Dual-Power Charging Station for Mobile Devices with Renewable Energy

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Abstract - There is a vast challenge to provide reliable charging of mobile devices and other electronic devices in remote locations where there is no reliable power supply. Thus, in this project an automated mobile phone charging station with renewable energy such as solar and wind is proposed which is suitable for areas without electricity and for urban environments that require electricity due to emergencies. The electronic circuit in the project will also be powered by a solar cell, which means that the entire project will be made entirely from renewable energy sources. The prosed design is implemented with an initial model and the expected outcome was validated with the results.

Keywords: dual-power charging, renewable energy, automated charging station

I. INTRODUCTION

In recent years, energy has played a critical role in human and economic growth while affecting the global peace. The entire yearly energy consumption of the world has grown, where three-quarters of the total came from fossil fuels. With the conflict between fast advances, oil will last around 40 years and natural gas will last about 60 years. Renewable energies, such like wind and solar, are built on current technology provide both clean and efficient energy output

Cell phones are one of the most popular ways of communication today and one of the most affordable electronic devices due to technological advancements. Aside from network service availability, a consistent power supply on the mobile unit is the primary concern of every mobile phone user, which is reflected by the battery indicator icon, which shows the amount of charging and draining of the phone's battery [1]. Cell phones, like many other electronic devices, are powered by electricity and must be recharged on a regular basis. This is especially true for smart Android phones, which deplete battery power much more quickly than standard mobiles [2]. Power banks are available on the market for quick emergency charging where they are expensive. Even though battery technology has advanced in terms of performance and capacity, smartphone batteries are unable to meet power needs [1].

Charging stations seem to be a feasible option in remote areas without access to the grid, where people have a low income yet high energy usage. Charging stations can be powered by diesel or renewable energy sources (primarily solar, but also wind and hydro), and they can charge mobile phones, batteries, lanterns, and other electronic devices, as well as serve as a shop, cultural or recreational center. The municipality, a private entrepreneur, a local area, a village association, or a non-governmental organization (NGO) may own or operate these stations. The user can pay a per-charge fee or a monthly or weekly fee, depending on whether they own or rent the charging station.

The system should be as convenient to use as possible, since users may misuse the system, the use of unneeded components should be avoided, and all connection options should be addressed in the system's architecture [3]. To avoid the duplication of malfunctioning systems, systems must be field-tested before replication. The system's components include PV modules, wind turbines, batteries, an inverter, and different controllers. These parts collaborated to provide enough energy to power the phones. As the user is usually concerned whenever the battery power level is getting low, especially when there is little hope of electricity restoring energy for the phone, this project provides an alternative charging system for many phone users today without relying on the national electricity grid, which is unpredictable, but instead relying on the natural gift of the sun to generate electricity [1]. The solar and wind powered mobile phone charging systems, which contain a rechargeable battery and charge adaptors for various phones, can be newly installed in public places like bus stops, children parks, and junctions. As a result, the user can just plug his phone into the system to charge it.

As aforementioned, there is a challenge to provide reliable charging for mobile devices in the event of an electrical outage or failure to carry an energy store in an emergency. Thus, the main focus of this study is to set up an automated mobile phone charging station using energy sources that are renewable such as solar and wind, suitable for rural areas without electricity and for urban cities that require electricity on emergencies. A novel cost-effective wireless charging system has been introduced to the design with the use of inductive coupling where pre-trial test bed results were obtained with a range of distance for the designed transmitter and receiver circuits. A general model of the proposed design has been implemented and tested to prove that the design provides accurate results where the product can be introduced to the marked as a cost-effective solution for the energy requirement.

II. METHODOLOGY

Any autonomous electricity producing system that incorporates more than electricity power to the grid or on site is referred to as a dual power system. The main benefit of dual-power energy is that it can get energy from both solar and wind sources. The sun's rays are absorbed by the solar panel and converted into DC electricity. And the wind turbine revolves owing to the force of the wind, and its rotor is connected to a generator, which likewise rotates and produces AC electricity. With the aid of an AC-DC converter, this AC current is converted to DC. Both currents now run at the same time and flow to the circuit board, where they charge the mobile phones connected by wires. The system is consisting consists of a microcontroller, solar panel, DC motors, wind turbine, batteries, an LCD display and an automated cell phone charging system.

The basic block diagram of the system is shown in Fig.1. A solar panel with an 18V, 10W output is employed, with the output varying depending on the intensity of incident light. In addition, a dynamo was used for windmill, where the output variation depends on the trinity of the wind and direction. A voltage amplifier is used to increase the voltage produced by the wind system while a voltage multiplier is used as an AC to DC converter. The voltage generated by the solar cell and windmill connected to the load switch.

