RESEARCH ARTICLE OPEN ACCESS

Microcontroller Based Coin Counter with Segregator and Packing System

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Abstract:

This study is focused on providing automation and elimination of errors occurring in coin sorting and handling. This study usestheGizduino ATMEGA 328 microcontroller and Arduino programming language respectively. The machine will only process the Philippine peso coins: one peso, five peso and ten peso. The final output of the system is the packed twenty pieces of coins of the three denomination mentioned. The machine passed the over all evaluation of the committee. Hence the result indicates that the machine is of good quality evidently to be technically and physically functional, capable of performing its system process.

Keywords — **coin sorting, coin segregator, automated coin packing**

I. INTRODUCTION

In the Philippines, the first coins were used in 1861. Until now, people still use coins in their everyday lives. Ther are those that deal with coins everyday like banks, tranport groups, casinos, charitable instituitions and the like [1].

Coin counter technology is one of the basic technological methods today. Aside from bank use, it is also consumed by people from medium to large scale business. Meanwhile, a coin segregator is another technological advancement in the banking industry. Coin sorting machines have the ability to sort from a random collection of coins into separate bins for different denomination.

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[2].

The Filipinos are too inclined in retail than in wholesale. With this, the researchers suggest that this demand should be given attention. In connection to this, the business industry uses coins in wide variety nowadays. This made the researchers to come up with the idea of coin sorting, counting and packing system.

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[3].

This study intends to develop a system that counts, sort and pack different coins automatically and aims to manifest the principles of an actualmicrocontroller-based counting, sorting, and packing system of coins that aims to (automate

counting sorting and repacking in banks and other institutions).

The design and development of the research is expected to provide more efficient coin handling performance. Instead of spending too much manual labor in coin handling, the project aims to obtain automation in coin segregating, counting and packing.

The extent of the coin segregator covers only 3 different coins namely 1, 5 and 10 Philippine peso coins. After the segregation of coins, it will be packed by twenty piles at the packing station.The maximum load on the coin hopper shall be limited of 40- 60 coins and limited to 20 piles of packed coins.

II. METHOD

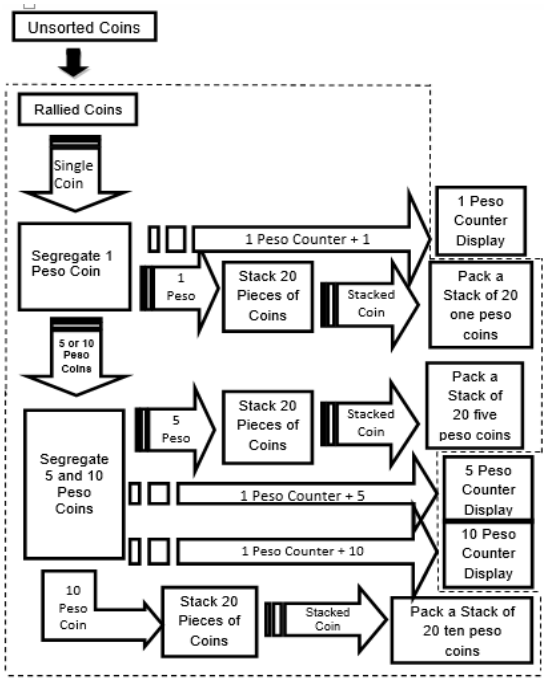

Fig. 1 Process flow of the system

Fig. 1 shows the flow of the system. The process begins when random collection of coins is poured to the coin hopper; the spinning disc on the hopper continuously spins taking one coin at a time to transport to the hole on the hopper. The one peso coin passes through a proximity sensor for it to be counted and goes to the coin bin. The counter display for one peso then displays the number of one peso coin that passed through the proximity sensor. However, if the coin is either five peso or ten peso, the coin goes to the coin feeder and then to the coin slot. The coin slot identifies the coin and at the same time counts the coin. After the coin is identified, it goes to the coin bin ready for segregation. The sensor in the coin slot gives off pulse to the microcontroller; the microcontroller then interprets the pulse given by the sensor. After which, the microcontroller sends signal to the segregator servo. The segregator servo moves to either left or right depending on the signal given by the microcontroller. The segregated coins go into its respected coin bin. Whenever the coin counts reach the count of 20, the coin goes to the conveyor and then through a heater for packing. The packed coins then goes to a collecting bin as finish output.

