International Journal of Electrical Engineering & Emerging Technology, Vol. 03, No. 02, DEC 2020, pp 30-33

Design of Solar Tracking System Using Piezoelectric Effect for Multi-Power Generation Based on IoT

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[**Received on:** 12-11-2020 **Accepted on**: 24-11-2020 **Published on:** 08-12-2020]

***Abstract* — The generation of electrical power and its practice is one of the headlines of the present time. Nowadays, the number of energy sources are present, but they are neither renewable nor cheap, non-renewable reserves of the world is almost depleting, and the demand of the electric power is increasing rapidly than anything in the present time. Thus, the world is shifting towards the renewable sources of producing energy as the demand of masses rises and require more power for their daily routine things. This project gives the idea of sustainable energy generation by utilizing the latest technology such as piezoelectric sensors (converts pressure into electricity) and solar power. In simple terms, the objective is to have a solar panel outputting its maximum possible power all day long, which occurs when the panel tracks the sun and rotates accordingly, to receive sunlight to the fullest extent always during the day time. With this, piezoelectric-based energy harvesting technology is applied to generate electricity from mechanical stress (vibrations). Depending on the availability of the power sources, this arrangement allows the two sources to power the load separately or simultaneously. An effective method of electrifying or producing electricity using solar energy and a piezoelectric energy recovery path is implemented in this article.**

***Index Terms* — Hybrid Energy Harvesting, Solar Panel, Piezoelectric Plate, Internet of Things (IoT), and Solar Tracking.**

I. INTRODUCTION

With pent-up concerns about global warming, thermal power plants, and other pollution, many countries are now looking for green energy technologies, which will help them to save the biosphere for future generations. Besides hydropower, photovoltaics and vibrations have the greatest potential to meet our energy needs. Vibrating energy can deliver large amounts of energy on its own, however, it is very unpredictable because lightning can be here and disappear in another. Therefore, there is solar energy during the day, but the solar radiation differs due to the intensity of the sun and unpredictable shadows cast by clouds, birds, trees, etc. The main disadvantage of vibratory and photovoltaic systems is their irregularity, which makes them unreliable.

If one source is not available or does not meet the load requirements, the other power source can compensate for the difference by combining these two alternative sources. Solar power has been the profitable renewable energy source for the past two or three periods. Today, it is used in a wide variety of fields such as industry and home use. The solar system must collect as much energy as possible from the sun and convert it into electrical energy. Other sort of energy is vibrational power or raindrops (mechanical power), that is transformed into electrical energy through the piezoelectric phenomena. To execute the task efficiently, the concept of piezoelectricity was presented. This article describes that the piezoelectric energy harvesting method is useful for generating power through the rain. Piezoelectricity is the electrical charge that builds up into hard stuff which is persuaded due to mechanical force applied. This proposed scheme aims to produce electricity production more sustainable, cost-effective, and environmentally friendly using advanced technologies.

The Internet of Things (IoT) can be used for tracking and tracing purposes to control the hybrid system. The IoT is the network of physical devices surrounded by electronics, software, sensors, and network connectivity that enable objects to collect and exchange data. In general, IoT is the exchange of information.

II. WORKING OF SOLAR PANEL

Sun powered boards work with photovoltaic cells by captivating daylight, creating coordinate current (DC) electricity. A large area sun-oriented cell piece can be molded to make a photovoltaic gadget, in which the light enters the sun oriented cells and is ingested by the semiconductor interface, the covalent electrons can be mixed between the P-type and N-type silicon by the photon with adequate vitality to generate an electron void. They will have partitioned each other by the electric field space charge and the electron will travel to the positive power locale of the N locale and the electron gap will move to the negative power locale. With the charge division of the semiconductor interface layer, it will create a voltage between the P locale and the N locale. For crystalline silicon sun-based cells, a commonplace esteem of the open circuit voltage is 0.5 ~ 0.6 V. The more sun powered vitality is captured by the semiconductor interface and the bigger range of the sun-oriented cells, the more prominent the electrical current when the framework is in operation.

Sun oriented energy may can be turned into power with the assistance of energy converters. The converter may be a sun-based cell. It will deliver modern pairs of electron gaps when

the light sparkles on the PN bulge of the semiconductor, beneath the activity of electric field within the PN bulge, the electron gap will lead to the P locale of the N locale, and the electrons will be diverted within the N locale within the P locale and deliver electric current after being related with the circuit.

