Hearing aid Battery Charger Cum Tester

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***Abstract*-In India hearing aid users are increasing every year. It could be because of the awareness created among the population, enhanced literacy rate, awareness created by NGO's and ASHA workers. According to the statistical data out of 100 people 13 are born with disability of which 3 would be hearing impaired. The Hearing aid users are classified based on the severity of impairment. They could be mild, moderate, moderately – severe and profound hearing loss. Hearing aid is used as amplifying devices for their impairment. To make them work efficiently, hearing aid with proper battery power level plays a vital role as they are power sources. Hearing aid users purchase batteries which are the essential spares. These if not used properly may drain out the energy immediately. Replacement of batteries will cost more to a wearer. This used battery after use may pile up as e-waste adding to environment pollution (Land pollution). This project will be focusing mainly in reducing buying more batteries for the wearer. Helps to save money as the charger designed will be of indigenous and low cost. Therefore, contributing in reducing e-waste and saving environment.**

The idea proposed is to design a charger for the Hearing aid batteries with a LCD display. There will be three prime inputs solar panel used to trap solar energy which is renewable, ac input and a USB port which can be connected to the PC.

Keyword-- E-waste, Rectification, Buck converter, Voltage divider, Voltage sensing Relay, LCD.

I. INTRODUCTION (*HEADING 1*)

The World Health Organization (WHO) reported that 360 million people, over 5% of the world's population, have a disabling hearing loss[9].
However, the global production of hearing aids is 10% below the total need. In developing countries, the situation is worse, as the current production of hearing aids meets less than 3% of the total need.

1.1 Overview

A hearing aid is a device designed to improve hearing by making sound audible to a person with hearing loss. Hearing aids serve to improve hearing ability by amplification of parts of the audio spectrum. Conventional analog hearing aids offer limited performance and are difficult to adjust properly for a given patient. Furthermore, due to mechanical vibration and shock, as well as component aging, their characteristics are known to deviate from the original prescribed setting. To overcome this problem the usage of digitalized hearing aid came into existence[1].

Due to the digitalization of hearing aids, usage of battery in the hearing aid came into existence. The batteries were marketed at a reasonable price. As a result batteries were sold at a high rate. As batteries are the most practical solution when it comes to powering smaller electronic devices of every kind. Rechargeable batteries have found their way into our daily life for almost every device, yet a huge number of disposable batteries are still being used. An estimated 1.4 billion disposable hearing aid batteries are dumped in landfills annually. On the other hand, there is an ongoing trend toward greater environmental awareness and "green" technologies. Used battery after use may pile up as e-waste adding to environment pollution. adding to environment pollution[4].

YEAR	E-WASTE GENERATED (Mt)	POPULATION (billion)	E-WASTE GENERATED (kg/inh)
2010	33.8	6.8	5.0
2011	35.8	6.9	5.2
2012	37.8	6.9	5.4
2013	39.8	7.0	5.7
2014	41.8	7.1	5.9
2015	43.8	7.2	6.1
2016	45.7	7.3	6.3
2017	47.8	7.4	6.5
2018	49.8	7.4	6.7

Table 1: Global Quantity Of E-Waste Generated

1.2. Functional principle of batteries

Every classical and state-of-the-art battery generally follows the same principle. It typically consists of at least four components:

- The anode, or negative electrode, gives up electrons to the external circuit. It is generally a metal, which is oxidized during discharge.
- The cathode, or positive electrode, accepts electrons when the battery is connected to an electric circuit. It is usually a metallic oxide or a sulphide, but oxygen is also used (e.g., in zinc-air batteries).
- The electrolyte provides the medium for the transfer of ions inside the cell between the anode and cathode. During battery discharge metal atoms that are missing electrons move through the electrolyte towards the cathode.
- Often a separator is required to electrically isolate the positive and negative electrodes.

