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Real Time Monitoring of Valeriana Jatamansi Plant for Growth Analysis

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Abstract

In present time, Wireless sensor network (WSNs) is widely adopted in diverse field like engineering, sciences, health, home, military, railway stations, airports, industries etc. Agriculture is also a warm of area in which WSNs is used to improve production, monitoring, intruder prevention and profitability of the crops and in turn Precision agriculture (PA) .Further, integration of WSNs in agriculture can monitor the progress of the crops and provide real time data to the farmers such as moistures, temperature, water and other resources. In this paper, a sensor device with the help of Arduino board is designed to monitors the growth of valeriana jatamansi plant in the greenhouse. The proposed device is capable to sense the moisture of soil and detect the insects in the planting area of plant. The data from the greenhouse to the farmer's base station is transmitted through the help of Wi-Fi module.

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1. Introduction yugalkumar.14@gmail.com,

Wireless sensor network (WSNs) is a network composed of nodes which transmit or receive data without any wired medium. Each node in WSNs has its own transmitter, receiver, and battery unit. The infrastructure of WSNs is very small and consists of few or large number of nodes. It can be divided into two types structured and

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unstructured WSNs. In structured WSNs, each node is deployed in architectural manner and position of each node is predefined in the network. Whereas in unstructured WSNs, nodes are deployed in random order and no architecture is defined in the network [1]. There are many applications areas in which WSNs can help in monitoring and tracking such as military, health, environment, business, airport, home appliances, factories etc. The fig. 1 gives the overview of a wireless sensor network. Each sensor nodes communicate with wireless link and information is transmitted from sensor nodes to base station and after processing of data, it can transmit to end users.

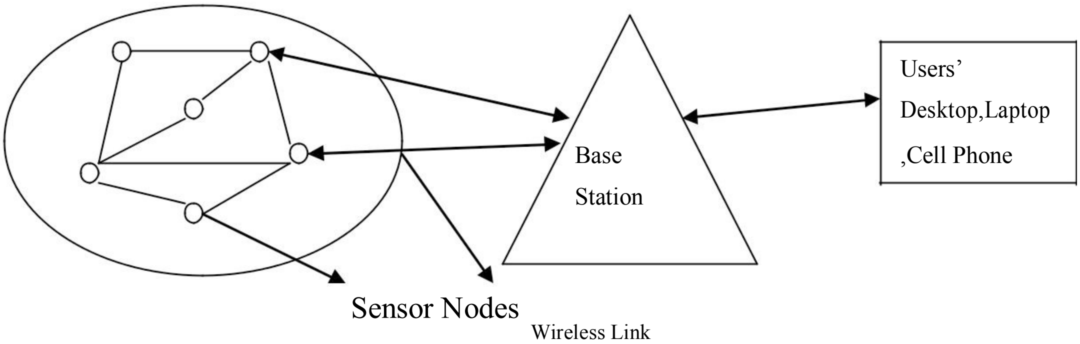

Fig. 1: Overview of Wireless sensor network

Recently, WSNs are widely adopted in the field of agriculture filed. Due to the increasing demand, farmers put many efforts to increase the productivity of crops, vegetables etc. by introducing different technologies in agriculture lands. Precision agriculture (PA) is one of them which can be used for effective farm management. It can be defined as incorporate the technology in agriculture fields is to enhance the production of crop and provide better resources for the crop at right time that can help prevent the crop from degradation. PA helps in managing spatial and temporal changes within a field, providing real time data to the users for improving the quality of crop and decreasing the environmental impacts on the crops.PA uses technologies like remote sensing, surveillance of field through satellite and wireless sensor networks etc. These technologies can help the farmers to provide the information of agricultural field regarding temperature, moisture; irrigation, intrusion detection.

