table 4.1. Besides that, from the experiment done to determine the amount of dispensed fish food it is revealed that suitable stepper motor input revolution for 3gram, 6gram and 9gram are 1.5 revolutions (6144 steps), 2.5 revolutions (10240 steps) and 3.5 revolutions (14366 steps) respectively. Even though, the experiment is done by trial and error, this finding is very important to control the step inputs of the stepper motor via Arduino Uno. As for the experiment to test investigate the design of the screw conveyor, it is confirmed that the angle of inclination of screw conveyor did not affect the allowable capacity or conveying process of the screw conveyor design for this project.

Nevertheless, there are some problems and setback occurs during the undergoing of this project. One of the setbacks is the design of the screw conveyor. Due to its size and dimension, the design used for this project cannot utilize the available equation for calculating the screw conveyor capacity and power. In the industry, the calculation and constant factors is used for huge loading and capacity; thus for this particular project, the calculation is not suitable. If the calculation can be made, more accurate amount of dispensed fish food can be determined and percentage error also can be determine by comparing the actual amount with the theoretical amount in Analysis A. Besides that, due to poor soldering skills the electrical components were not connected rightly and problems faced during microcontroller programming took so much time. Hence, troubleshooting of the electrical components needed to be done regularly and this has delayed the progression of this project. However after continuous testing and troubleshooting, the error arise is able to be reduced.

As for the overall conclusion, the design and fabrication of the automatic fish feeding system is successfully made. The accurate and suitable amount of dispensed fish food is also successfully determined. Besides that, a user interface and warning feedback were also have been implemented in this automatic fish feeding system. Even though there are some limitations to the design and also few problems arise during the undergoing of this project, however they are successfully solved through some adjustment and modification without changing the proposed objectives of this project.

5.3 Recommendation

As mentioned before, this automatic fish feeding system also have some limitation and setback. Thus, the following are the lists of recommendations or alternative for future work and research. In terms of electrical and electronics element, here is the list of what can be improved:

a) Use printed circuit board (PCB) technique to reduce the size of circuit board and save times and energy.
b) Upgrade the functionality of the fish feeding system by adding more user option to the user interface feature such as number of feeding sessions or exact feeding time.
c) Utilize the function of infra red sensor so that user can gives control input or instructions via remote control.
d) Adding user-friendly and safety features to the fish feeding system to ensure the safety of the pet fish and aquarist.

On the other hand, in terms of mechanical elements of this automatic fish feeding system, here is the list of what can be improved:

a) Fabricate the screw conveyor by CNC machining or rapid-prototyping to achieve more accurate dimensions and smooth finishing.
b) Increase the scale of the fish feeder machine so to expand the fish food storage. If the food storage is increase, then the fish feeder can operates for a longer time.
c) Design the screw conveyor following the standard screw conveyor design so that the calculation for conveyor capacity, speed and power can be determined.

