SMARTPHONE CHARGING USING RFID

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***ABSTRACT*— This article presents a smartphone charging using Radio Frequency Identification (RFID) for performance analysis. RFID are microchips which can be attached to products in order to allow their contactless identification via radio frequency. Smartphone has become one of the most technologies that are frequently used by human beings to stay connected with other people. However, a frequent charging using plug can increase the power consumption and may result in electricity wastage especially in public places especially in library of UiTM Shah Alam. Therefore, a new approach for charging a smartphone is presented in this paper to optimize the number of people using smartphone charger and save power consumption. It is designed at a lower cost as possible to make it safe to use and energy efficient. In this paper, Atmega 328p acts as a microcontroller to ensure the system works smoothly and reducing the complexity of the schematic circuit. This smartphone charger works when the RFID card is successfully scanned and allows the user to choose how long the charge is charging.**

Keywords- rfid, relay, smartphone charging, power consumption, number of people use smartphone charger

I. INTRODUCTION

In this modern era, the growth of technologies has many significance and benefits for all human kind. These technologies are developed to help and ease the human work. However, the technologies are always need improvement over time to increase its efficiency and reduce the production costs. This Smartphone Charging using RFID is invented to be one of the technologies that can help people to charge their mobile phones in public places specifically library UiTM Shah Alam.

An unlimited number of user and period to charge smartphone has cost high power consumption as well as being a high demand to the students. Hence, this project is about to optimize the number of people using smartphone charger for certain period and in the meantime reduces the power wasting by the users. Scope of work for this project is once the menu is chosen; the user cannot choose another menu unless the timer is up. The usage of battery as the power supply to the Atmega 328p is also quite inconvenient. This is due to the battery's power that run out suddenly during the charging process is still ongoing.

This system is inspired from the RFID Smart Tags that have been use on the highway. Using a RFID is a good approach for automated identification of products. RFID acts as an identification for the users to use and calculate the cost that should be charge to the user depended on the route they use. "An Authentication Protocol in a Security Layer for RFID Smart Tags"[1] is one of the references used in this project. In this project, RFID is used to identify the owner of a car to prevent it from get stolen.

Another reference for RFID is about "Smart Parking System using RFID and GSM Technology"[2]. In this paper, RFID and GSM technology is used to prevent theft of vehicle during parking. Furthermore, an article about "Combining RFID-Based Physical Access Control Systems with Digital Signature Systems to Increase Their Security" is also use to increase the security of human beloved things[3].

Next, RFID is also use to improve lives. This project has been done by Xuemei Li and his teammates about "RFID Based Smart Home Architecture for improving lives"[4]. This project let the resident relax and free from worries theft as they can gain information about their houses easily.

Other than that, "Building a Smart Home Environment for Service Robots Based on RFID and Sensor Networks" is also use to improve lives using RFID[5]. This project consists of three main components which are smart objects with a RFID tag and smart appliances with sensor network functionality, the home server that connects smart devices as well as maintains information for reliable services, and the service robots that

perform tasks in collaboration with the environment.

RFID technology also can be used as a payment method that has widely been applied in the public traffic systems, retail business and other ticketing businesses for its convenient functionality of storage-and-update of electronic data, and its transmission safety during data exchange in between RFID tags and reader[6][7]. This project of a smart charging machine uses this RFID approach, enable user to charge their electronic device using RFID card. The same approach also use by L. Cai, X. Gu, J. Li, C. Huang, C. Li, Q. Qin, and J. Guo that proposed a novel topology of charge pump using RFID tag[8].

There is also system that uses RFID, as a method to charge electric vehicle like "Design of RFID Mesh Network for Electric Vehicle Smart Charging Infrastructure". This paper proposes a mesh network RFID system for user identification and charging authorization as part of a smart charging infrastructure providing charge monitoring and control.

