AUTOMATED PREPAID LOADING DEVICE USING RFID TECHNOLOGY

by

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A Design Report Submitted to the School of Electrical Engineering, Electronics Engineering, and Computer Engineering in Partial Fulfilment of the Requirements for the Degree

Bachelor of Science in Computer Engineering

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Approval Sheet
Mapúa Institute of Technology
School of EECE

This is to certify that I have supervised the preparation of and read the design report prepared by **Ronnel Angelo M. Bajon, Billy Fernand P. Macatangay, Darwin Christopher R. Tantuco, and John Eldrin M. Tolentino** entitled **AUTOMATED PREPAID LOADING DEVICE USING RFID TECHNOLOGY** and that the said report has been submitted for final examination by the Oral Examination Committee.

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Design Adviser

As members of the Oral Examination Committee, we certify that we have examined this design report, presented before the committee on **November 17, 2012**, and hereby recommended that it be accepted in fulfilment of the design requirements for the degree in **Bachelor of Science in Computer Engineering.**

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We would also like to thank Lord God for his continuous guidance and help.

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- Chapter 3
- Chapter 5
- C# Programming

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- Database Modelling
- C# Programming

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- Chapter 4
- ACEduino Microcontroller Programming
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- Chapter 1
- Chapter 2
- Chapter 3
- PCB Design

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Abstract

Prepaid loading service is continuously evolving with different methods such as loading cards and the automated devices that are being used at present. This design aims to construct a device that is capable of providing prepaid loading service which utilizes the Mapúa Institute of Technology (MIT) identification card and the student and faculty database for its automation and provision of cashless transaction. In addition, the device has lower cost compared to the existing automated device available in the market but can still deliver the same service. The design successfully proved that the MIT ID cards and users' database can be used for automation and cashless payment since the expenses are charged to the user's school account. All objectives of the design are attained and additional studies are recommended to improve the design.

Keywords: RFID, loading device, automated, database

Chapter 1

DESIGN BACKGROUND AND INTRODUCTION

Prepaid loading service is continuously evolving and is provided with different technologies such as the prepaid cards; and the related technology that saturated the Philippine market today is the electronic loading business (e-loading), which is known for its fast and affordable way of loading cell phones. The proposed design presents an automatic way of delivering prepaid service using the e-loading business where the users can enjoy its benefits.

Customer

The Mapúa Institute of Technology (MIT) Intramuros campus bookstore is a place where students buy school supplies and other school necessities. It is strategically located near the campus' entrance and exit for the students to quickly access the place. The bookstore has two counters, where each one can accommodate one customer at a time.

Need

Aside from selling books and school supplies, the MIT bookstore is also providing prepaid loading service like E-Load and Auto-Load. The bookstore employees are using a traditional way of loading where they have cellular phone(s) with SIM cards registered for prepaid loading of network providers'

subscribers. The transaction is done by first, entering the customer's mobile number and the requested load amount into the loading cellular phone and then receiving the cash payment. The transaction requires some time thus, the customers who want to load their cell phones during instances when the MIT bookstore is full of customers buying school supplies, may feel very inconvenient especially the students who need prepaid load urgently. The long line of customers seeking for prepaid load can also cause delay to the line of students buying school materials. Therefor the MIT bookstore needs an alternative way of selling prepaid load to the students of MIT.

Solution

Objectives – The goal of the design is to provide an automatic prepaid loading service which utilizes the Mapúa Institute of Technology (MIT) identification card and the student and faculty database for the user's payment to offer cashless transactions during the prepaid cell phone loading. The design aims to be a low cost automated loading device that uses commercially available electronic components.

Constraints – The main limitation of this design is that it requires a registered MIT student card to be operated. The loading service is only available to Smart, Globe, and Sun network users. The amount of prepaid load that can be purchased is limited to 15, 25, 50 and 100 Pesos. In the event of loss of power and network provider problems, one will not be able to use the design. The

design is not using the MIT database but a different database, which contains basic information of the students that can be also found in the MIT database. The user can't use the device to load the same number within thirty minutes and is limited to enter three incorrect formats.

Impact – Through the design, the students can purchase prepaid load even if the bookstore is closed as long as the device has power and network connection. Additionally, the design opens a new method of using the MIT account for paying in-school services. The MIT ID is also used as a tool for verification to provide secured transactions. Finding the components needed for any necessary replacement is easy since the device uses parts available from local electronics stores.

Differentiation - The first big change in the design compared to the traditional prepaid loading is that it is automated. Secondly is that the design utilizes the MIT Identification card system to verify who the user is and gives an MIT student a quick access to the prepaid loading device. The transactions of the users will be synchronized to their MIT billing account which can give them the opportunity to pay at the treasury office any time. Lastly is that the design keeps records of all information about the transactions done by each user to an electronic database rather than on a log book. The database can be then backed up for future use.

Benefits

Since the device can be placed anywhere in the school vicinity, the MIT bookstore can still provide prepaid loading service even if they are closed. The employees of MIT bookstore can have more mobility when it comes to their selling of school supplies. Also, it will be an additional profit to the MIT Bookstore and to the Treasury.

Definition of Terms

ACEduino – a single-board microcontroller that includes a software suite for programming it.

Database - an organized collection of data, today typically in digital form.

GSM Module - a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator.

Liquid Crystal Display (LCD) - a type of display commonly used in digital watches and many portable computers.

Network Service Provider (NSP) - a business or organization that sells bandwidth or network access.

Prepaid Loading - commonly referred to as pay-as-you-go, pay-as-you-talk, "pay and go", or prepaid wireless. It is a mobile phone for which credit is purchased in advance of service use.

Radio Frequency Identification (RFID) Reader - a device that is used to interrogate an RFID tag. The reader has an antenna that emits radio waves; the tag responds by sending back its data.

Radio Frequency Identification (RFID) Tag - a microchip combined with an antenna in a compact package; the packaging is structured to allow the RFID tag to be attached to an object and be tracked.

Chapter 2

REVIEW OF RELATED LITERATURES AND STUDIES

Call and Text Messaging in the Philippines

The Philippines is known as the "SMS (short message service) Capital of the World" (Periabras, 2012). Having this epithet, no doubt that most Filipinos particularly the students spend most of their time and money just to text or call their friends or relatives. According to the recent statistics, there are more than 70 million users or mobile-service subscriptions in the Philippines alone, of which there are approximately 1.39 billion SMS messages being sent daily, or roughly in a year there were 142 billion text messages sent, which is entirely greater than the average SMS messages sent per year in Europe, China and India. (Research and Markets, 2010 and Text Messaging)

Cell Phone Loading

Based on loadphones.com, load is a term used in the Philippines for mobile phone prepaid credits or airtime. Load can be used for text messaging, talking or downloading mobile content from any prepaid phone. Load can also be transferred between mobile subscribers on the same operator network.