III. WORKING OF PIEZOELECTRIC TRANSDUCER

Piezoelectric materials operating principle is based upon the piezoelectric effect. When a mechanical force or stresses are applied to certain materials along their certain planes, they generate an electrical voltage at the output. Voltage measuring instruments could be utilized to measure the output voltage. Piezo basically means the formation of an electrical polarization in a piezoelectric material in response to applied mechanical stress. This effect is called as direct-effect and effective for making sensors. Whereas, Piezoelectric Effect can be defined as, there are some materials generate an electrical voltage whenever mechanical stresses are acted upon them or, we can say, when the piezoelectric materials are supplied by with voltage, they tend to change their axis on a certain plane. The effect is known as the piezoelectric effect. Thus, working nature of the piezoelectric material could be closely related to the appearance of electrical dipole-moments in solids.

IV. WORKING OF IOT MODULE

The process begins with devices that have sensors attached with them. These devices are connected to IoT Module (NodeMCU) through Arduino Nano which collect data from all the connected devices and is showed on the server through dedicated IP. These important data are then used to perform tasks and hence in this way, IoT module works with systems that collects and send data to dedicated IP address. Four major components are combined into a full IoT system that are described as under:

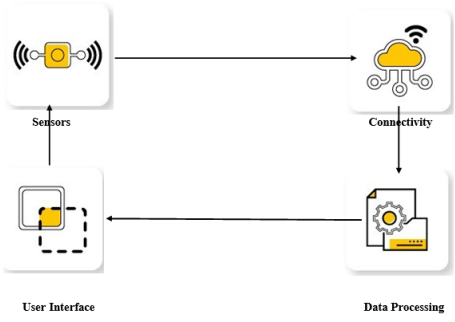
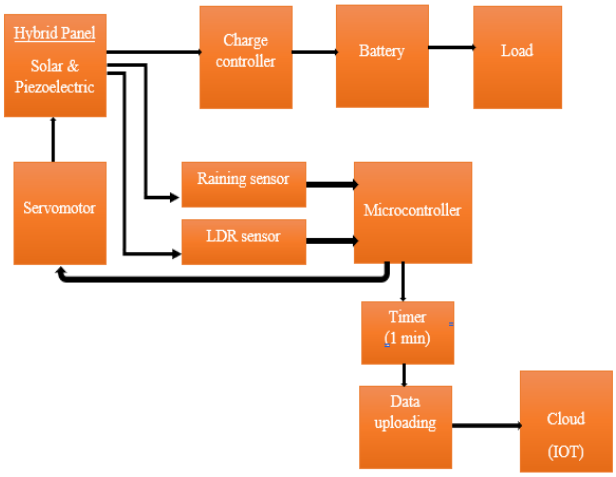


Fig. 1. IoT system

1.*Sensors:* The foremost component to consider in IoT (Internet of Things technology) is sensor. A sensor picks up all the real time data from attached devices. These sensors are built in the devices which collects all the data to be used later.
2.*Connectivity:* Once the data is collected it is transferred to the IoT module (NodeMCU). But to transfer the data, the devices will need a medium that is internet. The effectiveness of IoT security highly depends on the speed and availability internet medium.
3.*Data Processing:* After reaching the data to IoT module (NodeMCU) the data must be analyzed so that the right action can be taken. After processing data, it is sent to display unit.
4.*User Interface:* The last stage is user interface when the data is processed, it is displayed on server through computer screen where we can measure the different parameters like voltage(V), current(I), power, moisture content and etc.

V. METHODLOGY

A. *BLOCK DIAGRAM*



There is a hybrid designed panel in this project, which consists of a solar plate at one side while the other side having a piezoelectric plate. The panel will rotate automatically through a servo motor depending on the environmental conditions. When the day is bright, the solar plate will be faced up and the piezoelectric plate will face up when there is rainfall. LDR is used to sense the sun and a humidity sensor to detect rainfall. The microcontroller (Arduino) along with the servo motor, is connected to the IoT tracking device and moisture sensor.