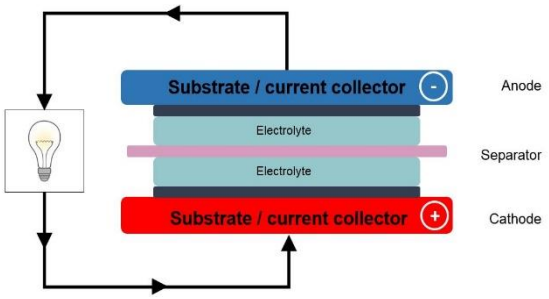

Fig 1: Basic components of a battery

Zinc air battery is the most commonly used hearing aid battery. It is activated by removing the sealing tab allowing oxygen from the air to pass into the cell and start a two-step chemical process. This chemical reaction produces about 1.35–1.4 V in the standard battery types[7].

Applications of solar energy have been a research topic for decades. In recent years, it has attracted even more interest due to the challenges on the environment, fuel source, and automotive industries. Using solar power to charge batteries is not a new idea. A simple way to accomplish this is to connect a photovoltaic (PV) panel directly to a battery. The Solar-Powered Charger, seeks to deliver the benefits of solar power in a compact and portable package.

The Universal Serial Bus (USB) was introduced in 1996 and has since become one of the most widespread and convenient interfaces for electronic devices. Commercial USB chargers draw predetermined amount of current from USB charging port, and disconnect from the charging port if the amount is not supported. Thus, a built-in battery should be used as an energy buffer.

The High-power DC and AC supply options are envisaged for the charging of batteries, each of them having different features. This paper considers the AC supply option and deals with the main issues that it poses like an onboard high-power battery charger and its impact on the grid.

1.3 Objectives

The following are the main objectives of this project:

- To design a hearing aid battery charger.
- To design a charger for the hearing aid battery which can work on three modes of power supply. They are as follows:
    1. Solar energy
    2. USB port
    3. AC mains
- To reduce the conventional hearing aid batteries.
- To reduce e-waste in the country.

In the following sections in this paper, discussed about the literature survey, which gives the idea about the authors and there proposed work. Discussed about the Methodology and the implementation of the hearing aid charger and its design and also its advantages and disadvantages and finally result.

II LITERATURE SURVEY

Robert E.Morley [1] in (1988) proposed a work based on VLSI Based Design of a Battery-Operated Digital Hearing aid. In this paper a two-chip design is proposed wherein one chip is responsible for data acquisition and re-construction while a second chip is dedicated to the DSP circuitry.

Kwen-Siong Chong, Bah-Hwee Gwee, Joseph S. Chang [2] in (2007) proposed a work based on A Low Energy FFT/IFFT Processor for Hearing Aids, the paper present a 16-bit low voltage energy efficient (FFT/IFFT) processor specifically for hearing aid applications.

Peter Pracný , Ivan H. H. Jørgensen , Erik Bruun [3] in (2013) proposed a work on System-level power optimization for a ΣΔ D/A converter for hearing-aid application, deals with a system-level optimization of a back-end of audio signal processing chain for hearing-aids, including a sigma-delta modulator digital-to-analog converter (DAC) and a Class D power amplifier.

Manmohit Singh,Maninder Kaur,Siby John [4] in (2014) proposed a work on E-waste: Challenges and opportunities in India,in which the E-waste legislations form the legal basis for an e-waste management plan. Basic approach to handle e-waste at global level and individual nation's social structure, combine to form nation's e-waste legislation.

Madeleine Brannon, Phillip Graeter ,Donald Schwartz, Joost R. Santos [5] in (2014) proposed a work on Reducing electronic waste through the development of an adaptable mobile device, in which the electronic products such as mobile devices are ubiquitous and the rates with which they are acquired and replaced by the consumers continue to rise.

Bora Tar and Ayma [6] in (2014) proposed a work on, An Overview of the Fundamentals of Battery Chargers, in which a battery-operated devices in such devices,it is more practical and cost effective to use rechargeable battery cells in order to avoid frequent replacement of batteries.

Nihal Kularatna [7] in (2015) proposed a work on, Rechargeable batteries and their management,in which batteries come in two different basic types, disposable primary and rechargeable secondary. Primary batteries combine significantly greater energy density with very low self discharge rates compared to rechargeable chemistries.

M.Mauthe [8] in (2017) proposed a work based on ,Microprocessor CMOS Circuit For Hearing Aids,in which a three channel micropower CMOS circuit for a programmable hearing aid is presented. It allows the compensation of even difficult hearing impairments by dividing the dynamic losses separately.

