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# IoT Based Environment change Monitoring & Controlling in Greenhouse using WSN

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**Abstract**: As we know greenhouse parameters monitoring and controlling plays a very important role for quality production of crops. The purpose of this paper is to design a simple Raspberry Pi 3 based circuit to continuously watch & read the values of Soil moisture, Humidity, Temperature and light of the environment that are constantly changed and controlled in order to get maximum development of plant. In this paper we present a system to monitor soil quality with the help of wireless sensor nodes. The data is acquired from each sensor used in this system. In past Attention was needed for a farmer to protect his field from different disasters caused either by human or by nature. Efforts of human are not sufficient and also farmer has to pay for manpower. Here we are using few sensors to monitor the field are Temperature sensor, Humidity Sensor, Soil Moisture sensor to check whether the field is dry or wet and a LDR to verify the lighting at that place. This system maintains the soil quality which is required to grow the particular crop properly.

By using this system, the farmer can Predict & Analyze the greenhouse parameters. Tomatoes & Brinjals these two crops are selected for the prediction & Analysis. Two samples of crops are taken and the system had been verified for these crops in greenhouse environment. Finally, total power consumption and total expenditures consumed per year is estimated for controlling devices. Because of this the farmers will be able to predict the total amount for controlling action of crops for next year. By using this system, it is seen that with controlling action the product quality & quantity is increased than crops grows without controlling action.

**Keywords**: IoT, Controlling Devices, Wireless sensor network, Raspberry-Pi

## I. INTRODUCTION

Monitoring and controlling of greenhouse environment play an vital role in production of crops in greenhouse. To effectively control & monitor the greenhouse parameters it is essential to design a monitoring and controlling system. The main aim of this system is to design a simple Raspberry Pi 3 centered circuit to continuously watch & read the values of temperature, humidity, soil moisture and sunlight of the normal environment that are constantly changed and controlled in order to get maximum development of plant [4] . The Arduino Uno Nodes are also used which collects data from various places in green house & they communicates with the Raspberry-Pi node in real time in order to control the light, soil moisture, Humidity and Temperature efficiently inside a greenhouse by actuating a lights or slider, Water pump, Heater and Fan according to the essential condition of the crops. An LCD is also used for displaying the different values acquired from the various sensors and the status of the various devices. The components are easily available in market which reduces the manufacturing and maintenance costs. Also the software can be changed at any time. Because of this the proposed system will Cheap, Portable & Little maintenance solution for greenhouse uses, especially in rural areas and for small scale agriculturists. This system helpful for the farmers who are situated at remote areas from the field & this system will also use to analyse & predict the total expenses of controlling action for crops. [7]

## II. LITERATURE SURVEY

In 2017, Fang Chen, Linlin Qin, Xiaofeng Li, Gang Wu, Chun Shi [1] The wireless sensor network based on ZigBee is established successfully in this system we designed. Wireless sensor nodes can be easily arranged in different positions in the greenhouse, completing the data acquisition and storage which consist of the greenhouse air temperature, air humidity and soil temperature. And the automatic control of the greenhouse equipment is also realized.

In SEP 2016, Bulipe Srinivas Rao, Prof. Dr. K. Srinivasa Rao, Mr. N. Ome [2]. This is IoT based system used for monitoring of Noise & Air Pollution which is tested for monitoring two parameters. This system also sent the sensed parameters to the cloud. These values or data will be used for future analysis and easily shared by the other users.

In DEC 2015, Ojas Savale, Anup Managave,Deepika Ambekar,Sushmita Sathe[5].Because of IoT, WSN will interact with the real world. This system has the sensors which enable the connection of agricultural field to the IoT .Because of

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this system the quality of product will get improve. The connection sets up the links among agronomists, farms, and thus improves the production of agricultural products.

In 2015, Thu Ngo Quynh, Nien Le Manh, Khoi Nguyen Nguyen [6]. Greenhouse environment monitoring system of WSN based on ToT technologies. More concretely, we analyze different Greenhouse models in Hanoi and Dalat cities of Vietnam. We develop also extensive simulations of large size Greenhouse models using different routing solutions of ToT: single-path RPL and multipath RPL (ELB, FLR, ELB-FLR) protocols.

