INTERACTIVE SELF-SERVICE SAVING KIOSK FOR SCHOOL FEES

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Abstract

The study aims to develop an interactive self-service saving kiosk which will allow students to pay their tuition fees through electronic means. Through the use of the current technology, some problems like the increasing number of promissory notes on the side of the school's administration as well as the rough experience of students in paying their tuition fees will be minimized. It has no minimum amount per transaction so that the students will have their chance to save their excess money and be able to pay on time.

The device was created through the integration of the software and hardware system. The hardware, consisting of the barcode scanner, coin acceptor, bill acceptor, Raspberry Pi, LCD and vibration sensor, functions through the use of Python programming. On the other hand, the software fetches and updates the data from the cashier's dummy account to the kiosk. However, the process has three phases: the design and development of the kiosk; the pilot testing of the kiosk; and the implementation of the study. The researchers only focus on the first phase so series of testing was conducted to prove the device's accuracy and reliability.

The study uses a methodology by Dr. Winston Royce that is typically used in software development, the Agile Development method. It was concluded that the kiosk was an accurate and reliable device that could be used by the students to help them accumulate funds to pay their tuition fees through electronic means.

Keywords: Interactive self-service kiosk, Raspberry Pi, Python and PHP programming, coin and bill acceptor and vibration sensor

Introduction

Saving is one of the major activities that all individuals desire to do specially that each of us aims to save money for future use prior to what and where we intend to use it. And for students, their objective is that they have to save all the excess allowance that they have without even knowing where to use it decisively. However, some try to save to be able to pay for their school fees on time.

According to survey, almost all students try to save money but only few are capable of doing it the right way. That is because, not all of them have bank accounts where they can keep their savings and avoid unintentional expenses. In addition, students are also having a hard time paying their school fees which requires the cashier's assistance in the process. Some also find the cashier's treatment bias. There are also instances where the students have been waiting for hours but still unable to pay due to limited working hours.

Modes of payments in different colleges and universities come in various arrangements such as in cash, personal checks, over-the counter collection facility with different banks, credit or debit card payment either in full or installment basis. Most of the state university engages more on cash payments either in full or installment which includes teller's assistance. Also, the increasing number of promissory notes is also a burden to the administration when it comes to collection.

With that, the study aims to make a self-service machine [1][2][3][4] which will not only assist the students in paying their school fees through electronic means but also help the students in building the right attitude towards saving. The process consists of three phases: the design and development of the kiosk; the pilot testing of the kiosk; and the implementation of the study. In this case, the study focused only on the design and development of the device where the researchers will test the device to prove its reliability and accuracy.

Scope of the Study

The study focuses on the design and development of an electronic payment system in state university for the student's school fees which enables the user to see the student's general information, the subjects they're enrolled to, assessed fee, total school fee, history of their payment and their remaining balance. The researchers have identified the scope and limitations of the project to clearly state the boundaries of the project.

The scopes of the study are the following:

- It includes a feature for manual input of I.D. number through the LCD in case the printed barcode on the I.D is deteriorated.
- The system accepts both Philippine peso coins and bills which make it convenient especially when exact payment is intended.
- The kiosk prints out a receipt and requires the user's e-mail address so that an electronic mail will be sent to the user which will serve as a proof of transaction.
- The device's storage response time is also dependent to speed of the internet connection and it is connected through LAN cable.
- The kiosk is linked with a monitor where a dummy cashier's account where the cashier can check the total amount of money inside the kiosk together with the total number of each denomination and its subtotal; see the status of each peripheral; track the history of transaction per day or its log time; check the pending request for official receipts; search a student number which makes it faster for the monitor to view the student's profile.
- The system is capable of notifying the cashier's dummy account when the numbers of paper bills and coins that have been deposited have already reached 200 and 1000 pieces respectively.
- The device is intended to be supplied with 220Vac which will eventually be used to cater different DC voltages with the total power and current requirement of 90 watts and 11 amperes respectively. It is also connected with an uninterruptable power supply to make sure that all transactions will be successfully catered.
- Once the transaction has been interrupted along the depositing stage, the user will be able to retrieve the money that has been deposited on the next transaction.
- The kiosk automatically shuts down at 9:00 P.M.