2. Precision Agriculture

WSNs contribute huge role in Precision agriculture. With the help of WSNs in PA, real time data of agricultural field is transmitted to the user by using different communication technologies [2] that are listed in Table 1. The different typesof sensors are used in agricultural field [3] and these sensors are mentioned in Table 2. Sensor nodes help for collecting the information like temperature, humidity, moisture of soil, speed of wind, intrusion detection and transmit the information to the user and on the basis of processes information, farmers can respond. In a huge farming field, it is difficult for farmer to investigate the growth of crops regularly and provide resources to the crop. With the help of sensor network, the growth of crops is examined, day by day progress and condition of crop reported to farmer. PA using WSNs reduces the load of farmer, provide real time information of field to the farmers, and increase the productivity of the crops. In agriculture field, sensors can also provide risk assessment informationsuch as detection of animals or insects in the farming field and lack of resources like water, moisture, pesticides and temperature [4].

PA using WSNs have great benefits to the farmers. Some of advantages using WSNs in PA are given below [1].

- Sensor nodes help in collecting information of environment that is temperature, wind speed, moisture, and condition of weather.
- Surveillance of large area of field can be easily done.
- Save water by irrigating fields only when needed.
- Real time information of fields can be easily obtained.

Fig. 2 depicts the deployment of sensor nodes in agricultural field and process of collecting information from agriculture land. Further, the collected information is transmitted from base station to users system and database with the help of internet

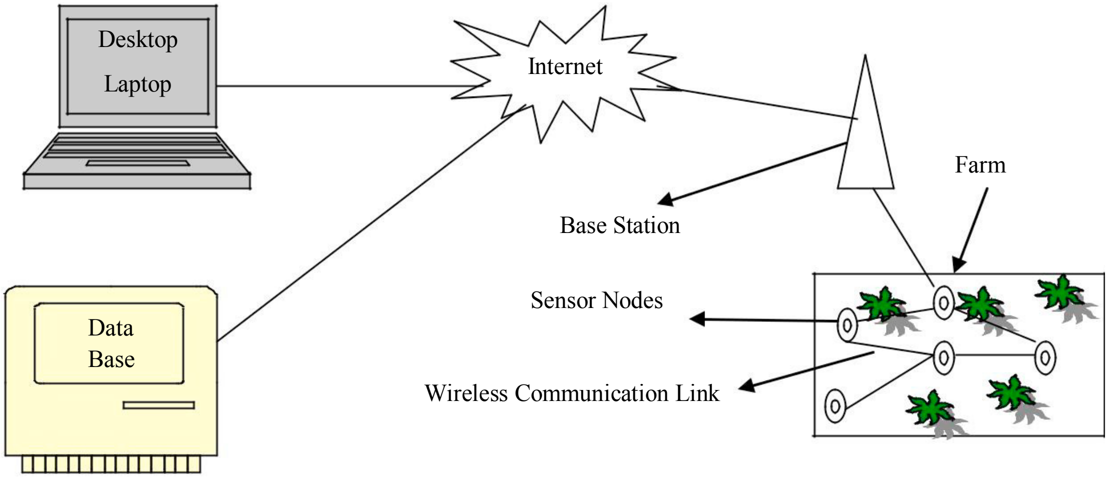

Fig. 2: Overview of Precision agriculture using WSNs

Table 1: Communication technologies use in WSNs

Communication Technology	Frequency	Range
Bluetooth	2.4 GHz	100 meters.
ZigBee	2.4 GHz	Upto 1.5 km
Wi-Fi	2.4 GHz	30-35 meters.
GPRS	2.4 GHz	Coverage area of GPRS
Wi-Max	2-66 GHz	Less than 50 km

Table 2: Different types of sensors used in Precision agriculture

Sensor Name	Parameter Measure	References
Hydra probe II soil sensor	Soil temperature, moisture, humidity	www.stevenswater.com
MP406 Soil moisture sensor	Soil Properties temperature, moisture, humidity	www.ictinternational.com.au
EC sensor (EC250)	Soil Properties temperature, moisture, humidity	www.stevenswater.com
ECH2O soil moisture sensor	Soil Properties temperature, moisture, humidity	www.ictinternational.com.au
CM-100 weather sensor	Weather conditions like temperature, atmospheric pressure, wind speed, wind direction.	www.stevenswater.com

