Battery Protection against Overheating

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Abstract- In day to day life, people tend to leave their electronic devices such as phones and laptops constantly plugged into power sockets overnight or during the day. Due to poor ventilation of heat which is generated from constant electrical supply to the battery, the battery starts losing its life and degrades in efficiency. This may lead to overheating or complete damage of the device in certain cases. This project is an attempt to overcome the problem of overheating of the battery thus saving the battery, device and the charger. The devices give a signal as soon as they are fully charged which in turn will be transferred to the Arduino board[2]. As soon as the Arduino board receives the signal, the connection from the Arduino to the extension cord will be disrupted leading to no power supply to the devices hence saving it from any further damage and keeping it safe for use.

Keywords- Arduino, Bluetooth HC-05, Overcharging, Charge Automation, Switching Circuit, transformer.

1. PROBLEM STATEMENT

It's an issue that has tormented mankind since the beginning of the cell phone. Lithium particle batteries can respond ineffectively if your telephone encounters hoisted temperatures prompting a harming impact towards your battery. In the event that you have a case on your gadget that does not enable the warmth to get away, this warmth will build the temperature of the battery and cause cell oxidation which will contract the limit of the life the life expectancy.

2. INTRODUCTION

It has been a problem that has tormented humankind since the beginning of the cell phone. We utilize out trusty pocket PCs so much that they once in a while overcome a day with any power left. Huge numbers of us connect them to the charger around evening time and not turn off the same, content in an information that we will wake up to a completely charged gadget. Be that as it may, is it extremely safe to keep our telephones connected to the charger once they are completely charged? It has a harming effect on the battery by shortening its life expectancy. There are a ton of wrong and unproved thoughts on the subject. Be that as it may, what is the reality? Lithium particle batteries can respond inadequately if your telephone encounters lifted temperatures prompting a harming impact towards your mobiles. On the off chance that you have a case on your gadget that does not enable the warmth to get away, this warmth will expand the temperature of the battery and cause cell oxidation which will contract the limit and abbreviate the life expectancy of the battery.
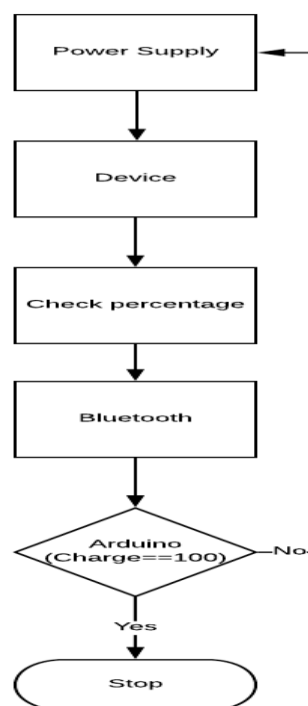
PROJECT DESCRIPTION

Figure 1. Workflow Diagram

This project comes up with the solution to this problem thus leading to automatic cut off of the charge once the device reaches 100% charge[8]. This will help protect the battery from any further damage thus increasing its life span. Few hardware and software requirements are used in order to achieve the automatic cut-off and solve this issue. The hardware we have chosen to achieve this is Arduino UNO which is going to work on two different modes, high and low according to the message received by it[4]. The message to it will be sent to it by the Bluetooth module depending on the power status of the phone for which an app is developed that will help in the automatic cut off of the mobile from the charger. The power supply to the Arduino UNO will be stepped down from 220 V to 6 V using an AC to DC step down transformer. We have used a LED light to indicate once

the charge has stopped flowing to the phone as it will be connected directly to the charger of the mobile.

3. LITERATURE SURVEY

In order to conserve the battery's health from overcharging, we need to understand the fundamentals of each component that are going to be used. To give the reader a wider scope of this domain, we have a referred several papers which address the same problem.