The limitations of the study are the following:

- The system is not capable of accepting coins smaller than one peso both in size and in value.
- The sensitivity of the coin acceptor is also dependent on the circuit attached to it since it is relative to the incident light of that the light dependent resistor (LDR) detects.
- The system is not capable of dispensing the money out once it has been read by the acceptors. Thus, the user needs to be sure before depositing.
- The kiosk is connected to the internet through cable which makes it limited to short distances.
- The thermal paper should also be manually refilled.
- There is no password for each student's account and the software is not yet encrypted.

The system is not integrated with a server where the students can view their accounts online.

System Process Flow

The system process flow of the kiosk as shown in Figure 1 is explained through the use of each block which completes the system.

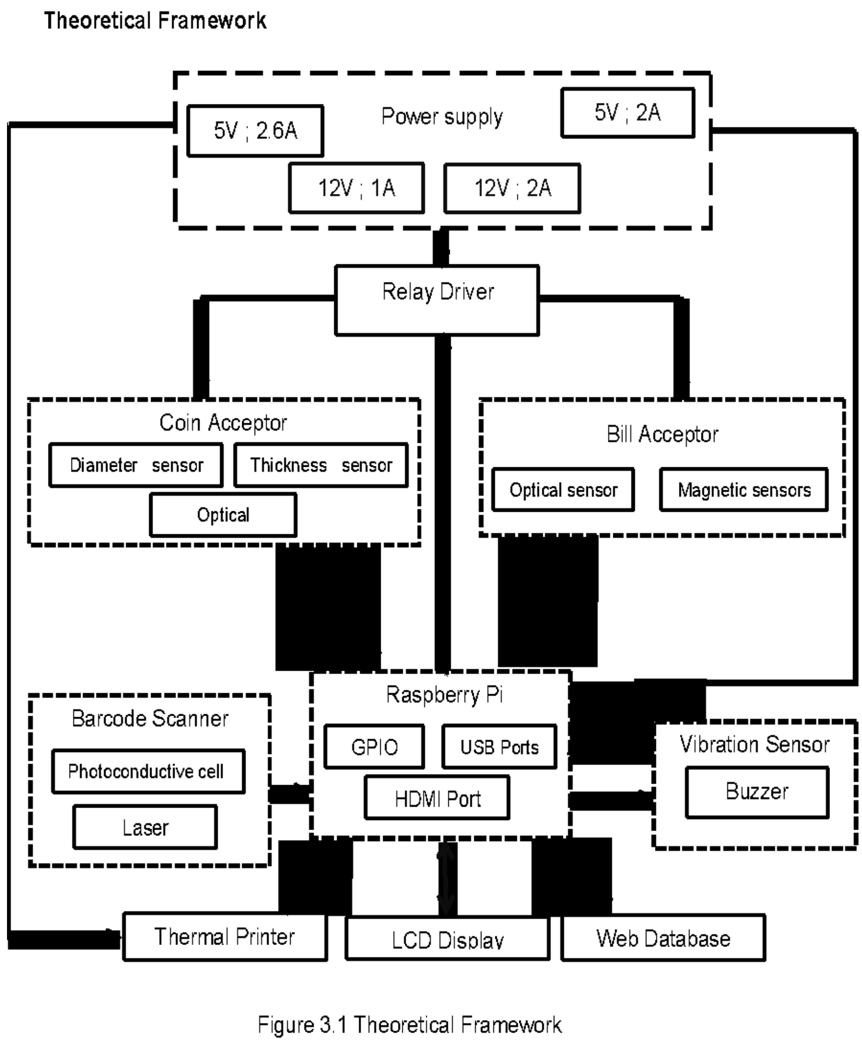

Figure 1: System Process Flow

The device is powered with 220Vac which will be converted to direct current through AC-DC power supplies. Since the peripherals used have different voltage and current requirements, different power supplies were used in the device. A relay driver is used to control both the bill and coin acceptors. It is made up of relay and transistor to ensure proper switching capability due to accurate circuit triggering. It has two different ports to cater two different voltage supplies for coin and bill acceptor. When raspberry pi sends logic 1 to relay driver, this will provide a signal for both acceptors to function. The coin acceptor serves as an input device to the system. With the use of diameter sensor, thickness sensor and optical sensor, the device can easily classify the types of coins together with its value. It has three pins connected to the Raspberry Pi through the GPIO pins which receive the signal sent by the coin acceptor. Like what the coin acceptor does, the bill acceptor functions as another input component, having optical and magnetic sensors to identify the value of the bill inserted. Single GPIO pin is connected to it to accept the digital pulses sent.

