International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume: 3 | Issue: 4 | May-Jun 2019 Available Online: www.ijtsrd.com e-ISSN: 2456 - 6470

Monitoring and Controlling Device for Smart Greenhouse by using Thinger.io IoT Server

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How to cite this paper: Win Sandar Aung | Saw Aung Nyein Oo "Monitoring and Controlling Device for Smart Greenhouse by using Thinger.io IoT Server" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-4, June 2019, pp.1651-1656, URL: https://www.ijtsrd.com/papers/ijtsrd25212.pdf

IJTSRD25212

ABSTRACT

Smart greenhouse system will be convenient way to get the data from greenhouse. IoT will provide all work done and information update and current status of the greenhouse to the person from anywhere and at anytime. Greenhouse production mainly human force and production capacity is low. The greenhouse information which the owner gets is limited and the process is time consuming but real time. Using Iot based on smart greenhouse can quickly obtain to monitor greenhouse environment data such as humidity, temperature and light intensity, real time and accurate. Various sensors sense and collect information to transmit the background processing centre, after analysis can be precise, can be used both manual and automated control system. The results of the system are simulated with the help of Proteus simulation software. And the experimental result evaluation of the implemented control system for greenhouse is based on the environmental factors of orchids, the propose plant grown in smart greenhouse. Orchids are expensive products in plant market. So orchids are chosen to grow in the smart greenhouse.

Keywords: *Arduino, nodeMCU, proteus software ,thinger.io cloud server*

I. INTRODUCTION

With the rapid development of electronic and agricultural technology research and their applications have been paid more and more attention, especially the greenhouse has become an important role. Greenhouse is a said to be a place that creates the best conditions for plant growth, can change plant growth and avoid influence on plant growth due to outside changing seasons and severe weather [1].

The optimum condition of plant growth is obtained on the basis of taking full use of natural resources by changing greenhouse environment factors such as temperature, humidity, light, and water concentration.

Several authors have proposed using IOT concept in agriculture [2] and greenhouse [3]. Some researchers [4] have described an embedded system approach for monitoring greenhouse based on sensing data such as humidity, pH of water, wetness of soil, temperature and light intensity. Some other researchers [5] have developed a greenhouse monitoring system using GSM. Their proposed system uses sensors and SMS technology.

However, most systems lack a real-time representation of the measured data and the feature of controlling the actuators of greenhouse system remotely. This paper mainly aims to design the greenhouse monitoring and control system which will display the sensed data on a webpage and will also provide the facility of controlling and monitoring the system remotely. Especially auto mode and manual mode are intended to be selected via Internet access.

II. Smart greenhouse Control System

Fig. 1 shows the general block diagram of the whole system. As the input of the system, smart phone or PC is used for defining auto or manual modes length. For manual mode, light intensity, water pumping and fans will be controlled without depending light intensity, temperature and humidity. For auto mode, all sensing data will be applied for activating light bulb, pump motor, exhaust fan and intake fan.

