

# Smart Garden with IoT based Plant Monitoring System

S. P. Singh<sup>1</sup>, Arif Iqbal<sup>2</sup>, Jaswant Singh<sup>3</sup>, R. Kumar<sup>4</sup> and Ashwin Kumar Yadav<sup>5</sup>

<sup>1,2,3,4,5</sup> Department of Electrical Engineering, Rajkiya Engineering College, Ambedkar Nagar (U.P.), India

**Abstract**— Internet of things (IoT) is associated with a system of interconnected electronic devices through the internet due to which users and machines can interact with each other. Interactions include the exchange of real-time data (from devices to consumers) and commands (from consumers to devices). This paper presents IoT based smart garden which can be used to monitor the plant growth by monitoring the soil moisture and availability of sunlight throughout the daytime. Why monitor through IoT based device? In today's fast-growing world, people are very much busy in their works and usually forget to water their plants or couldn't place the flower pot at the right place where there is sufficient sunlight. Hence, our system is equipped with light intensity and soil moisture sensor. It checks the availability of sunlight and moisture content in soil for the plants on regular time intervals basis and the data is collected by the Bolt IoT platform. After the processing and verification of data by using a logic which is created using Integromat (cloud-based logic designing), accordingly an SMS is sent to our smartphone through Twilio (cloud communication platform) and then the user will take required action according to the data. This smart gardening system will provide convenience and comfort to the user without their physical presence and helps better care of our garden.

**Keywords:** Smart Garden, Bolt Wi-Fi, Integromat, Internet of Things

## I. INTRODUCTION

In today's world with busy schedule, people forget to take care of their home, particularly nourishing and watering of plantation. With the growing pace of time the technology had brought in a great revolution in the world and made our daily life works a lot easier. Virtual reality has taken over the normal life. We are busier on social networking site like Facebook and WhatsApp rather than in our real life. So what if we give the updates of their garden on their smartphone. Therefore, we sought to develop a device which can monitor our garden and then communicate with the user. Kevin Ashton in 1999 coined the word Internet of Things. IoT brought the way to establish the communication between the humans and physical objects. So, our system is equipped with sensor for light intensity and moisture, which checks the sunlight intensity and moisture content of the soil in the plantation on the regular time basis and the data is collected by the Bolt IoT platform. That data is analyzed and communicated to the users.

## II. RELATED WORKS

### A. Smart Garden

Table I shows the comparison [1] of related works in Smart Garden projects, equipped with Smart Watering System consisting of Wireless Sensor Networks [2], Automated Plant Watering System [3] and IoT-based Green House System using Splunk Data Analysis [4].

TABLE 1: Smart Garden Projects

<b>List of smart-garden projects</b>	<b>Specifications</b>
Smart Watering System for Garden using Wireless Sensor Networks	<ul style="list-style-type: none"> <li>• Operating System: TinyOS</li> <li>• Soil Moisturizer Sensor Module</li> <li>• Wireless Sensor Use Solenoid Valve as Actuator for flowing the water to the plant</li> </ul>
Automated Plant Watering System	<ul style="list-style-type: none"> <li>• Arduino System</li> <li>• Moisture Sensor</li> <li>• Water Pump</li> <li>• Relay for activate the water pump using Altemate Current (AC)</li> </ul>
IoT-based Green House System with Splunk Data Analysis	<ul style="list-style-type: none"> <li>• Raspberry Pi System</li> <li>• Display the data from sensor to the "Splunk" for Analysis purpose Multi-Module Sensor</li> </ul>

### III. METHOD AND MATERIAL

The proposed architecture of the IoT device is shown in Fig.1. Here the role of Bolt IoT Wi-Fi module is to gather and send it to cloud. Further the data are sent to Integromat logic. During running scenario in Integromat logic, Bolt receives the read data both in digital and analog form through Bolt IoT App for the monitoring of light intensity and soil moisture. To set the current and operational time in the scenario requires the three sets of variable kits/tools. This enables to check the availability of sunlight in plantation area and soil moisture content in different times and is compared to the set limiting value. After the processing and verification of data using Integromat through a developed logic (cloud-based logic designing), accordingly an SMS is sent to our smartphone through Twilio (cloud communication platform) and then the user will take required action according to the data.

