DESIGN AND IMPLEMENTATION OF AN AUTOMATIC COIN SORTING AND COUNTING MACHINE

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DESIGN AND IMPLEMENTATION
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AND COUNTING MACHINE

GOH CHIN GUAN

Thesis submitted in partial fulfillment of the requirements
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Dedicated, and appreciation for the understanding, encouragement and fully support to my beloved parents, and sisters.

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ABSTRACT

In this modern year, we can see that many automatic devices like drinking machine, washing machine, arcade game machine, massage chair and other coin operated machine using the automatic coin device to act as the coin counter and sorter. But, most of the coin counting machine in Malaysia is incapable to differentiate between the old and new Malaysian Coins accurately. The systems of the machine that are available in the market are not good enough because sometimes it makes mistake when detect the value of coin and cause the error calculation in the result. In this project, a coin operated machine which can differentiate old and new Malaysia coin accurately and automatically.is implemented. An automatic coin counting and sorting machine prototype is developed by using ARDUINO as the main controller. This work included design the simple display panel to show total quantity of each coin and total amount of coin value as the Crystal Display (LCD) has been implemented to display the result. The coin acceptor has been used as it acts as coin selector to determines the denomination of coin and forbid any invalid or unwanted coins. The coin sorting system is designed by using servo motor and the stepper motor to hold and distributes coin to the corresponding slot. Through the project, this integrated design has high performance for coin counting and sorting in terms of user-friendly, accuracy, and attractiveness.

ABSTRAK

Pada tahun moden ini, kita dapat melihat bahawa banyak peranti automatik seperti mesin minum, mencuci, permainan arked, kerusi urut dan lain-lain duit syiling mesin dikendalikan dengan menggunakan peranti syiling automatik untuk bertindak sebagai kaunter duit syiling dan tukang pilih. Tetapi, kebanyakan duit syiling mesin pengiraan di Malaysia tidak berupaya untuk membezakan antara syiling Malaysia lama dan baru dengan tepat. Sistem mesin yang terdapat di pasaran tidak cukup baik kerana kadang-kadang ia membuat kesilapan apabila mengesan nilai duit syiling dan menyebabkan pengiraan ralat dalam keputusan. Dalam projek ini, duit syiling yang dikendalikan mesin yang boleh membezakan lama dan baru Malaysia syiling tepat dan automatically.is dilaksanakan. Satu pengiraan syiling automatik dan menyusun mesin prototaip dibangunkan dengan menggunakan Arduino sebagai pengawal utama. Kerja-kerja ini termasuk mereka bentuk panel paparan mudah untuk menunjukkan jumlah kuantiti setiap syiling dan jumlah nilai duit syiling sebagai LCD telah dilaksanakan untuk mendapat keputusan seperti. Para penerima syiling telah digunakan kerana ia bertindak sebagai pemilih syiling untuk menentukan nama pengenalan syiling dan melarang mana-mana syiling tidak sah atau tidak dikehendaki. Sistem menyusun syiling direka dengan menggunakan motor servo dan motor pelangkah untuk memegang dan mengedarkan syiling untuk slot yang sama. Melalui projek ini, reka bentuk bersepadu ini mempunyai prestasi yang tinggi untuk mengira duit syiling dan pengasingan dari segi mesra pengguna, ketepatan, dan daya tarikan.

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LIST OF SYMBOLS

x   position at time t

v_0 velocity at time $= 0$

x_0 position at time $= 0$

a   acceleration

e_A back emfs induced in the A phase windings

e_B back emfs induced in the B phase windings

i_A A phase winding currents.

I_B B phase winding currents.

v_A A phase winding voltages.

v_B B phase winding voltages.

K_m Motor torque constant.

N_r Number of teeth on each of the two rotor poles

R   Winding resistance.

L   Winding inductance.

R_m Magnetizing resistance.

B   Rotational damping.

J   Inertia.

ω Rotor speed.

Θ Rotor angle.

T_d Detent torque amplitude.

LIST OF ABBREVIATIONS

LCD   Liquid Crystal Display

Emf   Electromagnetic Fields

CHAPTER 1

INTRODUCTION

1.1   PROJECT BACKGROUND

The creation of the coin counting and sorting machine is exist for the purpose to help people record down the quantity and total value of coin and divide the coin to corresponding slot automatically. The concept of the coin counter is mostly based on the detection of the dimension, weight, edge of credit pulses by using sensor. The coin sorting tray is designed to sort different type of coins based on the size of coin in different denomination (Richard E. McCarty, Jr., 2001). For the old design of the device, it is just a simple mechanical construction that only has the basic function of counting and sorting the coin and it has many limitations such as the limit of quantity of coins and fails to identify different coins accurately (Joseph J. Geib, Steven S. Kuhlin, 2001). Nowadays, the high technology has shown the improvement to the counting and sorting machine as the modern device becomes more advanced to running the counting and sorting process. Now, the device has the characteristic of simplicity, convenience and high efficiency as the counting and sorting machine can be computerize and it brings speed and accuracy to us. The coin counting and sorting system can be found in various device like vending machine, washing machine, drinking machine, message chair to help the machine handle the work of coin counting and sorting.

1.2   PROBLEM STATEMENT

Many of the coin operated machine in market is incapable to detect between the old and new Malaysia coin with high accuracy and this resulting coin value loose.

1.3   PROJECT OBJECTIVE

a) Implement a coin operated machine which can differentiate 10, 20 and 50 cent of old and new Malaysia coin accurately and automatically.

b) Implement the coin counting and sorting system to the machine by using microcontroller ARDUINO as the operating platform.

1.4   PROJECT SCOPE

The microcontroller ARDUINO is used as the processing unit to operate the automatic coin counting and sorting system of the machine. This project including the design of the simple display panel to show total quantity of each coin and total amount of coin value as the LCD has been implemented to display the result. The coin acceptor has been used as it acts as coin selector to determines the denomination of coin and forbid any invalid or unwanted coins. The coin sorting system is designed by using servo motor and the stepper motor to hold and distributes coin to the corresponding slot.

CHAPTER 2

LITERATURE REVIEW

2.1   INTRODUCTION

This chapter including the development of the coin operated machine from its early invention until latest modern today. This chapter has also discussed about the concept and theories of the coin operated machine to do the coin counting and sorting process. Analyzing and understanding from the literature review is important because it act as the guidance for the project.

2.2   EARLY INVENTION

In the early invention, the mechanical device of the coin machine is capable to do the counting and wrapping all kinds of coin – gold, silver, nickel, and copper in USA. It consists of a counting-board, a separate counting tube for each denomination and size of coin, and separate brass tubes for attacking and wrapping (Jens H. Molbak, 1888).

The process of operation is simple. A handful of coins of any denomination are placed in a counting-tube of the right size. The tube is then run rapidly over the grooved tracks of the counting-board, where they are deposited. Each track holds only ten coins. When the coins are all placed on the track, the board is slightly tilted, thus throwing the coins into the spaces between the tracks. One end of the board is then raised, and the coins quickly run down the aisles into the stacking-tube to the end of the tray. This tube contains a paper wrapper, which can easily be closed when the tube is opened. Formerly coin counting was a job for an expert, but this machine equals in speed and

accuracy the best of the old-time money-handlers known to banking fame (Jens H. Molbak, 1888)..
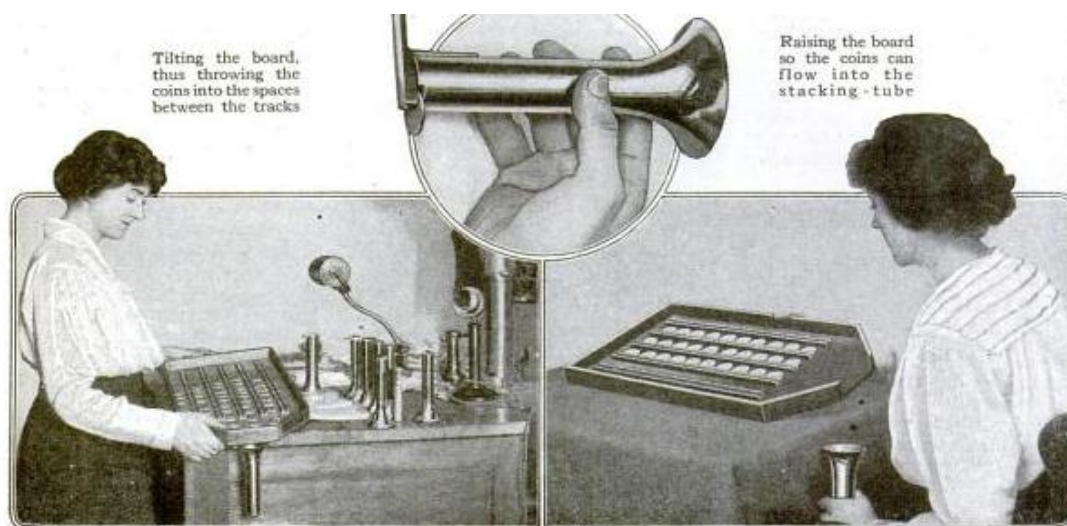
Figure 2.1: The early invention of the coin counting and wrapping machine

Source: Jens H. Molbak 1888

2.3   SENSOR IN COIN DISCRIMINATORS

Coin discriminators or commonly known as coin selector usually can be found in a coin-operated machine like vending machine, washing machine, drinking machine, or slot machine. The function of the coin selector is to determine the denomination of coin as well as to forbid any fake or invalid coin. The operation time to detect each coin is very fast as possible the consumer will not realize the delay between each insertion of the coin during the operation (Edward H. Bell, 2004).

