Performance Evaluation of Electricity Generation from Living Plants

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***Abstract*— The production of electricity from natural gas, coal and other fossil fuel is non- renewable. There is a need for efficient, sustainable and renewable energy. This project uses that kind of sustainable energy. It is centred on a natural process and is safe for both the environment and the plant. This project concentrates on obtaining electrical energy from the living plants and the effect of temperature, humidity and soil moisture on the production of electricity is also studied. Plants photosynthesize organic matter through carbon dioxide, water for its growth and thus capture solar energy. A little amount of the organic matter is excreted through the roots into the soil as a waste product. Naturally occurring bacteria which are electrochemically active, break down the organic matter in the rhizosphere and produce electrons. When electrodes are placed near the roots, in the soil, the ions travel towards the electrodes and produce electricity from this surge. The three sensors, DTH11, Soil Moisture Sensor and Voltage sensors are used to study how voltage varies with respect to these parameters. The sensed data is transmitted through the ESP8266 Wi-Fi module into the Thinkspeak cloud. Then the analysis is done by collecting the data from the cloud.**

***Index Terms*— electrodes, humidity, living plants, rhizosphere, soil moisture, sustainable energy, temperature.**

I. INTRODUCTION

Nowadays, technology is developing and it plays a major role in all human lives. As technology develops, the resources are used widely. Energy-saving reflects an attempt to reduce the energy consumption by less usage of energy. This can be done either by more effective use of renewable energy or by lowering the amount of service used. This research focuses on generating electricity from plants. The process does not affect the plant as well as the environment. The plants make their food by photosynthesis. Photosynthesis is the method of transforming solar energy into chemical energy by the green plants and some other species. Some fundamental procedure to harvest weak electricity from living plants was achieved by embedding electrodes into the plants, thereby completing the connection with the conditioning circuit, electrical energy is extracted [5]. It is also described that the combination of the copper-zinc electrode is used to produce the highest voltage in the aloe vera plant. When coupled constructed wetland- (CW) with microbial fuel cells (MFC), (CW-MFC), is used, at the initial stage (1- 8 days), the CW-MFC plant voltages

(0.51- 0.53V) were near the mean voltage of the CW-MFC plant (0.50V). Here, a single-chamber which is free from the membrane is continuously fed up using microbial fuel cell and is coupled with constructed wetland, in which the cathode is placed in water for the use of oxygen from the air for reduction reactions and the anode is submerged in a supporting matrix near the rhizosphere to acquire organic substrates in the influents or deprived of wetland plants root as fuel [3]. In Plant-e, the material used for the anode and cathode is carbon material. Titanium wires were used to form a circuit as a current collector. In this, the carbon- carbon electrode pair is used. The extracted electrical energy would increase proportionately, by rising the number of electrodes embedded in the plants [5]. In the existing method, the electrode pair which is used for generating voltage from the living plants produces an only low amount of voltage. The generation of electricity from plants is affected by various parameters which include both physical and environmental changes. Thus, the effect of various parameters on the generation of electricity from the plants has to be studied. The primary objective of this research is to harvest electricity from plants and to study the effect of temperature, humidity and soil moisture on the production of electricity.

II. METHODOLOGY

The objective of this paper is to illustrate the generation of electricity from living plants and to study the effect of temperature, soil moisture and humidity on the production of electricity. Glucose is formed during the photosynthesis process of the plants. Part of the energy produced by photosynthesis is used for plant growth, and the remainder is excreted into the soil. Within plant roots, electrochemically active bacteria are present. Glucose decomposes with the bacteria. As a consequence, they produce carbon dioxide, electrons and protons. Carbon dioxide is released back into the atmosphere. When the anode and cathode are placed near the plant's root, electrons are attracted to the anode due to its positive charge, and the protons are attracted to the cathode due to its negative charge.

In this paper, the method to produce around 1 Volt from a single plant is shown. The proper choice of electrode pair will increase the voltage obtained from the plant and the electrode has been selected based on a study of trial results. More than one plant can be connected in series to obtain higher voltage as shown in Fig. 1. This obtained voltage can be given to the DC-DC step-up boost converter MT3608. MT3608 requires a minimum of 2V to produce a maximum of 28V. This boosted voltage can be given to any low power device. The voltage produced from living plants varies by various parameters. These parameters include the temperature of the environment in which the plant is growing, the humidity of the air around the plant, the moisture content in the soil in which the plant grows, etc. Studying the effect of these three parameters, temperature, humidity and soil moisture on the production of electricity from the living plants will help to understand the production of electricity from living plants.

These above parameters are measured using the sensors, DHT11, soil moisture sensor and voltage sensor. The microcontroller used here is Arduino UNO. The sensor values are given to the microcontroller. The data is sent from Arduino UNO to Thingspeak cloud [2]. This occurs with the help of the ESP8266 (NodeMCU) Wi-Fi module connected with Arduino UNO. The Thingspeak is an IOT platform in which channels are created so that data can be stored in it and we observe the variation in voltage concerning the temperature, humidity and soil moisture.