Loading business is one of the fastest industries in the Philippines. Prepaid mobile subscribers are growing fast every day and the demand of prepaid load is increasing thus, the mobile phone load expense is considered to be one of the

burdens of the Filipinos. According to WINS Universal Cell phone Load 2012, there are around 70 million registered mobile phone users in the country today, 98% of which are prepaid load users. The average Filipino purchases P30 load per day, this would translate to P2.1 billion/day. Load just like food, shelter and clothing is now considered a basic need in the society. It is certainly one of the most highly consumable products today.

Philippine Load Companies

According to loadphones.com, there are 3 mobile phone companies in the Philippines: Smart Telecom which is a PLDT company, Globe Telecom which is an Ayala Group Company and the Sun Cellular.

Globe™ is a leading telecommunications company in the Philippines. Its mission is to transform and enrich lives through communications by way of its vision of making great things possible. Through its renewed commitment to "enriching lives through ease and relevance", its goal is to enrich everyday communications by simplifying and removing obstacles in communication technology so that it bring its customers closer to what matters to them most. (www.globe.com.ph)

Smart Communications, Inc. (Smart), on the other hand, is the Philippines' leading wireless services provider with 50.9 million subscribers on its GSM network as of end-June 2012. Smart has built a reputation for innovation, having introduced world-first wireless data services, such as Smart Money, Smart Load, Smart Padala and the Netphone. Smart also offers 3G and HSPA+ services, and

the country's first and only LTE network. Its Smart Link service provides communications to the global maritime industry. Smart Broadband, Inc., a wholly-owned subsidiary, offers a wireless broadband service, Smart Broadband, with over 1.63 million subscribers as of end-June 2012. Smart is a wholly-owned subsidiary of the Philippines' leading telecommunications carrier, the Philippine Long Distance Telephone Company. (www.smart.com.ph)

Digitel Mobile Philippines, Inc. (DMPI), commercially known as Sun Cellular is a wholly-owned subsidiary of Digitel, and is one of the Philippines' leading mobile telecommunication companies. It was established by DIGITEL in September 2001 to provide wireless public and private telecommunication services. Sun Cellular offers a wide range of service innovations for mobile telephony from voice, messaging and international roaming services, to wireless broadband and value-added services for consumers and businesses alike. It has received accolades over the years with awards such as the Most Promising Telecom Service Provider in Asia Pacific award in the 2009 Frost & Sullivan ICT Award in Singapore. (www.suncellular.com.ph)

Based on loadphones.com, Smart is the largest mobile carrier in the Philippines and Globe is the 2nd largest followed by Sun Cellular on the third spot. All three of these carriers use SIM cards to provide cellular services. Prepaid phone plans are by far the most popular way to stay connected in the Philippines. All three providers have prepaid options and SIMs. In the Philippines, load can be purchased for Globe, Smart or Sun phones at practically any store.

Philippine Loading Services

The sources of prepaid cellular phone loads in the Philippines are two: Prepaid Cards (also called the wholesale loading) and the Retail Loading (also known as E-Loading / Auto reloading). Between these two, Retail Loading is preferred by the majority of the Filipinos today. Due to its affordability and simplicity, Wireless Telecommunications Company sought after the prepaid loading station that is highly suitable in the Philippine setting. Moreover, retail Loading today has totally captured the Philippine market. As a result, prepaid cards can now be considered as obsolete, though there are still some who use prepaid cards. And because Retail Loading is a low-investment business to which a person can manage his/her own, Filipino businessman are attracted to this service and are persuaded to do retail loading business. Based on a related study entitled "Microcontroller Based SMS Micro E-load Vending Machine", Retail Loading has the very strategic way of selling load because it is obviously more affordable and has the greater income potential compared to prepaid cards (Cu and Uy, 2006).

Microcontroller Based Loading Machine using Money and Coins

The sources of prepaid cellular phone loads in the Philippines are two: Prepaid Cards (also called the wholesale loading) and the Retail Loading (also known as E-Loading / Auto reloading). Between these two, Retail Loading is preferred by majority of the Filipinos today. Due to its affordability and simplicity, Wireless Telecommunications Company sought after the prepaid loading station that is highly suitable in the Philippine setting. Moreover, retail Loading today has totally captured the Philippine market and prepaid cards can now be considered as obsolete, though there are still some who use prepaid cards. And because Retail Loading is a low-investment business which a person can manage his/her own, Filipino businessman are attracted to this service and are persuaded to do retail loading business. Based on a related study entitled "Microcontroller Based SMS Micro E-load Vending Machine", Retail Loading has the very strategic way of selling load because it is obviously more affordable and has the greater income compared to prepaid cards (Cu and Uy, 2006). This previous study aimed to automate the prepaid auto loading services implemented in the Philippines by constructing a vending machine to eliminate the cause of error in the conventional auto reloading services. The said project was composed of a microcontroller, a keypad, an LCD display, a money feeder, a money changer, a GSM module and a power supply. The microcontroller serves as the brain of the whole project, and money and/or coins are used to purchase loads. (Cu and Uy, 2006)