Met station one (MSO)	Weather conditions like temperature, atmospheric pressure, wind speed, wind direction.	www.stevenswater.com
SHT75	temperature, atmospheric pressure, wind speed	www.sensirion.com

Some recent works in the direction of PA are described as. Zhang et al., [6] monitors the physical strength of cotton plant with the help of WSNs. In this work, the leaf angle and chlorophyll concentration data are measured and transmitted to the system via USB. In other work, Bapat et al., [7] have applied WSNs for preventing farming field from intrusion attack. The nodes in the field are equipped with PIR sensor whenever an animal enters in the field, a buzzer would starts.Further, Keshtgari et al., [8] have developed a system which can be used to make global decisions regarding physical environment with the help of sensor nodes and base station communication. The proposed sensor network is based on IEEE 802.15.4 standard. The Real time data of climatologically and other environmental properties can also be sensed and modified using Zigbee wireless technology.Viani et al., [9] have designed a low cost wireless monitoring system for saving water in agriculture field and to increase the crop production according to weather condition. It is seen that Nagarajan et al.[] have developed an automation system based on sensor device which monitors the soil properties and starts automatic irrigation whenever it is required. It is noticed that ZigBee technology is used to transmit the data for users.

3. Proposed System

In this work, an automatic system based on sensor device is designed to examine the growth of the valerianajatamansi plant. The proposed system consists of hardware device i.e. Arduino Board, Temperature Sensor, Soil Moisture sensor, PIR sensor, Wi-Fi module, Water pump and Breadboard. The aforementioned devices are implanted with the help of programming and further used to monitor the growth of the plant.The various components of the proposed system are described as.

3.1. Arduino Board

Arduino Uno Board is a Single board microcontroller hardware device used for connecting multiple sensors. It helps for sending and receiving data from source to destination. Arduino is classified into two parts i.e. hardware and software [11]. The Hardware part of Arduino Board is composed of many components that can helpfor transmitting and receiving data. Fig. 3 shows the Arduino board and its components.

- USB socket (1): It is used for uploading program to the microcontroller and has a regulated power of 5V which helps to provide power to Arduino board.
- Reset Button (2): It is used to reset the currently uploaded command of Arduino.
- Microcontroller (3): Arduino consists of ATmep3Z8 microcontroller that can help for sending and receiving information and provides commands to the circuits connected to it.
- Voltage regulator (4): It helps in controlling the voltage supply in Arduino Board.
- Barrel jack 5): It helps to provide power to the board and regulates voltage of 9-10 volts
- Pins- Arduino board has 5V, 3.3V, GND, analog, digital pins.
- Power pins(6,7)- 5V and 3.3V pins regulate the voltage of 5 volts and 3.3 volts respectively in board also known as power pins.
- GND (8): GND refers to the ground which can be used to ground the design circuit.
- Analog pins (9): These pins are from A0-A5 helps in reading the analog data from the sensors.
- Digital pins (10): These pins are from 0 to 13 helps to provide digital information.