It provides feedback to the microcontroller whenever the IoT monitors the sunlight and thus runs the servo motor, that rotates the hybridized panel causing the solar plate to face the sun, producing electricity, and initiates charging of battery through the charge controller. Whenever the humidity sensor detects the rainwater moisture, it provides the micro controller feedback and thus drives the servo motor to rotate the hybridized panel and the piezoelectric plate will be faced up. Now the rainwater hits the panel and electricity is produced because of the piezoelectric effect, and it starts charging the battery through the charge controller. After that, the data will be uploaded by passing through 1-min timer through NodeMCU to cloud server and we can check the result anywhere but there should be availability of internet facility.

B. *EQUIPMENT SPECIFICATION*

TABLE I: List of components

Components	Ratings
Solar plate	20 Watt
PWM solar charge controller	10 Amp
Piezoelectric plate	
Acrylic Sheet	3x2 feet – 3mm
Battery	12V | 7AH
Arduino nano	
Arduino volt sensing module	0-25 Volts
MG996R servomotor	
ACS-712 current sensor	
ESP98266 Wi-Fi module	
Zener diodes	15V and 6V
Capacitors	1000µF | 35 Volts
Resistors	1K, 330Ω,
Buck converter	3 Amp
DC pump	12 Volts

C. *IMPLEMENTED HARDWARE (PROTOTYPE MODEL)*

Fig. 2. Model with solar at top

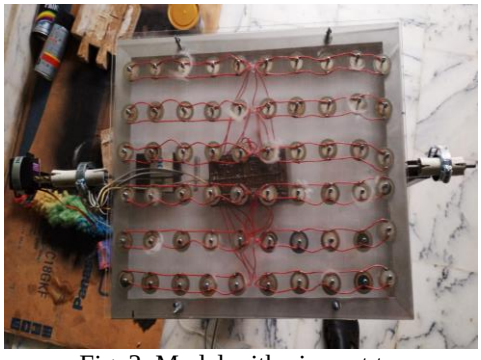


Fig. 3. Model with piezo at top

VI. RESULTS & DISCUSSION

After successful development of the system, the hybrid panel had rotated based on the weather condition and the following parameters were analyzed:

- Raining Status
- Solar battery voltage
- Solar battery current
- Solar Tracking
- Piezo panel voltage
- Piezo battery voltage.

A. *RAINING STATUS*

Upon initialization, the project will firstly check out the rain status.

- If there is availability of rainfall on the panel, servomotors rotate 180 to face up piezoelectric plate.
- Otherwise, in absence of rainfall, solar plate will be faced up through rotation.

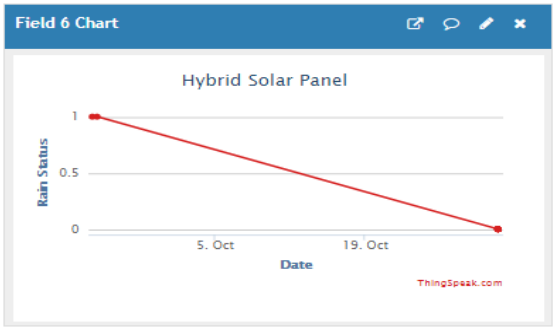


Fig. 4. Rain condition check

B. *POWER GENERATION THROUGH SOLAR SYSTEM*

In this analysis, when light intensity at instant falls on the plate and is identified through LDRs, the hybrid panel produces current in response of voltage and battery gets charged.

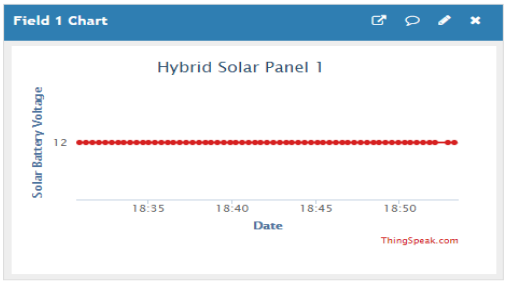


Fig. 5. Solar battery voltage

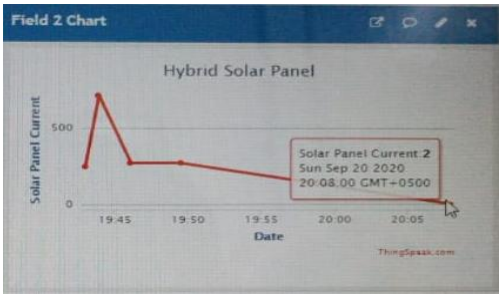


Fig. 6. Solar plate current

Also, power is successfully generated when sunlight is tracked at different angles with different intensity falls.