CHAPTER 3

DESIGN PROCEDURES

HARDWARE DEVELOPMENT

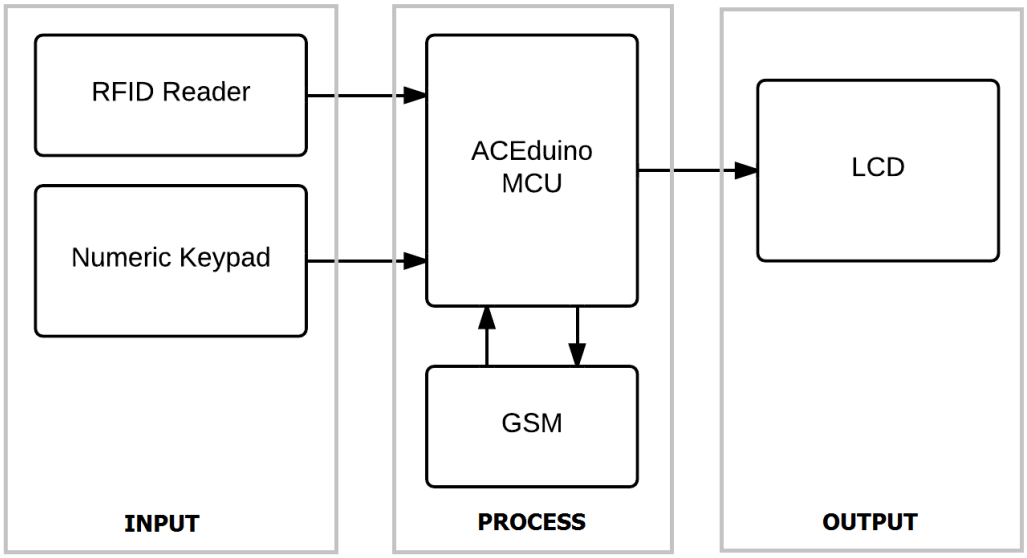


Figure 3.1: Design block diagram

The mode of operation of the system will consist of the input, output and process. The RFID reader will be the first input of the system where its main job is to fetch a serial code from an RFID tag. Another input device will be a numeric keypad where the user uses it to interact with the system. The output device of the system is an LCD. The LCD will act as a monitor that will guide the user in using the system. The GSM module along with the microcontroller will process all of the input values entered by the user. The GSM module will execute the last process in completing a prepaid loading.

SCHEMATIC DIAGRAM

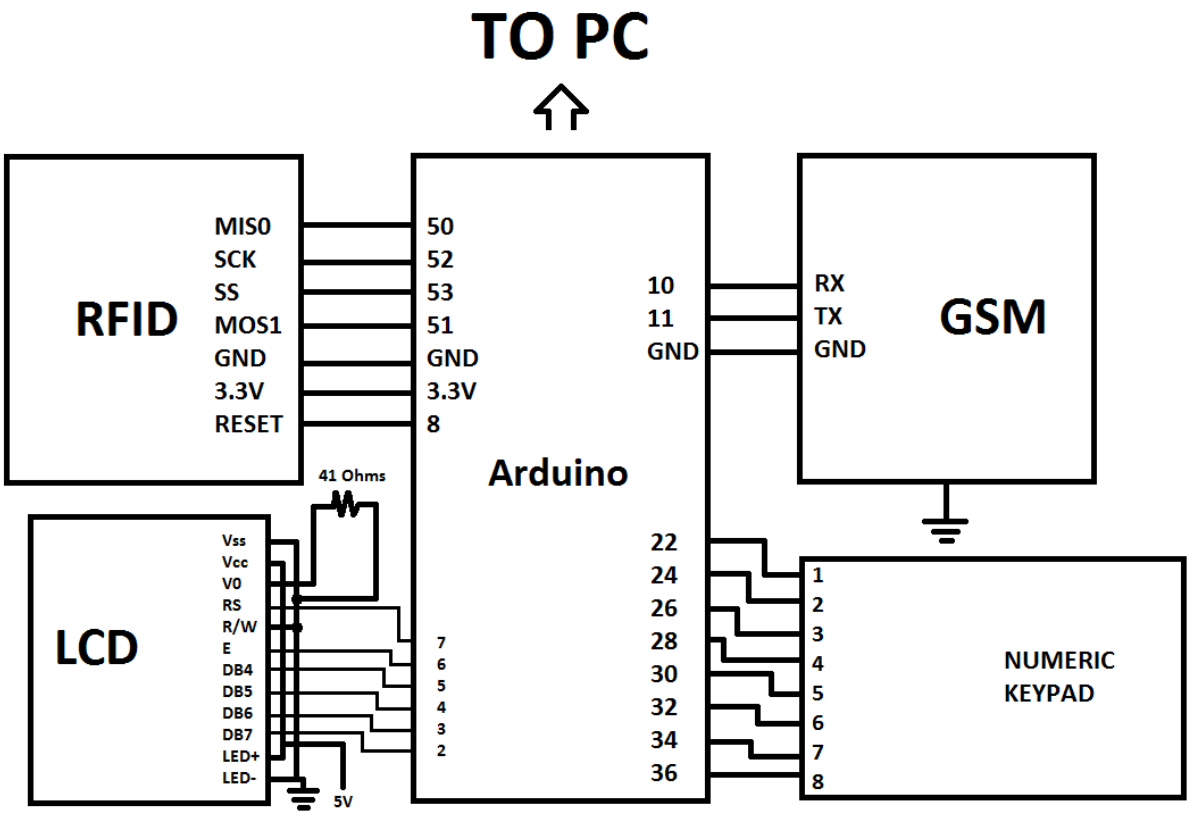


Figure 3.2: Design schematic diagram

The device is composed of six basic components, the RFID reader, LCD screen, GSM module, numeric keypad, ACEduino microcontroller and PC. The RFID reader is connected to the input ports of the ACEduino as well as the numeric keypad. The LCD screen is connected to the output ports of the microcontroller and the GSM module is connected to the input/ output serial ports of ACEduino. The ACEduino is communicating to the PC using the serial port connected to the both sides.