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APPENDIX A – Arduino Uno Coding

```
#include <LiquidCrystal_I2C.h>
#include <Wire.h>
#include <SimpleTimer.h>
#include <AccelStepper.h>

#define HALFSTEP 8
#define motPin1 12     // IN1 on ULN2003 ==> Blue   on 28BYJ-48
#define motPin2 11     // IN2 on ULN2004 ==> Pink   on 28BYJ-48
#define motPin3 10    // IN3 on ULN2003 ==> Yellow on 28BYJ-48
#define motPin4 9    // IN4 on ULN2003 ==> Orange on 28BYJ-48

AccelStepper stepper1(HALFSTEP, motPin1, motPin3, motPin2, motPin4);
int endPoint1 = 4096;// 1 full rev
int endPoint2 = 2048; // half rev

LiquidCrystal_I2C lcd(0x27,2,1,0,4,5,6,7,3, POSITIVE);
SimpleTimer timer1, timer2, timer3;
int hours, mins, secs;
long counter1, mytime1, interval1 = 2880000; // 3session every 8 hour
const int butGRAM1 = 4;
const int butGRAM2 = 5;
const int butGRAM3 = 6;
int buttonState1 = 0;
int buttonState2 = 0;
int buttonState3 = 0;
```

```
void GRAM1()
{ stepper1.moveTo(endPoint1); // 1st full rev
  stepper1.setCurrentPosition(0);
  stepper1.moveTo(endPoint2); // 2nd half rev
  stepper1.setCurrentPosition(0); }

 void GRAM2()
{ stepper1.moveTo(endPoint1); // 1st full rev
  stepper1.setCurrentPosition(0);
  stepper1.moveTo(endPoint1); // 2nd full rev
  stepper1.setCurrentPosition(0);
  stepper1.moveTo(endPoint2); //3rd half rev
  stepper1.setCurrentPosition(0); }

void GRAM3()
{ stepper1.moveTo(endPoint1); // 1st full rev
  stepper1.setCurrentPosition(0);
  stepper1.moveTo(endPoint1); // 2nd full rev
  stepper1.setCurrentPosition(0);
  stepper1.moveTo(endPoint1);  // 3rd full rev
  stepper1.setCurrentPosition(0);
  stepper1.moveTo(endPoint2);  // 4th half rev
  stepper1.setCurrentPosition(0);}

void setup()
{     Serial.begin(9600);
    lcd.begin (16,2);

  for(int i = 0; i< 3; i++) //blink 3 times
```

```
{ lcd.backlight();
  delay(250);
  lcd.noBacklight();
  delay(250); }
  lcd.backlight();

stepper1.setMaxSpeed(1000.0);
stepper1.setAcceleration(600.0);
stepper1.setSpeed(700);

pinMode(butGRAM1, INPUT);
pinMode(butGRAM2, INPUT);
pinMode(butGRAM3, INPUT);

//LCD initial confg
lcd.setBacklight(HIGH);
lcd.setCursor(0,0);
lcd.print("WELCOME!");
lcd.setCursor(0,1);
lcd.print("AUTO FISH FEEDER");
delay(3000);
lcd.clear();
lcd.setCursor(0,0);
lcd.print("AMOUNT OF FISH ");
lcd.setCursor(0,1);
lcd.print("FOOD? 3g/ 6g/ 9g");
delay(6000);
lcd.clear();
```

```
  timer1.setInterval(28800000,GRAM1);
  timer2.setInterval(28800000,GRAM2);
  timer3.setInterval(28800000,GRAM3);

  lcd.print("Next Feeding:  ");
  delay(2000);
  mytime1 = millis() + interval1;
}

void loop()
{
   buttonState1 = digitalRead(butGRAM1);
   if (buttonState1 >= 1)
   {timer1.run();
   lcd.setCursor (4, 1);
   if (millis() > mytime1)
   mytime1 = millis() + interval1;
   counter1 = (mytime1-millis())/1000;
   hours = counter1 / 3600;
   counter1 -= (hours * 3600);
   mins = counter1 / 60;
   counter1 -= (mins * 60);
   secs = counter1;

   lcd.print(hours);
   lcd.print(":");

   if (mins < 10)
   { lcd.print("0");
```

```
 lcd.print(mins);}
else
 lcd.print(mins);
 lcd.print(":");

if (secs < 10)
{ lcd.print("0");
 lcd.print(secs);}
else
 lcd.print(secs);}

buttonState2 = digitalRead(butGRAM2);
if (buttonState2 == HIGH)
{timer2.run();
 lcd.setCursor (4, 1);
if (millis() > mytime1)
mytime1 = millis() + interval1;
counter1 = (mytime1-millis())/1000;
hours = counter1 / 3600;
counter1 -= (hours * 3600);
mins = counter1 / 60;
counter1 -= (mins * 60);
secs = counter1;

lcd.print(hours);
lcd.print(":");

if (mins < 10)
{ lcd.print("0");
```

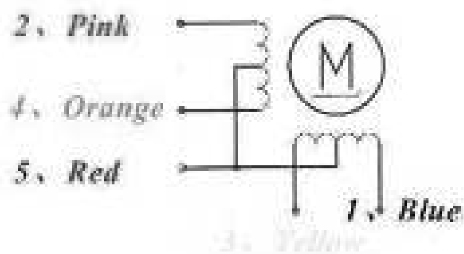
```
 lcd.print(mins);}
else
 lcd.print(mins);
 lcd.print(":");

if (secs < 10)
{ lcd.print("0");
 lcd.print(secs);}
else
 lcd.print(secs); }

buttonState3 = digitalRead(butGRAM3);
if (buttonState3 == HIGH)
{timer3.run();
 lcd.setCursor (4, 1);
if (millis() > mytime1)
mytime1 = millis() + interval1;
counter1 = (mytime1-millis())/1000;
hours = counter1 / 3600;
counter1 -= (hours * 3600);
mins = counter1 / 60;
counter1 -= (mins * 60);
secs = counter1;

lcd.print(hours);
lcd.print(":");

if (mins < 10)
{ lcd.print("0");
```