To make it easier to follow, we will broadly divide these papers into four major implementations which are in use today:

- Home Automation Systems

- Bluetooth-based Automation

- Wi-Fi-based Automation using Microcontrollers

- Wireless Operations on Microcontrollers

The paper "AN OVERVIEW OF HOME AUTOMATION SYSTEMS" by Muhammad Asadullah and Ahsan Raza of National University of Computer and Emerging Sciences, Peshawar, Pakistan propose the usage of an Arduino BT Board for Bluetooth-based Automation. The specifications provided by them indicate that the Arduino BT Board should have a range of at least 10 meters, with a data transmission rate of 3 megabits per second with a 2.4 GHz bandwidth. The drawback of this particular proposition is that only household appliances can be automated with this model. Coming to our proposed system, this particular shortcoming works in our favor as what we aim to achieve with this system does not have to do deal with heavy-grade appliances or industrial-grade equipment. This particular model is economically cheaper than other automation models as Bluetooth modules are easily available in the market.

The paper "BLUETOOTH-BASED SMART AUTOMATION SYSTEM USING ANDROID" by Poonam V. Gaikwad and Yoginath R. Kalshetty of SVERI's College of Engineering, Pandharpur, Maharashtra, India propose the usage of HC-05 Bluetooth Module which is an intermediate junction connecting an Android smartphone to an Arduino UNO board. The transmission of signals to-and-fro from both the smartphone and the Arduino UNO board result in the automation of home appliances such as lights, smoke sensors, door sensors, temperature regulation sensors, etc. Inspired by this model, we want to work towards the problem of overcharging battery shortcomings and prevent them from occurring.

The paper "ARDUINO-BASED BLUEOOTH CONTROLLED ROBOT" by Subankar Roy, Tashi Rapden Wangchuk and Rajesh Bhatt of CCCT Polytechnic Chisopani, Nandugaon, Sikkim, India also propose the usage of the same HC-05 Bluetooth Module for controlling a robot. The only component different from the above-mentioned paper is that they have employed a DC Motor to properly govern the functioning on the robot. This paper only confirmed our belief that the HC-05 Bluetooth Module is very efficient for our purpose and we are aiming to put it in use for our model.

The paper "WIRELESS COMMUNICATION USING HC-05 BLUETOOTH MODULE INTERFACED WITH ARDUINO" by Mrs. Anisha Cotta, Miss Varda Kalidas Naik Ekoskar and Miss Naik Trupti Devidas of Don Bosco College of Engineering, Fatorda, India explains how to correctly implement HC-05 Bluetooth Module with the Arduino UNO board under specific conditions. With the help of this paper, we would like to implement our model under the conditions and specifications mentioned and try to get solve the problem at hand.

4. MODULE DESCRIPTION

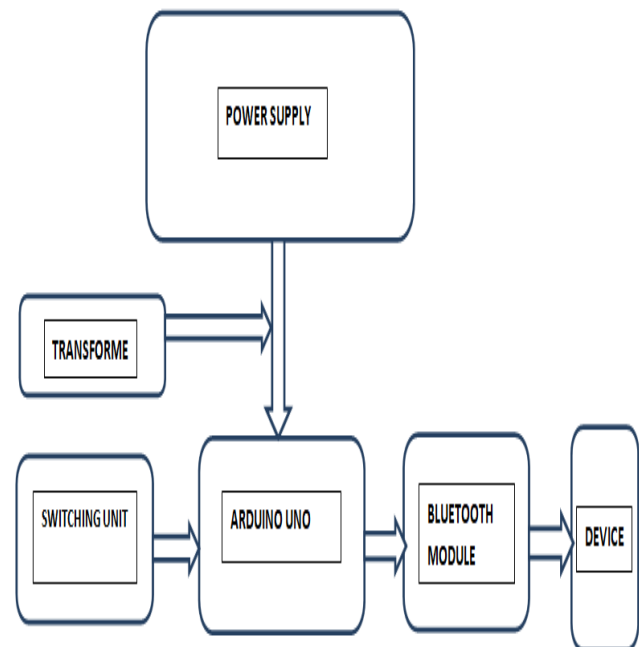The basic schematic of the project can be understood by the following block diagram:

Figure 2. Basic Block Diagram

A. Arduino

Arduino UNO is the circuit board which is used here for performing all the tasks that normally a microcontroller does. It should be tethered with the device using a cable or an adapter converting alternating current to direct current to run it[5].
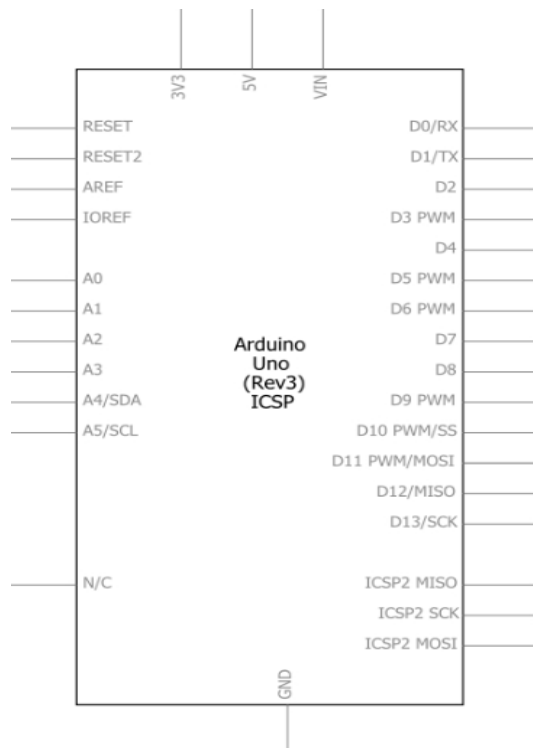
Figure 3. Arduino Pin Diagram

Arduino UNO is a free to all hardware board that has the software abilities to hitch with devices for interacting with the real world entities. Arduinos are microcontroller boards which are provided with capacitors and CPU sockets that can be interfaced with different expansion slot or circuit boards. They also have the serial USB slots on the board which is used to program the Arduino from other devices which are mostly computers[15]. So basically, the Arduinos are programmed using compilers of C/C++.

The compilers of any programming language can be used to code the Arduino but it should be taken care that it produces a binary machine code for the target processor. AVR and atmel provides an environment for these microcontrollers.

The project has an integrated development environment which is a platform for coding the programs for language processing and wiring. the Arduino will be connected to the phone using the bluetooth module. The bluetooth of the phone must be turned on while it will be connected to the Arduino using its pins on the breadboard. Once the connection is established between the two, there is a java script installed in the phone which keeps reading the battery status of the phone. There are various modules in the phone, one of them being the battery API which helps in doing so[7]. The Arduino UNO is already fed with the code which helps in reading the battery once its 100 percent charged.

After its fully charged, the Arduino reads it and performs the task of switching. The TX and RX mode works on either mode 1 or mode 0 and the code is designed in a way that after its fully charged, it changes position from 1 to 0 and vice versa. Once the mode is changed, current stops flowing from the Arduino. This is connected in between the charger and the phone and hence the charge stops flowing to the phone as well.

Avrdude is the software used to convert the executable code into a text file which would be in hexadecimal encoding that is fed into the Arduino board by the firmware[1]. To augment the process, they have free public libraries which can be accessed by the developer.
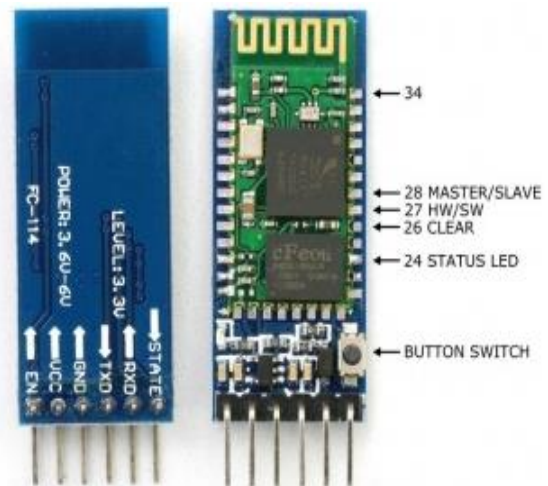
B. *Bluetooth Module*

Figure 4. Bluetooth Module HC-05

The HC-05 bluetooth module is specifically used to control the arduino boards through bluetooth connectivity. As explained earlier arduino can be connected to devices like android or a computer[14]. Hence here the android or the computer device can be controlled by the bluetooth HC-05 module.

The arduino board has master and slave devices. The HC-05 has the master device[12]. The device and the bluetooth module is paired and a password is given if necessary in order to avoid any other device interrupting it.