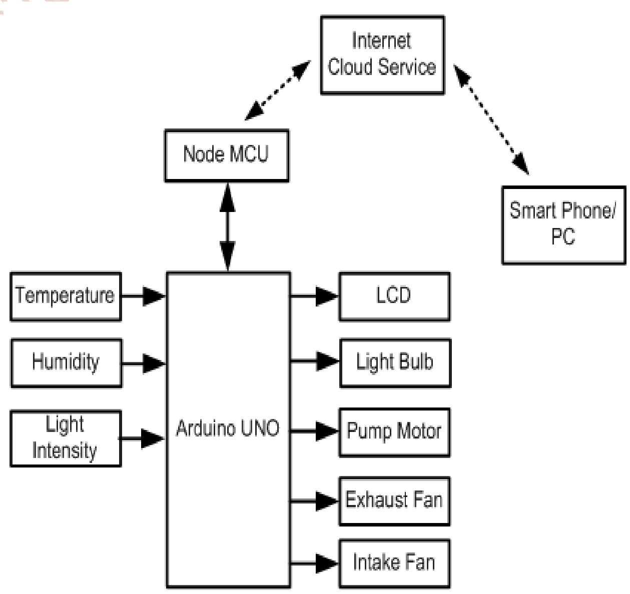

Figure1. General Block Diagram of the Green House System

III. Overall Circuit Design

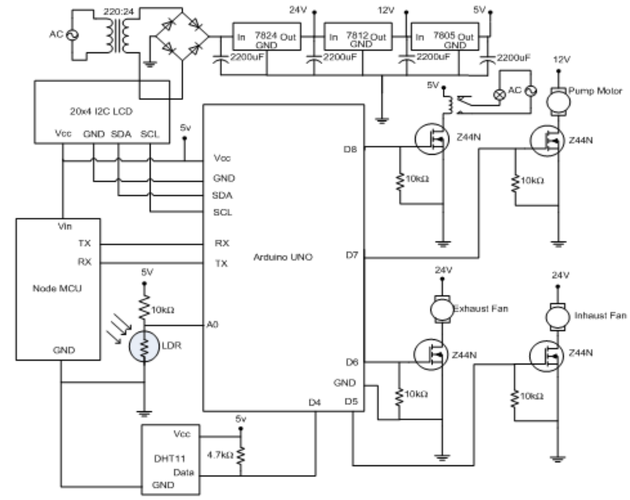

Figure2. Overall Circuit Diagram

Figure3. 24V 0.19A 2200 Rpm Fan 24V low power fans are used for exhaust and intake fans as shown in fig 3.

Figure4. 12V DC Pump Motor 350ma

For pumping system 12V DC pump motor (in fig 4) is applied and it can only draw 350mA current maximum. IRFZ44N N-channel MOSFET has 55V V_{DSS} and 49A I_D maximum rating. It can drive fans and pump motor easily. For light bulb, ac supply and relay drive is applied. Necessary DC voltage levels are regulated from 220:24V step down transformer.

IV. Functional Description

A. Light Intensity Sensing

The resistance of the Light Dependence Resistor (LDR) varies according to the amount of light that falls on it. The relationship between the resistance R and light intensity for a typical LDR is

$$R = \frac{500}{Lux} \qquad (1)$$

If the LDR connected to 5V through a 10 kΩ resistor as shown in fig 6, using voltage divider rule, the output voltage of LDR is

$$Vo = \frac{5R}{R+10} \qquad (2)$$

Substituting R from equation 1 into equation 2, the light intensity can be calculated using the following formula.

$$Lux = \frac{2500/Vo - 500}{10} \qquad (3)$$

Figure5. Light Dependence Resistor

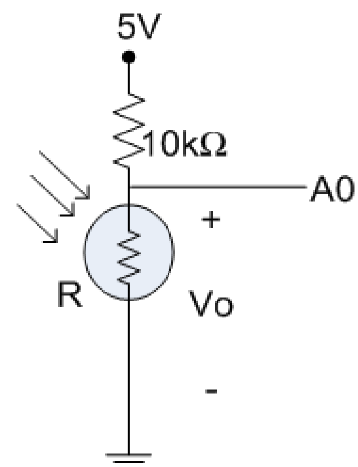

Figure6. Voltage Divider Circuit for Measuring Light Intensity

Moreover, Arduino UNO gives 10 bit resolution or 1024 ADC values for 5V range. The following equation can be applied for ADC to Vo conversion.

$$Vo = ADC * \frac{5}{1024} \qquad (4)$$

B. Temperature and Humidity Sensing

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature and humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

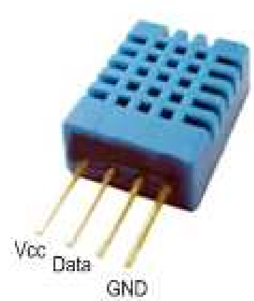

Figure7. DHT11 Sensor

The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20 meter signal transmission making it the best choice for Arduino UNO. Moreover measurable range goes for 20-90% humidity and 0-50 Celsius which is enough for green house application.