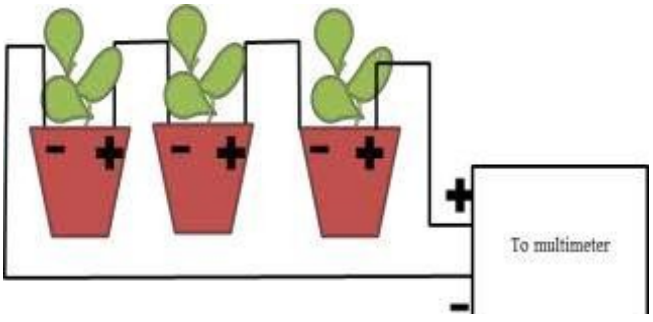

Fig. 1. Series connection of plants

III. ELECTRODE SELECTION

The selection of electrode to obtain a high voltage from a single plant was based on a study of trial results. The plant

taken for this study was one Rose plant. The trial results are shown in Table I.

TABLE- I: Variation of voltage with different electrodes

Anode	Cathode	Voltage(V)
Aluminium	Aluminium	0.2
Iron	Aluminium	0.4
Copper	Aluminium	0.64
Copper	Iron	0.94
Copper	Zinc	0.6
Carbon	Aluminium	0.4
Carbon	Iron	1.1
Carbon	Zinc	1.3
Carbon	Copper	0.6

It can be seen that the electrode pair of Carbon as anode and Zinc as cathode gives the maximum voltage of 1.3V in one Rose plant. Hence, based on this trial result, Carbon-Zinc electrode pair is chosen for further study.

IV. ANALYSIS OF FACTORS AFFECTING VOLTAGE PRODUCTION

The environmental factors which are affecting the production of voltage have been analyzed. The humidity, temperature and soil moisture has been taken into account for this study. This is done by collecting these data from sensors connected to the Arduino UNO and sending these data to the Thingspeak cloud with the help of NodeMCU. The data is then analysed with the help of the line graph.

The plants considered for this study are Rose, Aloe Vera and Hibiscus plant. The variation of temperature, humidity and soil moisture in the Aloe Vera, Rose, and Hibiscus plant has been shown in Fig. 4., Fig. 5. and Fig. 6. respectively.

To increase the voltage production, the optimum environmental parameters can be maintained. Also, the plants can be connected in series as shown in Fig. 2. to increase the voltage.

Fig. 2. Rose plants(three) connected in series

The Fig.2. shows that three Rose plants, when connected in series, gives about 2.31V. This can be used to light up an LED as shown in Fig. 3.