For the system to access a specified account, a barcode scanner is linked to the system. A laser beam is reflected off a mirror and swept left and right to read a bar code. The photoconductive cell generates a pattern of on-off pulses that correspond to the black and white stripes of the barcode. The analog signal is converted into digital signal via an A/D converter. The decoders interpret the digital signals and send them to raspberry pi which is used as the microprocessor in the system. It has a GPIO connector to which you can attach external hardware, HDMI port which can plug directly into the LCD with an HDMI cable and USB ports used to power the raspberry pi and enable other peripherals to connect. The LCD Display serves as the visual representation where the user will be able to interact with the device.

The thermal printer is used to print the receipt of the user in every transaction. It is a device that operates in the application of thermal (heat) produced by heating resistors in the printer. When the data to be printed is sent to printer, it heats appropriate heating resistors in the printer and burns the chemical coated in the paper thereby forming black impression. And for the security purposes of the device, a vibration sensor is used. Once it senses strong abrupt vibrations, it will send a signal to the buzzer. Once triggered, it will produce sounds as a warning or signal.

All the data are process using PHP and python programming [7], then transferred to the web database, a system used for storing all data and information that is acquired along every transaction. Web Database is designed to be managed and accessed through the Internet.

Results and Discussion

Since the study includes transactions that involve money, it is very important to know the reliability of the coin and bill acceptors used. Several tests were conducted to determine the logic status and the voltage level with respect to weight, diameter and thickness of the coins and the number of pulse as well as the voltage level for the bill acceptor with respect to the way of depositing the money and the physical status of the money as well. This is possible through the use of Raspberry Pi and Aceduino's analog read which is converted to voltage. The GPIO pins in the Raspberry Pi for the coin acceptor detect logic 0 when the coin is dispensed out and logic 1 when the voltage ranges from 1.34 to 3.3 volts.

The study used a Slovin's Formula to determine the total number of samples needed through the use of,

$$n = \frac{N}{1 + N * e^2}$$

Where: n = number of samples
N = total population
e = margin error

Using 13 hours as a regular running hour per day, 5 minutes as an average duration per transactions and 99% confidence level,

$$N = \frac{13 * 60}{5}$$
$$N = 156$$

$$n = \frac{156}{1 + 156 * 0.1^2}$$

$$n = 153.6037 \cong 154$$

The total samples needed to ensure the accuracy and reliability of the system is 154.

Coin Acceptor

The coin acceptor (HS-623) used has a coin slot of 30 mm in diameter and 3mm thick and is capable of accepting coins with 18mm to 29mm diameter and 1.2mm to 3mm thickness. It is capable of accepting Philippine peso coins such as one, five and ten-peso coins.

One peso coin is round shape with reeded edge. It has the image of Rizal Rizal, "Republika ng Pilipinas", value and the year of minting imprinted on its obverse and the logo of the 'Bangko Sentral ng Pilipinas' at the back.It also has an ideal weight of 5.35 grams and has a diameter of 24mm.