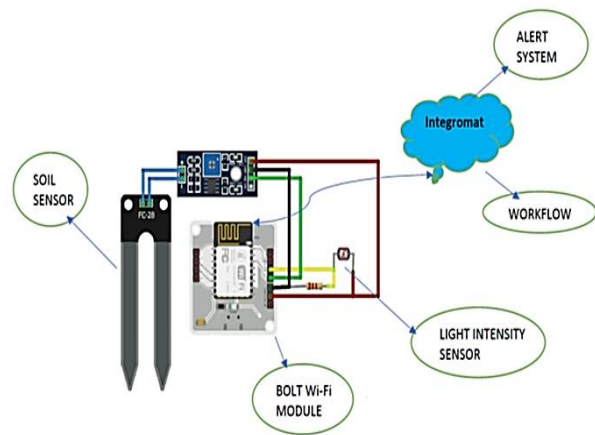


Fig.1. Architecture of Soil Monitoring System.

A. *BOLT Wi-Fi module:*

Fig.2 shows the BOLT Wi-Fi module which is an open source, cloud based IoT module with on board ESP8266-12S chips [6]. It is can easily connected to our smartphones with Bolt IoT apps. This board is powered through a USB cable with 5V DC supply. This module is equipped with GPIO (General purpose Input/Output)[1] facility. Based on ESP8266-12s there are multiple variety of IoT modules available. But Bolt IoT development module has the additional facility of Bolt cloud that can be accessed through Bolt app on our smartphone which is further connected to the module via Wi-Fi internet. The following TABLE II and III gives the general specification and pin specifications [7].

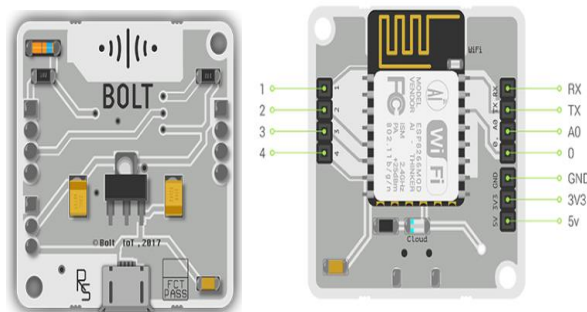


Fig.2. Bolt Wi-Fi module.

TABLE II: Showing general specification.

Parameters	Details
Connectivity and Processing Module	ESP8266 with custom firmware
MCU	32-bit RISC CPU: Tensilica Xtensa LX106
Operating Voltage	5V
CPU Clock Frequency	80 MHz
Wi-Fi	802.11 B/G/N
UART	8-N-1 3.3V TTL UART [using TX, RX, GND pins]

### B. Soil Moisture Sensor

Soil volumetric content is measured by using a Soil Moisture sensor. Water is one of the most important ingredients for the survival of the plants along with the sunlight. The moisture content of the soil decreases due to the evaporation and absorption by the roots of the plant. Thus, soil moisture sensor determines the real time moisture content of the flower pot or the fields. LM393 comparator is the main component of the sensor which has uses potentiometer to adjust the limiting value of detected dryness/wetness of soil [5]. These soil moisture sensors can be classified into two types: Frequency domain sensor and neutron moisture gauze [1]. Working principle of Frequency domain sensor is based on the measurement of soil dielectric constant by using an oscillatory circuit. Soil dielectric constant increases with increase in moisture and vice versa. Hence, it is estimated how much amount of water the soil is holding. On the other hand, is neutron moisture gauze, which works on the principle that the decaying radioactive sources emits the fast-moving neutrons which will gets collided with the protons and thus got slowed down. The measurement of the number of slow-moving neutrons will give the percentage of moisture in the soil.

