PUJ FARE COLLECTION SYSTEM: AN IoT APPLICATION

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ABSTRACT

Jeepneys have been around in the Philippines for several years and have served as the most common way of transportation, yet technological improvement is still on its way to the jeepneys. Electronic payment is now implemented on buses and trains, but not on jeepneys due to its design and way of payment that makes it challenging for implementation the electronic payment. With the new design of the jeepney, the proponents were able to make an electronic payment specific for jeepneys. This system used the RFID tagging technology coupled with databases. The Hardware consists of an Arduino that connects all of the components like RFID reader and trip meter. A local computer was also used for handling incoming and outgoing data on database. The software consist WAMP server. The system was able to track the passenger's travel distance and to use RFID tags in storing the passenger's information from the database. The system was able to collect payments seamlessly on jeepneys.

Keywords: *Jeepney; Electronic payment; RFID tagging; Arduino; WAMP; Database*

INTRODUCTION

Last June 27, 2017, the Department of Trade and Industry (DTI) released a new design for Public Utility Jeepney. With this design, the driver can collect the fare before a passenger sits inside the jeepney. However, this kind of solution takes time and can be confusing for the driver. The monitoring of the fare, same as the old design, is the problem of this kind of transportation. Although Filipinos have good conduct, others still don't pay for their fare right.

An AFC is a contactless smartcard-based end-to-end solution for fare collection and payment. This system benefits both the driver

and the passengers that reduce confusion and time-consumption (Ong, 2016).

With this technology, Filipinos can pay for their fare in Public Utility Jeepney (PUJ) using a smartcard. By integrating the Radio-Frequency Identification (RFID) Technology, an Odometer, and the newly designed PUJ, the typical problems in a PUJ can be solved. The proponents undertook the study to address the following problems: (1) how will the PUJ driver can know that every passenger pay for their fare?; (2) how will the PUJ driver be able to collect the fare's exact amount of their passenger automatically?; (3) how will be the calculation of the distance traveled for the exact amount of fare?; (4) how a passenger can ensure that he or she is paying the right fare?; (5) how can a passenger check the amount in his or her card?; and (6) how will the system be the same as the manual method of fare collection in a PUJ?

Objectives of the Study

In order to create and develop PUJ Fare Collection System that utilizes RFID technology, the study aimed to:

1. To have a RFID for the passengers and a RFID reader for the driver to collect the fares for each passenger;

2. To display the deducted fare and the distance traveled in a LCD Monitor;

3. To build a website to check the amount in their card;

4. To test the functionality of the system; and

5. To use indicators like LEDs and Buzzer that can alert the PUJ driver if the fare is been collected.

Significance of the Study

The system will be responsible for computing the fare of each passenger based on the start point and end point of their travel. The distance of travel will be calculated by an odometer and convert it for the right fare that benefits the commuters. With this system, fare, especially those that have discounts like students, senior citizens, and PWD, will be given correctly in its last centavos. In addition, this also benefits the driver of the PUJ because it guarantees all the passengers are paying for their fare to its equivalent distance of travel. The RFID card will be the substitute for the bills and coins of the commuters, and also for the PUJ driver. With this, the time-consumption when getting or collecting the payment for the fare will be minimized.

REVIEW OF RELATED LITERATURE

Synthesis of Related Litaratures

Using the GPS technology, it can track a Public Utility Jeepney. With this, calculating for the right fare will be solved. By computing the distance traveled, the start point and end point, it can give the right fare for the corresponding distance. By adding the technology of RFID, the proponents can produce an Automated Fare Collection System in a PUJ. Just tapping the card in the reader to determine its start and end point of travel, it will give the system fare for that distance. This technology can also monitor the quantity of passengers that board on the PUJ, and check the passengers who paid for their fare. With additional features, the user can view the log of their travel by using a smartphone. The proponent will develop an application that can record travel history in a PUJ.

CONCEPTUAL AND THEORETICAL FRAMEWORK

Conceptual Framework

The study aimed to design and develop a Fare Collection System that uses RFID and IoT technology for automatic collection of fare. Figure 1 shows the basic diagram of the system.

Figure 1. System Block Diagram.

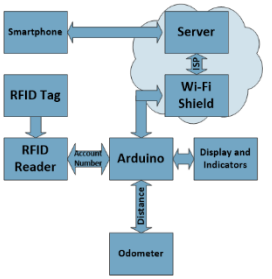

Figure 1 is shows that the Arduino was the main component of the system. The RFID technology was connected to the Arduino where it was used for identification system while the Odometer was used for measuring the distance travelled. Display and indicators were also connected to the Arduino like an LCD Display, LEDs, and Buzzer. It also had a Wi-Fi shield to connect to the SQL server. A smartphone checked the account balance in the website and viewed the logs where the user can see the fares that the passengers pay.

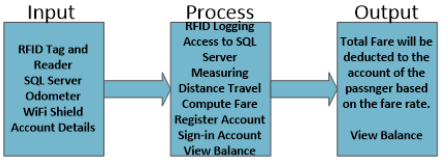

Figure 2. IPO Chart of the System.