The bluetooth module has the breadboard connected to the arduino which is also encoded. So, device is being controlled by the arduino which will get the required information or data via HC-05 bluetooth module[11].

The concept in HC-05 module is serial communication. So, the serial data is transferred to arduino when the required signal is need to be sent[10]. Once the bluetooth module and arduino is connected using the pins, the connection is ensured between the device and the board with the requirement of the

bluetooth turned on in the device[13]. This will then move to next step where the arduino will read the battery status of the device and then work accordingly.

5. IMPLEMENTATION

A. Voltage Conversion

The step-down transformers are used here for the conversion. The high voltage is converted to low voltage. Since it is a step-down transformer the output voltage is less than the input voltage. 220V is converted to 5V by using the step-down transformer. A step-up transformer can be used when we need to convert 5V to 220V. The output from the transformer is an RMS value and its peak value is given by the product of square root of two with RMS value, which is approximately 17V[3]. There are two different windings used and based on number of their turns the power varies.

Transformer model is 6-0-6 step-down transformer. The main purpose of transformer is here to power the breadboard with 6V supply and hence charge the phone. The primary side of the transformer is connected to the power supply via a power chord[6]. The primary side has more turns so as to down 220V to 5V. The secondary winding is a large wire due to increase in current and primary winding hardly conducts current that's why it is a small-gauge wire.

A resistor and a diode are on the breadboard to make a rectifier circuit between the transformer and the device. A 9V is given by the transformer. This 9V is supplied to rectifier circuit changing it to DC. The bridge rectifier is connected to secondary transformer. There is a conventional current flow from a point with higher potential to lower potential point[6]. Thus, the transformer is connected to the device and the device starts charging.
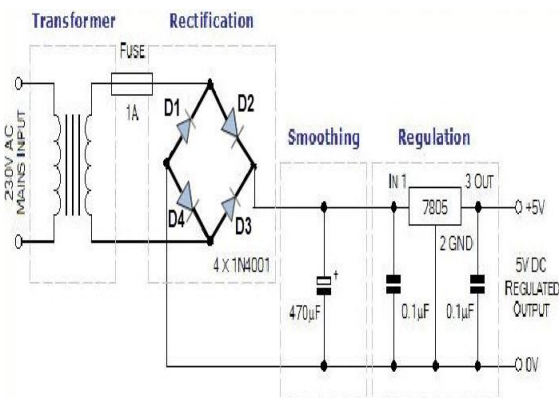

Figure 5. Circuit Diagram for Voltage Conversion

B. Arduino-Bluetooth Connection

The VCC port in the Arduino is connected to 5V output of the Bluetooth. Ground pin is connected to each other in both the modules. RX to TX of the Bluetooth and vice versa. It should be taken care that RX pin is 0 and TX pin is 1 in the Arduino.

Any other usage of pins need a library to run the Arduino. If the serial pins are 0 and 1, then before uploading the code the jumping wires are disconnected[15].
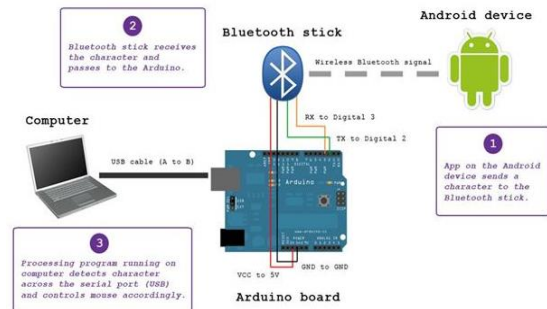

Figure 6. Connecting Bluetooth and Arduino

The concept in HC-05/06 is serial communication. When the button is pressed a serial data is sent to the bluetooth module. The other end of that module passes it over to Arduino through TX. The Arduino which is already encoded with the required code check the received data and compares it with the condition given[13-15]. The connection between the Arduino and Bluetooth is ensured by the requirement that Bluetooth on the phone is turned on.

C. Arduino-Phone Connection

The Arduino and the phone are connected through the Bluetooth module. Using the pins on the breadboard the connection is established with the Arduino[7]. When the connection is completed, there is a java script installed in the phone which keeps reading the battery status[9]. It has the path of status. The path is under /sys/device/power/battery/charge.