A. Design and Development

Fig. 2 is the isometric view of the coin counter with segregator. The machine was assembled using acrylic sheets and was installed with different components like the servo motor, microcontrollers, sensors and relay that can complete the whole process.

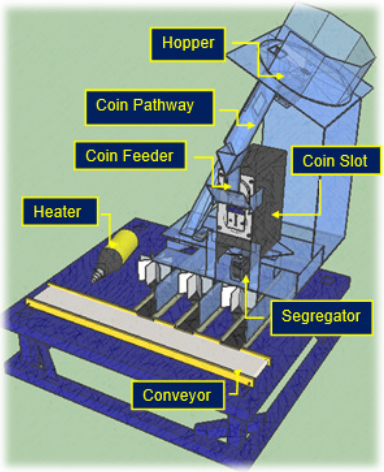

Fig. 2 Isometric View of the Coin counter with segregator

B. Coin Hopper

Fig. 3 is the coin hopper. Itreceives the bulk random collection of coins that needs to be segregated, counted and packed. The hopper ensures that only one coin at a time is fed to the system for processing.

The hopper is shaped like a circle with a diameter of 17.5 centimeters, a depth measurement of 8.5 centimeters and inclined in an angle of 27^{O}. The hopper is designed to hold up to a maximum of 1/3 of its volume weighing approximately 0.5 kilograms.The hopper has a spinning disc of 17.5 centimeters and has a hole that takes one coin at a time. A servo motor was also attached to the disc to make it spin continuously. The servo motor has a speed of 96 and operates at 5 volts.

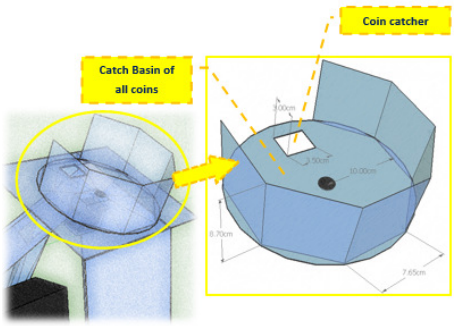

Fig. 3Coin Hopper

C. Coin Path

Fig. 4 shows the coin path with a length of 26.5 centimeters and a height of 5.25 centimeters. It has an inner width of 1/8 inch. The coin path has an angle of inclination of 30 degrees. A hole is made 9.1 centimeters away from the hole on the hopper and 0.5 centimeter from the bottom of the path. The hole is rectangular in shape and has a dimension of 2.20 by 5.54 centimeters. The dimension of the hole and the coin path's tilted position are the important feature that plays a great role for the coin path. These features make it possible for the one peso coin to be segregated directly without using any electronic device.

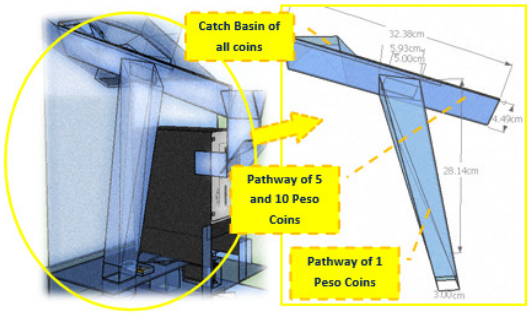

Fig. 4Coin Path

D. Proximity Sensor

Fig. 5 is the collision proximity sensor used for counting one peso coin for this project. Since the one peso coin segregates directly upon passing through the coin path, a proximity sensor is attached above the one peso coin bin. Sensor gives off a high signal and whenever a one peso coin pass through the proximity sensor, it gives off a low signal, thus makes the coin count.