The smart charging machine used relay as a switching device to turn ON/OFF the electric device connected to smart charging machine. It is quite similar to "Design of a portable wireless charging system based on relay technology" that uses relay as a switch in designing a portable wireless charging system[8]. Four coupling coil structure was propose in the paper as they are uses in relay wireless charging system of portable devices.

In this project, relay is not only act as switches, but it also works to protect the circuit from having an over voltage supply. "Ancillary Protective and Control Functions Common to Multiple Protective Relays" is used as a references to finish this project[9].

The main part for this project is Atmega 328p. It is very important in this project due to its function that acts as an engine to the whole system, especially to the circuit. The code for the system is write and burn into it step-by-step to ensure the system works sequentially.

Three projects have been used as references in this project, which is "Low-cost Smart Energy Management based on Atmega 328P-PU Microcontroller", "A Low-cost, Real-time Monitoring System for PV Plants based on Atmega 328P-PU Microcontroller", and "Design and experimental characterization of a low-cost, real-time, wireless AC monitoring system based on Atmega 328P-PU microcontroller"[10][11][12]. These projects have used Atmega 328p as their microcontroller.

II. METHODOLOGY

A. Introduction

Main parts of the system are RFID and relay. These two components are more likely to act as a switch as it is used to identify the users and allow the current flows.

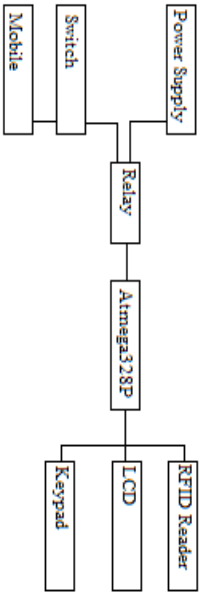

Fig. 1: Block diagram of Smartphone Charger

A successfully scanned card on the RFID module let the Liquid Crystal Display (LCD) to display a few choices of charging period and a keypad is used to insert the menu chosen. Once a menu is chose, relay will allows the current to flow and cut off the current when the time is up. The Atmega 328p is the processor as it contains the algorithms for the whole process.

This project is placed in library UiTM Shah Alam for 12 hours to be used by the students. The time of usage for the smartphone charging is then being recorded. In addition, a normal smartphone charging is also been taken to obtain the duration used. Both cases involved 12 students as a survey. The maximum period on using RFID smartphone charging can be used for 1 hour. Hence, only 12 students can fit in the 12 hours of survey.

B. Flow of the System

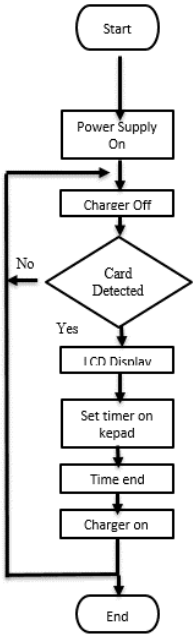

Fig. 2: Flowchart

Firstly, power supply must be ON to start the project. However, the charger will only be turned ON once the RFID reader detects the card and instantly it will send data to the Atmega 328p microprocessor. Liquid Crystal Display (LCD) is used in this project to display some instructions to the user on how to use the charger. Then, user can choose a timer on how long to use the charger using the keypad. After the set time is reached, the charger will be OFF to its initial state. The user can use it again by scanning the RFID card and follow the same step.

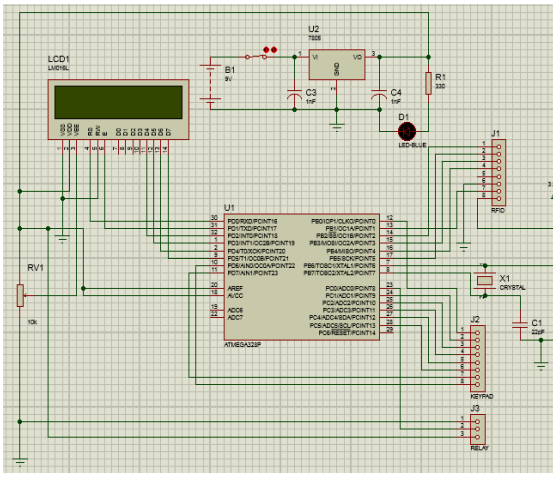

Fig. 3: Schematic diagram

The RFID reader Mifare RC522 RFID Kit is used. It has 8 pin and 7 of it is used.