SOFTWARE DEVELOPMENT

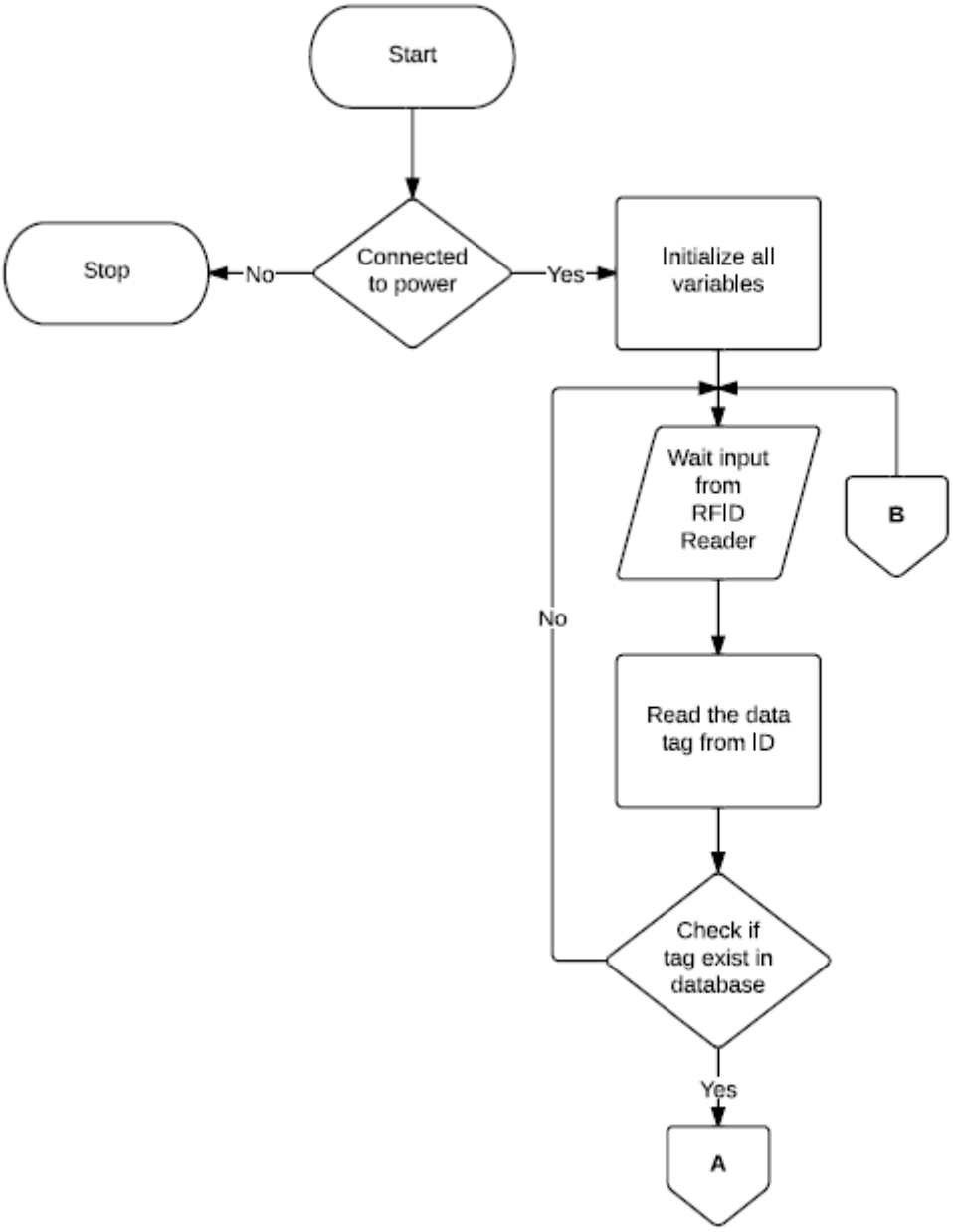


Figure 3.3a: System flow chart

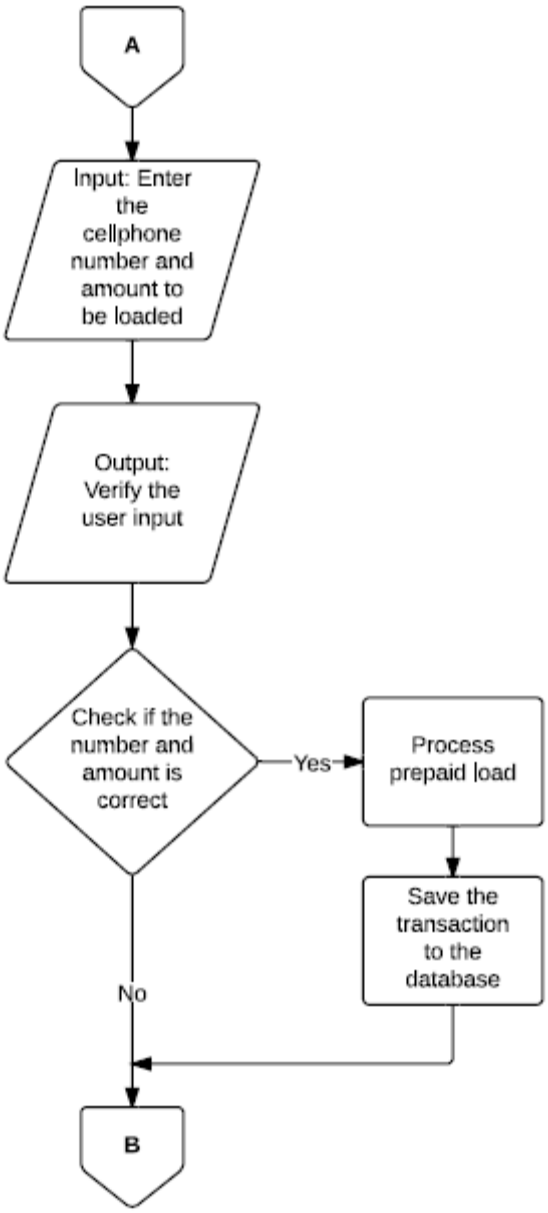


Figure 3.3b: System flow chart (continued)

Figure 3.3 is the flowchart of the designed prototype. The process starts as soon as the power supply is introduced to the circuit. The first process starts from initializing all the required variables. This helps the loading device to ready

itself for the next processes. It also clears any unwanted data that can cause the device to generate unwanted results.

After the initialization of variables, the device then enters an idle stage where the RFID reader waits for an ID tag to be tapped. When an ID tag is tapped near the RFID reader, the RFID reader then fetches the serial code from the ID tag. The RFID reader passes the serial code to the ACEduino microcontroller where it compares the serial code to the existing serial codes in the database. The microcontroller then checks if the serial code matches any of the serial codes in the database. If the serial code does not exist in the database, then the device will simply notify the user that the ID does not exist and returns to the stage where the RFID reader waits for another ID to be tapped. However, if the serial code thus exists then the device will continue with the next process.

When the ID tag of user is verified, the user may now enter the 11-digit mobile number using the numeric keypad. Then using the numeric keypad again, the user chooses the amount to be loaded. After these steps, the microcontroller checks if the mobile number entered is valid. If the module number is a valid number, the microcontroller now sends the input values to the GSM module.

The GSM module executes the final process of prepaid loading using the entered mobile number and amount to be loaded. If the prepaid loading is successful, the GSM module then notifies the microcontroller. Then the microcontroller updates the transaction records in the database.

After this step, the device will simply go back to the idle stage and then wait for another ID to be tapped.

Functional Requirements

I. Test Case

Add a New Record

Basic Flow

1. The administrator shall tap an unregistered RFID
2. The administrator shall input the necessary data for "Basic Information"
3. The administrator shall click the "Save" button to create the new record in the database.
4. The application shall display a notification that the record is successfully created.