In JUN 2014, P. S. Asolkar & U.S.Bhadade [7] International Jrnl. of Computer Applications (00975 – 08887) VOL 95– No.15. In this system we analyze the prediction of Greenhouse Parameters required for different crops like Cucumber, Tomato, Brinjal, Papaya and Chilies. The main objective of this Project is to design a model which is able to monitor temp., humidity, soil moisture, light intensity of crops in greenhouse.

## III.PROPOSED SYSTEM

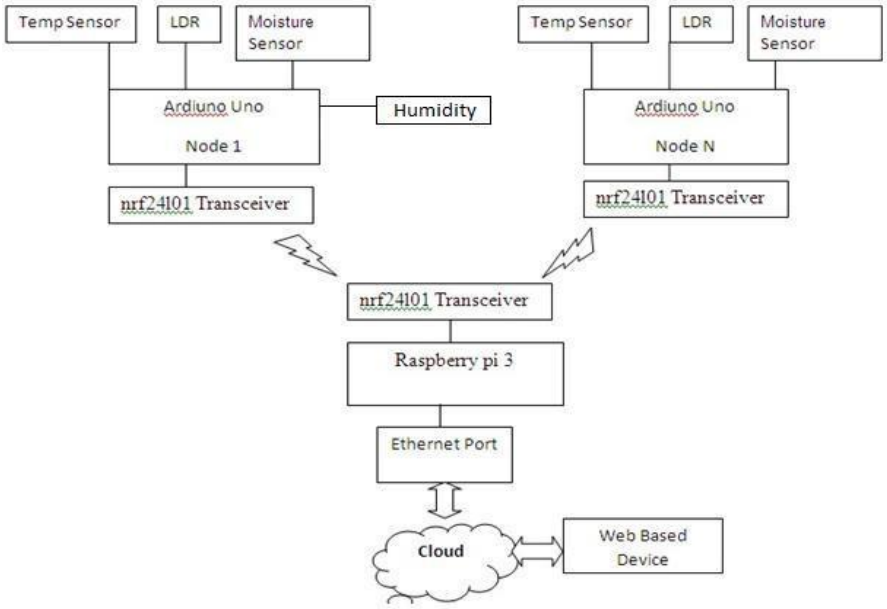


Fig. 1Greenhouse Monitoring & controlling system

*A. Temperature Sensor LM35*

LM35 is 3-terminal linear temp. Sensor from National semiconductors. This is Linear temperature sensor whose output voltage is varies linearly with change in temp. It can measure temperature from-55.0 °C to +150.0 °C. The voltage output of the LM35 increases 10.0mV per °C rise in temperature. LM35 can be operated from a 5Volt supply and the stand by current is less than 60µAmp**.** This temp. Sensor does not need maintains of an exactness of +/-0.39 degree Celsius at room temp. & +/-0.80 degree Celsius over a range of 0.0 degree Celsius to +100.0 degree Celsius. One more significant characteristic of this sensor is that it draws just 60µAmp from its supply and acquires a low self-heating capacity. This is available in different packages like T0-46 metal can & TO-92 plastic transistor-like package, SO-8 small outline package. FORMULA:

Temperature (°C) = (Vout/5) *100 (°C /V)


Fig. 2Pin Diagram of LM35 Temperature sensor

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TABLE I. TEMPERATURE SENSOR READINGS

| Temperature range (°C) | Temperature sensor O/P (Vout ) |
|---|---|
| 10 | 0.5V |
| 15 To 20 | 0.75-1.0V |
| 20 To 25 | 1.0-1.25V |
| 25 To 30 | 1.25-1.5V |
| 30 To 35 | 1.5-1.75V |
| 35 To 40 | 1.75-2.0V |
| 40 To 45 | 2.0-2.25V |
| 45 To 50 | 2.25-2.5V |
| 50 To 55 | 2.5-2.75V |
| 55 To 60 | 2.75-3.0V |
| 60 To 65 | 3.0-3.25V |
| 65 To 70 | 3.25-3.5V |
| 70 To 75 | 3.5-3.75V |
| 75 To 80 | 3.75-4.0V |
| 80 To 85 | 4.0-4.25V |

*B. Soil Moisture sensor*

Soil Moisture Sensor is a simple breakout for measuring the moisture in soil and similar materials. The Soil Moisture Sensor uses capacitance to measure the water content of soil (The Dielectric permittivity of the soil is a function of the water content is measured). Simply insert this sensor into the soil which is to be tested, and the volumetric water content of the soil is recorded in percent.

