International Journal of Engineering Research and General Science Volume 8, Issue 3, May-June, 2020
ISSN 2091-2730

Design and Fabrication of a Sustainable Paddle Operated Mobile Charger with Feedback Analysis from the Users

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Abstract—As a mode of easy transportation, the bicycle is a popular medium. The number of bikers is increasing day by day. They need to charge their phones while traveling a long way. The people are now conscious enough about saving energy even in the rural areas. The use of power banks cannot save energy rather it consumes energy. Whereas, a paddle operated battery charger uses the rotational energy to charge the phones without consuming energy. At present, people look forward to buying new and convenient gadgets. This would be an excellent option for them. In this paper, the design and fabrication of an innovative paddle operated mobile charger are described. Feedback from the users is also presented. The majority of the users provided positive feedback about this device

Keywords— Mobile Charger, Renewable Energy, Techno-economic Analysis, Environmental Impact, Energy Saving, Product Design, Sustainability

INTRODUCTION

As the environmental consciousness is growing, many people now a day are using bicycle. Besides the majority of the people now have mobile phones. To charge the mobile phone, usually electricity from the national grid is used. So a significant volume of electricity is used for this purposed. Again due to proliferation mobile, household members may not able to charge their mobiles altogether at a given time. Therefore if the mobile could be charged while travelling bicycles would save money on the electricity usage while make it convenient for the users. In this research, scope of development of such device was explored technically and economically. Then a sustainable design of the product was done and later fabricated with indigenous materials. The usage of this mobile charger was reviewed by a sample of the users.

SUSTAINABLE ENERGY

To safeguard the ecosystem there should be judicious use of energy resources. Therefore now a days the world is looking forward to the renewable energy and recycling. By definition, renewable energy is directly or indirectly from the sun and other natural environment. However, energy sources derived from the fossil fuels or related derived items from waste are not included in the realm of renewable energy. On the other hand, there are some environmentally friendly energy sources like human generated ones that could drive transportation like bicycles. Now such type of human generated energy could be used for other devices like mobile chargers, small amount of electricity generation, water purifying etc. By definition, sustainable energy is a harmony among environment, economy and business [1].

Renewable Energy

Any energy resource that is naturally regenerated over a short time scale and derived directly from the sun (such as thermal, photo-chemical, and photoelectric), indirectly from the sun (such as wind, hydro-power, and photosynthetic energy stored in biomass), or

from other natural movements and mechanisms of the environment (such as geothermal and tidal energy) [2, 3]. Renewable energy does not include energy resources derived from fossil fuels, waste products from fossil sources, or waste products from inorganic sources.

Forms of Renewable Energy

There are several forms of renewable energy. Among them, prominent ones are briefly described below:

Solar Energy: This form of energy relies on the nuclear fusion power from the core of the Sun. This energy can be collected and converted in a few different ways. The range is from solar water heating with solar collectors or attic cooling with solar attic fans for domestic use to the complex technologies of direct conversion of sunlight to electrical energy using mirrors and boilers or photo-voltaic cells [4]. Unfortunately these are presently insufficient to fully power our modern society.

Wind Energy: The movement of the atmosphere is driven by differences of temperature at the Earth's surface due to varying temperatures of the Earth's surface when lit by sunlight [5]. Wind energy can be used to pump water or generate electricity, but requires extensive areal coverage to produce significant amounts of energy.

Hydroelectric energy: This form uses the gravitational potential of elevated water that was lifted from the oceans by sunlight [6]. It is not strictly speaking renewable since all reservoirs eventually fill up and require very expensive excavation to become useful again. At this time, most of the available locations for hydroelectric dams are already used in the developed world.

Biomass: Biomass is the term for energy from plants [7]. Energy in this form is very commonly used throughout the world. Unfortunately the most popular is the burning of trees for cooking and warmth. This process releases copious amounts of carbon dioxide gases into the atmosphere and is a major contributor to unhealthy air in many areas. Some of the more modern forms of biomass energy are methane generation and production of alcohol for automobile fuel and fueling electric power plants.

Geothermal energy: Energy left over from the original accretion of the planet and augmented by heat from radioactive decay seeps out slowly everywhere in almost every day. In certain areas the geothermal gradient (increase in temperature with depth) is high enough to exploit to generate electricity [8]. This possibility is limited to a few locations on Earth and many technical problems exist that limit its utility. Another form of geothermal energy is Earth energy, a result of the heat storage in the Earth's surface.