In the structure of coin discriminators, it generally contains the structure and component like sensor for detect coin, coin entrance, avril, coin tubes and electronic circuit. For the mode of operation, the coin is insert to the coin slot and through coin path then passes through the sensor which is located at along the coin path to measure the coin's physical properties. The properties of coin like dimensions, weight, elasticity,

conductivity, and dropping time is measured based on the sensor used in the coin discriminator. Generally there are 4 sensor are commonly used, which is electromagnetic sensor, magnetic sensor, acoustic sensor, and optical sensor (Edward H. Bell, 2004).

The most commonly sensor that can be found in the conventional coin discriminator is the Electromagnetic sensor. This sensor is usually are the inductive sensor or Hall Effect sensor. The permanent magnet is normally place on the side of the coin path and the location of the magnetic sensor is directly opposite to the permanent magnet. A constant magnetic flux and magnetic field strength is generating across the coin path. When the coin is passes and go through the path, the coin will vary the magnetic flux density so that the initially form of the magnetic flux density in the space is been change, and this resulting specified change of the magnetic sensor and instantly induced the electromotive force (emf) . The induced emf's magnitude is influenced based on the metallurgical property like thickness and diameter of the coin. To detect the peak value of induced emf, the magnetic sensor is connected with an electronic sensor. Since different type of coin will produce specific peak voltage, it can be used to verify the validity of coin denomination (Earl Hovey C, 2001).

Besides that, there are other types of operation of magnetic sensor in coin discriminator that is implement the coin discrimination based on magnetic property with the oscillator circuit. Inductors and capacitors are usually used to build the oscillator circuit for this configuration of the magnetic sensor. When the coin is not exist, the oscillator circuit is at the predetermined frequency according to the value of components and configuration. The change in oscillating is occurring and the result will be change when the coin is detected based on the material and thickness of the coin (Earl Hovey C, 2001).

Secondly, the optical sensor is also widely used as the sensor to detect the coin in the coin discriminator. The secant segment of a coin at predetermined level is measure by using this sensor. This sensor is consists of the component of light emitting diode and light receiving phototransistor. This sensor is use to determine the diameter of the coin which the duration or delay between coin entering and leaving the barriers is stored (Earl Hovey C, 2001). If we assumed that the acceleration inside the path is

uniformly acceleration, the optical barriers consist of light emitting and light receiving placed at the same height need to be measured. Based on the equation 2.1, the time can measure based on the period when coin come enter the optical barrier and leave the optical barrier.

$$x = \tfrac{1}{2} at^2 + v_0 t + x_0 \qquad (2.1)$$

The third type of the sensor been used in the coin discriminator is acoustic sensor which consist of a microphone to gain the acoustic signal when the token or coin is hit to the anvil. The last type of the sensor that is commonly used is impact sensor that is used to measures the vibration or acceleration of coin when the impact is come on. This sensor is normally built by the piezoelectric materials and it is configured as accelerometers pressure sensors. The acoustic sensor and impact sensor is not practically because it is difficult to obtain the signal and then convert correctly to show the correct result (Earl Hovey C, 2001)..

2.4   COIN DETECTION AND RECOGNITION

The various techniques can be used to recognize and detect the coins of different denomination. The technique such as Circular Hough Transform, Artificial neural networks, heuristics approach has been used for the recognition of coin. The parameters such as size, weight, material have been used as the parameter to analyze and recognize the denomination of coin (Richard A. Mazur, G.Watts, Donald E. Raterman, Robert J. Crawford, 2001).

The steps of coin recognition to detect and recognize the coin is described. First, start the process and make the data capturing or also the data acquisition. Next, initialized the image segmentation process after the image is captured. The cropping of image is done after the coin image is been segmented. The feature of coin image for example texture and edge detection is been extracted. The calculation of the threshold value of grey scale image is obtained from the segmentation (Richard A. Mazur, G.Watts, Donald E. Raterman, Robert J. Crawford, (2001).
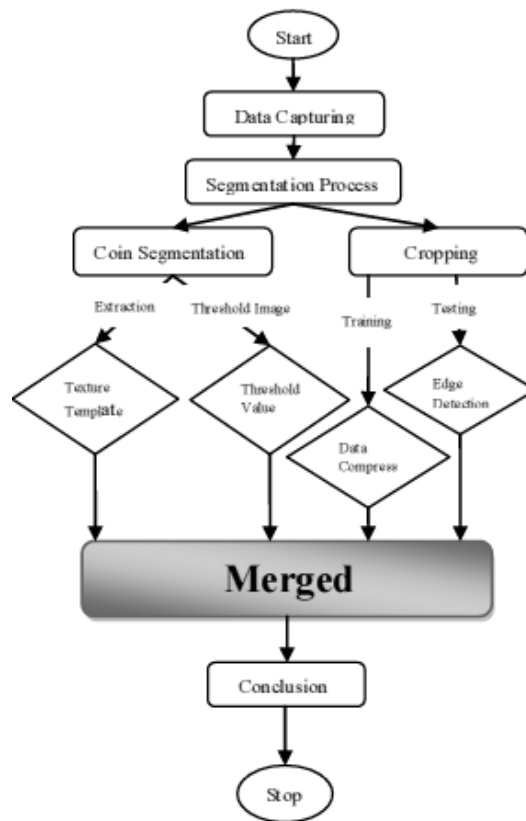
Figure 2.2: Flow Chart to represent the Recognition

Source: Richard A. Mazur, G.Watts, Donald E. Raterman, Robert J. Crawford 2001

2.5   COIN COUNTING PROGRAMMING

Various programming language can be used for the coin counting system. Below are the common languages that be used for the coin counting system:

- C
- C++
- Java
- Scratch
- Ruby
- Python

Besides counting the amount and quantity of the coin, the coin counting programming system can be view, print and save all counting results to the computer. A complete database can be built as the coin counting resulted can be saved. The example of the feature of using coin counting system are: upload coin counting results to computer, store counting results on computer, printing the counting results, have an overview of counting history(transaction history) and etc (Douglas A. Martin, 2012).

2.6   COIN OPERATED MECHANIC DESIGN

2.6.1   HIGH SPEED COIN SORTER WITH REDUCED SIZE

The invention of this coin sorter has the objective to provide a coin sorting system with operate at high speed and high accuracy in a size-reduced machine.

The coin sorter is including a rotatable disc which has a resilient top surface and also a stationary sorting head with the lower surface is positioned parallel to the upper surface of the disc. The sorting head from the lower surface create a numbers of coin exit doors for the purpose to sort and discharge different type and value of coins.. For the purpose to achieve one of the aims which is high number of coins in a small and size-reduced area, the coins are queued in a short gauging of length about 2 inches. So that, this short gauging region resulting the smaller diameter of the sorting head (Joseph J. Geib, Scott D. Casanova, Bogdan Kowalczyk, Glenn C. Gray, Steven S. Kuhlin, 2000).

The coin sorter is including a unitary base member. This unitary base member is recess in which the sorting head is inserted as it is automatically align with the rotatable disc. The unitary base member includes a number of integral coin chutes which each of the chutes will receives a particular coins exit doors and the coins are guided for each denomination (Joseph J. Geib, Scott D. Casanova, Bogdan Kowalczyk, Glenn C. Gray, Steven S. Kuhlin, 2000).
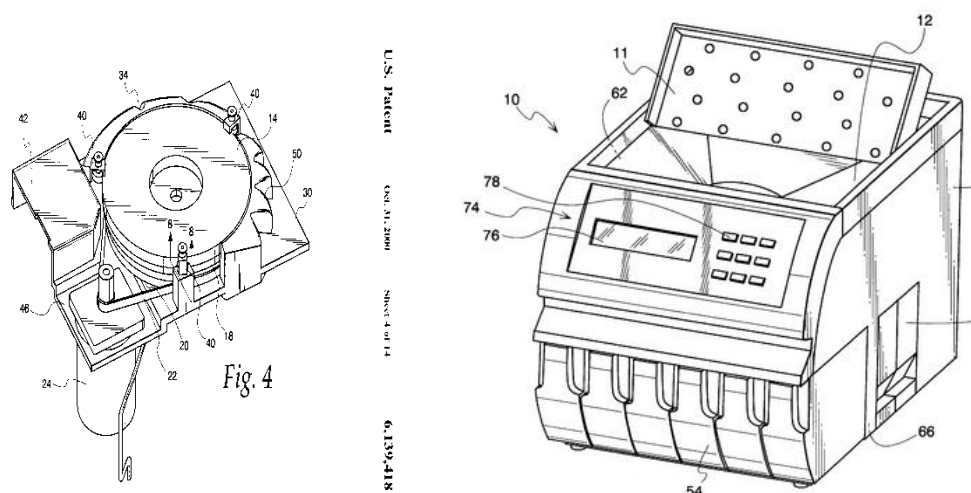
Figure 2.3: The design of the high speed coin sorter with reduced size.