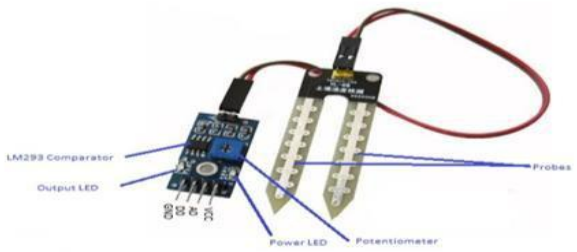


Fig. 3Pin Diagram of Soil Moisture sensor

TABLE II. SOIL MOISTURE SENSOR READINGS

| Soil Condition | Transducer Optimum Range |
|---|---|
| Soil is dry | 0v |
| Optimum level of soil Moisture | 1.8-3.6 V |
| Slurry Soil | >3.6V |

*C. Humidity sensor*

Humidity is the presence of water vapors in air. In Agriculture field, measurement of Humidity is important for Plantation Protection (Dew Prevention).

FORMULA: Tolerance= ±0.1Volt

RH = ((VOUT / VCC) – 0.16)/0.0062, Typical at 25 degree Celsius,
Where, Supply Voltage = 4.98 Volt

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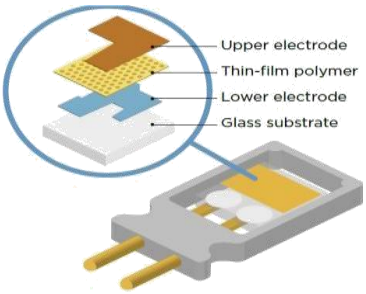


Fig. 4 Humidity sensor

TABLE III. HUMIDITY SENSOR READINGS

| Percentage RH (Humid.) | Transducer optimal range |
|---|---|
| 0.0% | 0 - 0.75V |
| 0.0% to 9.82% | 0.7-1.1V |
| 12.8% to 20.2% | 1.3-1.5V |
| 22.6% to 30.07% | 1.4-1.73V |
| 30.7% to 40.4% | 1.74-2.10V |
| 41.2%to50.3% | 2.075-2.33V |
| 51% to 60.02% | 2.374-2.63V |
| 61.6% to70.5% | 2.7-2.974V |
| 71.0% to80.1% | 3-3.272V |
| 81.1% to 90.0% | 3.2-3.5V |
| 91.0% to 100% | 3.6-3.8V |

*D. Light Dependent sensor*

LDR is a Low cost & simple device used to sense the presence and absence of light is necessary i.e. LDR are used as light sensors and the applications of LDR mainly include street light, alarm clock, light intensity meters, burglar alarm circuits.

Fig. 5.Light Dependent resistor

TABLE IV. LIGHT SENSOR READINGS

| ILLUMINATION STATUS | Transducer optimum range |
|---|---|
| Optimum Illumination | 0.0V-0.68V |
| Dim Light | 0.7V-2.4V |
| Dark | 2.5V- 3.1V |
| Night | 3V-3.44V |

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## IV.EXPERIMENTAL RESULT

The different readings of the sensors were recorded at green house during NOV 2015 to MAY 2016 in Nasik District, INDIA.Tomato & Brinjal these two crops are taken for Observations. For each crops the required optimum range of greenhouse Parameters is also considered.During observation it is seen that the two Environment factors are majorly responsible for better Growth of Crops i.e.Temp. & Humid. Thus there values are set separately for each Crop. Also the another two Parameters values set at 80 Percent for these two Crops i.e. Light Intensity & Soil Moist.