T Cutler [9] in (2016) proposed a work on, A design guide for rechargeable zinc-air battery technology ,in which the use of long run time, high energy storage, lightweight rechargeable batteries can be used for such applications. This paper first looks at rechargeable zinc air-battery technology in comparison with other rechargeable battery technologies.

Jinwook Kimand [10] in (2017) proposed a work based on,Free-Positioning Wireless Charging System for Hearing Aids Using a Bowl-Shaped Transmitting Coil ,in which a Wireless power transfer system for charging hearing aids is proposed. A bowl-shaped transmitting coil is to achieve free-positioning or wireless charging.

III METHODOLOGY

The microcontroller is a small computer on a single integrated circuit. In modern terminology, it is similar to, but less sophisticated than, a system on a chip(Soc)[8].

Input from either source would be given to the battery charger which gets charged for the predetermined levels. The unknown battery that needs to be charged is placed in the charging unit which will get charge from either source. During the charging process the LCD display will give the visual feedback about the level of charge of the unknown battery. If the charge present in the battery is 1.5V and 25mA of current then the LCD display will show the value of above 50% or else it will show the value of below 50%.

There are 4 different types of battery which is used for the hearing aid. These batteries are rechargeable batteries which are popularly known as button cells available in the market. One cell charged by the charger could be used for about 15 days and recharged again when required.

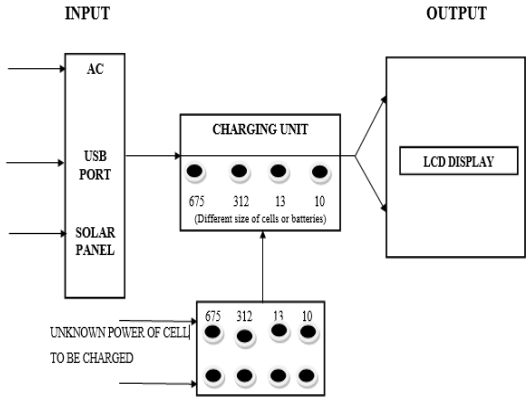

Fig 2: Basic Block Diagram Of The Hearing Aid battery charger

There are three primary inputs as shown in the Block diagram Fig.2 and this is given to the charging unit which is thereby linked to the batteries or button cells which are to be charged. The charging unit is built using Voltage Regulators and Relays, the input obtained is stepped down using a transformer and the desired voltage of the particular battery capacity is obtained using the rectification and filtering processes. The rechargeable battery is connected at the output of the relays and it charges when main power is available from any of the three sources.

The circuit also indicates the charging status, if the battery is drained completely then the display unit shows the battery percentage, if it is below 100% then it indicates that it must be charged, if the battery is completely or nearly charged then the display shows 100%. Therefore, this helps in knowing the status of charge of the battery.

Step 1:Give the primary input from any three given input form.
Step 2: Charge the battery using a charging unit.
Step 3: Show the battery level of the battery to be charged in the LCD display.
Step 4: If battery has 100% charge, then no need to charge the battery.
Step 5: Go to step 7
Step 6: If the battery level is less than or equal to 50%, then the charging process takes place.
Step 7: Stop the charging process.