Source: Joseph J. Geib, Scott D. Casanova, Bogdan Kowalczyk, Glenn C. Gray, Steven S. Kuhlin 2000

2.6.2   SENSOR-BASED COIN COUNTING MACHINE

The sensor-based coin counting machine is created with the capability of accepts a number of coins, count the coins and also displays the value and result to the end user.

The coin counting machine is consists of a coin discriminator sensor, a coin hopper with a container for receive numbers of coins, and a feed for accept the coins in the container to the coin discriminator sensor, and a controller for calculate the total value of the coins which is responsive from the coin discriminator sensor (Bruce R. Korman, August Golds, 2001).

The controller is controlling the container so that the coins have been extracted from the container by the feed. The feed is construct and build with a moveable backplate biased toward the container. The circular disc rotatably is also mounted to the moveable backplate, and the controller can dispense the coin by moving the backplate away from the container (Bruce R. Korman, August Golds, 2001).
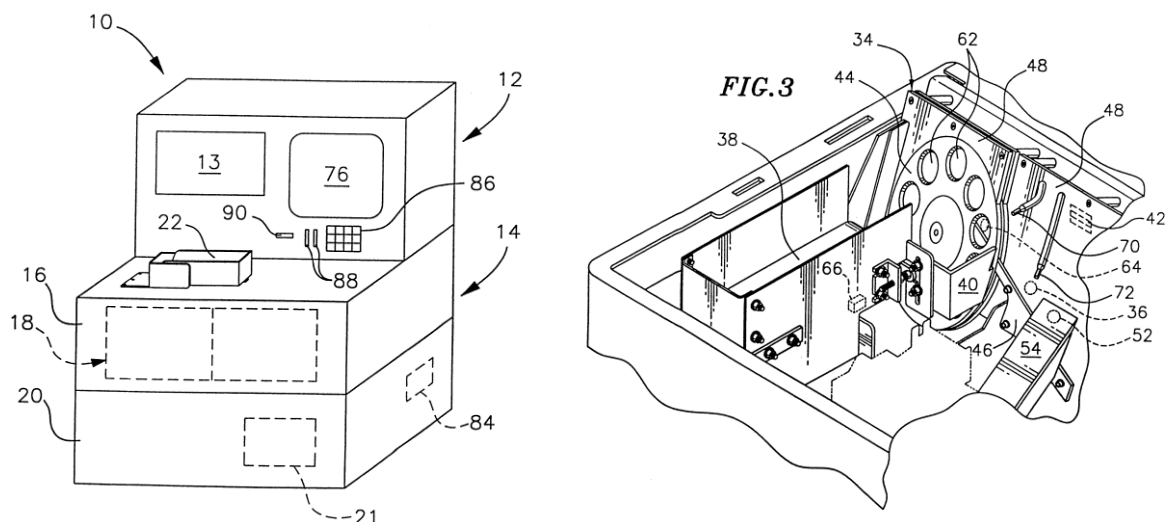
Figure 2.4: The design of the sensor-based coin counting machine.

Source: Bruce R. Korman, August Golds 2001

2.7   COMPARISON OF NEW AND OLD MALAYSIA COIN

As the target to be count and sort, the information about the Malaysian coin has been review as well. Malaysia 2nd series coins are introduced on 4 September 1989 as the Malaysian coins have the tradition and character design/theme. This series of coins are also known as "Cultural Artifact Series". The coin denominations issued at that time are 1, 5, 10, 20, 50 cent and 1 ringgit. The 1 cent and 1 ringgit is withdrawn from circulation from year 2005. On 25 July 2011, the Bank Negara Malaysia released Malaysia 3rd series coins. The coin denominations issued are 5, 10, 20, and 50 cent. We can still use Malaysia 2nd old coins when the 3rd series new coins start circulating (Malaysia Coin, 2011).

The 2nd series and 3rd series Malaysian Coins have different based on the size, diameter, thickness, weight, and material. Due to the different of 2 series of Malaysia coin, the coin have different denomination so that the parameter of the coin must be list down and been identify. This is because the coin recognition or detection are using the

parameter such as material or diameter to determine the value of coin. Table below are the detail show that the different between 2 series of coin (Malaysia Coin, 2011).

Table 2.1: Comparison between 2rd and 3nd series Malaysian Coin

Old Coin vs New Coin	Weight		Material		Diameter	
	Old Coin	New Coin	Old Coin	New Coin	Old Coin	New Coin
5 cent	1.41	1.72	Composite of Copper and Nickel	Steel	16.25	17.78
10 cent	2.82	2.98			19.40	18.80
20 cent	5.66	4.18		Brass	23.59	20.60
50 cent	9.33	5.66		Nickel Brass Clad Copper	27.76	26.65

Source: Malaysia Coin 2011

CHAPTER 3

METHODOLOGY

3.1   INTRODUCTION

This chapter is involved about the discussion to build the project which consists of hardware design and software design to complete the coin counter and sorter. The detail of each part will be discussed along with the figure related.
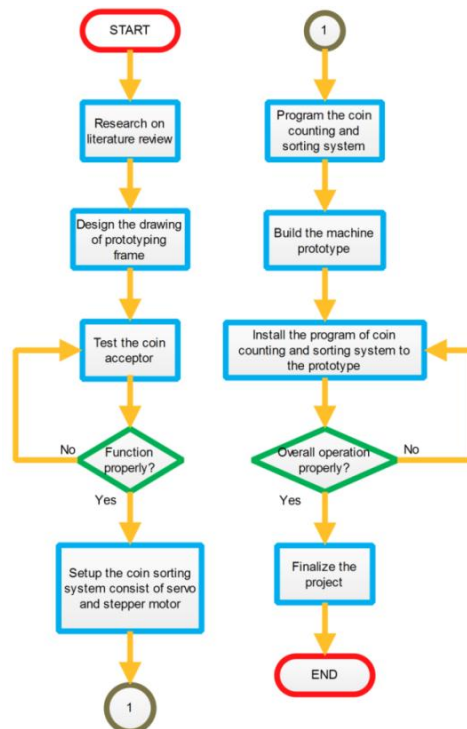
3.2   PROJECT FLOWCHART

Figure 3.1: Project Flowchart

Figure 3.1 shows that the overall flowchart to complete the project from the beginning to the end. First, start the project by revise literature review of related article, journal and scholar through online or the books in library. After that, the fundamental and the basic concept of the project will be known and understand. The concept to programming the counting system and the mechanism of build the sorting system should be clear. Next, the counting system will be designed as the coin acceptor is the device to count the coin value and it is interface to the computer through ARDUINO. The design of the counting system will be detail explained in the part below. Then, the sorting mechanism is being designed to allow 6 different coins to sort and store in the box respectively. The design of the sorting system will be detail explained in the part below. Next, both hardware and software is combine and assembly and the overall test to the machine is making to ensure that the machine is performing well. Finally, the data and result through the project is obtained to analysis the overall performance.
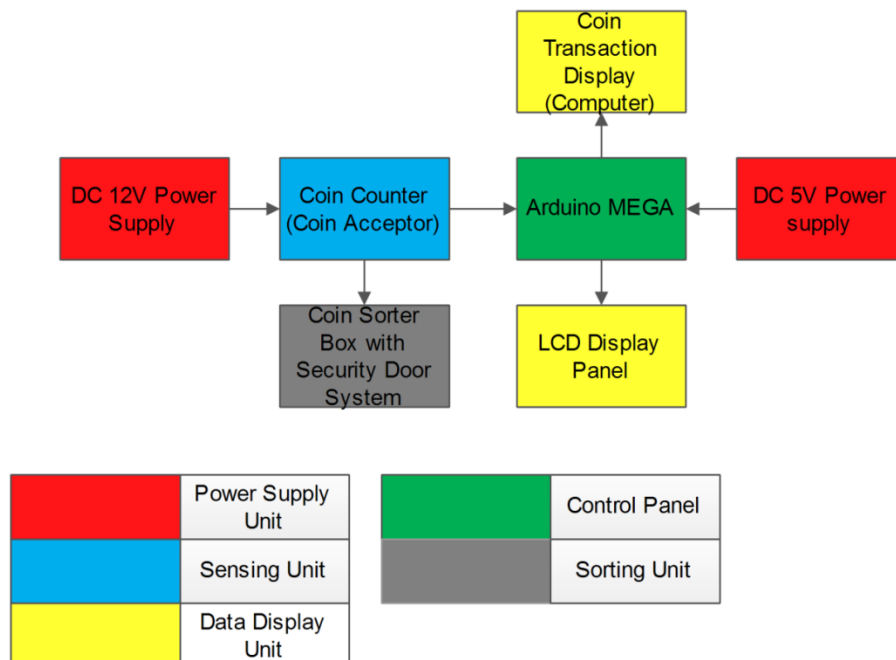
3.3   BLOCK DIAGRAM