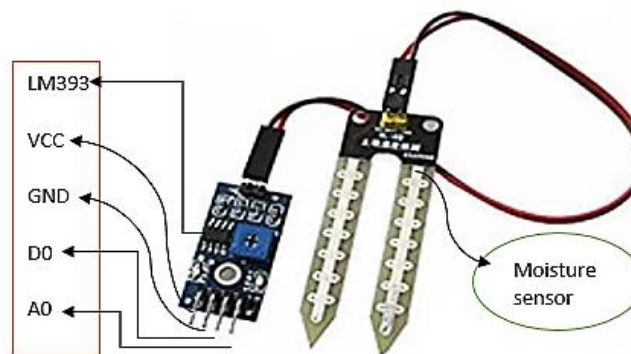


Fig.3. Soil moisture sensor.

TABLE III: PIN Definition

PIN	Definition
VCC	Power Supply
GND	Ground
D0	Digital Output
A0	Analog Output

### C. Light Intensity Sensor

Light intensity sensor is used to measure the light intensity available which is shown in Fig. 5. LDR (Light Dependent Resistor) is the component used in the sensor. It is basically a photocell which works on the principle of photoconductivity means the resistance falls as the increase in light intensity. Typically, it has the following resistances:

Daylight= 5000Ω; Dark= 20000000Ω

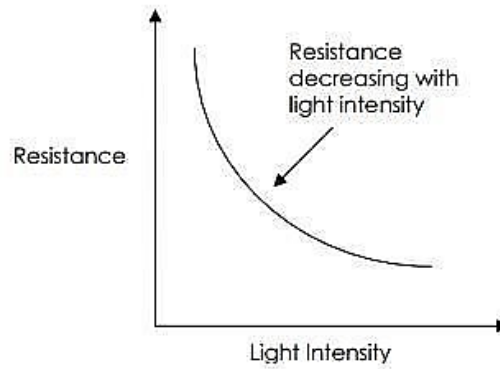


Fig.4. LDR resistance vs light intensity graph.

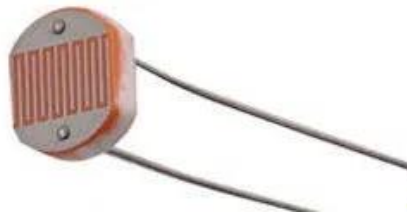


Fig.5. LDR (Light Dependent Resistor)

#### D. Twilio

Twilio is a suitable cloud-based platform for communication. It gives the facility to software developers to design programs to receive phone calls or send and receive SMS using the web service APIs [8].

#### E. Integromat

Integromat links the required apps/services/cloud with their corresponding sensors/modules for the creation of scenario to gather of data through a logic. So here we have to design a logic scenario that will run and collect the data when the request is called and Integromat will analyze the data and the required task will be executed. To connect with the Integromat we have to take following four steps which are as follows:

Step-1: Make an account on Integromat on the website [9].

Step-2: In dashboard, click on the button marked as “Create a new scenario” shown in the top right corner.

Step-3: Choose BoltIoT and Twilio in the services option.

Step-4: Design the logic flow as shown in the Fig. 6.



Fig.6. Creating workflow on Integromat

- Now to start the Bolt IoT service essential credentials will have to be entered i.e. device ID of Bolt, key of API, authentication token number, SSID and sender's number to avail the Twilio service as shown in the Fig. 7.