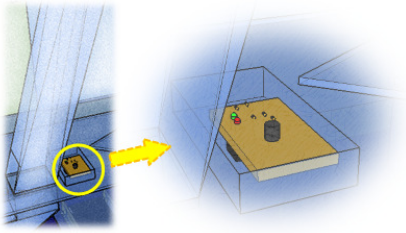

Fig. 5 Proximity Sensor

E. Coin Feeder

Fig. 5 shows the coin feeder located at the end of the coin path just before the coin slot. Like the coin path, the coin feeder does not have an electrical component or device attached to it. The coin feeder ensures that either the five peso coin or the ten peso coin is properly fed to the coin slot.

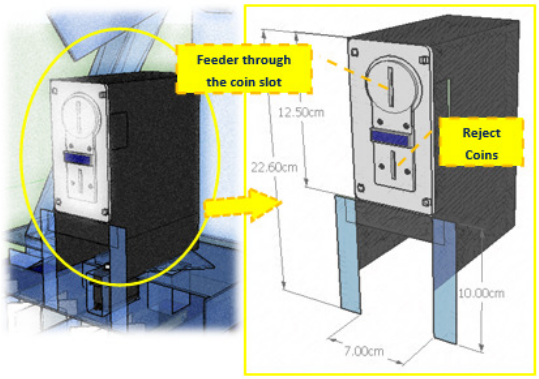

Fig. 5 Coin Feeder

F. Coin Slot

The coin slot as shown in fig. 6 was the receptacle that receives coin on a vending machine. The coin slot used for this study has a pulse sensor that identifies three different types of coin by emitting pulses and at the same time has a coin counter. The researchers lessen the task of the pulse sensor by directly segregating the one peso coin by the time it passes through the coin path. Only five and ten peso coin goes into the coin slot to be segregated and counted. The sensor gives off pulses depending on the coin going into the coin slot. The sensor gives either 5 pulses if a 5 peso coin goes in or 10 pulses if a 10 peso coin goes in. The coin slot is connected to the microcontroller and a segregating servo is connected to the microcontroller. The pulses given off by the coin slot is interpreted by the microcontroller, depending on the microcontroller, it sends a command to the segregating servo.

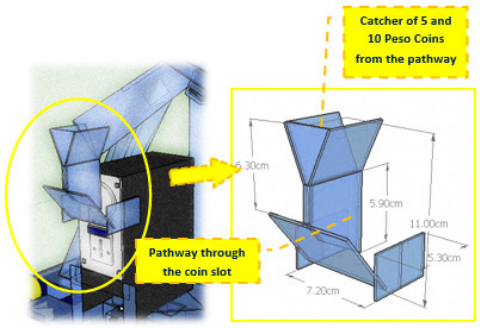

Fig. 6 Coin Slot

G. Segregator Servo

The segregator servo is the component that segregates the five peso and ten peso controlled by the microcontroller. Unlike the servo motor that spins the disc continuously, the segregator servo swings from left to right dependent on the program or command embedded in the microcontroller.

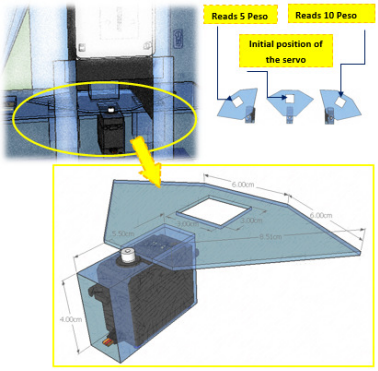

Fig. 7 Servo

Fig. 7 shows the different positions of the segregator servo, which was controlled by the microcontroller. The segregator servo receives command in the form of signal from the microcontroller. Since the coin slot gives off pulses to identify what coin passed through it, the microcontroller receives and analyze the signal given by the coin slot, the microcontroller on the other hand sends commands to the segregator servo. After interpreting the signal, the microcontroller sends commands to the segregator servo and swings it either going left or right. The segregator servo swings to the left 100º if it receives signal interpreted by the microcontroller as five peso coin. On the other hand, the segregator servo moves to the right 30º if it receives signal interpreted by the microcontroller as ten peso coin. The segregator servo has a time delay of 100 nanoseconds for it to go back to the original position 60º for it to identify the next coin stacked on the coin bin.