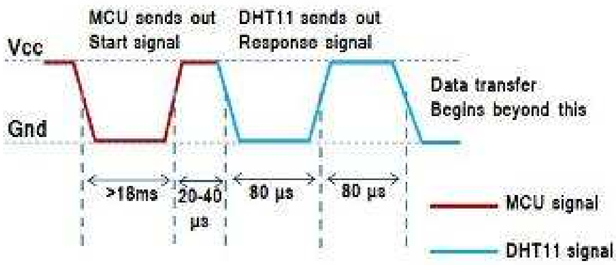

Figure8. Timing Diagram of DHT11 Data Transfer

Single-bus data format is used for communication and synchronization between Arduino and DHT11 sensor. One communication process is about 4ms. Data consists of decimal and integral parts. A complete data transmission is 40bit, and the sensor sends higher data bit first.

Data format: 8bit integral RH data + 8bit decimal RH data + 8bit integral T data + 8bit decimal T data + 8bit check sum. If the data transmission is right, the check-sum should be the last 8bit of "8bit integral RH data + 8bit decimal RH data + 8bit integral T data + 8bit decimal T data". Fig 8 represents the timing diagram for requestion from Arduino and signal feedback from sensor with 80 µs long bit size.

C. NodeMCU

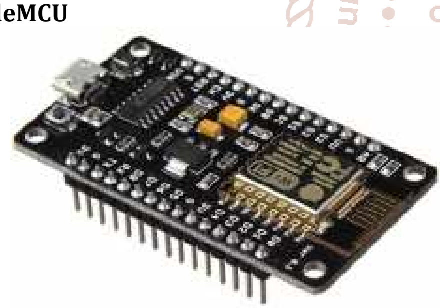

Figure9. NODEMCU using ESP8266

For Internet access, NodeMCU shown in fig 9 is applied to connect existing WiFi. It is an open source Lua based firmware for the ESP8266 WiFi SOC from Espressif and uses an on-module flash-based SPIFFS file system. NodeMCU is implemented in C and is layered on the Espressif NON-OS SDK [6]. The firmware was initially developed as is a companion project to the popular ESP8266-based NodeMCU development modules, but the project is now community-supported, and the firmware can now be run on any ESP module. ESP8266 is integrated with a 32-bit Tensilica processor, standard digital peripheral interfaces, antenna switches, RF balun, power amplifier, low noise receive amplifier, filters and power management modules.

D. Control Program Development

Using Arduino IDE and NodeMCU plugin, two programs was developed. The first one is embedded in NodeMCU for data transfer between Internet and Arduino. The second one stands for sensor reading, load controlling and connecting with Node MCU. These two program can be expressed the following flowchart shown in fig 10.

At the beginning of the system, Serial communication with 9600 bit per second transfer rate is applied between NodeMCU and Arduino. Reading Serial command, the system will distinct "auto mode" or "manual mode". For auto mode, all sensing data will be applied for activating loads. When humidity goes less than 50%, pump motor will be driven, and the system allows intake fan ON for blowing out inside wet air when humidity reaches over 80%. When inside temperature exceeds 40 degree Celsius, exhaust fan will be activated for cooling. Light intensity level of 10763 Lux is defined as minimum and whenever it goes low, the light bulb will be activated too.

For manual mode, direct command from Internet access is applied. And mode selecting will be done using Internet access too.

