Design & Development of Metal/Wood Cutting Tool by using Solar Energy: An Approach Towards Building Green City

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Abstract

Requirement of electricity of the world is increasing at very high rate because of industrial growth, increased and extensive use of electrical gadgets. Today world receives 80% of the energy from conventional non-renewable energy sources. So within short time span, all the sources will be completely exhausted. The best alternative source is solar energy. Solar energy can be used in many electrical appliances. This paper deals with solar energy based metal/wood cutting tool. Industries like automobile, packaging and medical etc. have increased the use of aluminum, as aluminum made things are quiet easier to manufacture, handle and reliable to use. In this paper, design of metal/wood cutting tool which uses solar energy is shown. Solar charge controller is simulated using MATLAB and hardware is prepared using arduino microcontroller.

Keyword- Arduino Microcontroller, Cutter, Pulse Width Modulation (PWM), Solar

I. INTRODUCTION

Sun rays can be converted in the form of heat and electricity, thus known as solar energy. It is the most essential for living life on earth. This energy is clean, economical, and pollution free compared to other resources and energy. Hence, solar energy is rapidly gaining notoriety as an important means of expanding renewable energy resources [1].

A solar panel is a large flat rectangle, typically somewhere between the size of a radiator and the size of a door, made up of many solar cells covered with a protective sheet of glass. The cells, each of which is about the size of an adult's palm, are usually octagonal and colored bluish black. Just like the cells in a battery, the cells in a solar panel are designed to generate electricity; but where a battery's cells make electricity from chemicals, a solar panel's cells generate power by capturing sunlight instead [2].
The system depending on the charging circuit the motor can be controlled. The solar power stores the energy to a battery and then runs the motor. Solar energy is radiant light and heat from the sun harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic, solar thermal energy, solar architecture and artificial photosynthesis [2].

It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on the way they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air. The large magnitude of solar energy available makes it a highly appealing source of electricity.

II. PROPOSED SYSTEM

In this paper solar energy based metal/wood cutting machine is proposed. In many countries, in the interior parts till today electricity is not available, or it is available for short period of time. In this area used of solar energy plays very important role. The proposed system shows how solar energy can be used in day to day life without polluting the environment and keep our city green. Further many industries today use aluminum because of the advantages offered by it. Hence, for cutting the metal lot of electricity is consumed. This proposed system shows how solar energy can be used for metal cutting. A metal/wood cutter is a structure used to chop logs into firewood, which can in turn be used to heat homes in winter. Each log that a Wood Cutter uses is turned into multiple pieces of firewood. Another use of wood cutter is for manufacturing of small wooden toys and stationary products. So lots of applications are there which uses the wood cutting machine. In this paper, a scheme is proposed which uses solar energy to generate electricity and that electricity is used to drive the motor which is connected to hacksaw blade. Hence, use of renewable energy sources is proposed here. The system depending on the charging circuit the motor can be controlled. The solar power stores the energy to a battery and then runs the motor. The block diagram of the proposed scheme is shown in the Fig. 1 below.

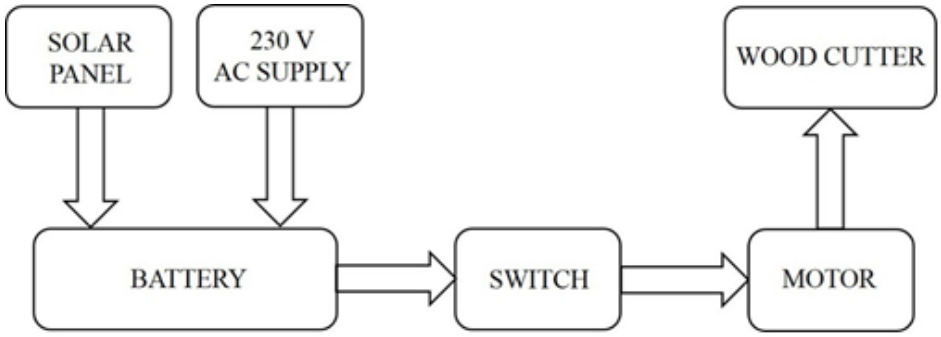

Fig. 1: Block diagram of proposed system

III. HARDWARE IMPLEMENTATION

A. Selection of Charge Controller Method

A solar charge controller regulates the voltage and current coming from solar panels which is placed between a solar panel and a battery. It is used to maintain the proper charging voltage on the batteries. As the input voltage from the solar panel rises, the charge controller regulates the charge to the batteries preventing any overcharging. Typically, there are three types of solar charge controllers available: on/off controller, Pulse Width Modulation (PWM) & Maximum Power Point Tracking (MPPT). The on/off type charge controller simply monitors the battery voltage and opens the circuit, stopping the charging, when the battery voltage rises to a certain level. MPPT charge controllers have highest efficiency but it is costly and need complex circuits and algorithm. PWM charge controller is best for this system which is treated as the first significant advance in solar battery charging.