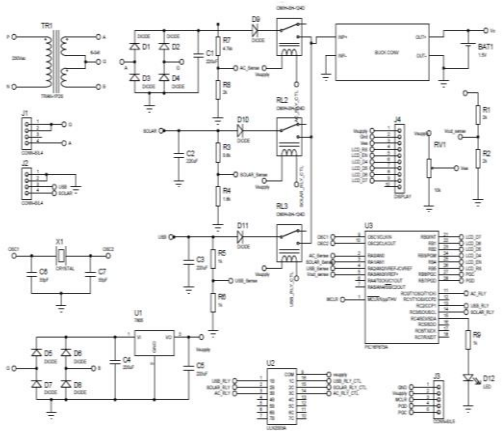

Fig 3: Shows The Circuit Diagram Of The Hearing Aid Battery Charger

3.2. Flow diagram

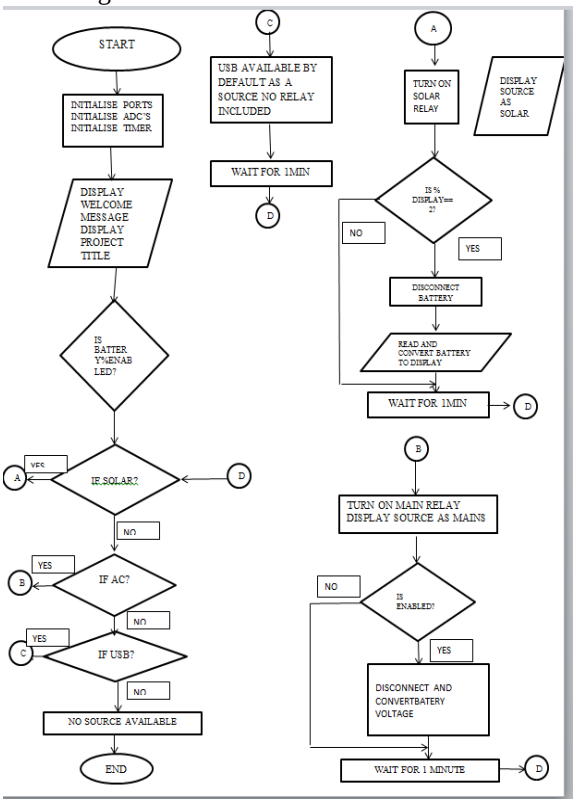

Fig 4 Flow diagram of the charging process:

3.3. Applications

- Used for Hearing aid button cells.

3.4. Advantages

- The charger is flexible.
- E-waste is reduced.
- Low maintenance.

- Cost effective.
- Reduce accidents.

3.5. Disadvantages

- Protection is required.
- Ageing
- If the cells are not placed properly then the cells discharge faster.

3.6. Hardware Requirement

The hardware requirement of the project are as follows:

- Step down transformer:TRAN-1P2S
- Buck converter:LM2596]
- Resistors:4.7K,1K,5.6K,1.8K.
- Capacitors:220µF,33pF
- Diodes:IN4148
- Solar panel
- USB port
- Relay:ULN2003A
- Microcontroller:PIC16F873A
- LCD display:16x2
- 3V Battery Slot

3.7. Software Requirement

The software requirement of the project are as follows:

- Embedded C
- MP LABX

IV IMPLEMENTATION

This chapter gives information about the implementation of the proposed project.

Hardware Implementation

4.1. Implementation of Solar input

The solar energy is abundant in nature and it is also a renewable source of energy which can be used for powering the electronic gadgets. Hence solar energy is one of the input for charging the battery.

The process of using solar energy in our project is as follows:

Place the solar panel directed towards the sun. The heat of the sun is then absorbed by the solar panel. The internal structure of the panel consists of small diodes, which will allow the current to flow in one direction in order to avoid the discharging of current from the other side.

The maximum output voltage of the panel which it can produce from the solar energy is 17 volts. But the minimum voltage required to power on microcontroller board, the voltage should be greater than or equal to 10 Volts.

The output of the panel is given to the microcontroller board to power the board. The microcontroller is programmed in such a way that the solar input is taken as the highest input priority. In this board ,the voltage regulator will convert the input voltage to a 5 volts constant voltage. The controller is programmed in such a way that it senses the battery voltage and it is displayed on to a LCD display.

The output of the panel is given to the voltage divider which divides the voltage by 2. This divider circuit is designed in such a way that the output from the divider circuit is 2.5 volts.

This voltage is given to the relay. If the relay gets the enough voltage from the input, then the relay will be activated. When current passes through the relay ,the inductance effect in the relay closes the switch to complete the connection.

The output of the relay is given to the buck converter which reduces the DC voltage to 1.65V. Then battery starts to charge.

Fig 5: Solar Panel

4.2. Implementation of AC main

Mains electricity is the general purpose alternating-current electric power supply. It is the form of electrical power that is delivered to homes and businesses, and it is the form of electric power that consumers use when they plug the electronic appliances to the wall sockets.

If the person is at homes and offices, he/she can charge the battery through AC mains. This AC main is used as the second input source for the battery charger.

The process of using AC mains in our project is as follows:

The 230 Volts supply is given to a isolation transformer, which will step down the input to 12 Volts AC.