Figure 3.2: Block Diagram of the Coin Counting and Sorting Machine

Figure 3.2 shows the overall block diagram of the project. It consists of five main parts which is the power supply unit, sensing unit, control panel, sorting unit and the display unit. The power supply unit consists of DC 12V power supply and DC 5V power supply is circuited to power on the coin acceptor and the microcontroller ARDUINO respectively. The sensing unit which is the coin acceptor is used to identify the 6 different Malaysia coins and forbid the foreign coin or counterfeit coin. The control panel which is the ARDUINO MEGA is the unit to count the quantity and total amount of the coin deposit in this machine. The sorting unit which is the coin sorting box is to sorting 6 different coins into the holder respectively. The security door system implement to the box that the coin only can be taking out if the correct password is enter. Otherwise, the magnetic door lock will remain lock and the user cannot open the sorter box. The display unit which include of LCD display unit to display the quantity and total amount of coin inserted, and the computer monitor unit are to display the coin transaction that record down all the history of the coin machine of each coin inserted with date and time.
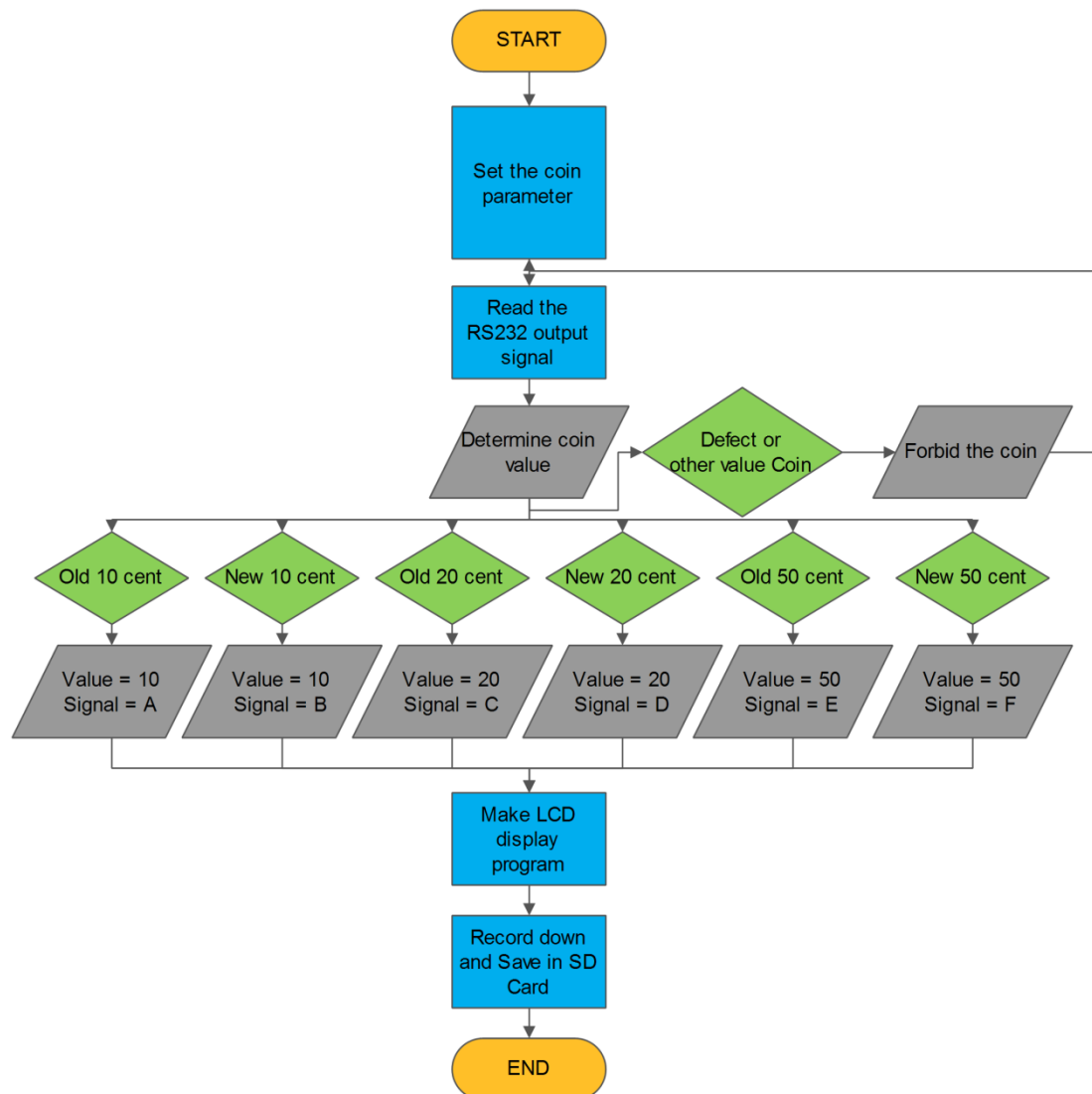
3.4 SOFTWARE DESIGN

Figure 3.3: The flowchart of coin counting system

Figure 3.3 shows the overall flowchart of the software design system. The project is using ARDUINO as the microcontroller to coding and makes the user-friendly display to the end-user. First, the ARDUINO is connected to the computer via USB cable and open the program 'ARDUINO' to start the coding.

```
if (pulses == 10)
    {
      Serial.println("Received 10 cent");
      money += .1;
    }
    else if (pulses == 20)
    {
      Serial.println("Received 20 cent");
      money += .2;
    }
    else if (pulses == 50)
    {
      Serial.println("Received 50 cent");
      money += .5;

     else if (pulses == 11)
    {
      Serial.println("Received new 10 cent)");
      money += .1;
    }
    else if (pulses == 21)
    {
      Serial.println("Received new 20 cent)");
      money += .2;
    }
    else if (pulses == 51)
    {
      Serial.println("Received new 50 cent");
```

Figure 3.4: Example of part of coding to identify new and old coin and count the value of coin

The coding as shown in Figure 3.4 is the example to identify new and old coin and count the value of coin. For example, if the coin value is RM0.10 (either old or new coin), the ARDUINO will receive the signal from the coin acceptor which is either 10 pulses or 11 pulses and thus the amount of money is been added by value RM0.10. To differentiate the value between new and old coin, setting of the signal from the coin acceptor must not be the same. For example, the pulse of old 10 cent and new 10 cent must be set as different value of signal like 10 pulses and 11 pulses respectively. So that, the machine can detects the difference of the coins.

For the LCD display unit, the user can check the total amount of coin deposit in this machine even without connect the machine to the computer. The user can use the

check button to scroll the content display in the LCD screen. When one of the coin slots is full, the display panel will remind and ask the user to withdrawn out the coins contain in the box.

3.5   HARDWARE DESIGN
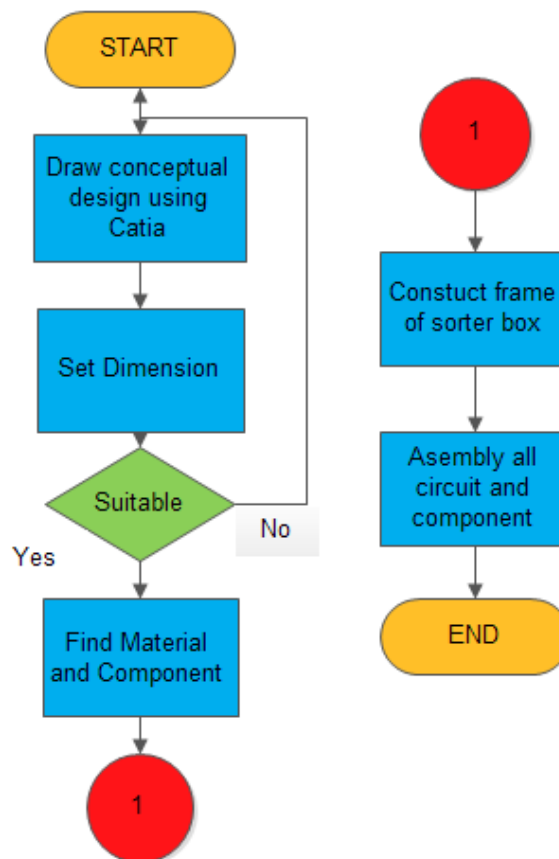
Figure 3.5: Flowchart of hardware design of coin machine

The process of coin runs though counting and sorting machine (the coin deposit machine) is shown as Figure 3.5. The coin is inserted into the coin acceptor to determine its value. If the coin is defect or counterfeit, the coin acceptor will reject the coin at the coin rejected door. If it is the old or new 10/20/50 cent, it will pass through the coin acceptor and reach the entrance of coin sorter. The servo motor will act as the holding arm to holding the coin and wait for the stepper motor to turn the rotary disc

which holding 6 coin slot to the correct position. After that the servo motor will open the gap of the holding arm and the coin will be drop down to its corresponding position.

