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An IoT based Energy Harvesting and Recycling System

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Abstract: Energy is very important in entire process of evolution, growth and survival of world. For a developing country like India, the energy criterion decides the growth of the country. Being the third largest power producer in the world, energy demand and scarcity rules the country. Energy demand in our country is increasing exponentially. Moreover, the increase in prices of fossil fuels and consequences of greenhouse gas emissions on environment have contributed towards renewed interest in development and enhancement of alternate energy resources. The present work focusses not only on generation of electricity from different resources but also aims at conservation and storage of this energy for its effective utilization. The objective of the project is conservation of energy by controlling the devices and monitoring the energy required for the same with the help of technology named as 'Internet of Things' which will act as wireless medium in communication of various signal to different physical devices.

Keywords: IoT: Internet of Things, solar panel, piezoelectric sensor, DC Motor

I. INTRODUCTION

Now a days, with increasing concern of global warming and the depletion of fossil fuel reserves, many are looking at sustainable energy solutions to preserve the earth for the future generations. Vibration, photovoltaic energy, wind energy and water turbines hold the most potential to meet our energy demands. Alone, vibration energy is capable of supplying large amounts of power but its presence is highly unpredictable as it can be here one moment and gone in another. Similarly, solar energy is present throughout the day. The earth receives about 1366 watts of direct solar radiation per square meter. One hour of direct sunlight is sufficient enough to generate a year's worth of power for the entire earth. Hence solar energy can prove to be one of the promising energy sources. Similarly, wind energy can also be classified as a green source of energy since its production does not involve emission of dangerous fumes. Investments in wind energy can help, bridge the power gap. When a source is unavailable or insufficient in meeting the load demands, the other energy source can compensate for the difference by combining the above-mentioned intermittent sources. Solar energy is the viable source of renewable energy over the last two-three decades. It is now used in variety of fields such as industries, domestic purpose. Solar energy system is designed to collect maximum power from sun and to convert into electrical power. However, Piezoelectric energy is produced when mechanical vibration is applied in a piezoelectric sensor. In order to gain the maximum output from piezoelectric few factors are to be considered which include amount of load applied, electrochemical coupling coefficient and scheme of arrangement. [1]

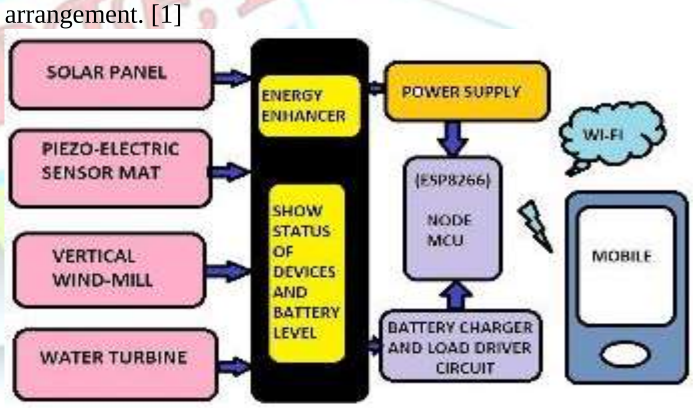

Fig 1: Block Diagram

Components Used:
Solar Panel
Piezo-electric material (Vibration mechanism)
Windmill
Turbine
Node MCU

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Battery level indicator
Battery charger circuit
DC-DC booster circuit

As shown in above block diagram (Fig 1) the main component of our project is solar panel, windmill, turbine and piezo-electric array. The given system is combined into a linear system. Here, every element works individually to contribute to power. In this the linear system if one system fails the other system can repeat it. The output of this linear system is given to one of the parts of the battery charger circuit. The battery charger circuit has LED as the indicators. It controls the voltage level and make sure that it should not cross 15V.The energy acquired from this linear system is stored in battery connected to another port of the battery charger circuit. The other ports of this system are left for further connection of any type of load. There is an indicator circuit which will show which device is ON and which device is OFF. And battery level indicator circuit will indicate the current rating of battery. The work of IOT is we are using node MCU module which is interfaced with this system to indicate battery monitoring i.e load for battery.

A. Solar Panel:

The term solar panel is used colloquially for a photovoltaic (PV) module. A PV module is an assembly of photovoltaic cells mounted in a framework for installation. Photovoltaic cells use sunlight as a source of energy and generate direct current electricity. A collection of PV modules is called a PV Panel (Fig 2), and a system of Panels is an Array. Arrays of a photovoltaic system supply solar electricity to electrical equipment. When photons hit a solar cell, they knock electrons loose from their atoms.[2] If conductors are attached to the positive and negative sides of a cell, it forms an electrical circuit. When electrons flow through such a circuit, they generate electricity. Solar is an intermittent power source that functions only when the sun is shining. We generate power from the solar panel i.e. photo voltaic cell. The solar panel consist of tracking system which is drive by DC motor according to voltage panel will rotate and we get higher amount of power. [3]

Fig 2: Solar Panel

B. Piezo-Electric Material:

A piezoelectric plate is a device that uses the piezoelectric effect to measure pressure, acceleration, strain or force by converting them to an electrical charge. The most common piezoelectric material is quartz. Certain ceramics, Rochelle salts, and various other solids also exhibit this effect. The essence of the piezoelectric effect works as follows: by applying a mechanical stress to a crystal, one can generate a voltage or potential energy difference, and thus a current.[7] We generate power from piezo electric mat (Fig 3) by simply walking and pressing by footstep. As piezo sensors power generating varies with different steps, get minimum voltage as 1 V per step Maximum voltage as 12 V per step. [8] This output voltage is proportional to the strength of shock or vibration.