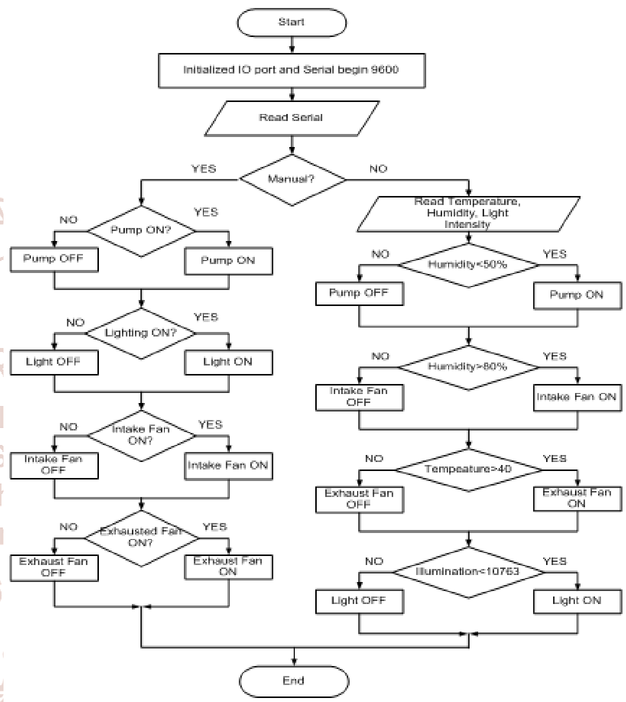

Figure10. Program Flowchart of Nodemcu and Arduino Uno

V. UPLOADING AND RETRIEVING SENSING DATA

For using IoT service, thinger.io cloud is used. Firstly, thinger.io account is created and logged in this account. Statistics section can be accessed as the default which can be seen some basic information about this account , like devices, endpoint, data buckets, dashboard and so on and shown in fig 11.

Figure11. Console Dashboard

Fig 12 is how the Smart Greenhouse connects with the thinger.io cloud server.