The Arduino has already been fed with a code which helps in reading the battery status once the phone is 100% charged. After it reads the charge percentage, it performs the task of switching. The TX and RX mode are switched from its default value of 0 and 1 respectively to 1 and 0[7]. As soon as the mode is changed the current stops flowing through the Arduino. The Arduino is connected between the charger and the phone. So, the current to the phone is cut-off.
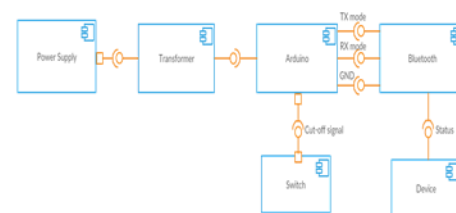

Figure 7. Component diagram

D. Charge Cut-off Indication

Arduino has TX and RX mode which in turn is mode 0 and mode 1.When the device is charging Tx is at high that is Tx=1 and Rx is at low that is Rx=0. When the device is completely charged the modes are interchanged. Now, Tx=0 and Rx=1. This stopped the charge flowing through Arduino and no current is cut-off. Along with device a LED light is also connected in series with the Arduino which is purely for indication purpose[2]. When the device is charging the led will glow indicating the flow of charge, the moment device is 100% charged the led will stop glowing. This will help the user know the function of the model, user can also keep a check on the function of the model and if the model is working properly or not.

While Charging	Completely Charged
Tx=1	Tx=0
Rx=0	Rx=1

Figure 8. Values of Tx and Rx

Resistors of 220ohms are connected in series with the led as the led only requires 2v-3v supply and may get damaged if higher supply is given and Arduino gives the output of 5v supply. In case of damage of led it can replaced easily. If the phone is not completely charged and the LED is not glowing, user can figure out that a fault has occurred in the circuit and the circuit can be checked.

6. FUTURE ENHANCEMENTS

The model we have designed is a basic automatic charge cut off system which prevents overheating of battery and protects the battery. This model can be enhanced further to work with battery with higher power consumption and capacity. Using the similar concept, the model can be used for laptops, I pad, phablets, tablets etc.

This model can be developed further to prevent overheating of boilers in factories with the help of temperature sensors. Overheating of the boilers is a major concern and has caused many accidents. We can combine this model with sensors where sensors will sense the surface temperature of the boiler and will notify the Arduino once a previously specified temperature has been reached, this in turn will prevent overheating and boiler kitting.

This model can be used for various purpose along with sensors.

E.g.: -

- Home geysers
- Boiling units
- Heaters
- Steamers.

The same model can be made timer based by using a 555 timer where the user can specify the amount of time for which the device is needs to be changed.

7. CONCLUSION

With the growing age of computers, microcomputers and supercomputers, it is rare to find people who don't use a smartphone. Battery is a major concern of every buyer, with increasing capacity of smartphones battery charging is always a concern. Smartphones are getting expensive every day and hence our model is a key factor in protecting the device and the health of battery.

Overcharging has always been a major concern of the users. Many accidents have been reported where not only the device but the user has been harmed as well. This has created a wave of fear between users regarding the overcharging of phone but at the same time the necessity of keeping the phones properly charged puts them in a dilemma. This model overcomes all the myths and fear regarding the overcharging of the phone.

The model is small and compact. It can be easily assembled and carried. The device can be easily connected to the Bluetooth module during charging. LED light indicates the working of the model and hence the user can be notified that the model is in working condition. All the components used are of low power consumption and user friendly. The faults can be easily rectified with the help of assistance, in any case the device will not be at risk and the user can leave the phone for charging. The model eliminates the need for manual operation of switch and hence relieving the user of the hassle to remove the phone from charging.

A. Precaution

Certain precautions must be taken in order to make the model work efficiently,

- Transformer is a major part of the model as it converts ac voltage to dc voltage and steps down 220v to 6v, wrong connections can lead to burning of the transformer and damaging of the entire circuit.

- Appropriate resistor values must be calculated and connected in the circuit.

- Connection of wires must be done properly for uniform flow of current.

- Bluetooth module must be connected to the device via Bluetooth.

- Arduino must be powered via a 9v battery for working and codes must be fed via a-b cable for Arduino Uno.

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