3.6   COIN ACCEPTOR
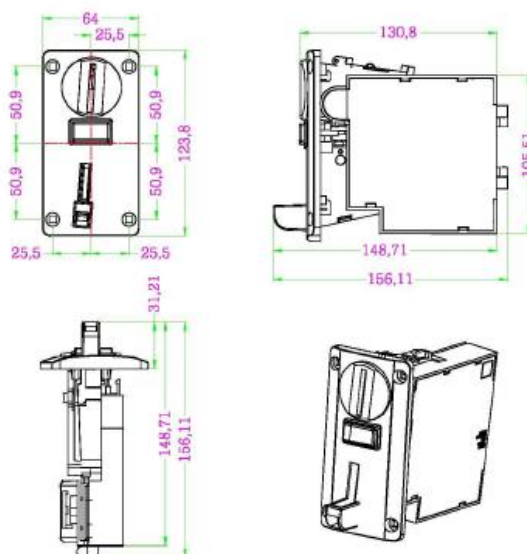

Figure 3.6: The coin acceptor model DG600F

Figure 3.7: Structure and dimension of the coin acceptor Model DG600F

Table 3.1: The pin configuration of the serial port of coin acceptor model DG600F

PIN	FUNCTION ACTIVE
1	+12V
2	Serial Signal Output
3	0 V
4	Counter Output Low
5	Inhibiting port

The procedure of coin parameter setting on coin acceptor is stated. First, button A is keep pressing till the 7-segment shown CP. When the 7-segmeny show CP, press the button A to select one of six groups of coins which C1, C2, C3, C4, C5, and C6. After that, pressing button A to display the word C1, and then press button B to display the value of coin as 00. Next, press the button B to adjust the value of coin from 01 to 99. After that, deposit the coins with same denomination for 20 times. When 20 coins is completely scanned, it will sound "bi.bi.bi". F is display on the 7-segment. Press button A to next group setting. Follow the step from step 3 to 6 to complete 6 group of coin parameter setting. After finish the setting, keep pressing button A and release when the 7-segment displays 88.

3.7   STEPPER MOTOR CONTROL

The calculation of the stepper motor is important because the rotary disc need to turn accurately to place 6 coin slot to the correct position which 6 different coins will be inserted during operation. The stepper motor is good in position control as we can control the angle by calculating the number of step of the motor. From Equation 3.1, the step of the stepper motor can be determined as the angle or one revolution can be set by using the equation. Usually the stepper motor has a size step of 1.8 degree.

$$\frac{\frac{360\ Degree}{1\ Revolution}}{\frac{1.8\ Degree}{Step}} = 200\ \frac{Step}{Revolution} \qquad (3.1)$$

As result, total of 200 steps is needed for rotate one revolution. Based on the Equation 3.1, the 6 degree of angle of coin slot can be calculate and decide. We can either using clockwise or anticlockwise to make the turning of the stepper motor to the rotary disc. Six number of step for corresponding coin slot will be used as the parameter in the coin sorting system.

Table 3.2: The angle of degree of coin slot to the size step of stepper motor

Coin	Angle of Degree (^{O})	Number of Step
Old 10 cent	60	33.33
Old 20 cent	120	66.66
Old 50 cent	180	100.00
New 10 cent	-120	-66.66
New 20 cent	-60	-33.33
New 50 cent	0	0

To control the mechanical output of the stepper motor, we need to use the input pulse trains, A and B based on the Equation 3.2 to 3.8 to obtain desired angular speed of shaft which is attach to the rotary disc.

$$e_A = -K_m \omega \sin(N_r\theta) \tag{3.2}$$

$$e_B = K_m \omega \cos(N_r\theta) \tag{3.3}$$

$$diA/dt = (v_A - Ri_A - e_A)/L \tag{3.4}$$

$$diB/dt = (v_B - Ri_B - e_B)/L \tag{3.5}$$

$$Jd\omega/dt + B\omega = T_e \tag{3.6}$$

$$T_e = -K_m(i_A - e_A R_m)\sin(N_r\theta) + K_m(i_B - e_B R_m)\cos(N_r\theta) - T_d\sin(4N_r\theta) \tag{3.7}$$

$$d\theta/dt = \omega \tag{3.8}$$

3.8 COMPONENTS AND MACHINE USED

Figure 3.8: 5mm Perspex

The Perspex (acrylic sheet) is used to build the frame of the prototype. The 5mm thickness of the Perspex is used to ensure that the frame has high strength and tough enough. After the Perspex is framed, it will be covered by the black sugar paper so that the overall of the prototype is presentable.

Figure 3.9: ARDUINO MEGA 2560

ARDUINO MEGA is act as the processing unit and it is used instead of ARDUINO UNO because the ARDUINO MEGA 2560 has more I/O pin than ARDUINO UNO due to this project need 29 digital pins connected to ARDUINO. Using ARDUINO MEGA is preferable as using ARDUINO UNO is easily running out of program space.

Figure 3.10: LCD with 2 X 16 display

Figure 3.11: Push Button

LCD 2x16 display is used so that 2 line of information can be shown (quantity of the coin and total amount of the coin). By using push button, the display panel can be scroll down so that 10, 20, and 50 cent of coin can be shown one by one.
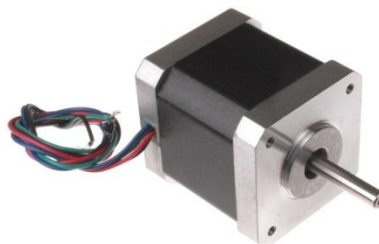

Figure 3.12: Servo Motor

Figure 3.13: Stepper Motor NEMA 17

Both servo motor and stepper motor is been used in the coin sorting system as the servo motor is attached with an arm and it's function is used to holding the coin drop from the coin acceptor and release when the stepper motor turn the rotary disc to its corresponding coin slot.
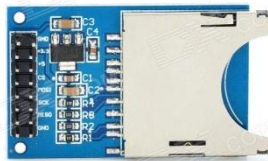
Figure 3.14: SD Card Module

The SD card module is used to store data and record of each coin inserted to the coin machine. The data will be record down in the text file (.txt file) and each transaction of the coin is list down with the current date and time.

Figure 3.15: 4X4 Keypad

Figure 3.16: Magnetic Door Lock

Keypad and magnetic door lock is used in the security door system as the user must be key in correct password otherwise the magnetic door lock will not release and the user cant taking out the coin from the box.

Figure 3.17: Drilling Machine

Source: Taizhou Feida 2014

Figure 3.18: 3D Printer
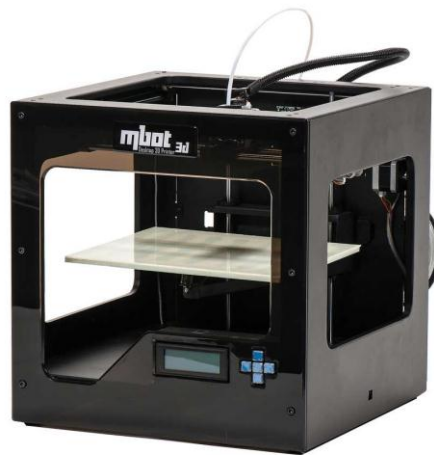
Source: Makerbot 2012

Drilling machine is used to drill 5mm hole for the purpose to screw and combine the Perspex. 3D printer is used to print the rotary disc that is connect to the stepper motor and this rotary disc is design with 6 hole (70mm diameter each) to holding 6 coin slot for the purpose to store the coin from the coin acceptor.
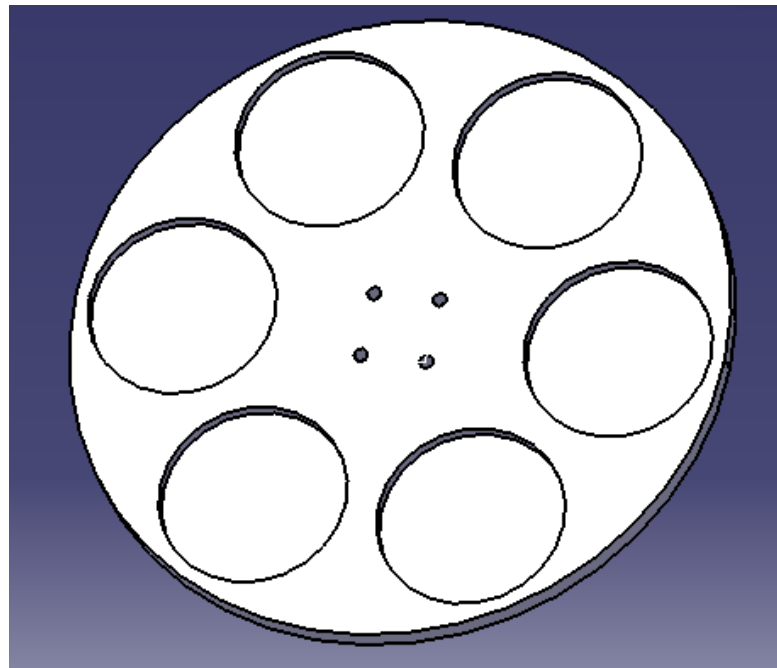

Figure 3.19: Design of rotary disc

CHAPTER 4

RESULT AND DISCUSSION

4.1   INTRODUCTION

In this chapter, the result is obtained and the performance of the coin counting and sorting machine is been investigate. The overall system of the prototype is completed and the testing of the prototype has been carried out to ensure obtained the high stability and the accuracy for the operation of the system. The resulted is obtained and indicated as the prototype of the coin counting and sorting is achieve to the requirement and meet the objective of the project.