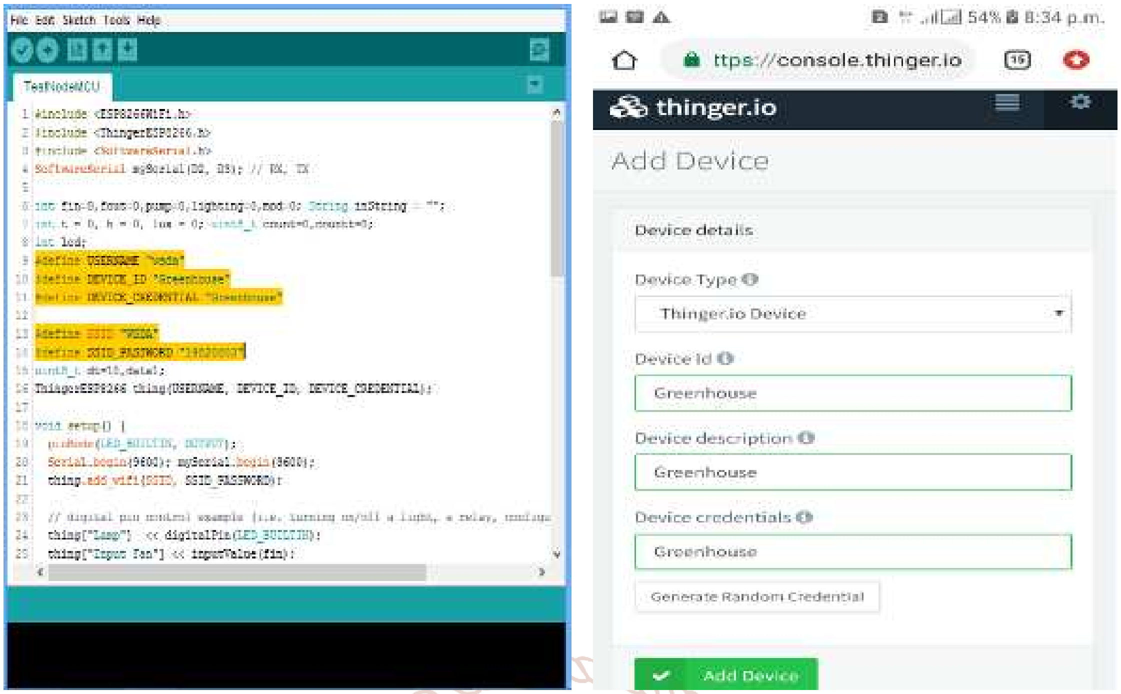

Figure12. Connecting the Device and Cloud

VI. EXPERIMENTAL TEST AND RESULT

The program is written using Arduino IDE and thinger.io and the I2C LCD is applied for debugging in Proteus Simulation. By testing with simulation, control sequence, sensing data and actuator driver can be tested. Auto and manual control mode can be chosen from the PC or mobile phone. For choosing auto mode, the simulation result is shown the following Figures. Fig 13 shows that pump is ON when the humidity level is less than the threshold value.

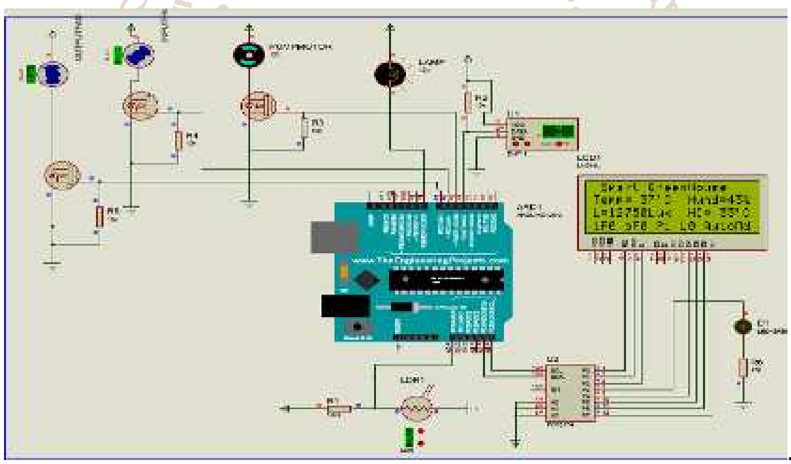

Figure13. Simulation result for pump is ON

Fig 14 shows that input fan is On when humidity level is more than the threshold value. When the temperature and illumination level are less than the threshold value, output fan and lighting system are ON.

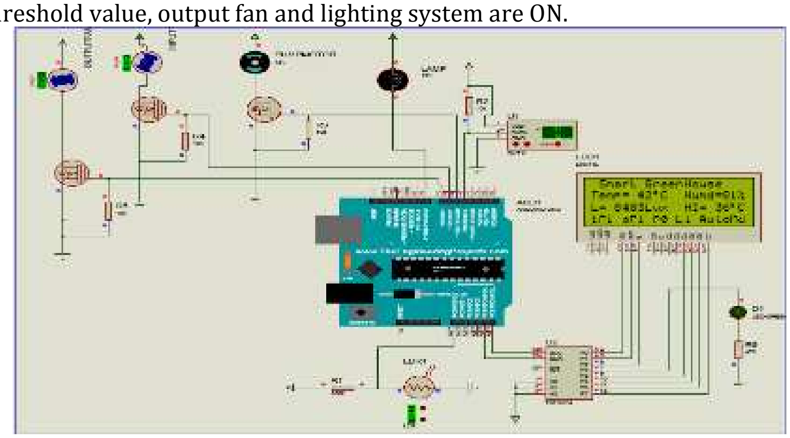

Figure14. Simulation Result for Lighting, Input and Output Fan are ON

Humidity level, temperature level and light intensity can be monitored in thinger.io cloud from anywhere and at anytime as shown in following fig 15, 16, 17.