Fig. 3. Glowing of LED from plant voltage

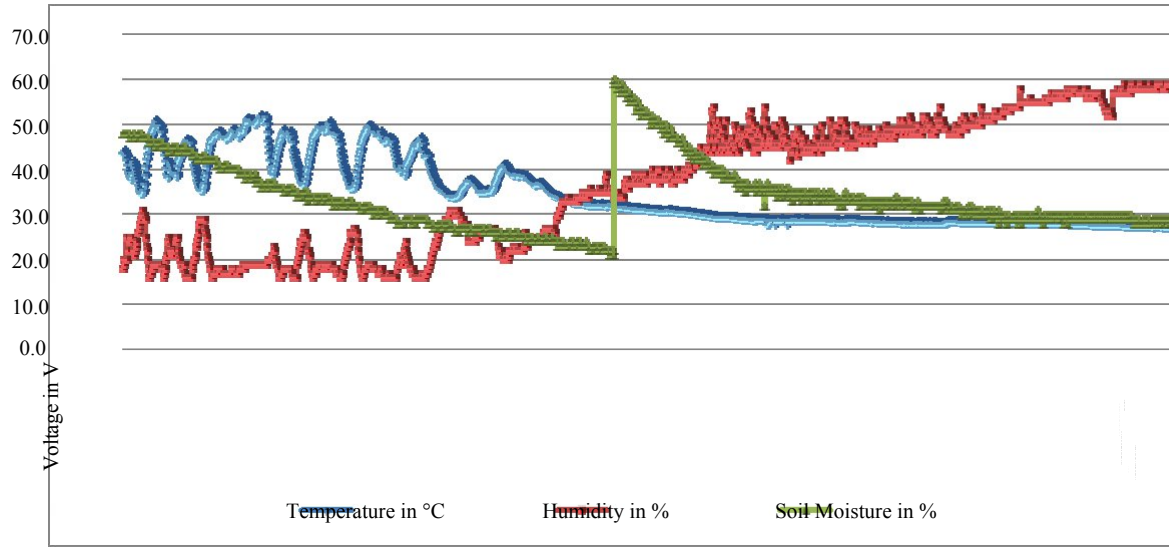

Fig. 4. Variation of voltage in Aloe Vera plant

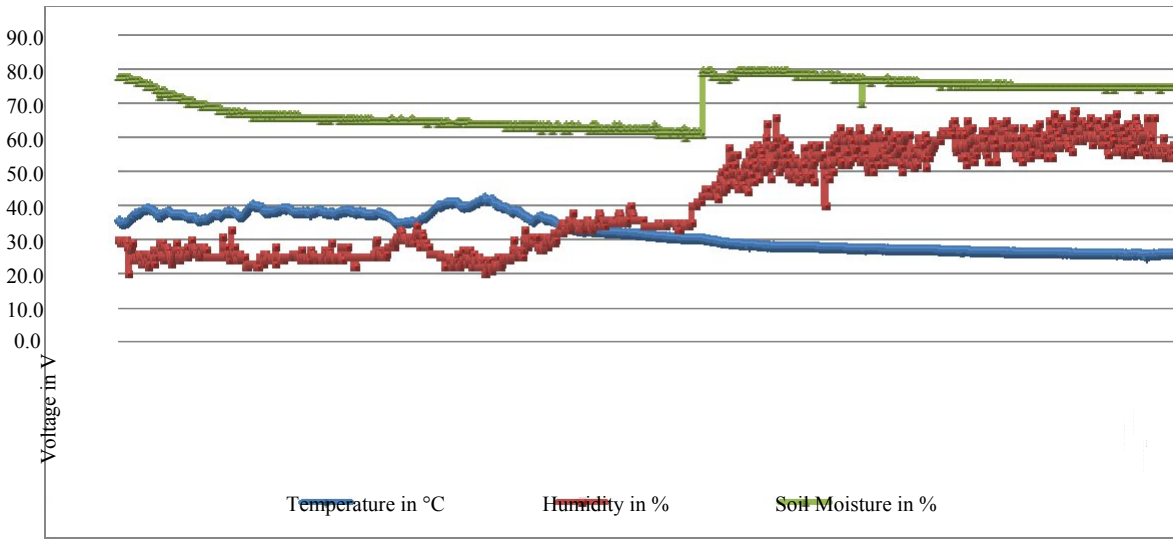

Fig. 5. Variation of voltage in Rose plant

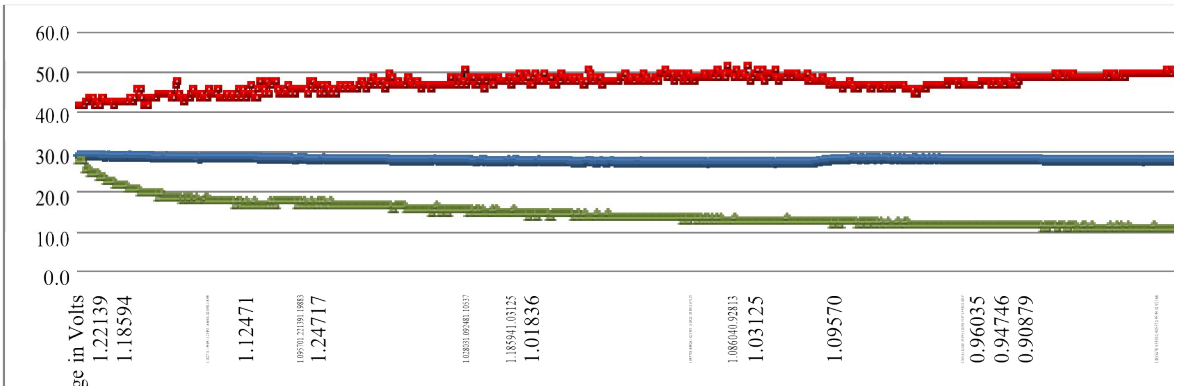

Fig. 6. Variation of voltage in Hibiscus plant

It can be seen in Fig. 4., Fig. 5. and Fig. 6. that the voltage decreases with an increase in humidity, decrease in temperature and decrease in soil moisture. The sudden increase in the soil moisture is due to the watering of the plant at that time. Therefore, the plant voltage is directly proportional to temperature and soil moisture whereas is inversely proportional to the humidity.

Thus, it can be noted that the production of voltage not only depends on only one parameter, but it depends on various environmental and physical factors. All these parameters affect the voltage production from plants, as these parameters are inter-related to each other.

V. CONCLUSION

Thus, the performance evaluation of electricity generation from living plants is done. In this project, the electric current is produced successfully. The effects of various parameters are studied and, in the future, it may be considered to control automatically the parameter changes in gardens. Also, the obtained voltage can be boosted to power up any appliance.

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