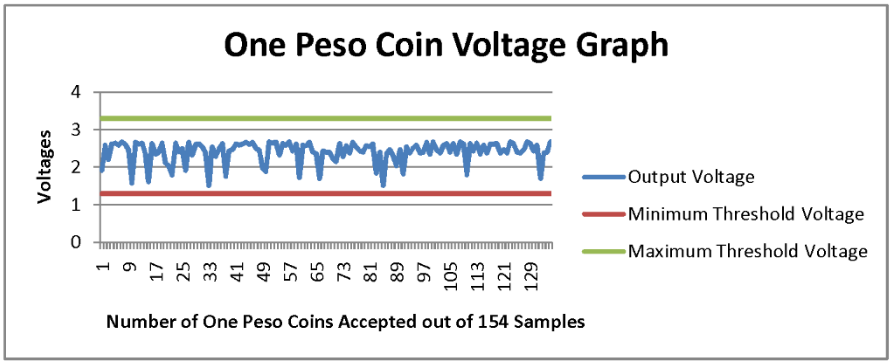

Figure 2: One Peso Coin Voltage

Figure 2 exhibits the testing conducted to gauge the reliability of the coin acceptor when it comes to one-peso coins. GPIO pin number 16 was assigned for every one-peso coin and it was tested 154 times by determining the logic status and by measuring the voltage level respectively. Logic status equivalent to "1" depicts that the coin was detected. However, some coins are ejected by the acceptor and they are not included in the figure above. The voltage level measured for one peso coin ranges from 1.52V to 2.68V. It shows that 2.4 to 2.7 volts have been read most often while 1.5 to 2.3 volts appear infrequently. Regardless, it shows that each one-peso coin accepted have been read successfully by the coin acceptor.

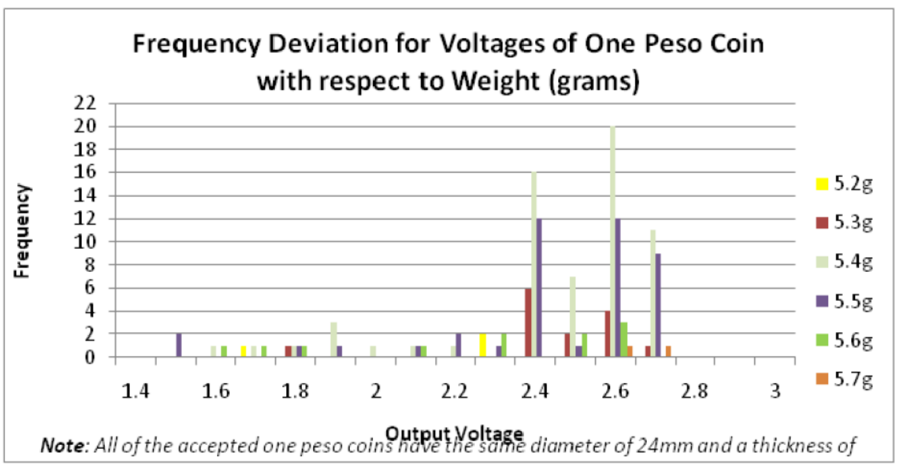

Figure 3: Frequency Deviation of One-Peso Coins Ejected with Respect to Weight

Figure 3 exhibits how frequent each voltage appears when the coin is accepted in 154 trials with respect to weight. Most of the Philippines' one-peso coins today have a weight of 5.4 grams and 5.5 grams and their voltage reading was dominant at the range of 2.4 to 2.7 volts. The graph suggests that the weight as well as the diameter and thickness of each one-peso coin has no significant connection with the voltage produced but they have something to do with the number of one-peso coins ejected by the acceptor.

Moreover, one-peso coins with the diameter of 24mm and thickness of 1.8mm are most likely to be accepted by the acceptor while one-peso coins with the diameter below 24mm and thickness equal or below 1.8mm are less likely to be accepted.

Five-peso coin is round shape with plain edge. It has the image of Emilio Aquinaldo, 12-pointed scallop border design, "Republika ng Pilipinas", value and the year of minting imprinted on its obverse and the logo of the 'Bangko Sentral ng Pilipinas' and 12-pointed scallop border design at the back. It also has an ideal weight of 7.7 grams and has a diameter of 27mm.

