Next Generation Plant Automation Based on MATLAB, ARDUINO & XBEE Radio

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Abstract – This paper shows the implementation of a plant automation system using wireless sensing and controlling unit for both indoor and outdoor plants. This plant automation system is done by sensing physical quantities like temperature, humidity, light and soil moisture resistance from their respective sensors which is placed around the plant and these sensors output is processed by ARDUINO unit and ARDUINO unit will take suitable actions based on these sensor value whether to or not to start sprinkler and artificial light, for example if the soil moisture sensor value is less than the threshold value than the sprinkler will get started and it will remain active until soil sensor value will not became greater than threshold value, etc. Along with this above explained functionality ARDUINO unit also transmit and receive serial data from a MATLAB based GUI through a wireless network path which is established by placing two XBEE radio modules between ARDUINO unit and PC. This MATLAB base GUI shows the current value of temperature, humidity, light and soil moisture resistance values and the status of the sprinkler and artificial light.

Keywords - MATLAB, ARDUINO, XBEE RADIO MODULES, RTC, SOIL SENSOR, TEMPERATURE SENSOR, HUMIDITY SENSOR, LIGHT SENSOR, SPRINKLER, ARTIFICAL LIGHT.

I. INTRODUCTION

As we know that every human body is different from other human bodies and so as its essential requirements, similarly plants essential requirements like sunlight and water are differ from other plants for example, CACTUS plant needs less amount of water than a ROSE plant, similarly the plants which grows in the tropical regions need more warm surrounding than the plant grows in the polar region. Growing plants need sunlight, water, nutrients, proper temperature and air. If deprived of any of these it will not be able to sustain itself.

So therefore in this paper we proposed a automation scheme in which according to the plant's requirement we will provide water and light to the plant because if a plant gets water and light less than or more than its need than its growth will be affected. Therefore we designed a system which will provide right amount of water and light to the plant so its growth will not get affected by the over watering and lighting and along with this feature this system will work for both indoor and outdoor plants.

The ARDUINO unit takes the values from sensors (temperature sensor, humidity sensor, soil sensor and light sensor) and then compare these sensors values with the predefined threshold values of each sensors and if the sensor value is less than predefined threshold value than ARDUINO unit will take suitable action. The ARDUINO actions are as follows if the soil sensor value is less than the threshold value than the ARDUINO will switch ON the first relay circuitry with which the sprinkler motor is connected due to which the sprinkler start pouring water on the plant and this relay circuitry remains ON until the soil sensor's value gets below the threshold value.

Basically plants need 6-8 hours of sunlight daily, if the plant is placed outdoor than there is no need of a artificial sunlight because it will get the light directly from the sun, but if a plant is placed indoor than there is the requirement of an artificially light, so to sense the light availability the light sensor is used. Plants takes sunlight from 7 am to 3 pm normally. For timing reference we use RTC. If in between 7 am to 3 pm the light sensor sense the sunlight than ARDUINO will not turn ON the artificial light, but if light sensor does not sense the light than ARDUINO automatically switch ON the artificial light.

The indoor and outdoor temperature and humidity are changes differently. For example the intensity of the sun in the outdoor variate with temperature and humidity changes accordingly. Indoor exposure is less than the sun, and the air-conditioned environment, as compared to outdoor.

And we also made a GUI using MATLAB which will control and monitor the ARDUINO unit. The GUI shows the current values of all the sensors and the status of the controlling devices(sprinkler and artificial light) and along with this it will also have the AUTO and Manual mode to operate controlling device. If you set the ARDUINO in AUTO mode than it will takes values from the sensors and take suitable actions. But if you set the ARDUINO in Manual mode than ARDUINO discard the sensors values and forcefully ON and OFF the sprinkler and artificial light. The GUI and ARDUINO will be interfaced with each other with the help of wireless network made by XBEE radio module pair and this GUI can be access by both Mobile phone and PC. And for connecting PC or

Mobile and ARDUINO with XBEE radio modules the USART protocol is used. This automation system will help a plant in the better growth rate.