4.2   HARDWARE PART OF THE PROTOTYPE

The coin counting and sorting machine is implement involve construction and integration. The major hardware part can be divided as coin counter, coin sorter, and security door. Each of the part is developed and assembly becomes the machine. The main frame of the prototype is using prespex (acrylic sheet) as the cover to support all the hardware part and form the coin counting sorting prototype.

Figure 4.1: The frame of the coin counting and sorting machine prototype

Figure 4.2: The frame of prototype covered with black sugar paper

Figure 4.3: The backside of the prototype consists of keypad and security door

Figure 4.4: The inner part structure of the prototype

4.3   COUNTING SYSTEM

The coin counting system is used to detect the inserted coin to ensure that only valid coins are accepted and forbid any unknown coin. The LCD display will display the quantity of the inserted coin and the total amount of coin value in the machine .The coin acceptor is function to determine the denomination of each coin and forbid any unknown coin. Three LED color will light up when: blue color indicate that the machine is in operation to sorting coin, green color indicate the machine is ready for the coin to be inserted, the red color indicate will remind the user that one or more than one coin slot is fully stored.

Figure 4.5: Display of 10 cent quantity and total amount of coin

Figure 4.6: Display of 20 cent quantity and total amount of coin

Figure 4.7: Display of 50 cent quantity and total amount of coin

Figure 4.8: LCD display after one 10 cent is inserted

Figure 4.9: LCD display after one 50 cent is inserted

Figure 4.10: Blue light indicator

Figure 4.11: Green light indicator

Figure 4.12: Red light indicator

4.4   SORTING SYSTEM

The main part of the sorting system is consists of one servo motor and one stepper motor. The servo motor is jointed with an acrylic plate as the holding space for the inserted coin. The stepper motor is jointed with rotary disc by using the coupling. The rotary disc has six storing place for the coin so means that up to 6 coins can be stored in the machine. During the operation, the servo motor will hold the coin after the coin is inserted and wait until the stepper motor to rotate the disc to its corresponding position of the coin. The angle of degree for each coin slot can be check at Table 3.2. The servo motor will drop the coin and the stepper motor will rotate back to default position.
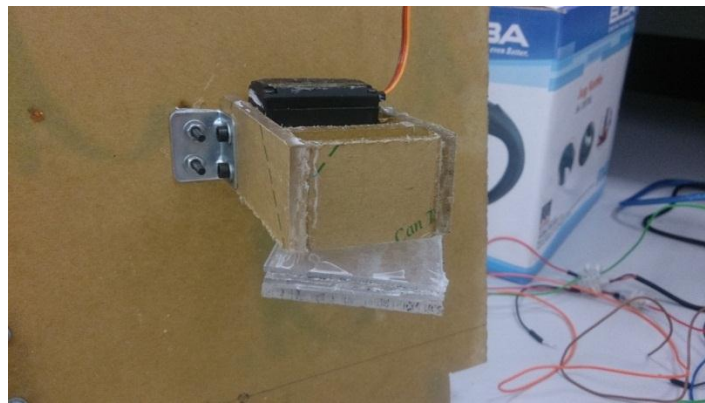

Figure 4.13: The servo motor with holding arm

Figure 4.14: Rotary disc with 6 coin slot

Figure 4.15: Old 10, 20, 50 cent coin slot storage

Figure 4.16: New 10, 20, 50 cent coin slot storage

4.5   SECURITY DOOR SYSTEM

The password system is consist of the 4x4 keypad and a magnetic door lock as the user can open the machine and taking out the coins there is stored in the machine only if the password is corrected. To open the security door, button B is pressed to reset and use keypad to enter the password. Then, button A is pressed after enters the password. If the password is correct, the magnetic door is released. Otherwise, the door remains locked. If the password is incorrect, button B is pressed to reset and need to enter the password again. After used, button C is pressed to lock the door.
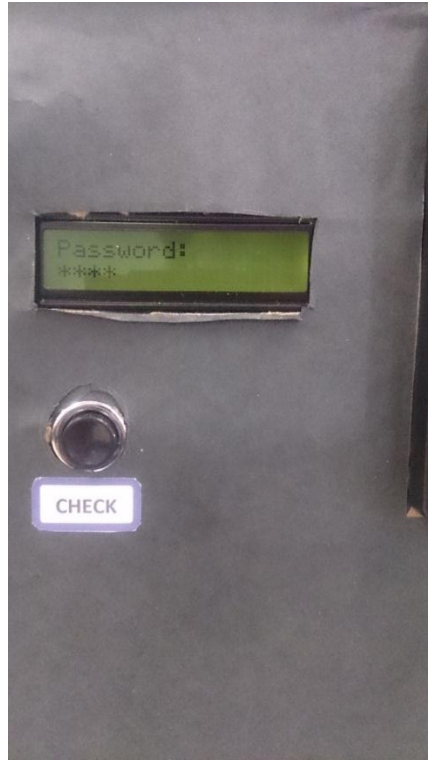
Figure 4.17: Password system display

Figure 4.18: Security door successfully opened
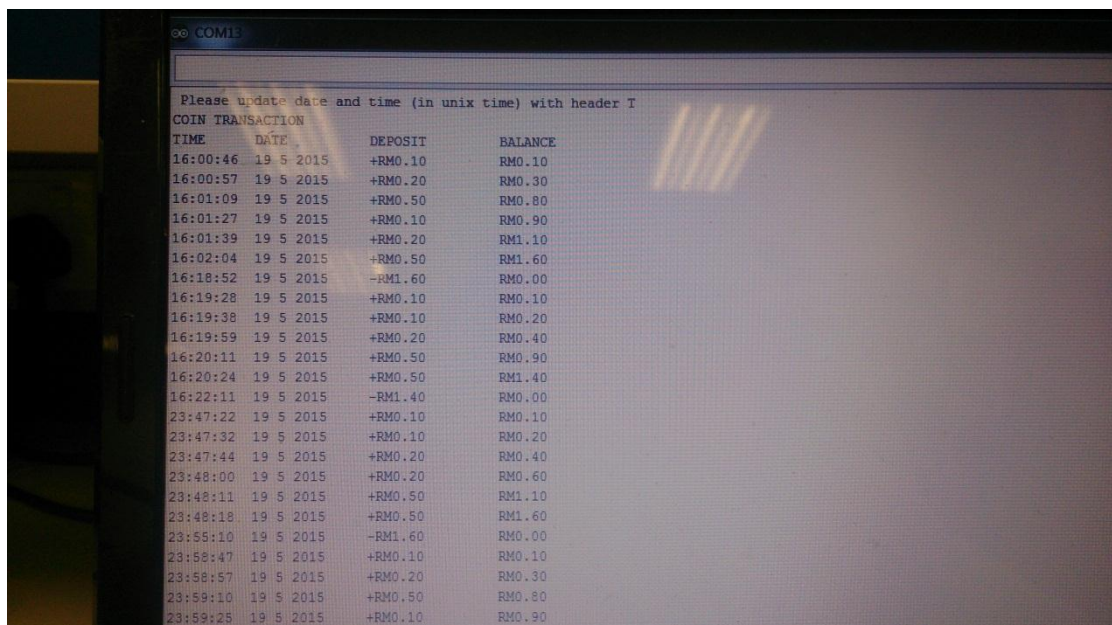
Figure 4.19: Security door cannot open with invalid password

Figure 4.20: Security door is locked

4.6 COIN TRANSACTION SYSTEM

Every coin inserted to the machine will be record and list down in the text file named 'BANKNOTE" and save to the SD card. The coin transaction record can be opened by insert the SD Card to the computer and open the text file "BANKNOTE". The coin transaction will note the coin value inserted and balance in the machine, as well as the current date and time of coin inserted. The date and time need to be updated when the machine is operated to ensure it has the correct date and time. The date and time must be entering with the format of UNIX TIME. UNIX TIME consists of 10 digits and it is the standard time format for the global time zone.

Figure 4.21: Coin transaction note

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1   INTRODUCTION

This chapter concludes the overall work that has been done in this project to meet the objective and solve the problem statement of the project. The suggestion and recommendation is been proposed for the project to make as an improvement for the future work if more accurate, stable, and functional result is needed for this project.