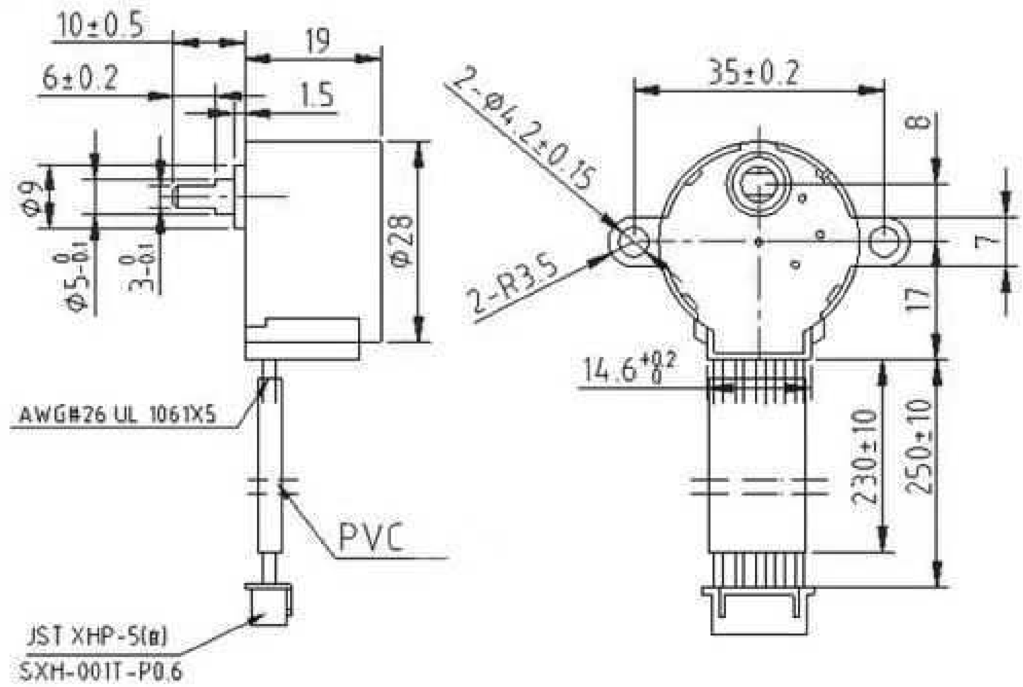
```
 lcd.print(mins);}
else
 lcd.print(mins);
 lcd.print(":");

if (secs < 10)
{ lcd.print("0");
 lcd.print(secs);}
else
 lcd.print(secs);}

stepper1.run();

}
```

28BYJ-48 – 5V Stepper Motor

The 28BYJ-48 is a small stepper motor suitable for a large range of applications.

Rated voltage :	5VDC
Number of Phase	4
Speed Variation Ratio	1/64
Stride Angle	5.625°/64
Frequency	100Hz
DC resistance	50Ω±7%(25℃)
Idle In-traction Frequency	> 600Hz
Idle Out-traction Frequency	> 1000Hz
In-traction Torque	>34.3mN.m(120Hz)
Self-positioning Torque	>34.3mN.m
Friction torque	600-1200 gf.cm
Pull in torque	300 gf.cm
Insulated resistance	>10MΩ(500V)
Insulated electricity power	600VAC/1mA/1s
Insulation grade	A
Rise in Temperature	<40K(120Hz)
Noise	<35dB(120Hz,No load,10cm)
Model	28BYJ-48 – 5V





P.O. Box 8231 Cherrywood Tauranga New Zealand Phone: ++64 7 578 7739 Fax: ++64 7 578 7749 E-mail: enquiry@kiatronics.com
Website: www.kiatronics.com

Atmel 8-bit Microcontroller with 4/8/16/32KBytes In-System Programmable Flash

ATmega48A; ATmega48PA; ATmega88A; ATmega88PA; ATmega168A; ATmega168PA; ATmega328; ATmega328P