H. Coin Bin

Fig. 8, coin bin receives pre-sorted coins. The coins that go into the one peso coin bin were already counted; on the other hand a coin bin receives the five and ten peso coin. The three different coin bins have different dimension since the coins differs in size. The coins are stored in stack inside the coin bin.

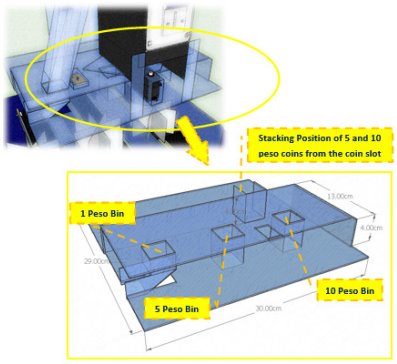

Fig. 8 Coin Bin

I. Counter Display

The Counter display showed in Fig. 9 consists ofdisplay that shows the number of coins that were already counted. Three denominations of coins have separate counter display. The counter display is also connected to the Gizduino Mini microcontroller hence; its action was dependent upon the command or signal it received from the microcontroller. The counter display also sends feedback to the microcontroller to complete the system process that needs values from the counter display.

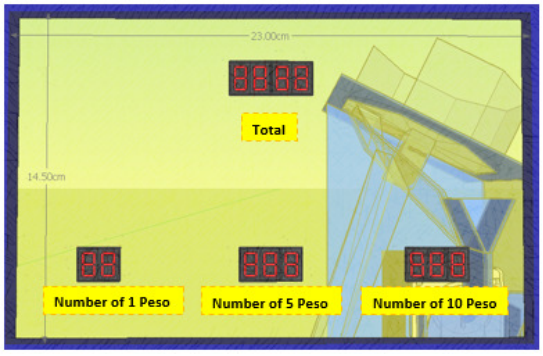

Fig. 9 Coin Counter Display

J. Program Flow

The system process is dependent upon the control of the microcontroller. However, all the actions of the microcontroller are based on the program stored in it. Challenges regarding programming the microcontroller include program calculation since the process needs accuracy for the best implementation of the project. Correct calculation and several simulations were done to achieve the best output of the program. Debugging and tracing the algorithm are essential in programming since adequate knowledge about this helps consume time less regarding trouble shooting the program.

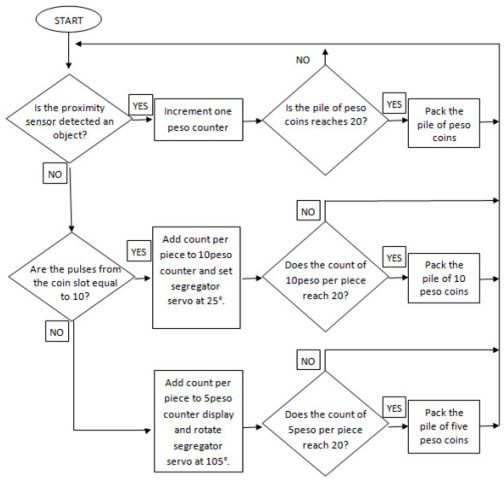

Fig. 10 Program Flow Chart

Fig. 10 shown above was the flow of the process which was controlled by the program at the segregator-microcontroller. As the coins dropped from the rotating coin hopper unto the coin pathway one by one, the signal from proximity sensor and pulse sensor at the coin slot waits to be disturbed in order to send signal unto the segregator-microcontroller to determine either it is one peso, five peso or ten peso coin passed through at the sensors. If the segregator-microcontroller receives signal from the proximity sensor, then the program can tell that the coin passed through at the sensor was 1 peso and sends signal at the counter-microcontroller to count the 1peso coin per piece. If the segregator-microcontroller receives signal from the pulse sensor which was attached at the coin slot, the program will ask the pulse received if it is either from 5peso or 10 peso coin. If the pulse signal