This new method of solar battery charging promises some very interesting and unique benefits from the PWM pulsing. These include:

1) Ability to recover lost battery capacity and desulfate a battery.
2) Increase the charge acceptance of the battery.
3) Maintain high average battery capacities (90% to 95%).
4) Equalize drifting battery cells.
5) Reduce battery heating and gassing.
6) Automatically adjust for battery aging.
7) Self-regulate for voltage drops and temperature effects in solar systems.

B. Fabrication of Charge Controller

Fig. 2 shows the fabricated circuit used for PWM charge controller. Circuit is divided into number of parts. Like voltage sensing, PWM signal generation, MOSFET switching and driver, Filter and protection, display and indication, load on/off etc. Each part of the circuit was fabricated and tested successfully. Voltage sensors are implemented by using a voltage divider circuit. PWM (pulse width modulation) is a technique by which one can control a digital output signal by switching it on and off very quickly, by varying the width of the on/off duration, it will give the effect of varying the output voltage [3], [4].

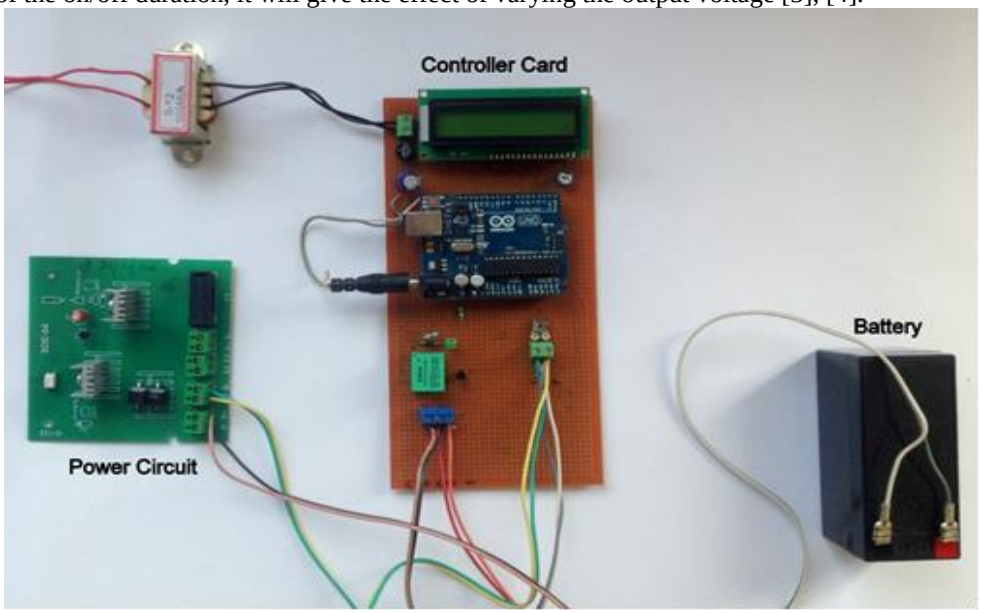

Fig. 2: Fabricated solar charge controller

$$V_{out} = \frac{T_{on}}{T_{on} + T_{off}} * V_{in} \text{ , where } T_{on} + T_{off} = T \text{ (time period)}$$

$$V_{out} = \frac{T_{on}}{T} * V_{in} \text{ , where } \frac{T_{on}}{T} * 100 \text{ is called duty cycle.}$$

PWM enables a digital output to provide a range of different power levels, similar to that of an analog output. The best example is fading a LED with different light intensity. This can be done by arduino, using the analogWrite () function. As Analog output pin is 8bit we can get maximum 2^8=256 or a range of values between 0 to 255. Sending the value 255, to the LED input produces 100% duty-cycle, which results in full power on a PWM pin. Sending the minimum value 0, to the LED input produces 0% duty-cycle, which results in no power on a PWM pin.

C. Microcontroller

An Arduino board consists of an Atmel 8, 16 or 32-bit AVR microcontroller with complementary components that facilitate programming and incorporation into other circuits. An important aspect of the Arduino is its standard connectors, which lets users connect the CPU board to a variety of interchangeable add-on modules known as shields. Some shields communicate with the Arduino board directly over various pins, but many shields are individually addressable via an I²C serial bus, so many shields can be stacked and used in parallel. Official Arduinos have used the mega AVR series of chips, specifically the ATmega8, ATmega168, ATmega328, ATmega1280, and ATmega2560. A handful of other processors have been used by Arduino compatibles. Most boards include a 5-volt linear regulator and a 16 MHz crystal oscillator, although some designs such as the LilyPad run at 8 MHz and dispense with the on-board voltage regulator due to specific form-factor restrictions. An Arduino's microcontroller is also pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory, compared with other devices that typically need an external programmer. This makes using an Arduino more straightforward by allowing the use of an ordinary computer as the programmer [5]. Flowchart of the software used in this project is shown in Fig. 3 below.