5.2   CONCLUSION

The design and fabrication of the automatic coin counting and sorting machine was successfully implemented by using ARDUINO. This machine has the user friendly interface system as the user can be easily understand to operate this machine for the coin counting and sorting process. This project has achieved the entire objective and solves the problem statement of the project and some features like security-door system had also add on to the machine. The overall result of the project is successful which the combination of mechanical, electrical, and the programming part is performing well.

5.3   RECOMMENDATIONS

Some recommendation has been suggest for the future work of this project

1. The denomination and properties of coin can be determine using image processing as the image processing is the artificial intelligent method with very

high percentage of success to classify an object. So the accuracy of coin detection can be increase.

2. The coin counting system should be update for the feature to counting more denomination of the coin so that all four type denomination of Malaysian coin (5, 10, 20 and 50 cents) can be identified.

3. The finger-print system can be act as the new method to unlock the security door system and it is the better option compare to the keypad system because the finger-print system is more secure which only the owner can unlock the door. Memorize the password to unlock the security can be also ignored if the finger-print system can be implement to this security-door system.

4. Using the concept of electromagnetic gates can increase the time to sort the coin as the electromagnetic gates can classify and sort the coin more efficient.

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APPENDICES A

ARDUINO CODING

(I) Code For Coin Counting and Sorting

```
long timeFromLastPulse = millis() - timeLastPulse;

  if (pulses > 0 && timeFromLastPulse > 200)
  {
   // sequence of pulses stopped; determine the coin type;
   if (pulses == 11)
   {

     digitalWrite(red, HIGH);
     digitalWrite(green, HIGH);
     digitalWrite(blue, LOW);
     delay(100);

     digitalWrite(forbid, LOW);

     lcd.clear();
     lcd.setCursor(0, 0);
     lcd.print("10 cent Qty:");

     ten +=1;
     amount +=0.1;
     aaa +=1;

     Serial.print("10 cent: ");
     Serial.println(ten);

     lcd.setCursor(13, 0);
```

```
lcd.print(ten);
//lcd.print(a);
//lcd.setCursor(0,1);
//lcd.print(a);

lcd.setCursor(0, 1);
lcd.print("Total: RM");
lcd.setCursor(9, 1);
lcd.print(amount);

writeSDSettings();
writeSDtenSettings();
delay(100);

// step one revolution  in one direction:
Serial.println("clockwise");
myStepper.step(33.3);
delay(1000);

myservo.write(45);
delay(1000);
myservo.write(0);
delay(1000);

// step one revolution in the other direction:
Serial.println("counterclockwise");
myStepper.step(-33.3);
delay(1000);

digitalWrite(forbid, HIGH);
delay(100);

digitalWrite(red, HIGH);
```

```
    digitalWrite(green, LOW);
    digitalWrite(blue, HIGH);
    delay(2000);


    digitalWrite(red, HIGH);
    digitalWrite(green, HIGH);
    digitalWrite(blue, HIGH);


    if (aaa>=3){
     //digitalWrite(forbid, LOW);
     //i = 5;
     lcd.clear();
     lcd.setCursor(0, 0);
     lcd.print("Slot reach limit");
     lcd.setCursor(0, 1);
     lcd.print("Pls remove!");
     digitalWrite(red, LOW);
     digitalWrite(green, HIGH);
     digitalWrite(blue, HIGH);
     delay(1000);
     digitalWrite(red, HIGH);
     digitalWrite(green, HIGH);
     digitalWrite(blue, HIGH);
     delay(1000);
     digitalWrite(red, LOW);
     digitalWrite(green, HIGH);
     digitalWrite(blue, HIGH);
     delay(1000);
     digitalWrite(red, HIGH);
     digitalWrite(green, HIGH);
     digitalWrite(blue, HIGH);
    }
}
```

(ii) Code for Security Door

```
//take care of some special events
  void keypadEvent(KeypadEvent eKey){
  switch (keypad.getState()){
  case PRESSED:

  Serial.print("Enter: ");
  Serial.println(eKey);
  delay(10);

  lcd.setCursor((passwd_pos++),1);

  Serial.write(254);

  switch (eKey){
    case 'A': passwd_pos  = 0; checkPassword(); delay(1); break;

    case 'B': password.reset(); lcd.clear(); lcd.setCursor(0, 0);
lcd.print("Password:");passwd_pos  = 0; delay(1); break;

    case 'C': lcd.clear();lcd.print("The Door is Lock");digitalWrite(doorlock,
HIGH);j=1;delay(1);

    default: password.append(eKey);lcd.print("*"); delay(1);
  }

  }

}

void checkPassword(){
```

```
if (password.evaluate()){  //if password is right open box

   lcd.clear();
   lcd.print("Door is Open");
   Serial.println("Accepted");
   digitalWrite(doorlock, LOW);
   j=0;
   Serial.write(254);delay(10);
   delay(500);



}else{

   lcd.clear();
   lcd.print("Invalid Password");
   Serial.println("Denied");
   digitalWrite(doorlock, HIGH); //if passwords wrong keep box locked
   j=1;
   Serial.write(254);delay(10);
   delay(500);

}
}
```

(iii) Code for SD Card Setting

```
void readSDSettings(){
  char character;
  String settingName;
  String settingValue;
  myFile = SD.open("abc.txt");
  if (myFile) {
  while (myFile.available()) {
  character = myFile.read();
  while((myFile.available()) && (character != '[')){
  character = myFile.read();
  }
  character = myFile.read();
  while((myFile.available()) && (character != '=')){
  settingName = settingName + character;
  character = myFile.read();
  }
  character = myFile.read();
  while((myFile.available()) && (character != ']')){
  settingValue = settingValue + character;
  character = myFile.read();
  }
  if(character == ']'){

  /*
  //Debuuging Printing
  Serial.print("Name:");
  Serial.println(settingName);
  Serial.print("Value :");
  Serial.println(settingValue);
  */
```

```
      // Apply the value to the parameter
      applySetting(settingName,settingValue);
      // Reset Strings
      settingName = "";
      settingValue = "";
      }
      }
    // close the file:
    myFile.close();
   } else {
   // if the file didn't open, print an error:
   Serial.println("error opening settings.txt");
    }
}
```

APPENDIX B

PIN ASSIGNMENT FOR ARDUINO MEGA 2560

To	Value	Enabled
Coin Acceptor RS232 Signal	Digital Pin 2	Yes
Forbid Switch	Digital Pin 4	Yes
LCD R/S	Digital Pin 34	Yes
LCD E	Digital Pin 35	Yes
LCD D4	Digital Pin 32	Yes
LCD D5	Digital Pin 33	Yes
LCD D6	Digital Pin 30	Yes
LCD D7	Digital Pin 31	Yes
Stepper Pin1	Digital Pin 14	Yes
Stepper Pin2	Digital Pin 15	Yes
Stepper Pin3	Digital Pin 16	Yes
Stepper Pin4	Digital Pin 17	Yes
Check Button	Digital Pin 9	Yes
Push Button	Digital Pin 8	Yes
Red LED	Digital Pin 5	Yes
Green LED	Digital Pin 6	Yes
Blue LED	Digital Pin 7	Yes
Servo	Digital Pin 12	Yes
Keypad Rows	Digital Pin 36,37,38,39	Yes
Keypad Columns	Digital Pin 40,41,42,43	Yes
SD Module CLK	Digital Pin 52	Yes
SD Module DO	Digital Pin 50	Yes
SD Module DI	Digital Pin 51	Yes
SD Module CS	Digital Pin 53	Yes

APPENDIX C1

GANTT CHART FOR FYP 1

NO	TASK	STATUS	WEEK													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Register For FYP Title	P	On Plan													
		A	Done													
2	Discuss topic with Supervisor	P	On Plan													
		A	Done													
3	Complete Executive Summary	P		On Plan	On Plan											
		A		Done	Done											
4	Search Information	P				On Plan	On Plan									
		A				Done	Done									
5	Complete Chapter 1(Introduction)	P				On Plan	On Plan									
		A				Done	Done									
6	Prepare Background	P						On Plan	On Plan	On Plan						
		A						Done	Done	Done						
7	Complete Chapter 2(Background)	P						On Plan	On Plan	On Plan						
		A						Done	Done	Done						
8	Plan Flowchart And Procedure	P									On Plan	On Plan	On Plan			
		A									Done	Done	Done			
9	Complete Chapter 3(Methodology)	P									On Plan	On Plan	On Plan			
		A									Done	Done	Done			
10	Material/Tool Order List	P												On Plan	On Plan	
		A												Done	Done	
11	Complete FYP 1 Report	P												On Plan	On Plan	
		A												Done	Done	
12	Present FYP 1	P														On Plan
		A														Done

P = Plan
A = Action

On Plan		Pending
Done		

APPENDIX C2

GANTT CHART FOR FYP2

NO	TASK	STATUS	WEEK													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Preparing Material	P	▮	▮	▮											
		A	▰	▰	▰											
2	Compiling Programming Part	P				▮	▮									
		A				▰	▰									
3	Build Mechanical Part	P						▮	▮							
		A						▰	▰							
4	Circuit Electrical Part	P								▮						
		A								▰						
5	Assembly Prototype	P								▮						
		A								▰						
6	Testing	P									▮					
		A									▰					
7	Complete Chapter 4 (Result and Discussion)	P									▮					
		A									▰					
8	Complete Chapter 5 (Conclusion)	P										▮				
		A										▰				
9	Preparing Poster FYP	P											▮	▮		
		A											▰	▰		
10	Present FYP 2	P													▮	
		A													▰	
11	Complete FYP Thesis	P														▮
		A														▰

P = Plan
A = Action

▮	On Plan	▮	Pending
▰	Done		

APPENDIX D

DATASHEET

PBC LINEAR
A PACIFIC BEARING CO.