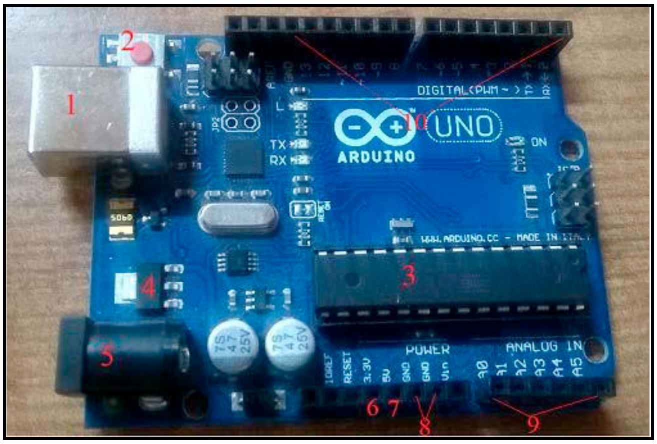

Fig. 3: Arduino UNO board

3.2. Temperature Sensor

Temperature plays vital role in cultivation of any crop, if the temperature is not suitable to the growing condition of the crop, than there is maximum chances of degradation of plant. Temperature sensor helps in measuring the temperature of the agricultural field. The variation in temperature of soil makes impact on the nutrient value of crop and growing condition of the crop. Therefore, for observation of real time soil temperature and understanding the changes in soil temperature, a temperature sensor can be used. In our setup, LM-35 sensor is used; it is low cost sensor device and potential to work in range of −55°C to 150°C. This sensor is used to measure the temperature of the soil. In Arduino board LM-35 is connected in any pin between A0-A5 because it provides analogoutput. As shown in Fig. 4, LM-35 has three pins in it VCC, Output, GND. VCC pin helps in supply of voltage, output pin helps in providing output voltage and GND pin used to ground the circuit.

3.3. Soil moisture sensor

Soil moisture sensors determine the water content in the soil and works on the principal of electrical conductivity. Soil moisture sensor works on the property of the resistance, If the resistance of the soil between two point decreases than there is increase of water content in the soil. Soil moisture sensor has two components one is probe and second is circuit. The probes are created using two metal rods and are separated using smaller foam block which keep two probes apart. The probes are inserted into the soil and the distance between two probes is same. The current is passed through with the help of resistance which is connected in series.

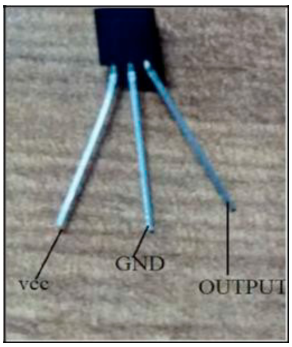

Fig.4: Temperature sensor LM-35

The circuit board of soil moisture sensor contains LM293 comparator, output LED, power LED, potentiometer, 4 pins. LM293 comparator consists of two independent voltage comparators that are developed to operate from single power supply over a huge range of voltages. The working temperature range of LM293 comparator lies between −25°C to 85°C. The pins in the circuit are VCC,GND,A_0,D_0. VCC pin helps in regulating the voltage into the circuit. GND is used to ground the circuit; A0 pin is used for analog data and D_0 pin is used for digital information. Fig. 5 shows Probes, circuit and Soil moisture sensor.

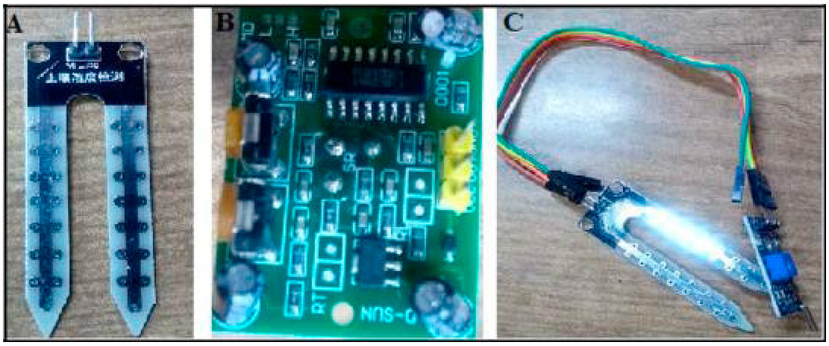

Fig. 5: (a) Probe (b) circuit (c) soil moisture sensor

3.4. PIR Sensor

Protecting farms from animals and unwanted material is also a big challenge for the farmers. With the help of PIR sensor also known as Passive infrared sensor farmers that can detect the presence of animals or humans in farming land. PIR sensor has three pins GND, VCC, D0. The working range of PIR sensor is up to 20 feet and work on power supply between 5v-12v. Fig. 6 shows PIR sensor and its circuit.