Alternate Flow

In the event that the tapped RFID is already registered

1. The application will not proceed to the window for entering the data for Basic Information.

Test Case ID:	Create01	
Test Case Name:	Create Student Record	
Test Case Desc:	To create a record of basic information.	
Test case status:	Accepted	
Test status (P/F):	P	
Test priority:	High	
Test steps		
Step	**Expected**	**Actual**
1) Tap the RFID to the reader.	RFID tag is displayed.	RFID tag is displayed.
2) Enter Student Number, Family Name, Given Name, Middle Name, Contact Number, Email Address, Street, Barangay, Town City and Province.	Student Number, Family Name, Given Name, Middle Name, Contact Number, Email Address, Street, Barangay, Town City and Province are displayed.	Student Number, Family Name, Given Name, Middle Name, Contact Number, Email Address, Street, Barangay, Town City and Province are displayed.
3) Click Add Button	A message will be displayed indicating a successful adding of student record.	A message will be displayed indicating a successful adding of student record.

Table 3.1: Create student record test case

Edit Student's Record

Basic Flow

1. The administrator shall enter a student number
2. The administrator shall select the edit record command.
3. The administrator shall modify the student's basic information.
4. The administrator shall click the save button to alter the student's information in the database.

Test Case ID:	Modify01	
Test Case Name:	Modify Student's Record	
Test Case Desc:	To modify the record of student's general information.	
Test case status:	Accepted	
Test status (P/F):	P	
Test priority:	High	
Test steps		
Step	**Expected**	**Actual**
1) Enter student number.	Student number is displayed.	Student number is displayed.
2) Click Modify Button	A message will be displayed indicating that the entered student number is present or not present in the database.	A message will be displayed indicating that the entered student number is present or not present in the database.
3) Enter Family Name, Given Name, and Middle Name.	Family name, Given Name and Middle Name are displayed.	Family name, Given Name and Middle Name are displayed.
4) Enter Contact Number, Email Address, Street, Barangay, Town City and Province.	Contact Number, Email Address, Street, Barangay, Town City and Province are displayed.	Contact Number, Email Address, Street, Barangay, Town City and Province are displayed.

5) Click Save Button	A message will be displayed indicating that modification of student record is successful.	A message will be displayed indicating that modification of student record is successful.

Table 3.2: Modify student record test case

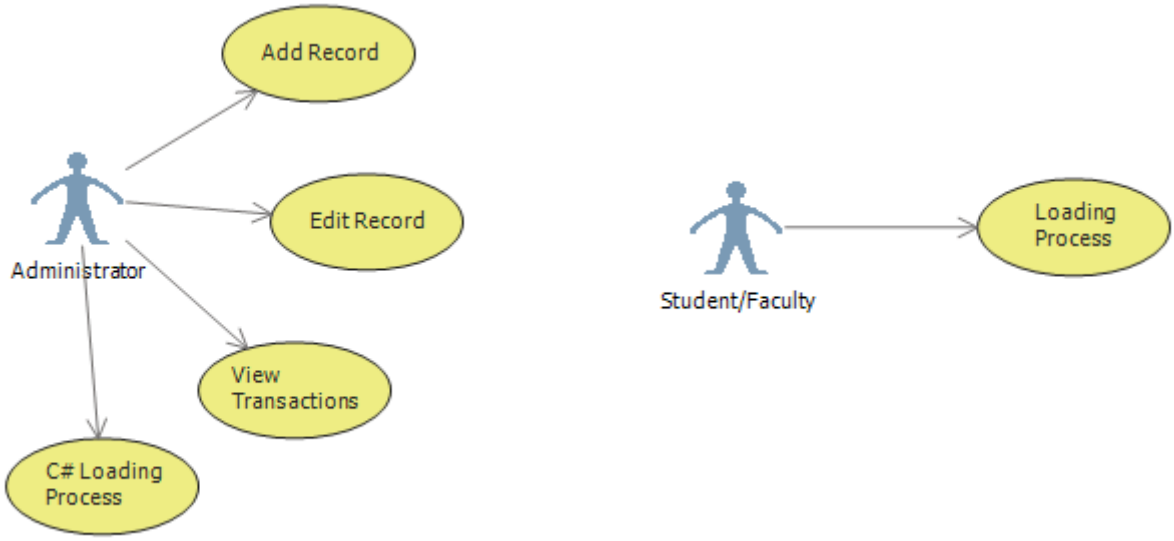


Figure 3.4: System use case diagram

Figure 3.4 shows the basic use case diagram that is used to come up with the number of test cases. The administrators can use the device to add record, edit record, view transactions, and modify the C# program loading process.

PROTOTYPE DEVELOPMENT

1.) ACEduino MEGA 2560

The ACEduino MEGA 2560 works as the main controller of all the components presented in the circuit. It processes all the data coming from the RFID reader and numeric keypad and is responsible for handling the data to be used by GSM module.

2) RFID Reader

The RFID Reader is responsible for reading data in the RFID tag which is the MIT ID. It validates whether the data in the tag is present in the database.

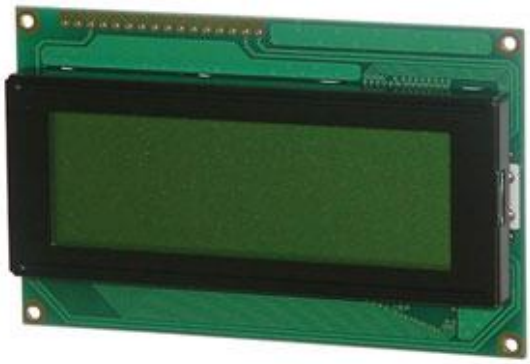
3) GSM Module

The GSM module is one of the main components of the device. It has a SIM card slot and is responsible for sending and receiving text messages.

4) Numeric Keypad

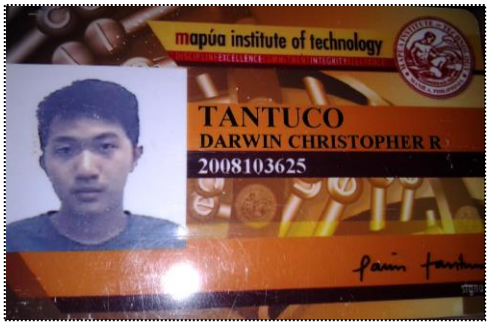
The numeric keypad is mainly used as an input in the device. It is used to enter a user password, mobile number and in choosing the network provider and amount of prepaid load.

5) LCD



The LCD serves as the main output of the device. It acts as a monitor that will guide the user in using the device.

6) ID Tag (Mapúa ID)



The Mapúa ID is a passive RFID tag that holds a unique data. It is tapped in the RFID reader and the data is fetched through serial communication.

