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An Automatic Power Cut-off Appliance with Smart Battery Optimizer

Saipunidzam Mahamad, Muhammad Farid Mohd Zaid

Computer and Information Sciences Department, Universiti Teknologi PETRONAS,
32610 Seri Iskandar, Perak, Malaysia

saipunidzam_mahamad@utp.edu.my

Abstract. Appearance of new technology every single day in today's world is not some strange phenomena. The current trend shows new devices created to help and ease people's life, however, is still lacking in some factors which include Computing. Many had faced with issues of the battery lifetime, power drain due to overcharging and others. Even though there are some applications that claimed can help users to avoid the decreased of the problem but still users need to manually do the prevention such as unplugging the charger when the battery is full. Thus, this paper will present a development of an internet of things (IoT) device which can communicate with a mobile application to help people in handling their electronic appliances. The appliance integrated with an application that able to automate process, monitor the charging activities and apply mechanism to prevent an overcharging with some pre-setting value. Initial study received positive feedback thus support the development of this project. It gave beneficial to the society and simultaneously reduce the rate of producing the Li-ion battery waste in the world.

1. Introduction

Everyday people are inventing a new thing either as innovative product or enhancing technology to ease people's life from time to time. Invention on battery is one of phenomenon for all electronic appliance. In order for an electronic device to work or switch on, it will need a power supply such as a battery. In this new age, there are many types of battery that can be used to power up an electronic device and selection of the battery type also very crucial process for creating a new electronic device especially on how long the electronic device can be used for a day. Many of the inventors created a new electronic invention that will be using a battery that can be recharge when it has worn up as this method can indirectly attract the users to buy and use the device as they do not have to buy a new battery every time the battery is dead.

Energy conservation indicates to decreasing energy through utilizing less of an energy benefit. Energy conservation varies from effective energy employ, which refers to utilizing less energy for a constant service. Conserving energy gives researchers more opportunity come up with solutions and alternatives. In reality, all energy produced and utilized has an impact on the environment. Indeed, even energy from very normal sources affects the environment. To sustain the energy, is to create an energy without placing them in risk of getting expired or drained and can be used repeatedly. Sustainable energy ought



to be broadly encouraged as it does not make any damage the environment and is accessible generally free of expense.

Batteries are the most widely recognized type of daily hazardous waste. However, the environmental effect of batteries is not constrained to the waste stream. Natural effects happen in the production, dissemination and end-of-life periods of the battery life cycle. Researcher agreed that a lead battery are key to a cleaner, greener future [1]. It is a most environmentally sustainable battery innovation and a pioneer in sustainable power source stockpiling arrangements. The spotless, sustainable power sources expected to help make a sustainable society.

A rechargeable battery is very good for all electronics device, as it will save user's money to buy a new battery. This benefit will also come with a deficit as that rechargeable battery may not last very long if the users always overcharge the battery. This occurrence always occurs due to hectic lifestyle as always forget to unplug the battery charger. The decreased battery life will really give a very bad experience when it comes to a place that do not have any power supply plug as a damaged rechargeable battery will always need the current to flow in it in order for it to power up the electronic device.

Even though, users will have the option to replace their rechargeable battery, but it will be quite costly. Some of the rechargeable battery have been permanently embedded inside the device which require some technical skills to replace it and give difficulties to users. The damaged battery may cause by overheating when charging for a long time or too many running applications. An excess heat that has been produced by that situation will damage the battery over time.

Therefore, this paper presents a study that integrate the development of a power cut-off appliance that integrate with application to monitor the charging activities. It applies some mechanism to send signal in between application and devices that will help users to maintain their original rechargeable battery for a longer time. The output of this research also will be a better solution for current mobile applications thus prevent the overcharging phenomena.

2. Literature Review

Battery is a device that have electrochemical cells that will be connected to external connections to act as a power source for electronic devices. According to Scrosati et al. [1], battery is a portable device that is capable of giving the stored chemical energy as electrical energy to power up any electronic devices. The battery has a high conversion efficiency with zero gaseous emission so that will make battery one of the green source of energy if compared to fossil fuel. Hannan et al. [2], battery is a high energy density, long lifespan and high efficiency energy storage that way better than the renewable energy like solar energy and wind energy. This is due to the battery properties itself make it better as it is portable and rechargeable plus it also easy to use.

There are many type of battery has been produced and the usage of the battery in any electronic devices is not a new phenomenon to people nowadays if compared to people who live in 1800 when battery first invented. According to Guo et al. [3], battery nowadays is widely used in any portable electronic devices and any new energy inventions such as the electric car. Zou [4] added that battery is commonly used throughout the globe in any devices that need electrical energy to power it up. All these statements have shown that battery nowadays is one of the most crucial things that is needed by human in order to survive in this new world.