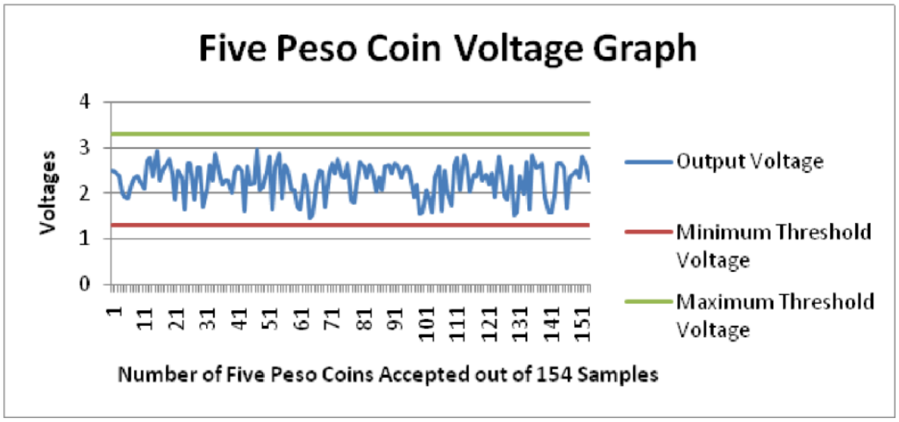

Figure 4: Five Peso Coin Voltage

Figure 4 exhibits the testing conducted to gauge the reliability of the coin acceptor when it comes to five-peso coins. GPIO pin number 20 was assigned for every five-peso coin and it was tested 154 times by determining the logic status and by measuring the voltage level respectively. Logic status equivalent to "1" depicts that the coin was detected. One coin is ejected by the acceptor and it was insignificant. The voltage level measured for five-peso coin ranges from 1.47V to 2.94V. It shows that 2.4 to 2.6 volts have been read most often while the other voltages are distributed to different levels. Regardless, it shows that each five-peso coin accepted have been read successfully by the coin acceptor.

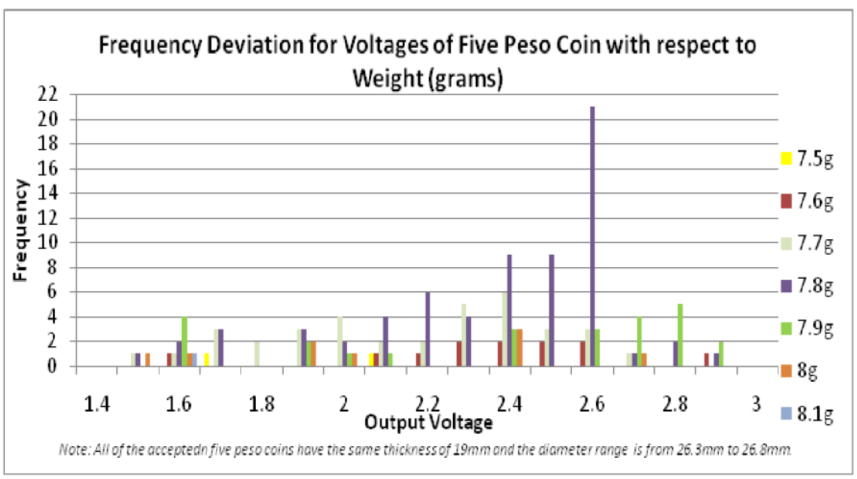

Figure 5: Frequency Deviation of Five Peso Coin with Respect to Weight

Figure 5 exhibits how frequent each voltage appears when the coin is accepted in 154 trials with respect to weight. Most of the Philippines' five-peso coins today have a weight of 7.7 grams to 7.9 grams and their voltage reading was dominant at the range of 2.2 to 2.8 volts. The graph suggests that the weight as well as the diameter and thickness of each five-peso coin have no significant connection with the voltage produced.

Ten-peso coin is round shape with interrupted milled edge. It has a ring with "Republika ng Pilipinas" and year of minting imprinted on it, the profile of Andres Bonifacio and Apolinario Mabini with its value on the center and the logo of the 'Bangko Sentral ng Pilipinas' at the back. It also has an ideal weight of 8.7 grams and has a diameter of 26.5mm.