SUMMARY

Features

- **High Performance, Low Power Atmel®AVR® 8-Bit Microcontroller Family**
- **Advanced RISC Architecture**
  - 131 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 20 MIPS Throughput at 20MHz
  - On-chip 2-cycle Multiplier
- **High Endurance Non-volatile Memory Segments**
  - 4/8/16/32KBytes of In-System Self-Programmable Flash program memory
  - 256/512/512/1KBytes EEPROM
  - 512/1K/1K/2KBytes Internal SRAM
  - Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
  - Data retention: 20 years at 85°C/100 years at 25°C(1)
  - Optional Boot Code Section with Independent Lock Bits
    - In-System Programming by On-chip Boot Program
    - True Read-While-Write Operation
  - Programming Lock for Software Security
- **Atmel® QTouch® library support**
  - Capacitive touch buttons, sliders and wheels
  - QTouch and QMatrix® acquisition
  - Up to 64 sense channels
- **Peripheral Features**
  - Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
  - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Six PWM Channels
  - 8-channel 10-bit ADC in TQFP and QFN/MLF package
    - Temperature Measurement
  - 6-channel 10-bit ADC in PDIP Package
    - Temperature Measurement
  - Programmable Serial USART
  - Master/Slave SPI Serial Interface
  - Byte-oriented 2-wire Serial Interface (Philips I^2C compatible)
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
  - Interrupt and Wake-up on Pin Change
- **Special Microcontroller Features**
  - Power-on Reset and Programmable Brown-out Detection
  - Internal Calibrated Oscillator
  - External and Internal Interrupt Sources
  - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby
- **I/O and Packages**
  - 23 Programmable I/O Lines
  - 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF
- **Operating Voltage:**
  - 1.8 - 5.5V
- **Temperature Range:**
  - -40°C to 85°C
- **Speed Grade:**
  - 0 - 4MHz@1.8 - 5.5V, 0 - 10MHz@2.7 - 5.5.V, 0 - 20MHz @ 4.5 - 5.5V
- **Power Consumption at 1MHz, 1.8V, 25°C**
  - Active Mode: 0.2mA
  - Power-down Mode: 0.1µA
  - Power-save Mode: 0.75µA (Including 32kHz RTC)