RFID tag was scanned via the reader and its identification was sent to Arduino. Required data were received from SQL through the WiFi shield and the distance was received by the help of the Odometer. The processes consist of RFID logging, accessing the SQL server, measuring distance travelled, and computing the fare. After that, the total fare was deducted to the passenger's account.

In the website, the inputs were account details for logging process. Then, the processes were register account, and sign-in. The output was to display account balance and the log of traveled of the particular passenger.

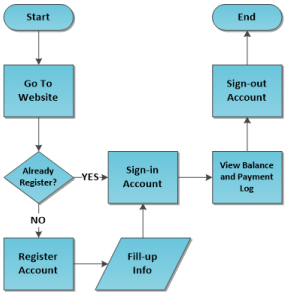

Figure 3. Flow Chart for Website

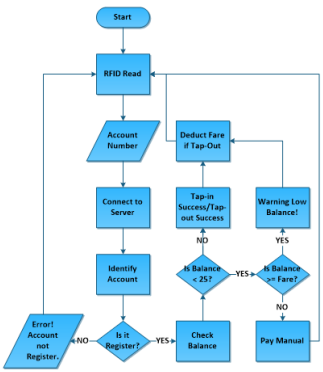

Figure 4. Flowchart of the Fare Collection System.

Figure 3 shows the functions of the website. First as you open the website, it will have a Sign-in Page. If the user is not registered yet, there is an option of registration to have an account. After signing-in, the webpage will show the payment log of the passenger and their balance. With this security option of having an account, the passenger must sign-out after checking the travel log or their balance. The second flowchart shows the Fare Collection System. As the system starts, it will wait for RFID to be read. Then it will connect to server to identify the

account then determined if the account is already registered. If the RFID Tag is not yet registered, the user must register it first in the website for the system; otherwise, the user cannot use the RFID Tag. On the other hand, if it is already registered, the system will notify the user that tap-in or tap-out is success. After that, the balance will be checked if it is below 25. It will again check the balance if it is greater than the fare that will be deducted. If the balance is less than the fare, the passenger must pay its fare manually.

Theoretical Framework

- RFID Tagging

RFID stands for Radio-frequency identification. RFID tagging is an ID system that uses radiofrequency for identifying and tracking. This includes the RFID tag, the reader, and the host system for the processing of the data (Rouse, 2010).

- Arduino Mega 2560

An Arduino UNO is a microcontroller board that can have several inputs and several outputs at the same time. It is powered with a USB cable or an AC to DC adapter or even a battery. Arduino UNO has variety of applications which can be used in several places (Arduino Mega 2560, 2017).

- Arduino WIFI 101 Shield

It is an IoT shield with crypo-authentication which allows easy connection for Arduino, good for IoT projects (Arduino WiFi Shield 101, 2017).

- LCD Module

LCD (Liquid Crystal Display) screen is a device that displays the output needed by the user. The commonly used LCD is 16x2 display which can have an output of 16 letters per row. (LCD Display, 2017).

- Odometer

It is a device that measure the distance travelled by a vehicle. A magnet is attached to a wheel and a pickup attached to a frame. In every revolution, the magnet passes to the pickup and gives signals. This signal is used to calculate the distance travelled (Nice, 2017).

- SQL

It stands for Structure Query Language, used for communicating with a database and is the standard language for relational database management systems (What is SQL?, 2017).

Proposed Design

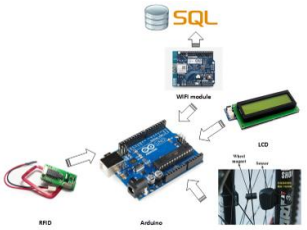

Figure 5. System Architecture.

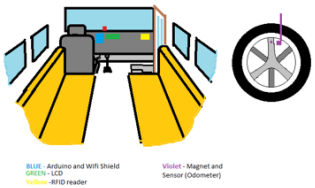

Figure 6. System Breakdown.

Figure 5 illustrates the entire design of system, or the general form/hardware and software of the research. Figure 6 shows how the hardware was placed in the jeepney. In this design, the door (colored in brown) in this jeepney was in front, right beside the driver. The RFID was right beside the door so the passenger can easily tap their RFID tags. Then, the LCD screen was in the middle so that everyone can see it. The Arduino and WiFi module were right beside the driver and the magnet and sensor were placed on the wheel for the odometer.

RESULTS AND ANALYSIS

Function of the System

Figure 7. Start-Up of the System.

After powering up the system, the connection of the system to the router was first established as shown in figure 7. This start-up of the system showed that the backlight of the LCD Display and also the 3 LEDs were turned on to check the hardware if it is working.

Figure 8. Finished Starting Up.

Figure 9. Standby Status.