The output of the transformer is center tapped to produce 6-0-6 volts across the output .It is connected to the bridge rectifier and also the microcontroller board.

The same process happens from the voltage divider and the voltage regulator

The AC mains is set as the second priority input to the charger.

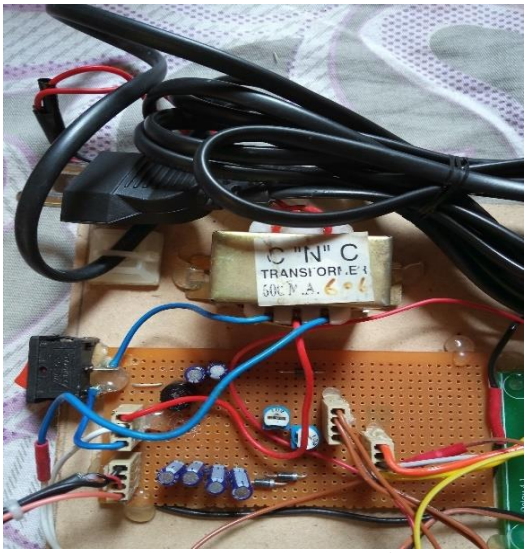

Fig 6: Circuit connections of AC main

4.3. Implementation of USB

As the number of computer users in the world as been on an increasing trend, hence it has been incorporated as one of the inputs in the project.

This flexibility will be a boon to a working class community as they can charge their batteries during their time of work.

The threshold voltage for USB is 2.5 Volts. As the output of USB is 5 volts,it cannot drive the micro-controller board and the charging process simultaneously. Hence, the display is not turned on.

The usage of relay is also not incorporated as the connection is been made directly to the charging module.

Hence, the battery is charged from this implementation. The USB is given as the least priority input to the charger.

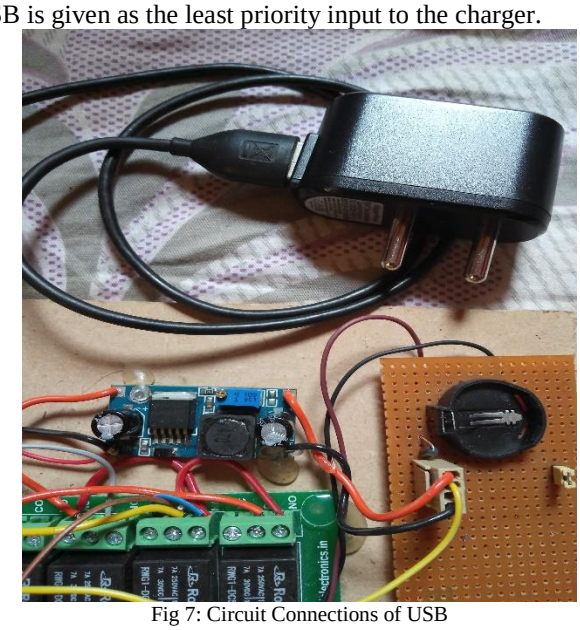

Fig 7: Circuit Connections of USB

V RESULT

A three way input charger will be designed for the batteries in Hearing aids. This considerably lower down the replacing of batteries frequently. The batteries can be recharged and used for a longer span with better durability. By this there will be reduction of E-waste in environment at a higher extent.

Designed a charger for the Hearing aid batteries with a LCD display. The charger is fed with three inputs, solar panel used to trap solar energy which is renewable, ac input and a USB port which can be connected to the PC. Commercial USB chargers draw predetermined amount of current from USB charging port, and disconnect from the charging port if the amount is not supported. The High-power DC and AC supply options are envisaged for the charging of batteries, each of them having different features.