1. Pin Configurations

Figure 1-1. Pinout ATmega48A/PA/88A/PA/168A/PA/328/P

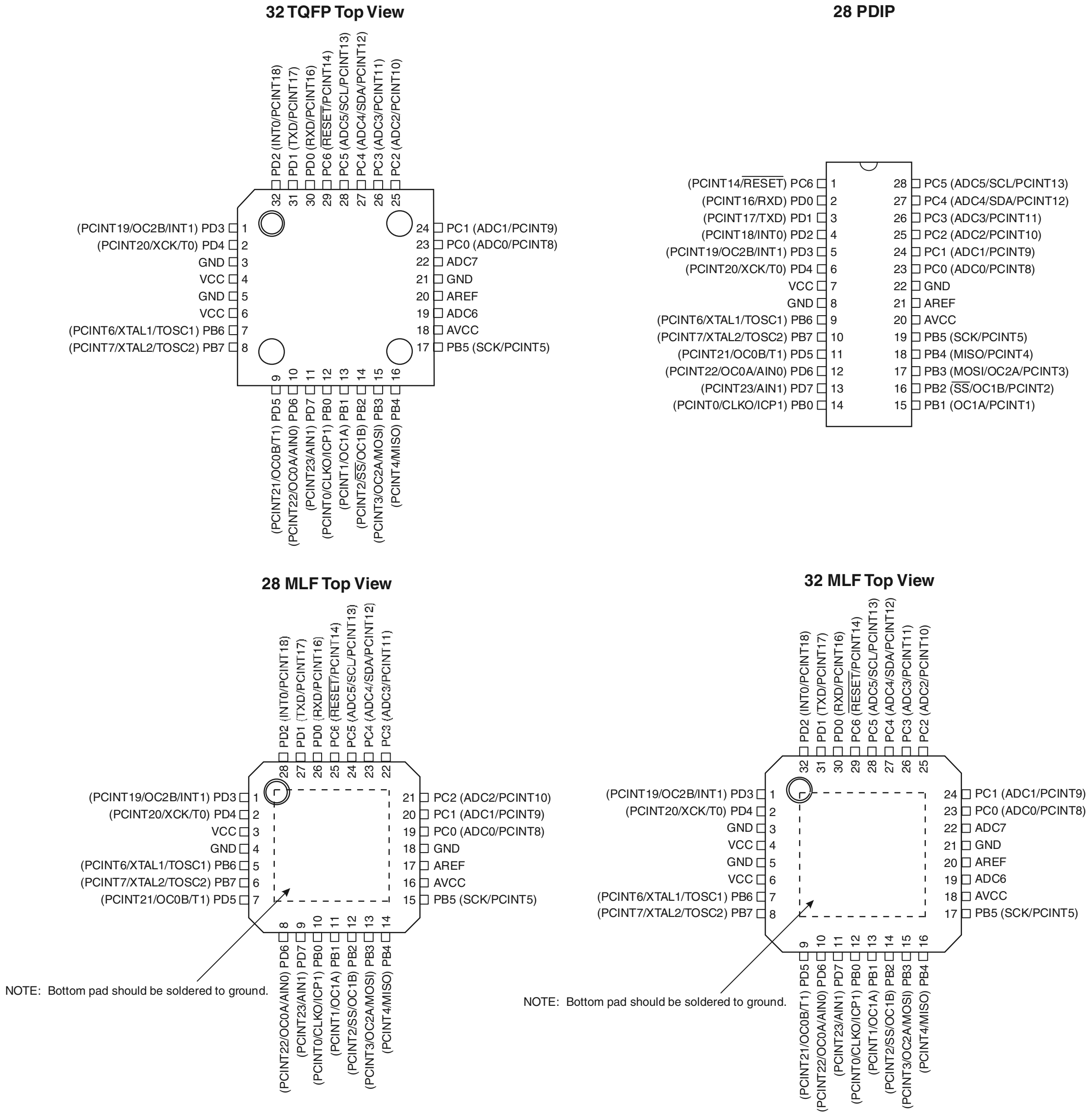
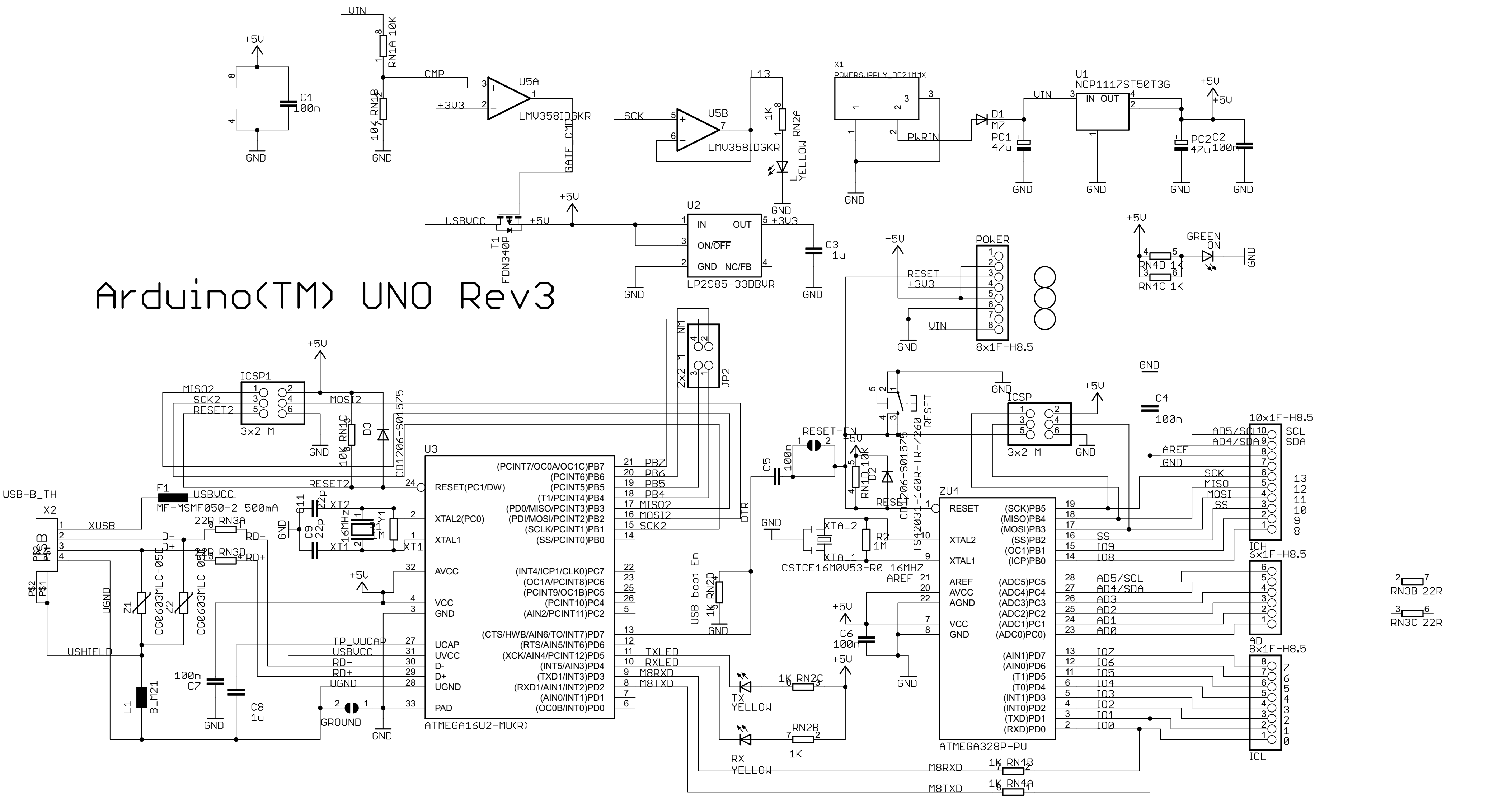