After turning it on, the LCD displayed a note as shown in figure 41. After few seconds, the buzzer immediately turned off. Eventually, the system went to Standby operation as shown in figure 42. The LCD Display's backlight was turned off. The 2 LEDs, and the Yellow LED were the only ones that were turned on to indicate that the system was in its standby status.

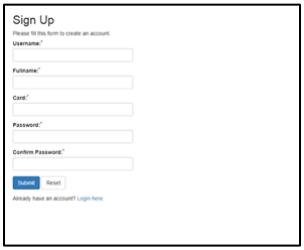

Figure 10. Registration Website

If a passenger has a card and still not registered, they can register it through the system's website. The website will ask for your full name and the card's unique tag as shown in Figure 10.

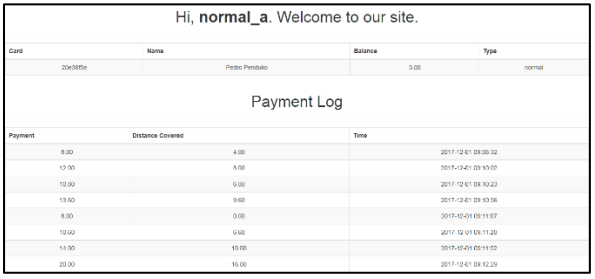

Figure 11. Drilling of the 555 Timer Circuit Design.

Once the passenger sign-in in the website, it will go to the designated webpage to view the remaining balance, as well as the travel log of the passenger as shown in Figure 53. It displays the payment, the distance covered and also the date when you traveled.

Reliability of the System

Test		
1	91.67	100
2	100	100
3	91.67	100
4	100	100
5	100	100
6	91.67	100
7	100	100
8	100	91.67
9	100	100
10	100	100
Percentage	**97.50**	**99.17**

Figure 12. Establishing the Connection of the System to the Server

Summary

The establishment of connection of the system to the router is shown in table 3. System JEEPA got 60%, while System JEEPB got 80% because the connection of the router was low. The proponents considered that the WiFi module was the problem for having difficulty in establishing the connection because of low-end quality of the module and it lacked features for a user friendly device. They also concluded that the problem was also in the program itself because the proponents found it challenging to integrate with the Arduino that lacked libraries and did not have enough knowledge to use the AT command set. This problem same goes by establishing the connection of the system to the server that the System JEEPA got 97.50 and the System JEEPB got 99.17.

SUMMARY

The study entitled PUJ Fare Collection System: an IoT Application was developed using a database server software called WAMP (Windows - Apache, MySQl, PHP) and PHP programming language for communication between the device deployed on jeepney and the server. The systems used were Arduino, odometer or tripmeter to measure the distance covered, WiFi module to connect to the network, and RFID module to read the RFID tags. Using HTTP request method, the Arduino was able to send and receive data from the server. When the card is tapped, the card's id and distance is stored on a

certain table on the server, and when tapped again the card is removed and payment is computed based on distance covered and type of payment(normal, student, senior, PWD) and the account in the server will be updated. Registration page was also made to register new cards. Login Page and Account page were made for the user to see their load and payment history. Every function was added stage by stage to the prototype until it met the objectives and desired output of the proponents.

CONCLUSIONS

After testing the functionality of the system, the proponents concluded that the system was able to act as an automated payment collection system. The proponents were able to utilize the buzzer and LEDs to give audio and light signals to the passengers using the system. Light and audio signals varies to the events happening in the system like tapped in, tapped out, payment, low balance, manual pay, and not registered cards. The proponents were able to provide passengers their own unique card for their accounts and a device on a jeepney that is registered to the owner of the jeepney or driver's account. Using RFID technology, the system could collect fares for each passenger.

Using odometer/tripmeter, the system was able to measure the distance travelled of each passenger; with this the fare rate per kilometer is maximized down to centavos. The system was able display certain information on the LCD like - greetings, card is tap in or tap out, payment made and distance covered.

The proponents built a website to check the amount of the passenger's card. In addition to this, the website also provided the registration process of the card. Every account will be asking their information, especially the card's unique character. When the account is successfully signed-in, the user can see their balance, also there is a payment log where it shows the distance covered, the payment of the fare, and the date of events that occurred.

The proponents tested the functionality of the system. The system was made in a stage-by-stage process. Functionalities were added and tested one by one until all functions were met. After series

of development and testing, the system was able to meet the objectives and target output of the proponents. The system was able to automatically collect the payment of the passengers on jeepneys.

FUTURE DIRECTIVES

The proponents' recommendations are as follow.

The proponents suggest adding a loading station system for loading and withdrawing of money, and an admin system which is a graphical user interface to easily access the accounts and upgrade the type of cards (student, senior, PWD) The future researchers can use Raspberry Pi for the device to test which is more efficient for this project. The proponents suggest using a better Wi-Fi module with documentary and library premade for Arduino IDE. They can also use Arduino with built-in Wi-Fi module.

LCD display can be upgraded to LED display for better output and more information can be displayed. Test for accuracy of odometer/trip meter on actual PUJ. Migration of the local server to a cloud server.

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