7.) Resistors

The resistor is used in the LCD and in the power supply. In the LCD, a resistor is needed to properly adjust its contrast.

8.) Connecting wires

The connecting wires are used to attach the pins of the RFID reader and GSM module to the ACEduino microcontroller.

Component Price Listing

COMPONENT	PRICE (PHP)	QUANTITY	PRICE (PHP)
ACEduino Mega 2560	1450	1	1450
RFID Reader	1750	1	1750
GSM Module	3275	1	3275
Numeric Keypad	175	1	175
4x4 LCD	750	1	750
Resistor	2	1	2
Connecting wires	12	30	360
Case	200	1	200
TOTAL			**8127**

Table 3.3: Component price listing

Chapter 4

TESTING, PRESENTATION, AND INTERPRETATION OF DATA

RFID Reader Test: Loading of the user's data

Since the prototype will utilize the Mapúa Institute of Technology (MIT) identification (ID) card, it will be crucial for the RFID reader to work properly anytime and during transactions. The test will focus on the functionality of the RFID reader.

Procedure:

1. First, set-up the prototype and make sure it is connected to a power supply.
2. Then connect the prototype to a server or a computer using its corresponding COM ports.
3. Next, run the MIT-Loading C# application then go to "RFID-test" tab inside the application. The data retrieved by the RFID reader can be viewed in this part of the application.
4. To test the functionality of the RFID reader, a single MIT ID should be initially tapped for the control data and be manually recorded.
5. Then, the same MIT ID is tapped ten times. The consistency of the data retrieved by the RFID reader will be checked manually if it is still the same with the control data.

6. Mark each trial table 1 with "Y" if the new data retrieved by the RFID reader is consistent with the control data.

Figure 4.1: Initial output of the device

Figure 4.1 shows the initial output the device displayed when it was powered on.

Figure 4.2: LCD output when ID is recognized

Figure 4.3: Enter password LCD output after ID is recognized

Figure 4.4: LCD output when ID is not recognized

When an ID registered in the database is tapped on the device, the device notified the user that the ID was recognized, as shown in Figure 4.2 and then proceed to "Enter Password" display, as presented in Figure 4.3. Another test

was conducted for tapping an unregistered ID and this resulted to the "*ID not recognized*" display, as seen in Figure 4.4.

Is loading of user's data through RFID successful? (Y/N)										
Trial 1	**Trial 2**	**Trial 3**	**Trial 4**	**Trial 5**	**Trial 6**	**Trial 7**	**Trial 8**	**Trial 9**	**Trial 10**	**% Correct**
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**100%**

Table 4.1: Testing loading function results

Loading of the user's data through tapping of ID on the RFID reader involves identifying whether the user is using the official Mapúa Institute of Technology identification card (MIT ID) that is present in the SQL-database. If the user is not using MIT ID, the device will display an error message "*ID not recognized*" as shown in Figure 4.4 and will not proceed to the next instruction. This test will determine the functionality of the system for both instances.

Table 4.1 shows the result of the test that determines the functionality of the device by conducting series of trials to verify whether single tapping of the MIT-ID could both load user's data successful. Hence, the test is 100%.

GSM Module Test: Prepaid Loading

This test focuses on the functionality and reliability of the GSM module when it comes to prepaid loading. The test will get the number of times a prepaid load is successfully sent to the recipient number after several trials.

Procedure:

1. Set-up the prototype and make sure it is connected to a power supply.
2. Connect the prototype to a server or a computer using its corresponding COM ports.
3. Next, run the MIT-Loading C# application.
4. Follow the instructions shown in the LCD to complete a loading transaction.
5. Repeat the loading transaction times for each of the load amount and network provided.
6. Fill up and complete Table 4.2. For each of the corresponding trials, mark "Y" if a confirmation message arrives to the recipient's number and "N" if the prepaid loading is unsuccessful.

Figure 4.5: LCD output with user password

Figure 4.6: Correct password LCD output

Figure 4.6 shows the testing of the device LCD output when the six-digit password was entered. The notification if the password is correct is shown in Figure 4.7. Figure 4.14 shows the testing when the incorrect password was entered.

Figure 4.7: Network selection LCD output

Figure 4.8: user 11 digit number LCD output

Figures 4.8 and 4.9 show the testing of the network selection and input number functions of the device, respectively. Figure 4.13 shows the testing when the incorrect password was entered.

Figure 4.9: Amount selection LCD output

Figure 4.10: Input verification LCD output

Figure 4.8 shows the amount of prepaid load the user wanted. The testing result for each amount is shown in Table 4.2. Figure 4.11 shows the output of the number and the amount for user verification.

Figure 4.11: Loading LCD output

Figure 4.12: Loading success notification LCD output

After the verification, the device will then process the input. The loading process takes some time and Figure 4.12 shows the LCD output while processing. Figure 4.13 shows the output after the device processing with the "*Thank you*" greeting.

Figure 4.13: Incorrect password LCD output

Figure 4.14: Invalid number LCD output

Trials	Sun				Smart/TNT				Globe/TM			
	Amounts				Amounts				Amounts			
	15	25	50	100	15	30	50	100	15	25	50	100
1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
0	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	100%	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4.2: Device greeting and loading success notification LCD output

Program

The RFID reader will then fetch the Serial Number from the tapped ID; and the system's program will use that serial number to verify whether the user is included in the database of the currently enrolled students or not. If the user is found in the student's database, the device will then prompt for a password for

security purposes. If the user failed to give the student's password, it will not proceed further to the loading process.

The Loading Process

After the user has entered the correct password, the device will prompt the user to choose the network (Smart, Sun, Globe) and the user's 11-digit cell phone number. Table 4.2 shows the results of testing that determines the device's capability to do its main function: to send the cell phone load successfully to the cell phone number entered by the user. Series of trials were conducted in this test and the test objects are the different networks at different specified load amounts. Table 4.2 indicates that the testing is 100% correct; however, it was not applicable at all cases. There were instances wherein the user attempted to use the device to purchase cell phone load at the same number simultaneously; and the cell phone load request was discarded by the load service provider. It is because there is a 5-minute delay predefined in the availability of service whenever a user attempts to load at the same number. This delay blocks the number from loading to avoid sending simultaneous cell phone loads at a single request.

If the cell phone number entered is not valid, where the user has entered less than or greater than 11-digits, the device will prompt an *"invalid number"* message as shown in Figure 4.15. If the number entered is not a genuine cell phone number, (for example the number is not with this format: 09xxxxxxxxx),

the device will still proceed the loading to the load shop but it will discard by the process. Also, if the number entered does not match with the indicated network, the load service provider will discard the process.