Stepper Motor NEMA 17

This document describes mechanical and electrical specifications for PBC Linear stepper motors, including standard, hollow, and extended shaft variations.
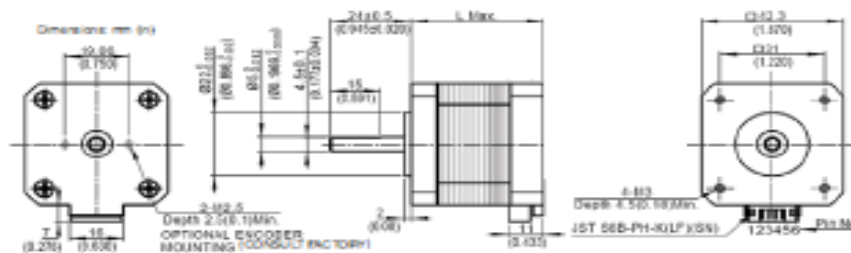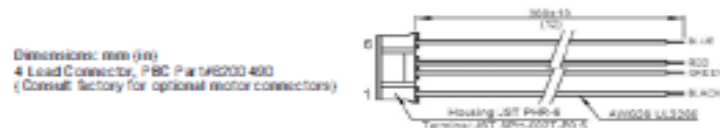
Phases	2
Steps/Revolution	200
Step Accuracy	±5%
Shaft Load	20,000 Hours at 1000 RPM
Axial	25 N (5.8 lbs.) Push
	85 N (15 lbs.) Pull
Radial	29 N (6.5 lbs.) At Flat Center
IP Rating	40
Approvals	RoHS
Operating Temp	-20° C to +40° C
Insulation Class	B, 130° C
Insulation Resistance	100 MegOhms

Standard shaft motor shown.

Description	Length	Mounted Rated Current	Mounted Holding Torque		Winding Ohms	mH	Detent Torque		Rotor Inertia		Motor Weight	
(Stack)	"L" Max	Amps	Nm Typ.	oz in Typ.	±10% @ 25°C	Typ.	mNm	oz in	gcm2	oz in2	kg	lbs
Single	33.8 mm (1.5 in)	2	0.48	68	1.04	2.2	15	2.1	57	0.31	0.28	0.62
Double	48.3 mm (1.90 in)	2	0.63	89	1.3	2.9	25	3.5	92	0.46	0.36	0.79
Triple	62.8 mm (2.47 in)	2	0.83	120	1.49	3.8	30	4.2	123	0.67	0.6	1.3

*All standard motors have plug connector. Consult factory for other options.

Standard shaft dimensions shown. All other dimensions apply to hollow and extended shaft options.
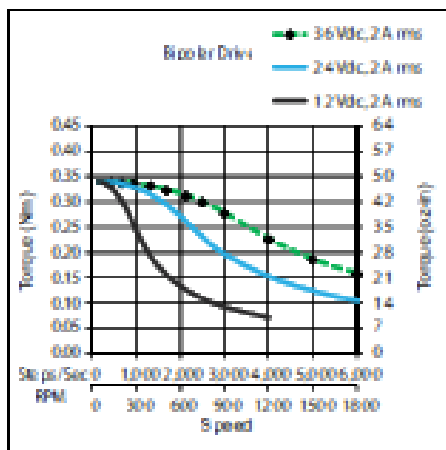
Dimensions: mm (in)
4 Load Connector, PBC Part #6200.400
(Consult factory for optional motor connectors)

LINEAR MOTION SOLUTIONS | www.pbclinear.com
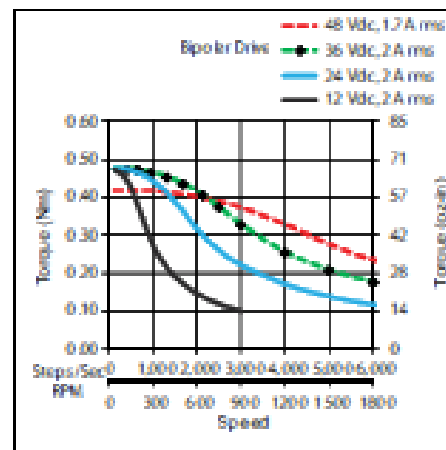
![PBC LINEAR - A PACIFIC BEARING CO.]
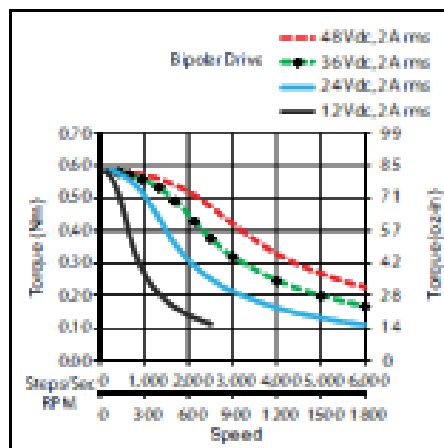
NEMA 17 **Stepper Motor**

*Performance curves apply to continuous duty cycles.
Consult factory for intermittent cycles or other voltages.*

Single Stack

Double Stack

Triple Stack

DG600F
Coin Acceptor
Technical Manual

2. Introduction

DG600F Series of coin acceptor is a electronic coin acceptor with high reliability, Which is widely used in amusement facilities, vending machines and so on.

2.1 Main Features:

➢ Enable to recognize 6 groups of coins in different denomination. (can exceed to 8 groups if need)
➢ Enable to forbid accepting all coins
➢ Industrial standard connector ---10Pin Parallel port
➢ Special connector ---5Pin Serial port
➢ Enable to release coins in jam
➢ Enable to self-diagnose

### 2.2 Specification:

➢ **Coin Size:**

Diameter:	17 – 30.5mm
Thickness:	1.25 – 3.2mm

➢ **Working Environment:**

Working Temperature:	0℃ to 50℃
Storage Temperature:	-30℃ to55℃
Ambient Humidity:	Up to 95% RH non-condensing
Working Voltage:	Normal 12VDC
	Min 10VDC
	Max 15VDC
Working Current:	Standby 50mA
	Max 450mA （At the instant of collecting coin）
Communication Interface:	Standard parallel port – 10Pin
	Special serial port -- 5Pin
Installation Position:	On any plane, the angle can't be more than 2 degrees between coin acceptor and vertical

4.3 Serial Signal Output

Serial signal output consists of a NPN transistor

◎ Signal output port
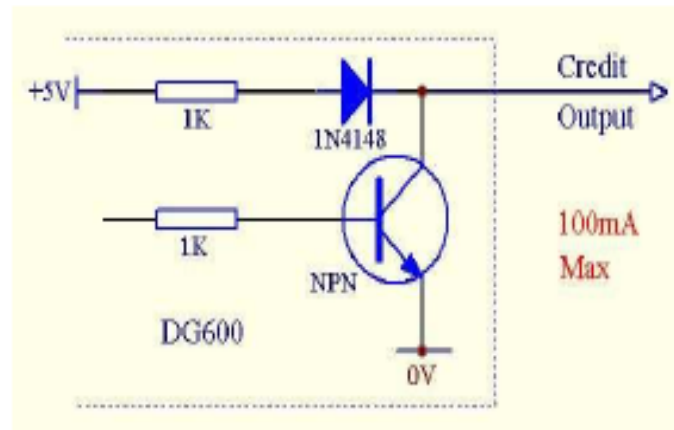
➤ In serial pulse signal output mode, on acceptance of enough coins (no less than machine charge amount), NPN transistor is turned on for a period of 25ms/45ms/65ms/100ms (+/-20%).

Machine will detect not only the edges of credit pulses, but also credit pulses width is not less than 20ms in valid, as to eliminate noise or incorrect pulse in output line 。

Note: It can set the period of 25ms/45ms/65ms/100ms in coin acceptor parameter A2.

➤ In serial RS232 signal output mode, on acceptance of enough coins (no less than machine charge amount), NPN transistor is turned on by RS232 signal

➤ Output signal quantity= Deposited coin amount / Machine charge amount

E.G.:

Coin $0.1 is set as 01, coin $0.5 is 05, coin $1.00 is 10, machine charge amount is set as 02. It means that,

Deposit 2pcs of coins $0.1 to send out a signal

Deposit a coin of $0.5 to send out 2pcs of signals and remain a coin $0.1 amount

Deposit a coin of $1.00 to send out 5pcs of signals