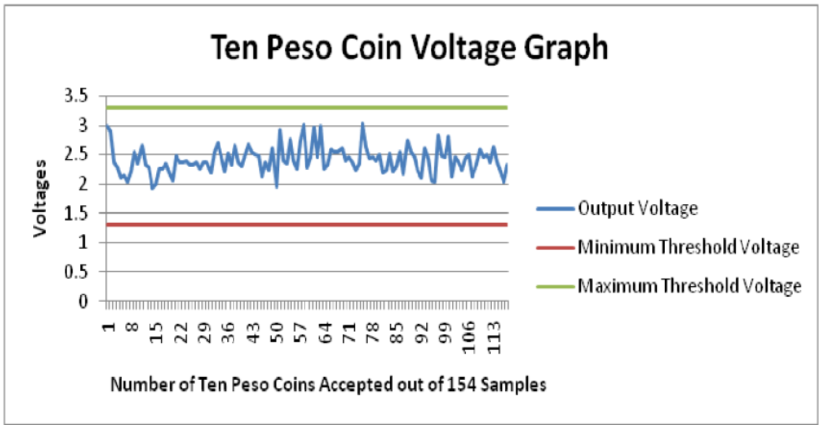

Figure 6: Ten Peso Coin Voltage

Figure 6 exhibits the testing conducted to gauge the reliability of the coin acceptor when it comes to ten-peso coins. GPIO pin number 21 was assigned for every ten-peso coin and it was tested 154 times by determining the logic status and by measuring the voltage level respectively. Logic status equivalent to "1" depicts that the coin was detected. One coin is ejected by the acceptor and it was insignificant. The voltage level measured for ten-peso coin ranges from 1.92V to 3.02V. It shows that 2.2 to 2.5 volts have been read most often while the other voltages are distributed to different levels. Regardless, it shows that each ten -peso coin accepted have been read successfully by the coin acceptor.

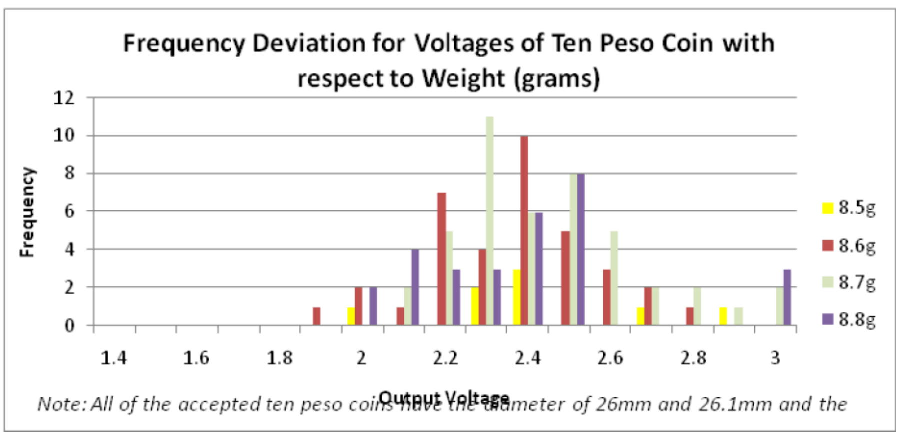

Figure 7: Frequency Deviation of Ten Peso Coin with Respect to Weight

Figure 7 exhibits how frequent each voltage appears when the coin is accepted in 154 trials with respect to weight. Most of the Philippines' ten-peso coins today have a weight of 8.6 grams to 8.8 grams and their voltage reading was dominant at the range of 2.2 to 2.6 volts. The graph suggests that the weight as well as the diameter and thickness of each ten-peso coin has no significant connection with the voltage produced but it has something to do with the number of ten-peso coins ejected by the acceptor.

Moreover, ten-peso coins with the diameter of 26mm and 26.1mm and the thickness of 2mm and 2.1mm are most likely to be accepted by the acceptor while ten-peso coins with the diameter above 26.1mm with any value of thickness are less likely to be accepted.

Bill Acceptor

The bill acceptor that has been used is BV20 which has an output voltage of 0 to 0.5 V for logic 0 and 3.7 to 12V for logic 1. In the testing that has been conducted, the voltage reading was all zero because a "Pull-up Switch Circuit"[8] was used. The output of the bill acceptor is an open-collector so there is a need for it to be pulled-up by Resistor R1. Hence, Transistor Q1 is normally open and the logic status across R2 was a "logic 1" if there's no bill inserted. If there is a bill detected, a pulse will be created; and because of the reason that the bill acceptor is an open collector, it will pull the base of Transistor Q1 on the Ground, so it will be turned off and the reading across R2 will be 0v.

The bill acceptor was modified to accept the current Philippine banknotes or bills that have a standard size of 160 mm by 66mm. Since the bills can be inserted in four different ways, each possible position was tried to ensure that the bill will properly be detected by the bill acceptor regardless of the way that it has been inserted.