SQL Database Test: Transaction Records

An organized record of transactions is also needed for the prototype. This set of test will determine the correctness of the data being stored in the SQL-Database.

Procedure:

1. Set-up the prototype and make sure it is connected to a power supply.
2. Connect the prototype to a server or a computer using its corresponding COM ports.
3. Next, run the MIT-Loading C# application.
4. Follow the instructions shown in the LCD to complete a loading transaction.
5. From the MIT-Loading C# application, go to the "View-Transaction" tab to manually verify if the last transaction had been recorded.
6. Complete and fill out Table 4.3. Mark each corresponding trials "Y" if the recorded data in the database matches the users input data and mark it as "N" if the record is wrong.

7. Repeat the loading and transaction verification process until each trial is complete.

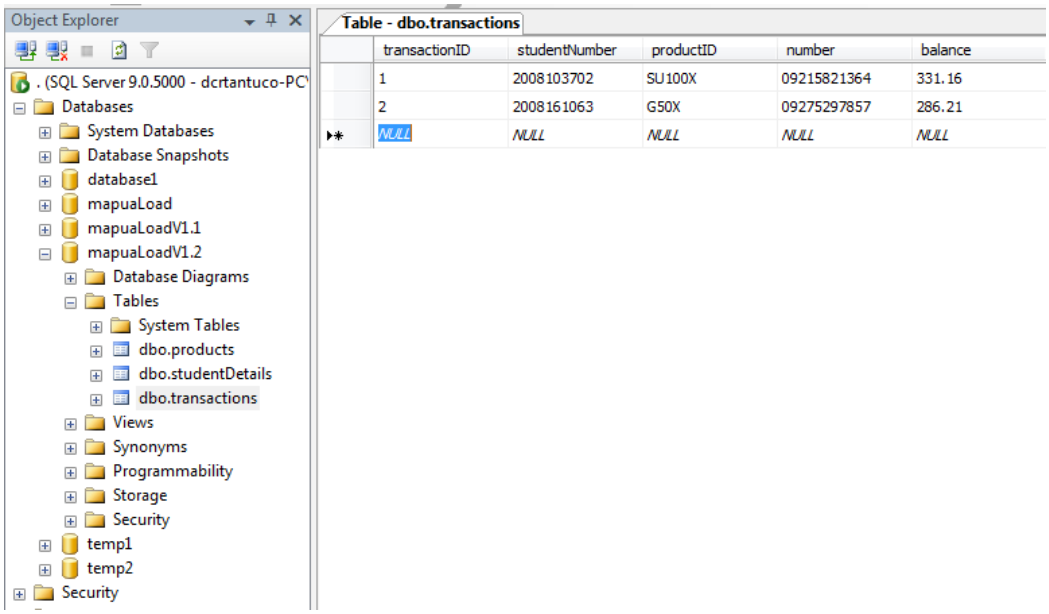


Figure 4.15: Transaction table

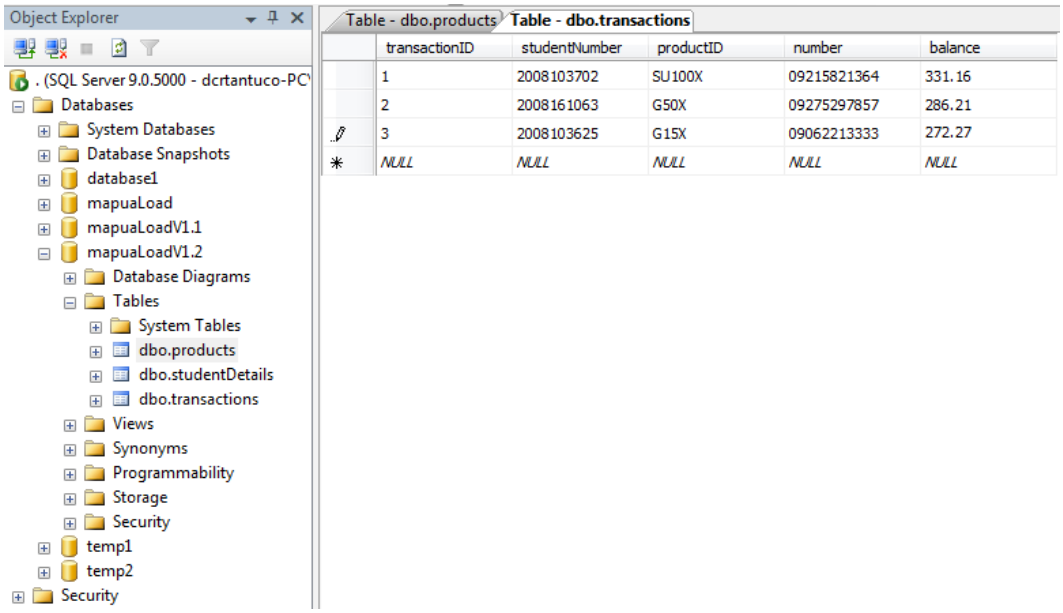


Figure 4.16: Transaction table after successful loading

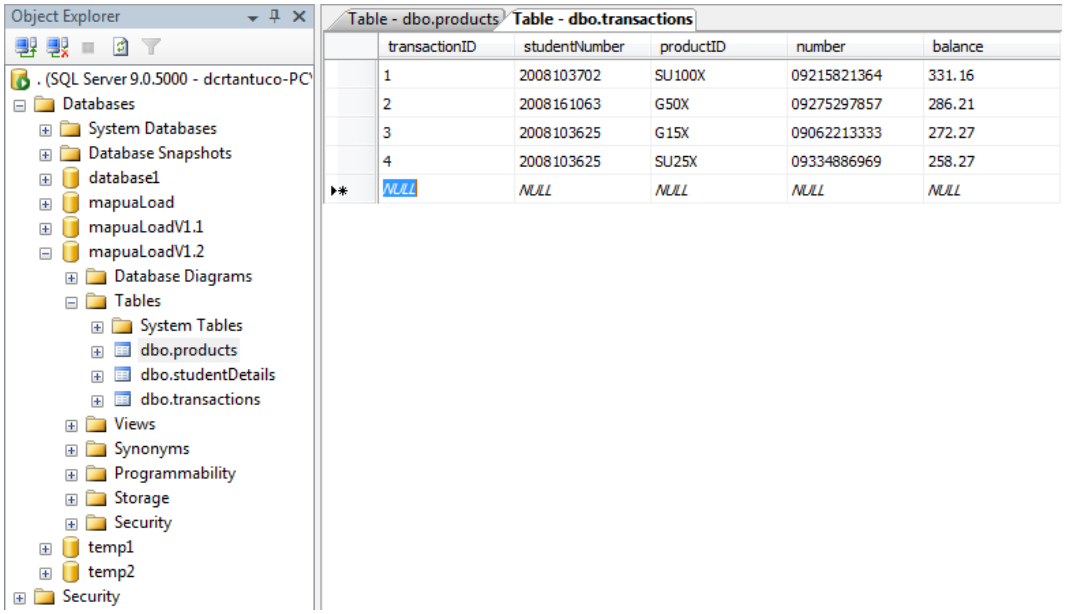


Figure 4.17: Transaction table after successful loading on different network

Trials	Transaction Recorded	Correct Student Number	Correct Mobile Number	Correct Product ID
1	Y	Y	Y	Y
2	Y	Y	Y	Y
3	Y	Y	Y	Y
4	Y	Y	Y	Y
5	Y	Y	Y	Y
6	Y	Y	Y	Y
7	Y	Y	Y	Y
8	Y	Y	Y	Y
9	Y	Y	Y	Y
10	Y	Y	Y	Y
Total	100%	100%	100%	100%

Table 4.3: SQL database testing results

Figure 4.15 shows the initial values of data in the SQL database before the testing. After successful loadings, another set of data are added in the database as shown in Figure 4.16 and Figure 4.17.

In Table 4.3 the result of the test shows how the records of every transactions is stored in the SQL Database. After each of the ten trials, the SQL-Database is checked manually and found out that all of the data needed for each of the transactions have successfully been recorded. The test shows 100% correctness in all the data recorded. The results of this test have proven that the SQL-Database used for the prototype is reliable when it comes to storing of records and retrieving of records.

Impact Analysis

Students are nowadays spending much of their pocket money for their cell phone load. At some time, even if loading their cell phone is of great importance, they choose to set it aside and spend their pocket money for food, for printing purposes or for other necessities instead. Now through this designed device, an MIT student is able to load their cell phones in a cashless way: that is, even if they do not have pocket money, they still can load their cell phones. Their load expense will proceed on their MIT balance account, and students can pay the balance anytime within the term- which is a great deal for MIT students. They can bother to pay their load balance even after the term and pay first those things that are urgent to be paid. In addition, the transaction in using this device

is fast. Consider a line of students buying school supplies to the bookstore, and a student at the end of the line who simply wants to load his/her cell phone— this is very inconvenient on the part of the student, and the worse is when perhaps the bookstore cannot accommodate loading services at such time. With the device's mobility, it can be placed anywhere in the school and students can just come and purchase load and go that easy in the place without any hassle. Another point is that, MIT is a technological school and needs to be technologically advancing as time goes by. And to implement this presented technology, it only needs inexpensive items that are purchasable within the country. Finally, since it is automatic e-loading, it eliminates human labor, though the manual cell phone loading does not imply much work.

Chapter 5

CONCLUSION AND RECOMMENDATION

Conclusion