### *A. Humidity in Green House*

Humidity is the quantity of water vapor present in the air. In the greenhouse it is required to maintain the optimum value of Humidity for quality production of Crop. The Plant Transpiration is affected only because of Humidity. Thus Humidity is important Parameter. During summer, Humidity is low because of dryness in air. Thus very speedily the Plants will transpire. Thus By considering this there are two important parameters i.e. temp. & Humidity is taken for measurements the field measurements in greenhouse which is given below. The table below shows the optimum range of Temperature & Humidity for Tomato & Brinjal.

TABLE V.OPTIMUM RANGE OF TEMP & HUMIDITY FOR GREENHOUSE

| Crops | OPTIMUM TEMP (degree Celsius) | Humidity (Percentage) |
|---|---|---|
| Tomatoes | 22-27 | 49-60 |
| Brinjal | 24-28 | 65-75 |

### *B. Analysis for tomato Crop*

The Production of tomatoes is majorly depends upon temperature. The Tomatoes production is increased in the warm temperature with more light. Low light (15 Percent of Summer Light) will greatly affect the tomatoes production. Greenhouse tomatoes require ideal temp.22 to 27 degree Celsius and very high humidity about 49 to 60 Percent to grow successfully. The temperature is fixed to be 27 degree Celsius and Humidity 60 Percent to Tomato and detect next readings. When the temp. & humidity is above the set value, and then Arduino Uno node will send the signal to the controlling device to perform controlling action. Therefore when temp. is above 27 degree Celsius then the Fan will on as shown in fig.6. Similarly, when humidity is above 60 Percent, then heater is on. Soil moisture is fixed at 80 Percent. Thus when moisture is above 80 Percent, water pump will off. Light intensity is also fixed at 80 Percent. When light intensity is above 80 Percent, slider is open & closed depending upon the light intensity i.e. slider maintains enough light in greenhouse and protect his field from extra light.

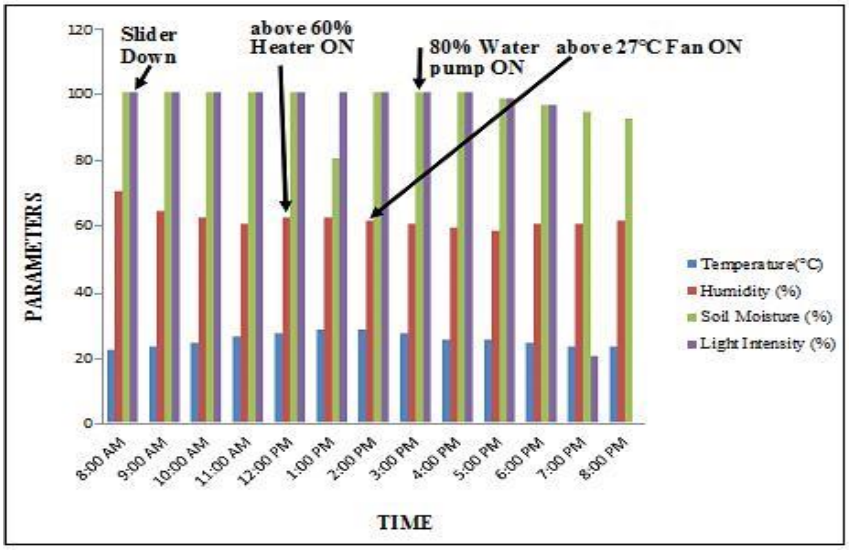


Fig. 6. Time vs. Parameters Controlling Action for Tomato crop

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TABLE VI. TIME DURATION FOR CONTROLLING DEVICE OF TOMATO CROP

| Greenhouse parameter | Device to control the greenhouse parameters | Time duration |
|---|---|---|
| Temp. | Fan | 1 hours 37 minutes |
| humidity | Heater | 2.55 hours |
| Soil Moisture | Water Motor | 60 Minutes |
| Light Intensity | Slider on greenhouse | In day time slider is down & at night no Operation. |

*C. Analysis for Brinjal Crop*

The optimum temperature for brinjal is set to 28 degree Celsius & Humidity is 65 Percent. It is observed that when the temp. & humidity is above the set value, and then Arduino Uno node will send the signal to the controlling device to perform controlling action. Therefore when the temp. is above 28 degree Celsius then the Fan will on. Similarly, when humidity is going above 65 Percent, then heater is on. Soil moisture is fixed at 80 Percent. Therefore when moisture will go above 80 Percent, water pump will off. Light intensity is also fixed at 80 Percent. Light intensity is also fixed at 80 Percent. When light intensity is above 80 Percent, slider is open & closed depending upon the light intensity i.e. slider maintains enough light in greenhouse and protect his field from extra light.