Table 1-1. 32UFBGA - Pinout ATmega48A/48PA/88A/88PA/168A/168PA

	1	2	3	4	5	6
A	PD2	PD1	PC6	PC4	PC2	PC1
B	PD3	PD4	PD0	PC5	PC3	PC0
C	GND	GND			ADC7	GND
D	VDD	VDD			AREF	ADC6
E	PB6	PD6	PB0	PB2	AVDD	PB5
F	PB7	PD5	PD7	PB1	PB3	PB4

Arduino(TM) UNO Rev3



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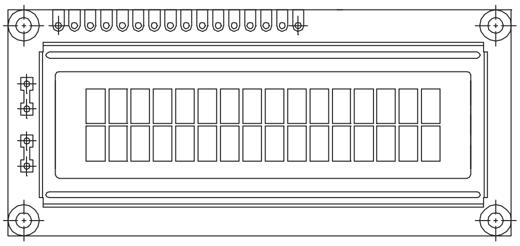
16 x 2 Character LCD



FEATURES

- 5 x 8 dots with cursor
- Built-in controller (KS 0066 or Equivalent)
- + 5V power supply (Also available for + 3V)
- 1/16 duty cycle
- B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED)
- N.V. optional for + 3V power supply

MECHANICAL DATA

ITEM	STANDARD VALUE	UNIT
Module Dimension	80.0 x 36.0	mm
Viewing Area	66.0 x 16.0	mm
Dot Size	0.56 x 0.66	mm
Character Size	2.96 x 5.56	mm

ABSOLUTE MAXIMUM RATING

ITEM	SYMBOL	STANDARD VALUE			UNIT
		MIN.	TYP.	MAX.	
Power Supply	VDD-VSS	- 0.3	–	7.0	V
Input Voltage	VI	- 0.3	–	VDD	V

NOTE: VSS = 0 Volt, VDD = 5.0 Volt

ELECTRICAL SPECIFICATIONS

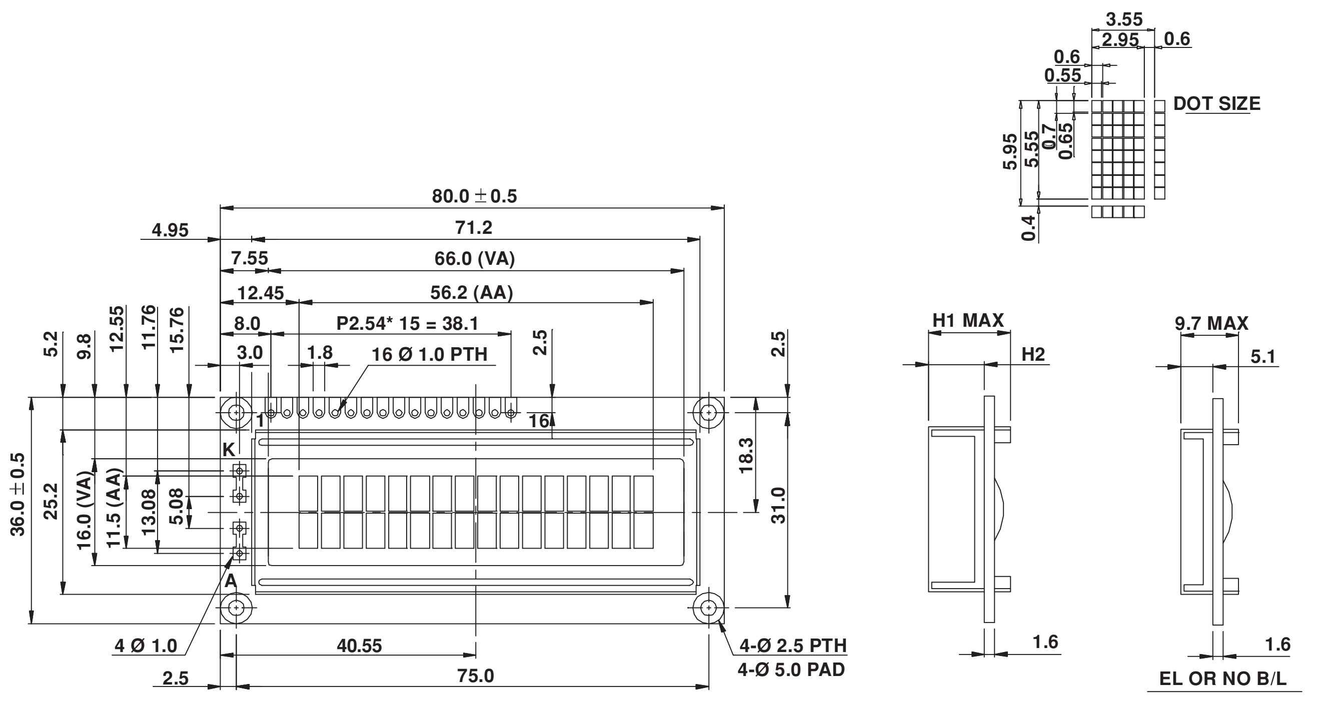
ITEM	SYMBOL	CONDITION		STANDARD VALUE			UNIT
				MIN.	TYP.	MAX.	
Input Voltage	VDD	VDD = + 5V		4.7	5.0	5.3	V
		VDD = + 3V		2.7	3.0	5.3	V
Supply Current	IDD	VDD = 5V		–	1.2	3.0	mA
Recommended LC Driving Voltage for Normal Temp. Version Module	VDD - V0	- 20 °C		–	–	–	V
		0°C		4.2	4.8	5.1	
		25°C		3.8	4.2	4.6	
		50°C		3.6	4.0	4.4	
		70°C		–	–	–	
LED Forward Voltage	VF	25°C		–	4.2	4.6	V
LED Forward Current	IF	25°C	Array	–	130	260	mA
			Edge	–	20	40	
EL Power Supply Current	IEL	Vel = 110VAC:400Hz		–	–	5.0	mA