Fig.7. Solar tracking through intensive torch light

C. POWER GENERATION THROUGH PIEZOELECTRIC SYSTEM

In this analysis, when rain or moisture is detected on the plate, the hybrid panel produces voltage which charges the battery by virtue of electric current.

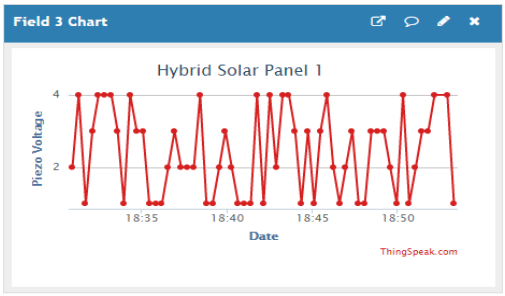


Fig. 8. Piezoelectric panel voltage

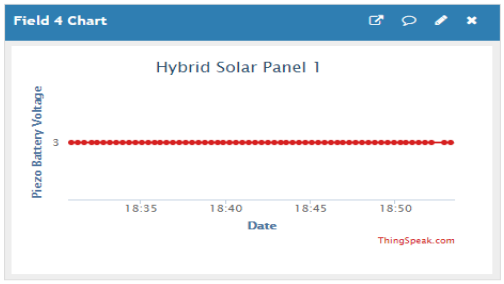


Fig. 9. Piezoelectric battery current

VII. CONCLUSION

Necessity of electricity is the part of our daily life. In this project, we present the design of hybrid system utilizing advanced technology-Internet of Things (IoT) and become successful as results showed an implementation of an efficient way of hybrid power generation i.e. solar power combined with piezoelectric power which provides path for obtaining continuous power generation from renewable energy resources based on weather conditions.

VIII. FUTURE RECOMMENDATIONS

i. Addition of Control System – After monitoring, we can control the appliances.
ii. Compass should be use of solar tracking degree measurement.
iii. MPPT can be installed for achieving maximum solar intensity.
iv. Power generated from piezo transducers can be efficiently measured by using high accuracy current sensors, which are capable are of recording 5-20mA current range.
v. For more convenient system, Android application could be design regarding IoT parameters.
vi. Better result could be observed on large scale implementation of this project.

REFERENCES

[1] Hybrid System tracking and Monitoring by Using IOT Technology for Industrial Automation: International Journal of Innovative Research in Science, Engineering and Technology, Vol. 8, Issue 3, March 2019.
[2] Hess, Herbert L., and Saied Hemati: Integrated Solar and Piezoelectric Renewable Energy Project.
[3] Towards a green and self-powered Internet of Things using piezoelectric energy harvesting. IEEE Access 7 (2019): 94533-94556.
[4] Hybrid energy sources status of Pakistan: An optimal technical proposal to solve the power crises issues. Energy Strategy Reviews. 24. 132-153. 10.1016/j.esr.2019.02.001. (2019).
[5] An Overview of Uninterruptible Power Supply System with Total Harmonic Analysis & Mitigation: An Experimental Investigation for Renewable Energy Applications. International Journal of Computer Science and Network Security ISSN: 1738-7906. VOL.18. 25-36. (2018).
[6] Power Management of a Stand-Alone Hybrid (Wind/Solar/Battery) Energy System: An Experimental Investigation. International Journal of Advanced Computer Science and Applications. 9. 10.14569/IJACSA.2018.090631. (2018)
[7] Integration of Renewable Energy Project: A Technical Proposal for Rural Electrification to Local Communities. IEEE Access 8 (2020): 2993903
[8] An IOT Based Solar Power Robotic Tracking & Monitoring System. Available at SSRN 3416985 (2019).
[9] HYBRID POWER GENERATION USING SOLAR, WIND AND PIEZO". International Journal of Advanced Engineering Research and Technology (IJAERT), Volume 5 Issue 11, November 2017, ISSN No.: 2348 – 8190