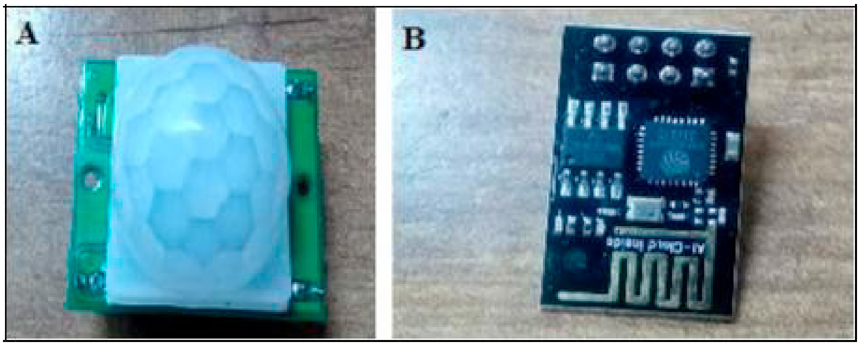

Fig. 6: (a) PIR Sensor (b) circuit of PIR Sensor

3.5. Breadboard

A breadboard is a collection of conductive metal clips used for temporary prototypes with sensors and test circuits design. Sensors can be interconnected by inserting their terminals into the holes and then establish connection with the help of wires. Breadboard consist of 5 rows and 64 columns every column is electrically connected from inside. In our setup with the help of breadboard, all sensors are integrated together with Arduino board.

3.6. Wi-Fi module

Wi-Fi module helps in transmitting data of arduino board to the system. In our system, ESP8266 Wi-Fi module has TCP/IP stack and microcontroller in it. It acts as a communication technology in our system and helps in setting up wireless link between nodes and farmer systems.

3.7. Water Pump

Water pump helps in irrigation and works on the voltage between 5v-12v. The water pump starts automatically; if soil moisture level is less than 15 and will stop when moisture level reaches upto 20.

4. Working Procedure of Proposed System

The working of proposed system includes a soil moisture sensor, an analog sensor, whose input is taken using A_0 pin of the Arduino UNO board. The soil moisture sensor (LM293)measures the moisture content of the soil on a scale of 0-100. Further, the temperature of soil is measured using temperature sensorLM-35. The irrigation pump is connected through temperature sensor LM-35. The PIR sensor is connected to Pin 3 of Arduino UNO. Each of these is powered using the 5V output of the Arduino and ground connected to the ground of Arduino. If the moisture content of the soil is below 15% the water pump automatically start irrigating and there is an increase in soil moisture readings till the moisture content reaches above 20%. Simultaneously, the PIR sensor is working to check if there is any intrusion in the field. The low state of PIR sensor indicates that there is no movement around it and the high state indicates movement. Now if the current reading of the PIR sensor is high and its previous state was low this indicates a new movement around the PIR sensor. The Arduino start noting the time in milliseconds. If the current reading of the PIR sensor is low and its previous state was high, indicates that the movement around the sensor has stopped. The difference in the time is calculated and converted to seconds from milliseconds. This is the duration for which the movement around the sensor existed. The Tx of the ESP8266 is connected to the Rx of Arduino board and Rx of ESP8266 is connected to the Tx of Arduino. The ESP8266 is powered using the 3.3v output of the Arduino. The CH_ PD pin is connected using to the 3.3V through a pull up resistor of 10K ohm. The data of the soil moisture content and the PIR sensor is send to a server by the help of ESP8266 this data can now be accessed by the user from anywhere. Table 3 shows the working procedure of our model in steps.

5. Results

This section describes the results of the proposed system. The working of the proposed system is tested for monitoring the growth of the valeriana jatamansi plant. The proposed device is tested on greenhouse constructed near to waknaghat, Solan, himachal Pradesh. Fig. 7 depicts the deploy sensor device in valeriana jatamansi plant.