DISPLAY CHARACTER ADDRESS CODE:

Display Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DD RAM Address	00	01														0F
DD RAM Address	40	41														4F

PIN NUMBER	SYMBOL	FUNCTION
1	Vss	GND
2	Vdd	+ 3V or + 5V
3	Vo	Contrast Adjustment
4	RS	H/L Register Select Signal
5	R/$\overline{W}$	H/L Read/Write Signal
6	E	H $\rightarrow$L Enable Signal
7	DB0	H/L Data Bus Line
8	DB1	H/L Data Bus Line
9	DB2	H/L Data Bus Line
10	DB3	H/L Data Bus Line
11	DB4	H/L Data Bus Line
12	DB5	H/L Data Bus Line
13	DB6	H/L Data Bus Line
14	DB7	H/L Data Bus Line
15	A/Vee	+ 4.2V for LED/Negative Voltage Output
16	K	Power Supply for B/L (OV)

DIMENSIONS in millimeters

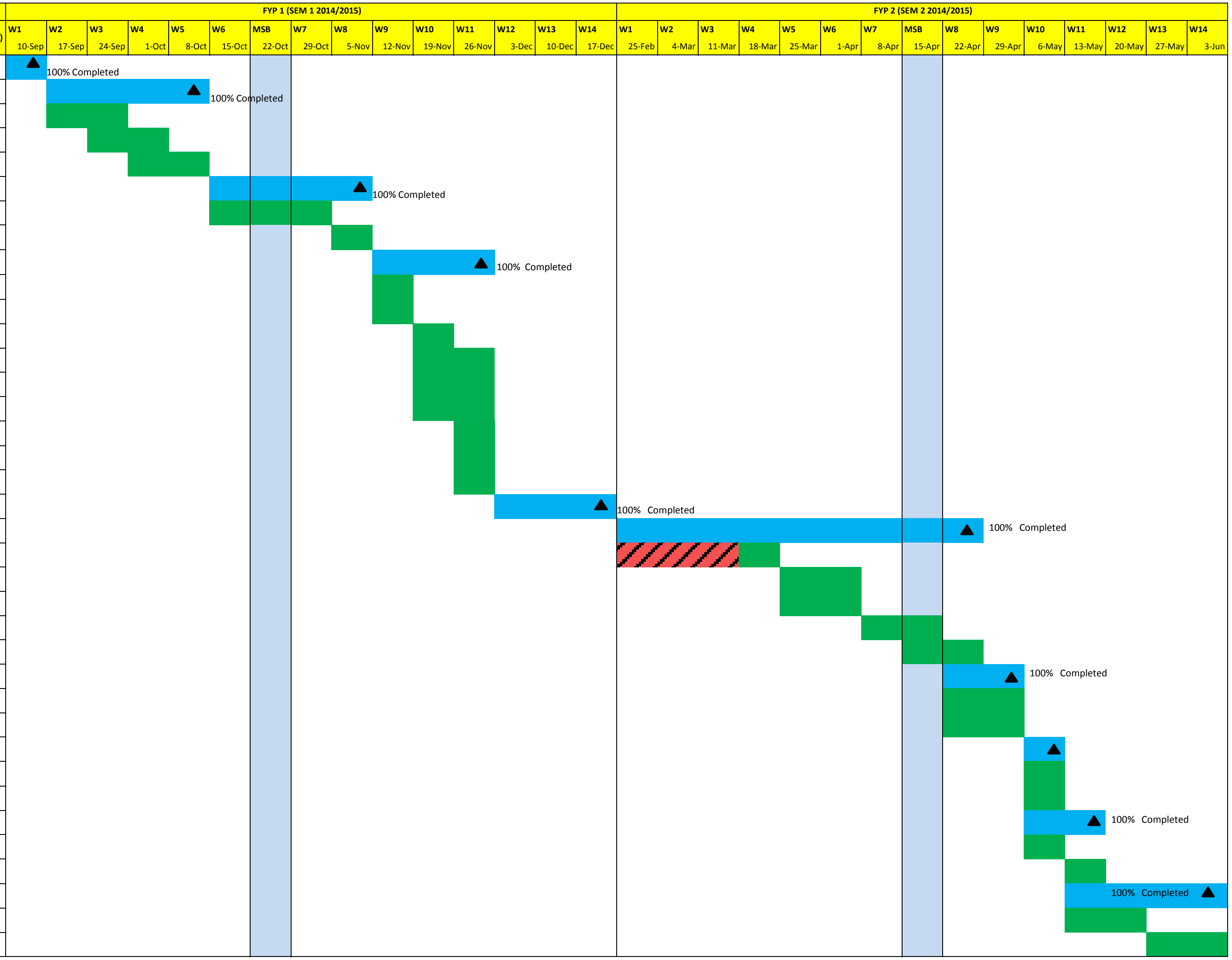


LED - H/L B/L

	HIGH	LOW
H1	13.2	12.1
H2	8.6	7.5

PROJECT: DESIGN & FABRICATION OF AN AUTOMATIC FISHING FEEDING SYSTEM FOR HOME AQUARIUM (1JJ)
STUDENT NAME: SITI AISYAH BINTI SAAHRI (FB11021)
SUPERVISOR NAME: DR.NORAINI BINTI MOHD RAZALI

Progress Report : #5			
Task No	**Task Description**	**Deliverables**	**Duration (Day)**
1.0	FYP Briefing	FYP Briefing	1
2.0	Project Background Research (Chapter 1)		30
2.1	Define project motivation	Project motivation	14
2.2	Define project problem statement & objective	Problem statement & objective	14
2.3	Define project scope & organization	Scope & organization	14
3.0	Project Literature Review (Chapter 2)		21
3.1	Review on precussor fish-feeding system design	Literature review report	15
3.2	Review on controller, transducer and actuator system.	Literature review report	7
4.0	Project Methodology (Chapter 3)		21
4.1	Define mechanical, electrical and software specifications	Machine general secification	7
4.2	Brainstorm, review and create the possible machine concepts	Sketches & flow chart	7
4.3	Finalize the machine details and specifications	Machine final specification	7
4.4	Design detailed mechanical components and assembly	Mechanical Components and Assembly CAD Drawing	14
4.5	Design electical circuits	Electrical Circuit CAD Drawing	14
4.6	Write program (coding)	Software	14
4.7	Design the manufacturing processes and specifications	Machine Process Specifications	7
4.8	Source and procure components	Components	7
4.9	Create bills of materials	Bills of Materials	7
5.0	FYP 1 Presentation & Final Report	Presentation + Report	1
6.0	Build and test the machine	Machine Prototype	49
6.1	Procure the mechanical and electrical components	BOM, receipt	5
6.2	Fabricate mechanical components	Mechanical Components	14
6.3	Fabricate electrical components	Electrical Components	14
6.4	Assembly of mechanical and electrical system	Assembled Machine	15
6.5	Testing, modification and delivery	Prototype Machine	14
7.0	Result Analysis and Discussion (Chapter 4)	Report MS5 - 21 Apr	30
7.1	Conduct an experiment and record machine performance		21
7.2	Study and analyse the machine performance		21
8.0	Conclusion and Recommendation (Chapter 5)	Report MS6 - 28 Apr	7
8.1	Create possible conclusion of the project		7
8.2	Identify possible recommendation for future works		7
9.0	FYP 2 Video + Poster	Video + Poster MS7 - 12 May	14
9.1	Draft and create FYP Video		7
9.2	Draft and create FYP Poster	Presentation + Report	7
10.0	FYP 2 Presentation & Final Report	Poster + Report	14
10.1	Finalize FYP Poster Presentation	Poster Presentation (20-22 May)	7
10.2	Finalize FYP Thesis	Thesis submission (24 June)	7



Task in progress | Task not in progress | Task not complete | Task complete