Other forms of energy: Energy from tides, the oceans and hot hydrogen fusion are other forms that can be used to generate electricity [9]. Each of these is discussed in some detail with the final result being that each suffers from one or another significant drawback and cannot be relied upon at this.

RESEARCH GAP & OBJECTIVES

From the literature review, it was found that different types of mobile charges were fabricated by different researchers and commercial entities. However, situations in Bangladesh and some other developing countries are significantly different those. Therefore it was justified to design and fabricate an innovative mobile charger considering local circumstances. So the objectives of the research were:

- To study about renewable energy and its practical applications.
- To design and construct the paddle operated battery charger.
- To do the techno-economic analysis of the product.
- To review the product with the feedback of a sample of the users.

DESIGN & FABRICATION

Circuit Diagram and Working Principle

The device takes higher alternating current (AC) and converts it to direct current(DC) for recharging a cell phone or other mobile device. We used a bike generator which is technically considered to be an Alternator. The circuit uses a rectifier, capacitor and a voltage regulator. The rectifier converts the back and forth lifting waves of AC to steady stream of DC. The large capacitor helps to

smooth up the voltage level. The voltage regulator holds the incoming DC power creating the voltage around 5 volts. This voltage is accepted and repeated for mobile phone. In short, when engaged, the generator wheel rolls against the bike tire. The motion produces electricity, and the greater the biker's pedaling speed, the greater the voltage output. The circuit board's bridge rectifier, which converts the AC to DC is connected by a cord from the generator. Therefore, the up-and-down, positive-to-negative current becomes a steady positive current. After that, the capacitor levels out the DC voltage and produces a steady voltage inflow to the voltage regulator. Fast pedaling can produce 30 volts or more, but the cell phone only needs five volts to charge. So the voltage regulator must be in place to protect the charger from literally burning out. The regulator controls the voltage keeping the voltage entering the cell phone within the threshold value.

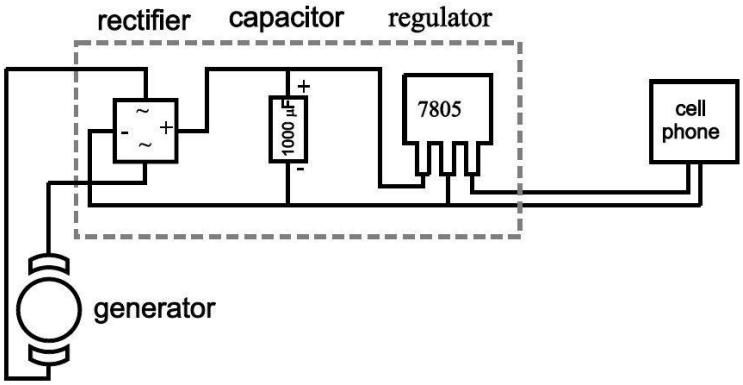

Figure 1. Basic Circuit Diagram of Paddle Operated Mobile Charger[10]

Materials and Tools Used

- Adapter socket cable
- Bicycle Headlight Generator ,12V 6W
- Grommets ¼ inch
- Small bicycle saddle bag
- Micro USB Adapter
- Grip clip
- 1000 µF 35V Electrolytic Capacitor
- Silicon Bridge Rectifier (400 V ,1.5 A)
- +5 V fixed voltage regulator 7805
- Cable ties
- Insulated ring tongue lugs
- Screws, bolts, washers , nut
- Hook up wire
- Wire tool
- Soldering iron and solder
- Screw drivers
- Drill and bits

Construction

At first a plastic box is taken and it is drilled according to the design. Using a machine screw, a lead is put on the plastic board secured with nuts and washers. The LM (linear monolithic series integrated circuit board) of which one end is used as input and another end as ground lead. Two wires have been cut and the red wire is attached to the input lead and the black wire is attached to the ground lead. It is mounted in the box with a screw. The capacitor is then attached to the rectifier and the leads are twisted together according the signs. The red (free) part is soldered to the positive end and the black part to the negative part. The adapter wire is cut and entered