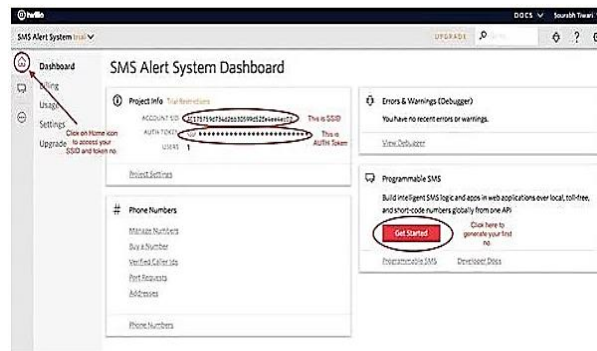


Fig.7. Connecting Twilio service to Bolt device ID.

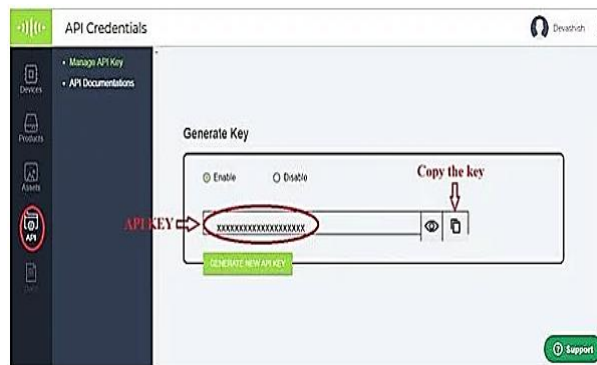


Fig.8. Entering API credentials on bolt app.

#### IV. Result and Discussion

This complete system of sensors, Bolt module and software have been done to monitor the garden. But for the testing purpose we setup the whole system in a small scale by in flower pot. We have created a working sequence in Integromat to setup an alert via text message (SMS) through Twilio. As soon as the light availability or the moisture content will get below the limiting value, an alert system will be activated and the SMS is sent to the user to take the required action as shown in the Fig. 9.

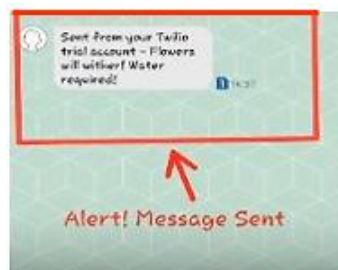


Fig. 9. Alert message to water the plant.

##### A. Soil Moisturize Module Sensor

The sensor output value are in percentages. During the testing, the dryness limit of the soil is kept at 35%. Therefore, when the soil moisture content will be less than the set threshold value 35%, then the sensor output is LOW else, it is HIGH for other value. This constitute a digital data on pin 0 in Bolt IoT module. During running of scenario in Integromat logic, Bolt receive read request both in digital and analog form through Bolt

IoT App for the data of moisture content. For a satisfactory condition, user receives a SMS as a plantation health alert.

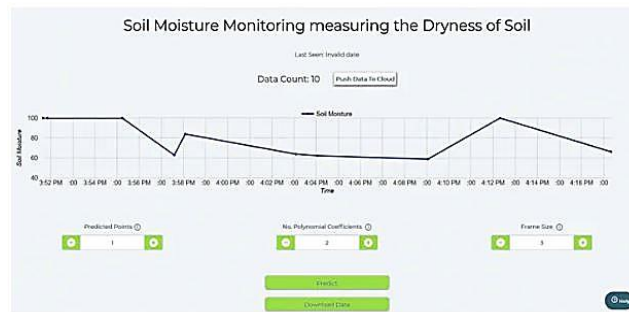


Fig. 10. Moisture vs Time graph.

### B. Light Intensity Module Sensor

This module contains LDR whose resistance increases as the light intensity decreases. LDR measures the amount of sunlight available for the plants. At the regular interval of time when the Integromat logic runs it requests the data from the bolt cloud. LDR senses the data which is taken as input to the Bolt unit after then it is sent to cloud from where it is used by the Integromat logic. Analog data of LDR is read from Bolt module at pin A0. But while using this component in the device, initially the system will check for daytime, and suitability of workflow logic to run on Integromat. For daytime it checks for any possible error (else, scenario will not be operated by Integromat). Fig. 11 shows the real time light intensity on Bolt app.