received was from 10peso coin then the segregator-microcontroller sends signal at the counter-microcontroller to count the 10peso coin per piece and the same time commands the segregator-servo to rotate at 25° within 500 milliseconds and return to its original position at 60° in another 500 milliseconds thereafter. If else the pulse signal received was from 5peso coin then the segregator-microcontroller sends signal at the counter-microcontroller to count the 5peso coin per piece and the same time commands the segregator-servo to rotate at 105° within 500 milliseconds and return to its original position at 60° in another 500 milliseconds thereafter.

K. Packaging

The coin packing system is not attached to the microcontroller but is controlled using a relay. The coin packing system is dependent upon the limit switch that is attached to the relay.

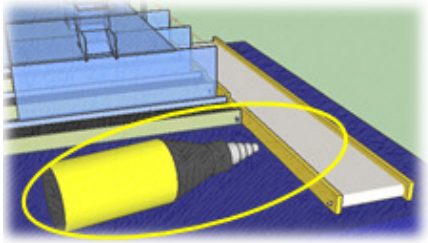

Fig. 11 Heat gun

The heat gun shown in the fig. 11 is the main component in the packing system since this is the component responsible for the sealing of the coins wrapped in shrink label. The heat gun is controlled by the relay that is connected to the limit switch which triggers the relay to turn on the heat gun whenever a coin pile is on the conveyor. The conveyor transports the coin pile from the coin bin to the heat gun.

III. RESULTS AND DISCUSSION

A. Design and Development

The design of the project as shown on fig. 12 as perspective view of the prototype consists of several components. These components are essential to the implementation of the project.

Fig. 11 Isometric View

The coin hopper as shown in Fig. 12 needs precise calculation to achieve a near perfect system. n order to address these problems encountered with the hopper, the researchers recognized that careful assembly of the materials should be done.

Fig. 12 Coin Hopper

The microcontroller receives and interprets the off pulses from the coin slot. It then sends signal to the segregator servo to sort the five and ten peso coin. The manner of the placement of the coin on the coin bin was a challenge since the dropping of coins in coin bin can't be controlled. The coins should be dropped horizontally on the coin bin so that the segregator servo can properly take one coin and place it on the designated coin bin.

To solve this problem, the researchers programmed the microcontroller for it to send signal to the segregator servo to make little movement in order to produce vibrations thus making the coins placed in a horizontal manner.

Fig. 13 Coin Slot and Segregator Servo (from left to right)

The next problem was regarding the segregator wiper as shown above on the right side of figure 4.1.3. The thickness of the material used as segregator wiper makes it takes two coins instead of just one coin. There was also a problem with the segregation of the ten peso coin. The side of the ten peso coin has rough texture, this makes the ten peso coin clog on the segregator wiper. To address this, the researchers used a material thick enough to take just one coin and the gap between the segregator wiper and base of the coin slot was given ample space to reduce friction, thus making the segregator wiper mover smoothly either to the left or to the right.

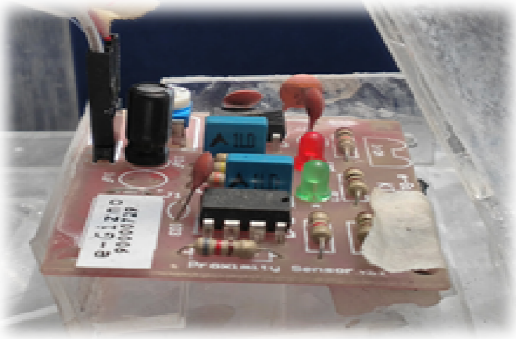

Fig. 14 Proximity Sensor

The proximity sensor shown in fig. 14 is very sensitive to the objects that pass through it. The sensitivity of the proximity sensor resulted to multiple counts with regards to the one peso coins.

Fig. 15 shows the packing process and the component of the process. The components include the a. Heat Gun, b. Conveyor, c. DC motors, d. relay and e. limit switch.