Fig. 7: Sensor device deploy in plant

Table 3: Working steps of the proposed system

Working Procedure of the Proposed System	
Step 1	: Declare pir_pin, pump_pin, moisture sensor pin and initialize them to their respective pin numbers
Step 2	: Declare moisture level, pir_state, value
Step 3	: Set pir_pin to input and pump_pin to output in setup() function
Step 4	: Initiate the serial monitor using serial.begin(baud rate) in setup() function.
Step 5	: Declare loop() function and execute the complete working in it.
Step 6	: Note the reading of the moisture sensor using analog_read().
Step 7	: If moisture content of soil is below 15% start the pump using digital_write().
Step 8	: As soon as the moisture level is above 15% stop the pump.
Step 9	: Note the reading of the pir sensor using digital_read().
Step 10	: If value is high and previous state was low start the time for detection and turn state to high.
Step 11	: Convert the milliseconds to seconds and print the duration for which the movement was detected.
Step 12	: End

Table's 4-5demonstartes the real time data collected from the proposed system for monitoring the plant for three days. These tables contain the value of different parameters such as soil moisture and intrusion and irrigation.

Table 4 Data recorded by device on Day 1 and 2

DAY-1			DAY-2		
TIME	PARAMETERS	VALUE	TIME	PARAMETERS	VALUE
12:00	Moisture Content	60	12:00	Moisture Content	38
12:02	Motion Detected		12:02	Moisture Content	38
12:05	Motion Ended	161 sec	12:05	Moisture Content	38
13:00	Moisture Content	58	13:00	Motion Detected	
14:00	Moisture Content	57	14:00	Motion Ended	60 sec
15:00	Moisture Content	55	15:00	Moisture Content	35
16:00	Moisture Content	52	16:00	Moisture Content	32
17:00	Moisture Content	50	17:00	Moisture Content	30
17:26	Motion Detected		17:26	Motion Detected	
17:28	Motion Ended	110 sec	17:28	Motion Ended	120 sec

18:00	Moisture Content	48	18:00	Moisture Content	28

Table 5 Data recorded by device on Day 3

DAY-3		
TIME	PARAMETERS	VALUE
12:02	Moisture Content	20
12:05	Moisture Content	20
15:00	Moisture Content	15
16:00	Moisture Content	12
16:00	Water Pump	ON
16:02	Moisture Content	13
16:02	Water Pump	ON
16:06	Moisture Content	18
16:06	Water Pump	OFF

The soil moisture content value of Valeriana jatamansi plant is illustrated in Fig. 8.The X axis represents the water content and Y axis represents the time in seconds. The value of soil water content is 0 that reflects that soil condition of the plant is not good and it needs irrigation to further growth otherwise plant will die due to lack of water level. .