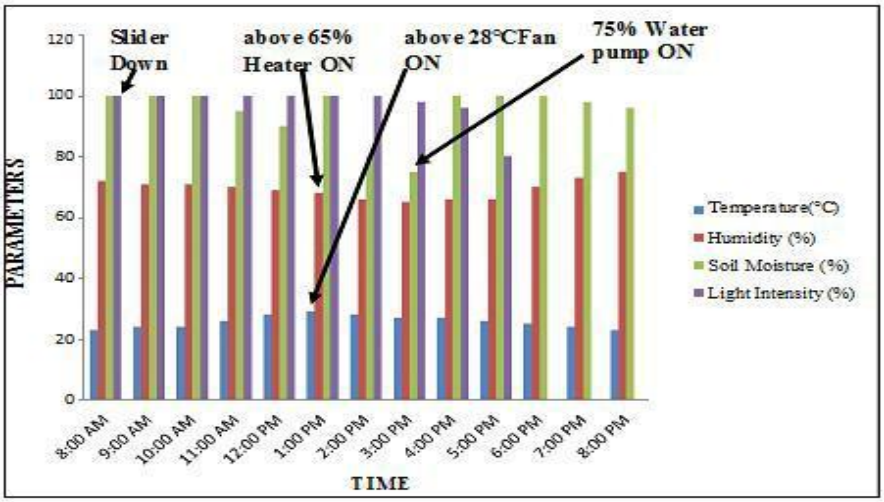


Fig. 7.Time vs. Parameters Controlling Action for Brinjal crop

TABLE VII.TIME DURATION FOR CONTROLLING DEVICE OF BRINJAL CROP

| Greenhouse parameter | Device to control the greenhouse parameters | Time duration |
|---|---|---|
| Temp. | Fan | 1.55 hours |
| Humidity | Heater | 1.57 hours |
| Soil Moisture | Water Motor | 0.52 hours |
| Light Intensity | Slider on greenhouse | In day time slider is down & at night no Operation. |

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*D. Prediction of Power Consumption & Annual Cost*

a) Power Consumption-

(Wattage × hrs. used/Day × Number of days/year) ÷ 1000 = Kilo-Watt Hour per Year

b) Annual Cost-

Annual Power Consumption (Kwh/Year) × Local Utility Rate/Kwh = Annual Cost Consume

1. LUR: 7 units
2. Wattage used by fan: 50 watt
3. Wattage used by heater: 1500 watt
4 .Water Motor: 0.5 horse power (375 watt)

TABLE VIII.TOTAL ANNUAL POWER CONSUMPTION & COST

| Name Of Crops | Growth Period (Days) | Total consumed Kwh/Year | | | Total Annual Cost in Rupees/Year | | | Total Power Consumption | Total Annual Cost (Rs) |
|---|---|---|---|---|---|---|---|---|---|
| | | Fan | Heater | pump | Fan | Heater | Pump | | |
| Tomato | 80 | 6 | 360 | 15 | 42 | 2520 | 105 | 381 | 2667 |
| Brinjal | 80 | 8 | 240 | 30 | 56 | 1680 | 210 | 278 | 1946 |

## V.CONCLUSION

This control system built on the IoT technology & Raspberry Pi node will help the farmer to control his field from remote location. This system is tested in various greenhouse environments & satisfactory observations were found. The controlling device action is also noted and mostly it is seen that quality and productivity of crops is much better than that of crops growing without controlling actions. The time taken by each controlling device is noted which is beneficial for farmers for estimation of total power consumption & total expenditure per year for specific crop.

## ACKNOWLEDGMENT

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