According to Shen [5], batteries will always possible on undergoing a process called accelerated degradation because of its harsh charging/discharging cycle and high peak power. This situation will

lead to the decrease of battery life time. In order to eliminate this kind of situation, there is a need to do a battery optimization technique to make sure the battery can last long. Alshurafa et al. [6], a battery optimization technique has successfully enhanced the battery life time up to 300%. The test has proven that with a battery optimization technique, it enhances a battery life time and at the same time conserve the energy of replacing the battery frequently.

Not only conserving the energy, battery optimization also can help users from any severely injured from burns associated with any battery-powered devices. If we did not take care of our smartphone battery correctly, the spontaneous battery explosion may happen [7].

Current battery optimization strategy that have been applied in laptop and smartphones is only by using the application that can give users tips on conserving their battery. There are no hardware or software that can help users optimizing their battery except by doing a manual job like plug out their electronic devices when their battery is full. This will give users an extra task whenever wants to charge their electronic devices. Due to certain circumstance such forgot to plug out their battery, it will lead to the situation of battery overheating and that situation may cause a decrease a battery lifetime as per discussion in an article by Guo et al. [8].

3. Methodology

3.1. System Architecture

Figure 1 shows the system architecture of the Smart Battery Optimizer device and mobile application. The medium of communication between the controller (device) and the mobile application installed in users' smartphones is by using the Bluetooth communication system. The mobile application will send a digital signal to the device whenever any one of the condition set by the have been met. Whenever users want to charge their smartphones, they will need to set the value of temperature and battery level that they want. After setting all the values, inside their mobile application, users just need to pair their smartphone with the device and everything will be done automatically. Users just need to make sure that their smartphones' charger is connected to the device so that the mobile application can controller the in and out of the electric current to the smartphone. The charging process of the smartphones will continue as usual as it will only stop when two condition that has been set earlier has been met. The first condition is when the battery level of the smartphones has reached the limit and the second condition is when the temperature of the smartphones has reached the maximum temperature set by the users.

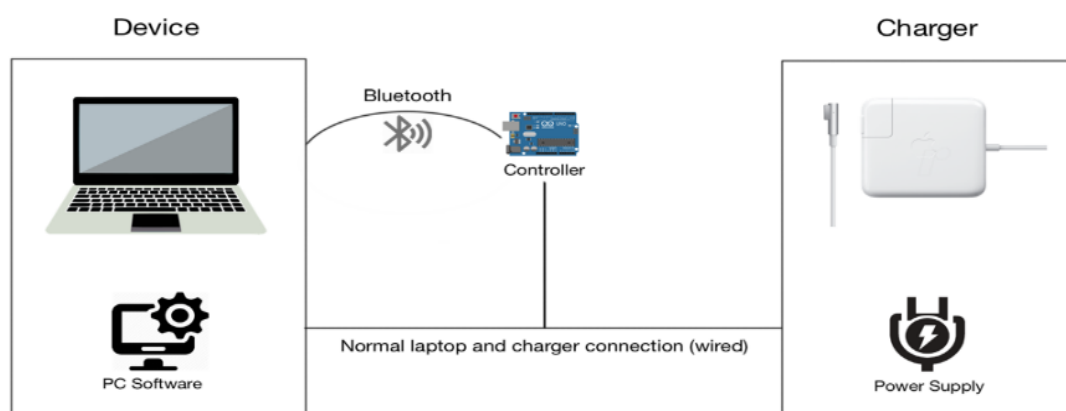


Figure 1. System Architecture for Smart Battery Optimizer

3.2. System Design

There are many battery optimizer applications that already exist in the market but based on my research, all of them need manual ways to preserve users' smartphones. As for now, there are no similar applications in the market that have the same functionality as this application. The reason why this application is different from the others is due to the automatically stop the electric current from flowing from the power supply to the smartphones. Even the charging cable that users use will not have any current flowing inside when the controller does its job.