RST, SDA, SCK, MOSI, and MISO pin is connected to pin 15,16,17,18 and 19 of Atmega328p sequentially. GND to ground and 3.3v is to 3.3v. To get the value of 3.3V, the voltage regulator is used.

LCD has 16 pin, and 14 pin is used to make it displayed for read and write function. As shown in figure above, only pin D0, D1, D2, and D3 are not used in this project. The pin VSS, RW, and LEDK is connected to the ground. The VDD and LEDA pin are connected to the 5V. The RS is connected to the pin number 2 of the atmega328p and E is connected to the pin number 3 of the atmega328p. VDD pin is connected to the middle pin of the 10k variable resistor as shown in the figure below. Variable resistor is used to control the contrast of the LCD display. For pin D4, D5, D6 and D7, it is connected based on the user choice, for this project, it was connected to the pin 4, 5, 6, and 11 sequentially.

The keypad used in this project is 4x4 matrix membrane keypad. It has 8 pin, four of it is for the row part and the other four is for column 4. Since this project is only used 3 rows and 3 columns, so only 6 pin are used and it is connected to the Atmega 328p. For this project, only pin 8,7,6 and 4,3,2 is used and connected to the pin 12,13,14 and pin 6,4,2 of the Atmega 328p sequentially.

III. RESULT AND DISCUSSION

In this section, the data obtained for the duration of using a smartphone charger for normal charging and smartphone charging using RFID presented. The smartphone in charging using RFID is successfully works as it has been used by the student in the library of UiTM Shah Alam. It is proves can optimize the number of users and saves the energy consumption.

1) Optimization the number of users

The table below shows the actual data obtained for the duration of smartphone charging process using normal charging and smartphone charging using RFID. The duration for the smartphone charging using RFID is limited to only 60 minutes as it is the maximum duration that can be choose by the users while the duration for normal charging is obtained from the survey that have been conducted in library of UiTM Shah Alam. The 60 minutes provided by the smartphone charging using RFID can supply up to 75% of the

battery of a smartphones. The data are then used to plot a graph.

Table 1: Actual data for number of students charging duration

Number of Students	Smartphone Charging using RFID (m)	Normal Charging (m)
1	60	80
2	60	90
3	60	50
4	60	50
5	60	70
6	60	70
7	60	60
8	60	50
9	60	75
10	60	40
11	60	60
12	60	70

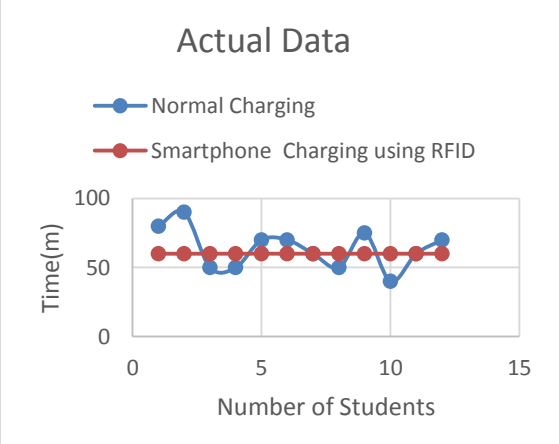

Fig. 4: Graph of actual data between time against number of student

The table below shows the measured data obtained for the duration of smartphone charging process using normal charging and smartphone charging using RFID. The data for the duration of smartphone charging using RFID is obtained bt placing the prototype in library of UiTM Shah Alam and allows 12 students to use it. The duration for normal charging of actual data is used to be the setpoint that act as comparator to the smartphone charging using RFID.