GPIO pin number 18 was assigned for the bill acceptor and it was tested with different conditions. The bill acceptor can detect all the bills inserted except when it is folded one centimeter and above. In result, all bills that have been detected will successfully be deducted will those that are ejected will not be credited.

System Testing

The system was conducted in three days to test the accuracy and reliability of the device. By comparing the amount that has been deposited to the amount that has been deducted to the account, the accuracy can be verified. In addition, the reliability is determined through the speed that the money is credited from the time that it has been deposited to the time that is has been deducted.

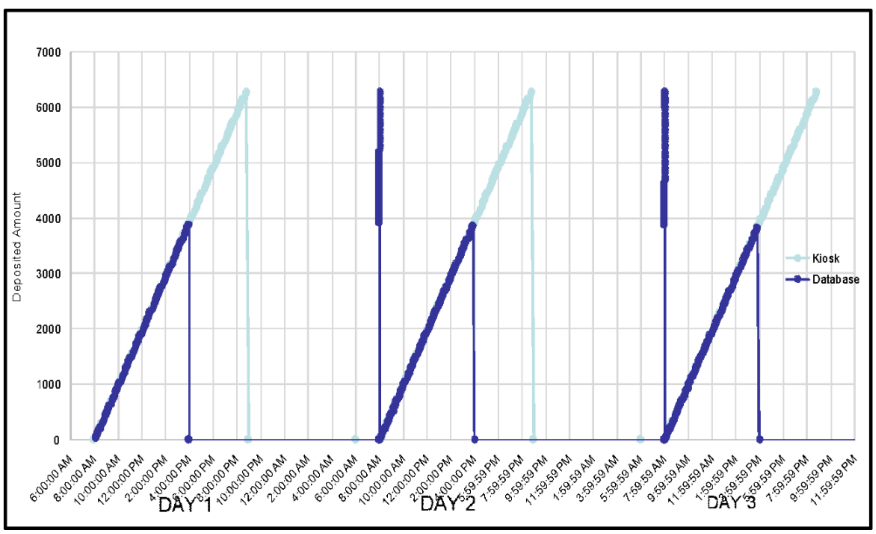

Figure 8: System Testing

Figure 8 shows that the kiosk and the database deduct the same amount on the system and the time that it takes for the database to deduct the amount deposited is close with that of the kiosk. However, when it reaches 4:00 PM or the actual cut-off on the cashier, the database credits all the transaction on the next day that the server has been opened. This is the same with what happens on the next two days of testing.

Conclusion

Based on the testing done and the results that have been gathered, it was concluded that e-Payment Kiosk can be used to introduce a new mode of paying the student's tuition fee through the use of the coin and bill acceptors that are programmed to accept and identify the value of each Philippine peso that will be deposited into it. The device is also guaranteed to be accurate in deducting the exact amount deposited to the user's account properly and is reliable in such a way that the cashier's dummy database credits all the transactions done in the kiosk in a real time manner.

In terms of accuracy, the coin acceptor is able to accept 87.66% for one-peso coins, 99.35% for five-peso coin and75.97% for ten peso coins out of 154 samples. The dependability of the coin from being accepted when it comes on the year of minting is only applicable for the one peso which ranges from the years 2003 onwards. However, the acceptance is still dependent to its physical appearance. Once it has been deteriorated and deformed it is more likely to be ejected. The coin acceptor's detection is also dependent to the circuit connected to it because once it has been displaced, the coin acceptor will fail. Thus, the coin acceptor's circuitry should be handled with utmost care. For the bill acceptor on the other hand, the acceptance is dependent to the physical status of the bill. As long as it is a current bill either new or old physically, rumpled, folded below 1cm and with ink writings, it will be accepted.

The kiosk is 100% accurate and reliable since all the money that has been deposited has been credited except when it has been ejected and through consistent results in the testing done. Both electronic mail and manual input of ID number have also functioned properly even if it just serves as redundancy when the thermal printer and barcode scanner fails. And the transmission of data depends on the available internet speed that has been used. With the use of 'Interactive Self-Service Saving Kiosk for School Fees' the school administration can provide assistance to the students in accumulating funds which will later on be used in paying their tuition through electronic means.

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