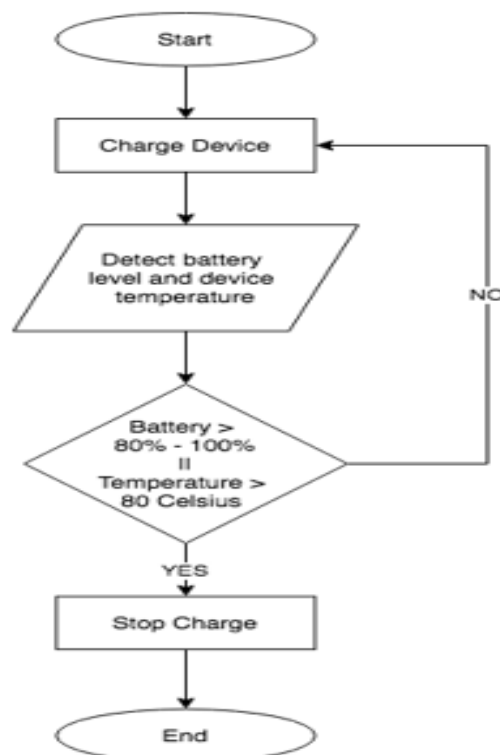


Figure 2. Smart Battery Optimizer Flowchart

Figure 2 shows the flowchart that explain more on how this device working. The process starts when the users want to charge their smartphones as the smartphones' battery has depleted. The users will need to set the limit of the smartphones' battery level and also the temperature as the controller will stop charging it receive a digital signal from the mobile application when the limit has been fulfilled. The mobile application installed in the smartphones will detect the battery level and also the temperature of the smartphones as it is running on the background. If the mobile application figures out that the smartphones has fulfil any one of the first and second condition, it will automatically stop the charging process. The charging process will start back if the software detects that the smartphones match either the third or fourth condition that is when the battery level of the smartphones has decreasing below the limit and also when the temperature of the smartphones decreasing below the maximum temperature set by the users. This process will loop until the users close the mobile application in their smartphones.

The usage of battery optimizer are needed to increase the battery lifetime, so user will have no problem to access their devices without any power source around them. This also will simultaneously reduce the rate of producing the Li-ion battery waste in the world as the Li-ion battery waste percentage always increase throughout the years.

4. Result and Discussion

A set of usability test has been conducted for a group of 10 respondents of users for the hardware device and software application. All the respondents come from diverse backgrounds such as students, professional workers and also full-time housewives. All the respondents have been given the hardware device with a smartphone that has been installed with the software application. After they test the product, all users have been given a link to complete an online survey that consist of six questions regarding their satisfaction and experience of using the product.

All the respondents have given positive feedbacks towards the hardware device and also the software application. Commonly, all users are very satisfied with the user interface of the Smart Battery Optimizer application as it is easy to use and easy to understand. The development of this product is to ease people's life in monitoring their smartphones during the charging process. It also can help users to extend their smartphone's life time from less than two years to four years or more.

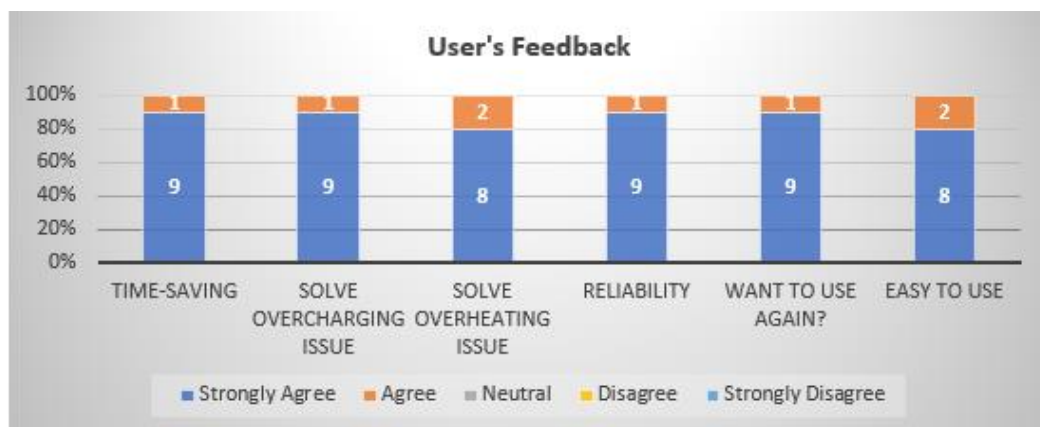


Figure 3. Participant Response

Figure 3 has illustrated that majority of the tester of the product agreed that this application and device can really save more time as it remove the time that we need to monitor whether our smartphones is fully charged or not. The 80%-90% of the testers agreed that this product can really solve the problem of overcharging and overheating of smartphones. 90% of the testers find that this application and device is really reliable, and they want to use it again after the test. All the testers have actually had the thought of straight away buy the product after the test as the product can really help to ease the daily routine. All the testers are very satisfied on the experience where they no need to monitor their smartphones when they charge it. They also find that this product also can really help them as it removes the feeling of worry as they charge their smartphones, as with this product, they will not face the overcharging and overheating situation.

5. Conclusion

Integrated Smart Battery Optimizer application both hardware and hardware is the solution to create a new and better way of controlling an electrical appliance. The development with a mechanism to automate the monitoring of charging activities would enable the process of cutting the power within the charging process. It will make electronic devices last longer and reduce waste of lithium ion battery as that will produced high impact pollution. By having this system, the battery lifetime will increase without any extra effort to plug out the battery every time it is fully charged. It improvise all the current applications in a way that all the manual job of getting users' smartphone battery optimize and the problems like overcharging situation could be solved.

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