Table 2: Measured data of number of students and charging duration

Number of Students	Smartphone Charging using RFID (m)	Normal Charging (m)
1	60	80
2	45	90
3	50	50
4	55	50
5	55	70
6	40	70
7	50	60
8	60	50
9	45	75
10	25	40
11	30	60
12	45	70

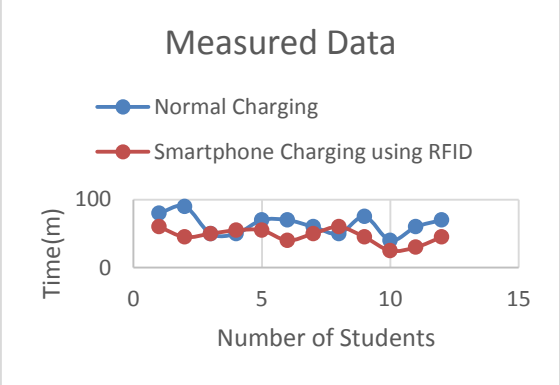

Fig. 5: Graph of measured data between time against number of student

The results obtained shows that the smartphone charging using RFID can optimized the number of users as the total time usages are 560minutes and 765minutes for charging using RFID and normal charging respectively. The differences of the time usages is 205minutes which is can be used for 3 more person. This project really gives more chance to the students to use the charger instead of being monopoly by some students.

2) Manual calculation to calculate kilowatt hours

To estimate the amount of energy consumption, it is necessary to calculate the kilowatt hours to get electricity bills in order to see the energy use more realistically.

The steps below explain how to calculate the kilowatt hours:

1) Find the wattage on the appliance label. It is usually found on the back or the base of the appliance.
2) Multiply the wattage by hours used per day.
3) Divide the result by 1000.
4) Multiply the answer by the number of days measured.
5) Multiply by the cost of electricity per kWh.

The normal wattage for the smartphone charger is 30W. Since the library of UiTM Shah Alam only open for 5days per week, the hours used per day will be 5days and the number of days measured will be 20days per month.

i. Calculation for normal charging

The total duration for normal charging is 765 minutes = 12.75 hours

1) 30W x 12.75h = 382.5 watt-hours per day
2) 382.5/1000 = 0.382kWh
3) 0.382kWh x 20days =7.65kWh
4) The electricity tariff that has been announced by Tenaga Nasional Berhad (TNB) for 1st January 2019 to 30th June 2019 is 39.45 cent/kWh.
   7.65kWh x 39.45 cent / 100 = RM3.02 per month

ii. Calculation for Smartphone Charging using RFID

The total duration for normal charging is 560 minutes = 9.33 hours

1) 30W x 9.33h = 279.9 watt-hours per day
2) 279.9/1000 = 0.2799kWh
3) 0.2.799kWh x 20days =5.598kWh
4) The electricity tariff that has been announced by Tenaga Nasional Berhad (TNB) for 1st January 2019 to 30th June 2019 is 39.45 cent/kWh.
   5.598kWh x 39.45 cent / 100 = RM2.21 per month

From the calculation shown above, it shows that the smartphone charging using RFID is quite cheaper compared to the normal charging. Thus, it can be concluded that the smartphone charging using RFID is really saves energy consumption as it uses relay to cut on and cut off the power supply when the timer is up. This indirectly solves the problem where users forgot to switch on the charger.

IV. CONCLUSION

Smartphone Charging using RFID is successfully developed and being test to achieve all the requirements validated. This project is able optimize the number of people using smartphone charger for certain period and in the meantime reduces the power wasting by the users. To conclude this project, it has achieved the objectives and gives more chance to the students to use this charger instead of being monopoly by some students.

V. ACKNOWLEDGMENT

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