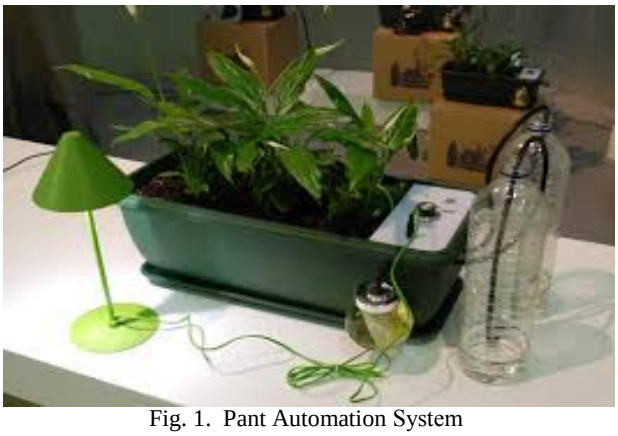

Fig. 1. Pant Automation System

II. SYSTEM MODEL

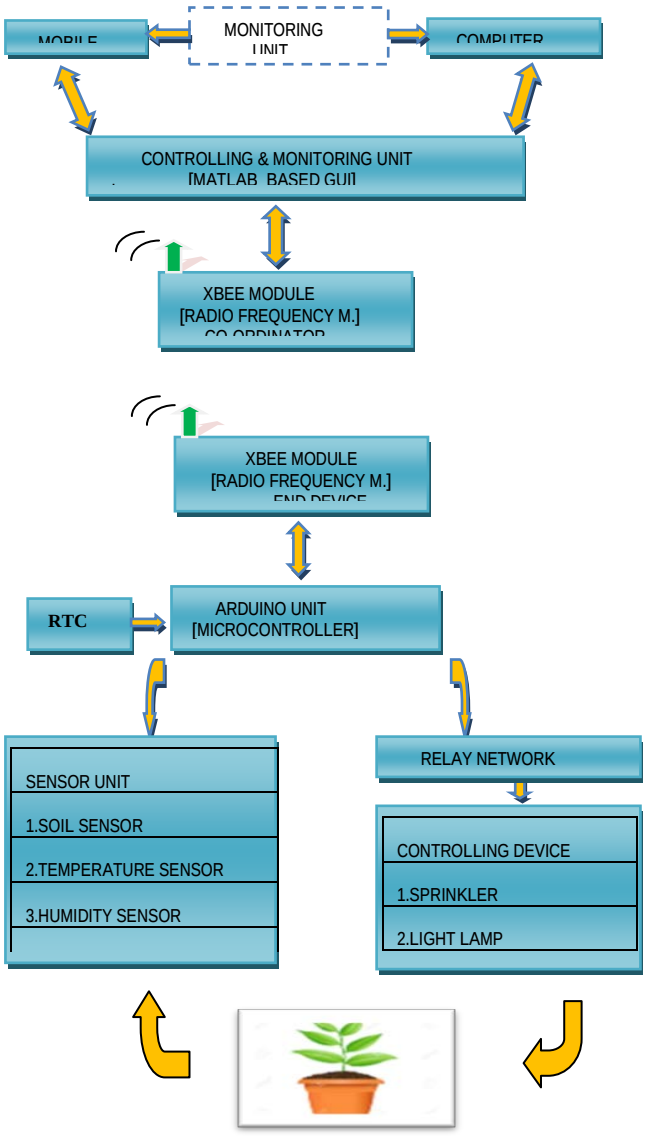

Fig. 2. Proposed Plant Environmental Monitoring System

III. PREVIOUS WORK

In previous work they uses a point to point network topology XBEE way, the use of multiple sensors captured signal, sensor measurements as temperature, humidity, PIR and volume etc. sensing signal value by ARDUINO platform capture and convert signals from the End Device XBEE passed to the coordinator node returns XBEE, coordinator connect to a computer using a USB or RS232 Wire transmission method to send data to the PC, using the program viewing data. Transmission process, retrieve data from the ARDUINO, the data sent to the End Device XBEE, by way of radio, transmitted coordinator XBEE, send over the data from the USB transmission to the PC, PC monitor interface for easy viewing. **Visual C #** is used to send control signals. Control Sent by Coordinator to End Device reads signals from the control pin ARDUINO control relay switch, in accordance with the needs of the environment to do the movements, when the value returns to below the threshold again send control signals, electrical switches off.