From the results of the testing and analysis of data, the researchers have concluded that an automated cashless prepaid loading service is achievable by using a device that makes use of the MIT identification card and the student and faculty database. The identification card is used by a student or a faculty member to purchase prepaid load without the need to pay for it right after the transaction since the amount spent by the user is automatically charged to his/ her school account. The design uses components and parts that make the device to have lower cost compared to the existing automated prepaid loading devices in the market.

Recommendation

Although all of the objectives in this paper had been achieved, the device still has some limitations and should undergo improvements.

The design is currently limited in providing prepaid loading service to the three networks providers namely Globe, Smart and Sun Cellular and so adding more networks for the user to choose for is recommended. The user can have more options if the future design can make the user enter any amount desired for prepaid loading other than the fixed amount available. A wireless connection

between the device and the PC server is also suggested since the device can be positioned in any desired places without considering the disadvantages of wired connection. Lastly, providing receipts is not included in this design. The inclusion of receipts will further formalize each transaction done with this design. Addressing these limitations will make the existing design more versatile.

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APPENDIX A

OPERATION'S MANUAL

System requirement for C# Application and SQL Server 2005

Item	Requirements
CPU	Pentium 4 1600MHz (or equivalent AMD)
Graphic Card	512 MB RAM graphic cards(or equivalent on-board graphic cards)
RAM	1 GB
Operating System	XP, Vista, Windows 7

Installation Procedure

1. Place the device on a flat surface for stability. The distance between the device and the PC with database depends on the length of the serial cord to be used.
2. Turn on the PC and execute the Windows database application needed on the PC.
3. Connect the serial cord from the device to the USB port of the PC.
4. Connect the power cord from the device to power supply.
5. Wait for the device to load until the LCD display shows the message, "Please tap your ID." When this message is shown, the device is ready for operation.

User's Manual

1. Tap user's official Mapúa Institute of Technology Identification card on the front side of the device.
2. Using the numerical keypad, enter user's six-digit password. Press the "#" key when done to proceed. The user can press the "*" button to delete the last entered character.
3. The LCD screen will now show the available networks for prepaid loading. Choose the desired network by pressing the button corresponding to the network. For example, press the "A" button to choose Globe network.
4. The device will now ask for the eleven digit number. Enter the user's eleven digit number. Press "#" to continue. The user can also press the "*" button to delete the last entered character.
5. The choices for the amount of prepaid load to be purchased will be shown. Choose the desired amount by pressing the button corresponding to the amount.
6. Wait for the confirmation message for the successful loading. If so, the transaction is complete.

Troubleshooting Guides and Procedures

1. **Unable to connect to COM port.**

   Ensure that the serial cord is properly connected to the device and to the USB port of the PC. Unplug and re-plug the ports on and restart the PC application.

2. **Unable to connect to the Database.**

   Make sure that the PC met the system requirements listed on the system requirements section. Check if the database needed is present and is working perfectly.

3. **Device did not recognize the ID card.**

   Confirm that the ID card is a registered card and is working properly. Additionally, ensure that the device is powered on.

APPENDIX B

Pictures of Prototype


Enter Password:
******
1 2 3 A
4 5 6 B
7 8 9 C
* 0 # D


Please tap your ID
ID not recognized
1 2 3 A
4 5 6 B
7 8 9 C
* 0 # D
133 C. DIMAANO ST., BAGONG POOK, LIPA CITY

APPENDIX C

Datasheets