through one of the two side holes and connected with output of the LM and the other side is with the charging cable. Another cable is connected with the rectifier in one end and in the other connected with the generator. The polarity on this side does not affect. After this, the whole thing could be mounted on a cycle. It may be put on either the rear or front axle. Usually it is on the rear. The cord is off of from the cell phone charger. The insulation from the cut end is stripped to expose about a half-inch of both the positive and negative wires. The circuit is assembled as shown in Figure 2. The wires are pushed from the components through the holes in the circuit board. Mounting pins are used to connect to the electronic components when necessary. Then it is connected from pin to pin with the hookup wire. The two cut, stripped leads from the cell phone charger to the mounting pins connected to the voltage regulator are soldered. The wire going to the center of the power jack is generally the positive/red one. The wire coming from the generator to the AC terminals of the bridge rectifier is connected thereafter. A layer of electrical tape is put to protect the solder side of the circuit board with. It will help to protect the circuit from shorts due to accidental contact with conductive material, and from exposure to the elements. The wire is then secured to the frame of the bike with tape (or zip ties). Afterwards, the circuit board is positioned somewhere out of the way like the base of the seat post. The charging cell phone while the biker ride may be kept to a convenient place like a basket hanging from the handlebars, in a tool bag under the seat or in a saddle bag on the rear rack or tucked into the waist belt. Finally, the phone may be plugged in and the biker may start pedaling. Here, the phone should react like the same way as if it were connected to a wall outlet. The assembled chargers are shown in Figure 2 to Figure 4.

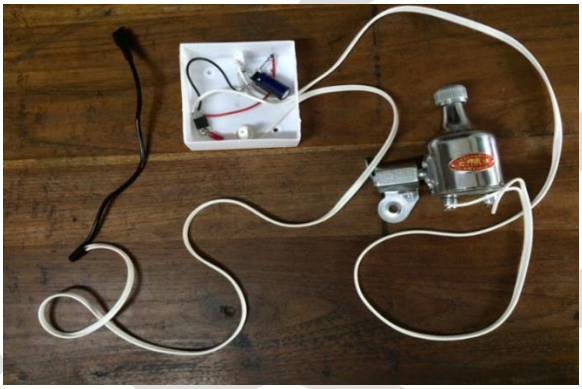

Figure 2 : Assembled Circuit & Generator

Figure 3: Paddle Operated Mobile Charger Assembled in a Bi-cycle

Figure 4: Closer View of Paddle Operated Mobile Charger in a Bi-cycle

FEEDBACK FROM USERS

A random sample of 10 users were taken who had used the product for two hours minimum. Then they were asked three questions. The questions are :

1. Are you satisfied with the product? Which option would you choose among Satisfactory, Average, Not Satisfactory?
2. If average or not satisfactory, What are the problems you faced while using the product?
3. What are the recommendations for the product?

The information collected from the feedback are provided in Table 1 and Figure 5.

Table 1 : Feedback from the users

User	**Satisfactory**	**Average**	**Not satisfactory**	**Problems**
01	✓			
02		✓		
03		✓		Tyre Wear
04	✓			
05	✓			
06	✓			
07			✓	Require more force to paddle
08	✓			
09	✓			
10		✓		Require more force to paddle

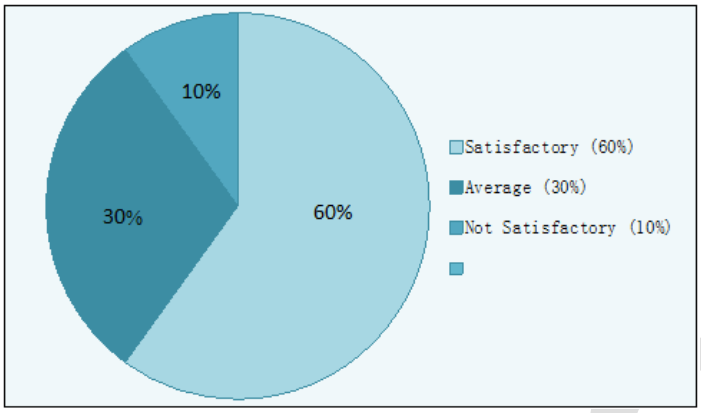

Figure 5: Pie Chart showing Feedback from 10 people using the product

The recommendations received from that sample of the users are as follows:

- Tyre wear can be reduced by using a rubber band around the contacting surface of the head of the generator with the tyre. This will reduce the wear without affecting the friction.
- Device should be made water resistant to use it in any time regardless of any season.

CONCLUSION

An innovative Paddle operated mobile charger was fabricated which is environment friendly & sustainable solution to the existing problem of charging smart-phones of the bikers. The feedback from the users was satisfactory. Further research can be done for upgrading the product. IT is believed that this innovation would be helpful for saving energy and thereby reducing environmental harm. Besides, the users will be benefited ecoomically too.

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