Fig 3: Piezoelectric Mat

C. Windmill:

A windmill is a structure that converts wind power into rotational energy by means of vanes called sails or blades, specifically to mill grain (gristmills), but the term is also extended to wind pumps, wind turbines and other applications. [5] The wind turns the blades which spins a shaft, in turn, prompt a generator to produce electricity. These blades (Fig 4) are connected to a generator, sometimes through a gearbox and sometimes directly. In both the cases, the generator converts the mechanical energy into electrical energy. Interestingly, most modern turbines turn in a clockwise direction. Depending on wind speed, most modern turbines can operate at speeds from as little as four meters per second to as much as 15 mps. Once the turbine's blades turns a shaft located inside of a box placed on top of the turbine, gearbox mode is propelled and more speed rotation is given off. A transformer within the turbine then converts electricity into a voltage suitable for distribution to a national grid. [6]

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Fig 4: Vertical Windmill

D. Turbine:

A turbine is a rotary mechanical device that extracts energy from a fluid flow and converts it into useful work. The work produced by a turbine can be used for generating electrical power when combined with a generator. A turbine (Fig 5) is a turbomachine with at least one moving part called a rotor assembly, which is a shaft or drum with blades attached. Moving fluid acts on the blades so that they move and impart rotational energy to the rotor.

E. Node MCU

Node MCU is a low-cost open source IoT platform. Node MCU is an open source firmware for which open source prototyping board designs are available. The name "Node MCU" (Fig 6) combines "node" and "MCU" (micro-controller unit).

Power Pins: There are four power pins viz. one VIN pin & three 3.3V pins. The VIN pin can be used to directly supply the ESP8266 and its peripherals.

GND: It is a ground pin of ESP8266 Node MCU development board.

I2C Pins: They are used to hook up all sorts of I2C sensors and peripherals in your project. Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized programmatically, and the clock frequency is 100 kHz at a maximum. It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

GPIO Pins: ESP8266 Node MCU has 17 GPIO pins which can be assigned to various functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light and Button programmatically. Each digital enabled GPIO can be configured to internal pull-up or pull-down, or set to high impedance. When configured as an input, it can also be set to edge-trigger or level-trigger to generate CPU interrupts.

ADC Channel. The Node MCU is embedded with a 10-bit precision SAR ADC. The two functions can be implemented using ADC viz. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented at the same time.

UART Pins: ESP8266 Node MCU has 2 UART interfaces, i.e. UART0 and UART1, which provide asynchronous communication (RS232 and RS485), and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 & CTS0 pins) can be used for communication. It supports fluid control. However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing log.

Fig 6: Node MCU

II. WORKING

The energy obtained from sun (Solar Energy) acts a source of energy and it is converted into electricity by solar panels. Moreover, another renewable source of energy that is being utilized is the wind energy. However, the energy from vibrations is attained with the help of piezoelectric sensors. Energy generated from Water turbine also contributes to the total energy generated. All the energy generated by individual devices is given to the circuit and the circuit channelizes the energy by adding all the energy coming from individual devices, thereby increasing the efficiency of device. Thus, circuit then passes the energy to battery charging circuit in order to provide charge to the battery. When all the devices are functioning simultaneously the charging of battery takes place in faster pace, thus reducing the charging time of battery. This circuit is connected to ESP8266 Node MCU which shows battery level on IoT platform by using a mobile application (Blynk App) using wifi (Fig 7). The role of IoT is to indicate battery level from

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anywhere on your mobile and according to the status of battery load can be connected or disconnected using blynk app when required. IoT provides compatibility and easy to control the load and access it.

Fig 7: Working IoT Setup

III. Conclusion

In this study, we have investigated the feasibility of applying piezoelectricity (Fig 8,9) to convert the mechanical vibrations to useful electricity. We have also used solar panels, windmill and water turbine to produce considerable amount of energy, in order to charge the battery with the help of a battery charger circuit. This energy stored in the battery can be used for operating CFL bulbs, LED bulbs and DC fans. The battery charging circuit is connected to Node MCU which shows the battery level on the IoT platform using blynk app using wifi (Fig 10). The status of the battery and the load attached to it can be controlled from anywhere using ESP8266. IoT provides compatibility and easy to control the load and access it. (Fig 11)

Fig 8: Piezoelectric output on DSO when non-uniform vibration is applied

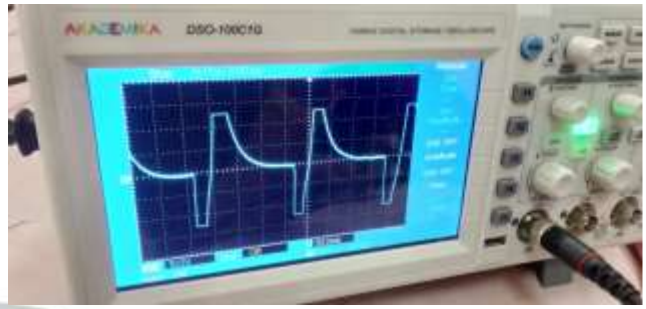

Fig 9: Piezoelectric output on DSO when uniform vibration is applied

Fig 10: Indicating battery level

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