IV. PROPOSED METHODOLOGY

In our work we proposed a star network topology to interface XBEE radio modules. We use a CO-ORDINATOR XBEE which controls the other END device XBEEs. The CO-ORDINATOR XBEE is connected through a controlling unit it can be a PC or a LAPTOP. The communication channel used to connect XBEE and a PC or a LAPTOP is a USB cable. The XBEE radio module can send and receive the SERIAL data (UART-TTL) but we are using a USB cable to interface XBEE and a PC or a LAPTOP, so first of all we

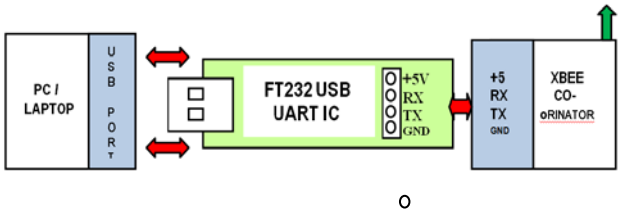

Fig. 3. XBEE and PC/LAPTOP interfacing at Controlling and monitoring Unit end

have to convert the SERIAL data into USB data format. Therefore we are using a FT232 USB UART IC which can convert the SERIAL data into USB data and vice-versa.

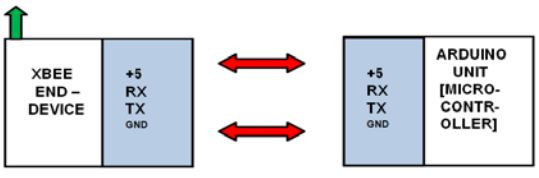

Fig. 4. XBEE and ARDUINO [MICROCONTROLLER UNIT] interfacing at ARDUINO UNIT end.

And in Fig.4 shows at ARDUINO unit XBEE END device is directly connected to RX and TX pins of ARDUINO because both work on UART TTL logic, so there is no need of data conversion.

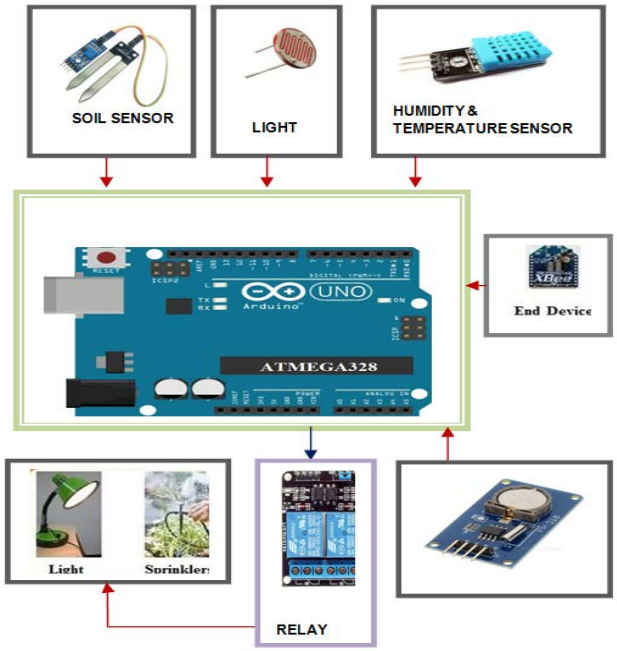

Fig. 5. ARDUINO UNIT with XBEE, SENSORS, RTC & RELAY

Fig.5 shows multi Sensors such as temperature, humidity, light & soil sensor, RTC and Relay network which control the sprinkler (water pump) and artificial light are connected with ARDUINO with wired network.