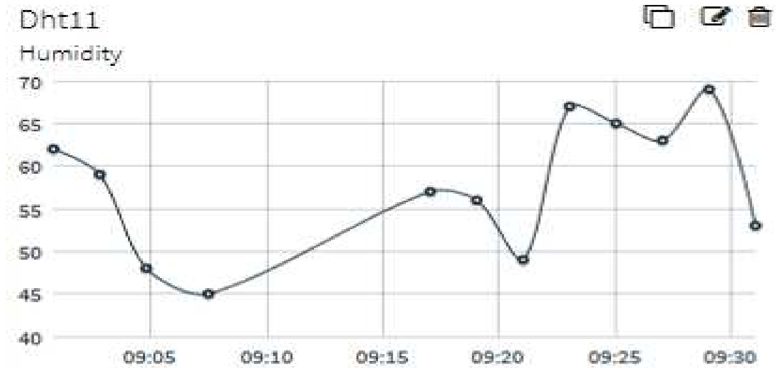

Figure15. Monitoring the Humidity Level

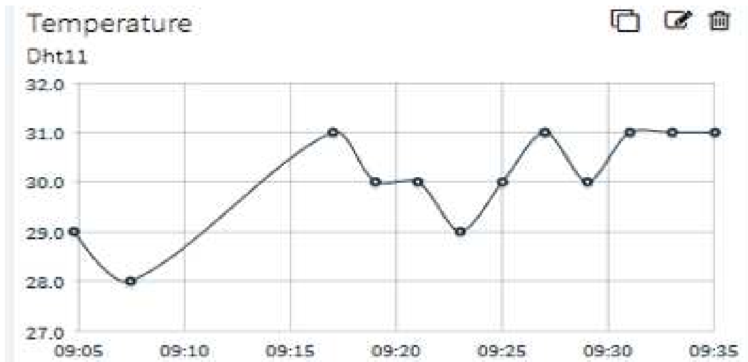

Figure16. Monitoring the Temperature Level

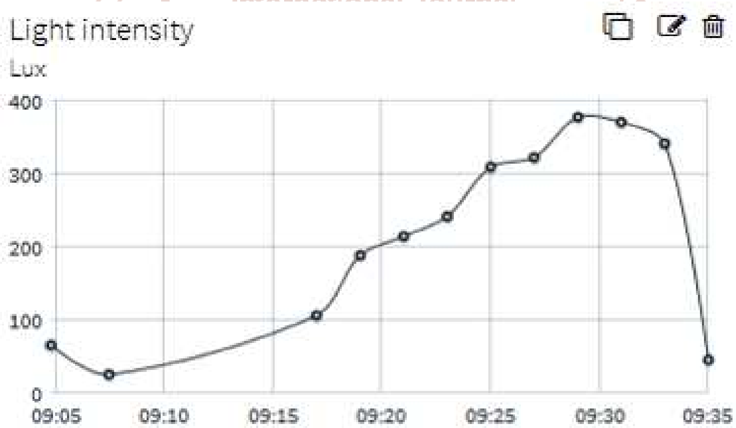

Figure17. Monitoring the light intensity level

And if manual mode is also chosen, the actuators are controlled from the PC or mobile phone as shown in fig 18.

Figure18. Controlling the actuators from mobile phone

VII. Conclusion

The proposed IoT based greenhouse monitoring system is a complete system designed to monitor and control the environmental parameters inside a greenhouse for small plants or flowers like orchid. The traditional system for greenhouse monitoring is labor intensive and time consuming. The proposed system saves time, money and human effort. According to Internet access, it can be controlled and monitored from anywhere in the world. It provides a controlled environment for the plants to prevent them from damage and thus increasing the analytical study about plants and flower in the field of biotechnology. The smart greenhouse automatically or manually controls the various parameters needed for the plants and sends the sensory data to a customized webpage for continuous and effective monitoring.

Acknowledgment

The author would like to thank Dr. Tin Tin Hla, Head of the Department of Electronics Engineering, Mandalay Technological University, for her kind advice and encouragement. Special thanks are due to her supervisor: Dr. Saw Aung Nyein Oo, Associate Professor, Department of Electronics Engineering and also thank all the teachers from the Department of Electronics Engineering, Mandalay Technological University. Finally, the author deeply grateful express to her parents and family members for their support and encouragement her during this research.

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