Fig. 15 Packing Process

The process of packing the coin has the same principle in sealing the caps of purified drinking water, using the shrink label as coin wrapping material. The shrink label was fabricated to create a tube like container for coin pile. A conveyor was also utilized as well to transport the coin.

B. Process Flow

The pre-sorted collection of three different types of coins is poured to the hopper, the spinning disc transports coin from the hopper to the coin path.

Coins pass through the coin path for segregation. The one peso coin falls off to the side hole of the coin path, the five and ten peso goes to the coin feeder.

The one peso coin passes through a proximity sensor that acts as the coin counter and is stacked in the coin bin. The five and ten peso goes into the coin slot to be identified and counted. The identified coin goes into a coin stack; the segregator servo segregates the coin placing it in its respective coin bin. When the count reaches 20, the coin pile is then fed to a prefabricated coin wrapper ready for

packing. The conveyor transports the coin pile to pass through a heat gun. After heat is applied to the coin pile inside the prefabricated coin wrapper, the coin comes out as packed of 20pcs coins.

IV. CONCLUSIONS AND RECOMMENDATIONS

The evaluation conducted on the coin segregator, counter and packing machine showed that the machine is able to perform the commands and program embedded in the microcontroller. The machine used Gizduino microcontroller and utilized C Language for the embedded program.

Based on the result of the evaluation conducted, the researchers concluded that the microcontroller-based coin counter with segregator and packing system is a helpful machine in the industry.

The researchers recommend that the following must be improved to further make the machine effective and useful:

a. The speed of process must be improved by decreasing the pulses by sampling and setting the pulse per coin from 5 to 1 pulse, 10 to 2 pulse for 5 peso and 10 peso coins respectively

b. The design of the hopper must be enhanced to increase the machine's capacity and speed.

c. The proximity sensor must be positioned higher to have more accurate reading to avoid occurrence of multiple counts from bouncing.

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REFERENCES

1. *R.A. Reyes, M. P. Tan, T.J. Torralba, "Coin Sorting and Counting Machine", Mapua Institute of Technology, Philippines, 2008*
2. *Goh Chin Guan, "Design and Implementation of an Automatic Coin Sorting and Counting Machine", University of Malaysia Pahang, 2015*
3. *Goh Chin Guan, "Design and Implementation of an Automatic Coin Sorting and Counting Machine", University of Malaysia Pahang, 2015*
4. *Awitan, Nena O., John Cyril R.Montejo, Marven L.Salcedo, Rhea Kristina R. Olano and Engr. Erich P. Abad. Development of a Coin to Paper Bill Changer Vending Machine. Mindanao Universty of Science and Technology. 2014*
5. *Bradford, Joseph, James Ronald, (2003).Coin Receptacle, Patent: US4921463A*
6. *Byrne, Norman, (2010).Coin Counting Machine with Irregularly Stacked Coins, Patent: US2796068A*
7. *Cummins, Allison, (2008).Coin Counters, Patent: US 5997395 A*
8. *Escoban, Chinchin, (2015). Program complexity. Carneigeimellon University, Pittsburgh, PA,*
9. *Furuya, Katusuke, (1998).Coin Discriminating Device, Laurel Bank Machine Co. Ltd., Patent: DE19803013640*
10. *Gilliland, Arthur. Microcontroller Applications. Pasedena, California. 2000*
11. *Keishing, Alphone P. "Coin Counting Technology" 2004. http://www.coincounting.com/background.html*
12. *Rapp, Joachim, (1989).Coin Counting Arrangement with Device for Separating Foreign Coins, Patent: DE3808159A1*
13. *Sheafi,Al Mahmoud,(2010).Microcontrol Basic Guides. New Dehli, Indonesia. 2010*
14. *Takeuchi, Hiroki, (2004). Precautionary mobile functions. Massey University Oakland*
15. *Warner, Swasey,(2000).Apparatus Method for Coin Counting, Receiving and Distributing, Patent: US4921463*