Fig. 6. GUI of NEW GENERATION PLANT AUTOMATION SYSTEM

ARDUINO takes data from multi sensors and convert the received sensors data into serial data (UART) and send the data to XBEE END device through RX-TX pins. The XBEE END device transmit this data to XBEE CO-ORDINATOR using RF FREQUENCY. ARDUINO receives serial data from XBEE END device which it received from XBEE COORINATOR.ARDUINO takes suitable action against this received data ON and OFF the sprinkler and artificial light.

We uses a GUI made by using MATLAB software to send and receive the serial data from XBEE COORDINATOR. This GUI is used to control the Sprinkler and Artificial light, and it also shows the current value of multi sensors such as soil sensor, light sensor, temperature sensor & humidity sensor.

V. SIMULATION/EXPERIMENTAL RESULTS

In this automation system there are two modes. One is Manual Mode and other one is Auto Mode. In Manual Mode you can forcefully ON and OFF the Sprinkler and Artificial light. In this Mode there are two Timers which shows from how long the particular device is On. You can also see the multi sensors values for reference. At a time only one Mode will be activated. Table .1 shows the operation of automation system in Manual Mode.

Table.1 MANUAL MODE OPERATION

Operation	Sprinkler	Soil sensor Current value	Light	Light sensor Current value
1.	OFF	>Threshold value	OFF	>Threshold value
2.	OFF	>Threshold value	ON	< Threshold value
3.	ON	<Threshold value	OFF	>Threshold value
4.	ON	<Threshold value	ON	<Threshold value

In Auto Mode you can set the threshold value of soil sensor and light sensor. If the current value of soil sensor and light sensor will become less than threshold value than automatically Sprinkler and Artificial light gets On and it will remain On until the current sensor value these sensors will become greater than threshold value. As we already discussed that plant need 6-7 hour light, so here we introduced a segment through which you can set the ON and OFF timing of Artificial light. In Auto Mode Sprinkler ON OFF totally depends on the soil sensor value but

Artificial light ON OFF depends on light sensor only in between the timing set by light ON and OFF timer, Otherwise it will not take light sensor value as reference and the Artificial light remain OFF. Table.2 shows the operation of automation system in Auto Mode.

Table.2 MANUAL MODE OPERATION

Operation	Sprinkler	Soil sensor Current value	Light	Light sensor Current value
1.	OFF	>Threshold value	OFF	>Threshold value
2.	OFF	>Threshold value	ON	< Threshold value
3.	ON	<Threshold value	OFF	>Threshold value
4.	ON	<Threshold value	ON	<Threshold value

VI. CONCLUSION

This study combines various sensors with ARDUINO and ARDUINO takes signals from XBEE passed to the monitor shows the current state of information and data, when the data than the set threshold will send control signals to the ARDUINO pin control relay so that the electrical opening action to improve the environment Back to the threshold Value will stop the action, the data to the monitoring terminal at the same time. You can set different threshold values of sensors for different plants based on their requirements. Observation on both indoor and outdoor plant to the automatic control monitoring, observation scores were significantly higher than the natural world to have grown rapidly growing plant, the study confirmed that this system worked for both indoor and outdoor plants. This automatic control system is effective because you do not need to have different automatic control system for indoor and outdoor plants. This automatic control system adjust itself according to its surrounding atmosphere whether it placed inside the house or outside of the house.

VII. FUTURE SCOPES

Well in future the controlling App (GUI) can be made by using LABVIEW instead of MATLAB. The biggest advantage of LabVIEW is fast and simple construction of the graphical user interface that facilitates the updating of parameters (no need to interfere with the code) and elegant presentation of the results. Creating a comparable user interface in MATLAB could be more painful and limited. Another advantage of LabVIEW is that most MATLAB functions are accessible from LabVIEW via the MathScript Node, which can actually pass data to m code, execute it and get results back. And in future we can also use a solar charger to charge the battery.

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