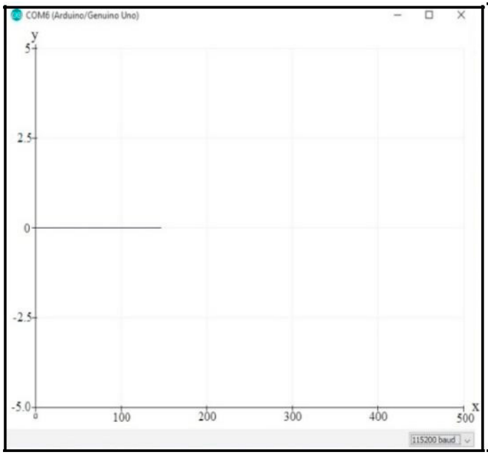

Fig. 8: Moisture level of plant is 0

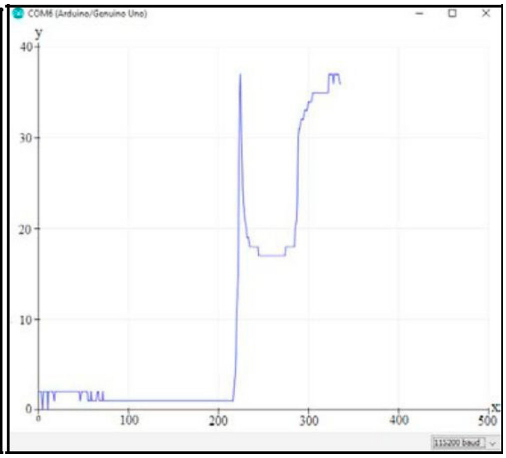

Fig. 9: Variation in moisture level of plant

Hence, the water pump connected to arduino uno board starts automatically when the soil moisture content is below 15 because if the soil water content value is below 15 than it effects on the growth of valeriana jatamansi plant. Fig. 9 demonstrates the variation in soil water content due to irrigation. After irrigation, the soil moisture level of plant is reached to 21 as shown in Fig. 10; water pump stop working and if again the soil moisture level goes below 15 water pump will start irrigating plant automatically.

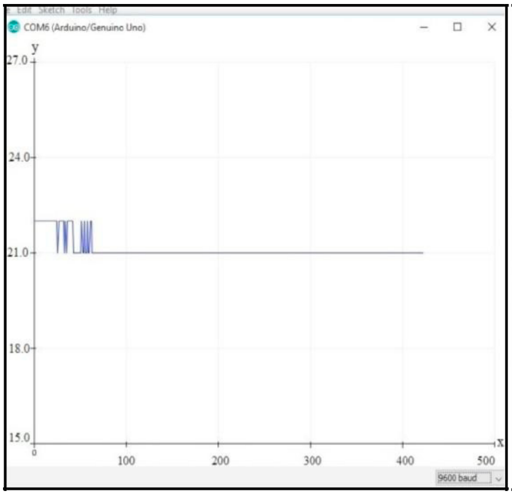

Fig. 10: Increase in moisture level of plant.

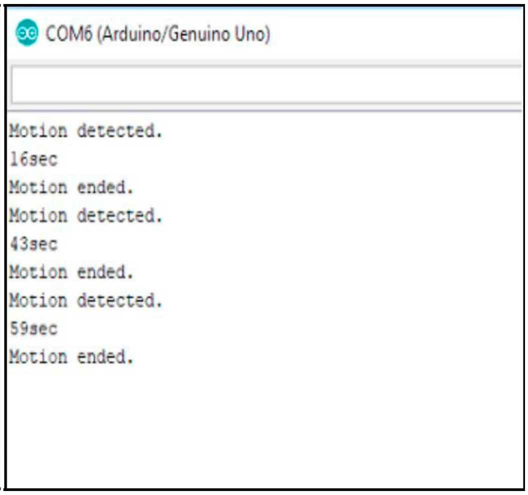

Fig. 11: Detection of motion

The PIR sensor is used to detect the presence of an intrusion like aunt, insects that affect the plant. The fig. 11illustrates the motion of intrusion in the plant is detected for 16 seconds; after that another motion of intrusion is detected for 43 seconds and last motion of intrusion is detected for 59 seconds. The whole result is transmitted to the user desktop with the help of Wi-Fi module and output is shown in serial plotter of Arduino IDE software.

6. Conclusion and Future work

In this work, real time simulation with the help of hardware devices like LM-35sensor, Arduino UNO board, ESP8266 module, Probes is done to measure the growth of valeriana jatamansi. The real time Information of regarding moisture content of soil , temperature and any intrusion occurrence in the valeriana jatamansi plant is detected through proposed system. The designed system helps in reducing the usage of water because it start irrigating plant only when there is decrease in soil moisture and if there is any occurrence of insect in surrounding area of plant so with the help of PIR sensor we can get to know about it. In future work we will increase the data transfer efficiency of our system by using better routing algorithm.

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