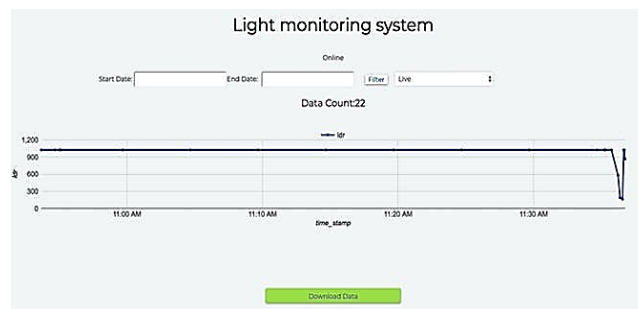


Fig. 11. Light intensity vs Time graph.

## V. CONCLUSION

The paper on the Smart garden with IoT based plant monitoring system is presented, where we successfully designed the system and tested on the small scale in the flower pot. The designed project can analyze the required data in the real time and then send result to the user in their smartphone apps to take required action. This system is very much user friendly and easy to use. There are almost no maintenances in the proposed system. The user can also check the real time moisture and sunlight availability on the Bolt IoT app in their smartphone along with the alerts. This device contains many sensors such as light sensor and soil moisture sensor which runs long without getting damage and is very cheap. The main processing unit on this device is Bolt IoT Wi-Fi module. Therefore, the designed low cost IoT device that can monitor our plants and gardens.

## VI. ACKNOWLEDGMENT

This work was financially supported by World Bank Technical Education Quality Improvement Program (TEQIP)-III Project of Rajkiya Engineering College, Ambedkar Nagar (U. P.)-224122.

## REFERENCES

- [1] Losant platform ( 2016) 2nd Int. Conf. on Contemporary Computing and Informatics (IC3I), Noida, 2016, pp. 764-768.doi: 10.1109/IC3I.2016.7918063
- [2] Abbas, A. H., Mohammed, *et al.* (2014). Smart watering system for gardens using wireless sensor networks. *2014 International Conference on Engineering and Technology (ICET)*. doi:10.1109/icengtechnol.2014.7016780
- [3] D. Divani and P. Patil (2016) Automated Plant Watering System. pp. 180–182.
- [4] Y. Chen, (2017) IoT-based Green House System with Splunk Data Analysis. IEEE Conf. Pap., no. iCAST, pp. 260–263.
- [5] bin Sadli, M. D. D. (2019). An IoT-based Smart Garden with Weather Station System. *In IEEE 9th Symposium on Computer Appl. & Indus. Electr. (ISCAIE)* (pp. 38-43).
- [6] Aldair, A. A., Rashid, A. T., & Mokayef, M. (2018) Design and Implementation of Intelligent Control System for Egg Incubator Based on IoT Technology. *In 2018 4th Int. Conf. on Electrical, Electronics and System Engineering (ICEESE)* (pp. 49-54).
- [7] Limited), B. (n.d.). IoT Platform. Retrieved August 27, 2020, from <https://www.bolttiot.com/>.
- [8] Communication APIs for SMS, Voice, Video and Authentication. (n.d.). Retrieved August 27, 2020, from <https://www.twilio.com/>.
- [9] Web Analysis for Itegromat - itegromat.com. (n.d.). Retrieved August 27, 2020, from <https://itegromat.com.cutestat.com/>.
- [10] Vani, P. D., & Rao, K. R. (2016) Measurement and monitoring of soil moisture using cloud IoT and android system. *Indian Journal of Science and Technology*, 9(31), 1-8.
- [11] Srilikhitha, I., Saikumar, *et al.*, M. (2017). Automatic irrigation system using soil moisture sensor and temperature sensor with microcontroller AT89S52. *In 2017 Int. Conf. on Signal Proc. and Comm. (ICSPC)* (pp. 186-190).