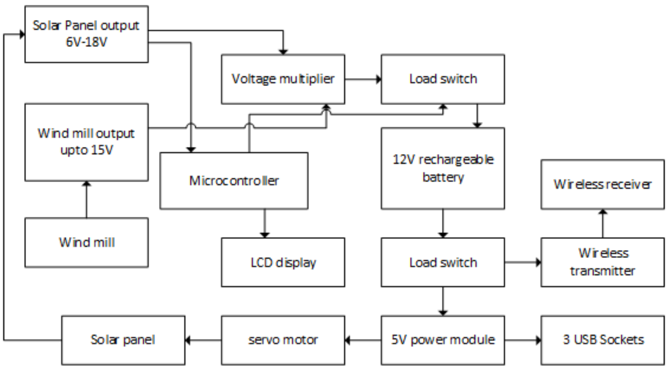

Fig. 1 Block diagram of the proposed design

The load switch consists, IRF9540N MOSFETs, 2SC1815 transistor and 10k resistor. The load switch consists, IRF9540N MOSFETs, 2SC1815 transistor and 10k resistor. Here the load switch working on the signal given by the microcontroller. In this circuit load switcher act as an overcharging protector and protect the battery from over discharging. If battery voltage is below 13.4V, load switch is enabled to charge the battery from the renewable sources, else if the battery voltage is below 11.5V, load switch is disabled to charge the devices from battery. The microcontroller displays the amount of solar, wind and battery voltages. It also displays the battery is charging enable status and battery is charging disable status. Battery output is connected to two 5V power modules, where they are used to drop the volage to 5V and connect it to the servo motor and three USB hubs respectively. The wireless charger directly connect to the battery is supported by the load switch.

The designed circuits for the transmitter and the receiver can be shown as in Fig. 2 (a), (b) respectively. The resonance frequency of transmitter will be impacted by the coil's manufacture where an optimal value was obtained with experiments as 6 cm in diameter, and 24 loops. The circuit generated the resonance frequency automatically and adapted if the load is modified. The receiver coils are comparable to the primary coils. Running the secondary and primary at the same resonant frequency allows reduced secondary resistance and optimal energy absorption at the transmitter's frequency.

LM2596 was used as the buck converter module for the system since it is with a good efficiency rating, consists of built-in thermal shutdown and its capability to limit the current.

III. Results and Discussion

With continuous experimentation from the designed circuits, it was found that on average 4V output can be obtained with a distance of 1.5cm from the unit with the input of $0.01V_{p-p}$ and 12MHz condition. The output can be increased and decreased gradually with the decrement and increment of the distance from the unit to the mobile device. The solar panel provided maximum 12V and 165mA current while single axis solar tracking was used to maximize the output of the panel. The output readings were displayed on LED display. The final product is shown in Fig.3.

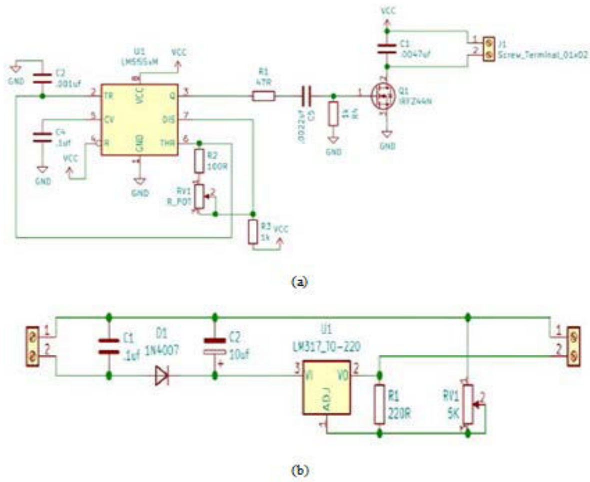

Fig. 2: (a) Transmitter circuit; (b) Receiver circuit

Fig. 3: (a) Physical appearance; (b) Final PCB; (c) LED Display

IV. Conclusion

A dual-power charging station with solar and wind power was designed and implemented in this study. A solution for electricity scarcity in rural location was provided with a cost effective and easy to install design. The design can be improved to a portable charging station with four wheels in the bottom stand and the charging rack can be further improved by adding 230V AC plug to support laptop charging. As a developing country with continuous wind and solar energy availability, this design could provide the general public more feasible access to charge their smart devices with low cost and user-friendly manner.

References

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