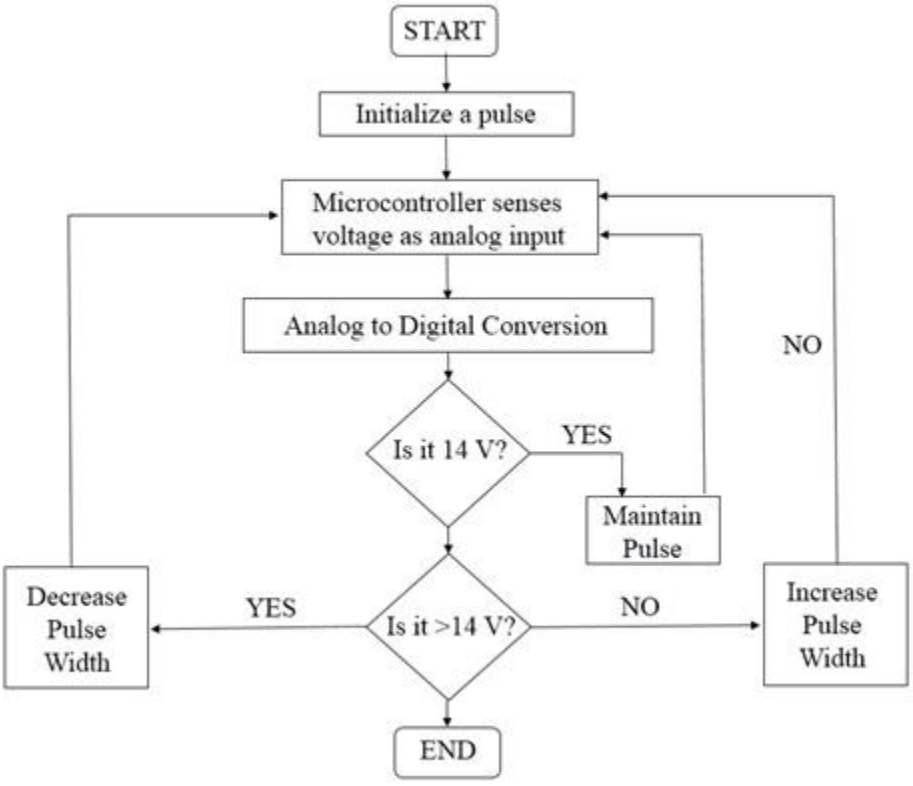

Fig. 3: Flowchart for solar charge controller

D. Hardware Testing and Results

Hardware was fabricated and tested successfully. Fig. 4 shows the working model of the proposed project. Voltage available from solar panel is sensed via a voltage divider circuit. Output goes to arduino analog input. Switching of Power device MOSFET is done by a PWM signal from control circuit. Another MOSFET is used to drive the load. Initially, the charge controller will check solar panel voltage and compare it with battery voltage and sends PWM signals to MOSFET in order to charge the battery. When solar panel voltage is below the battery voltage, PWM signals will not sent by the controller. When battery voltage is below the set value, charging will be done by sending PWM signals with 95% duty cycle. When battery voltage reached above set value, duty cycle will be reduced from 95% to 10%. Pulse Width Modulated waveforms are shown in the Fig. 5 below.

Fig. 4: Working model

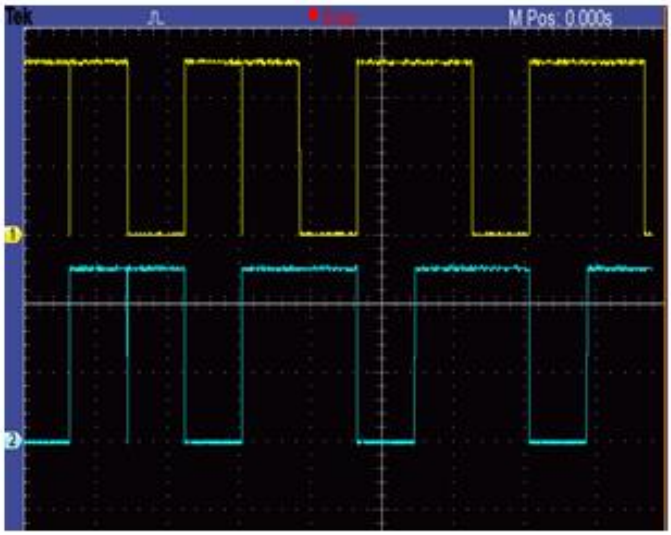

Fig. 5: PWM signal generation (duty cycle 70%)

IV. CONCLUSION

- After fabrication the machine run by using the solar energy can be used in small industries.
- The proposed topology eliminates the used of electricity and reduces the manpower.
- Using this system pollution can be reduced as it uses solar energy only.

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