5.1. Solar energy source output

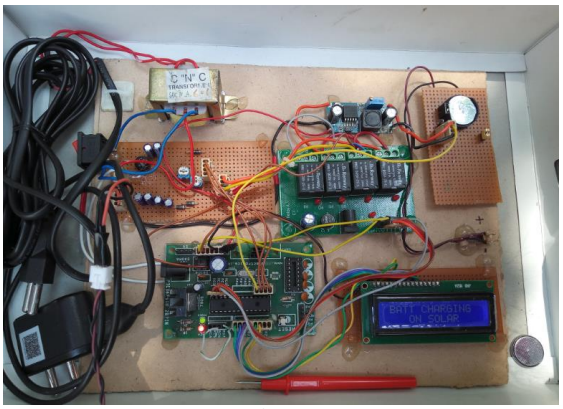

Fig 8: Working of charger in solar input

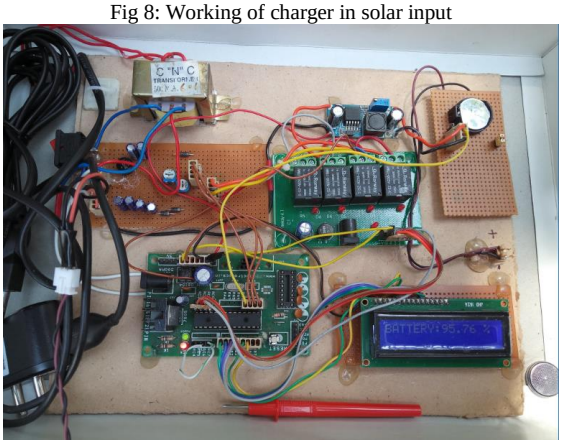

Fig 9:Battery Percentage In LCD

5.2. AC mains source output

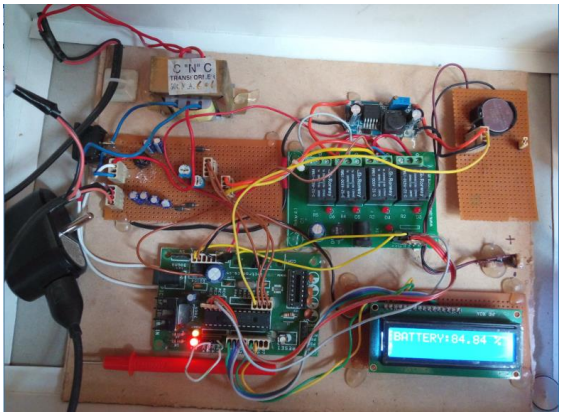

Fig 10:The Battery Percentage In LCD

5.3. USB source output

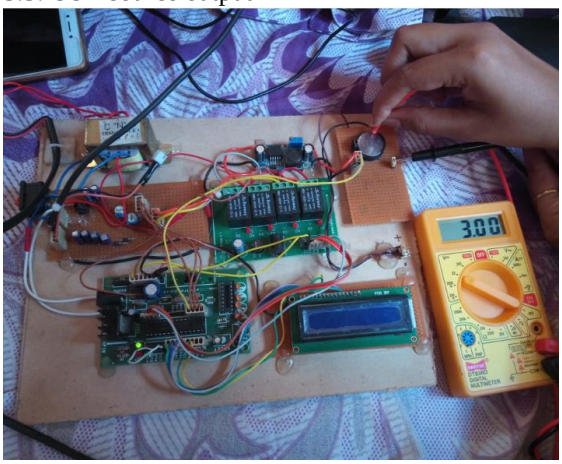

Fig 11: Charging the battery using USB

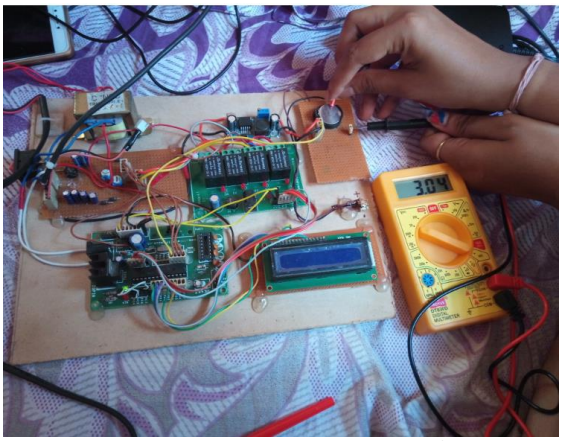

Fig 12:The increase in the voltage of the battery

VI FUTURE SCOPE

The hearing aid battery charger can be improved by following ways:

- Including a level indicator, which gives the visual display of the charge present in the battery which can be viewed in LED.
- Providing the display for the USB input source.

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