International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 11
July2016

IOT based Greenhouse Automation using ESP Wi-Fi module, Raspberry pi and AWS

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Abstract-**The goal of IOT based greenhouse automation is to provide suitable environment so they grow up properly, this involves controlling environmental like temperature, soil moisture , humidity , sun light and CO2 etc. controlling manually this physical parameters is very difficult task, thus by automation greenhouse can be maintained properly, in this way IOT based technology added advantage in connecting greenhouse things to internet, ESP8266 Wi-Fi module is used for reading sensor values inside the greenhouse, this received values are then sent to controlling and actuation system for this Raspberry pi is used, Amazon web services(AWS) is adopted for cloud storage, data analytics and visualization.**

Index Terms—**Greenhouse,** IOT, ESP8266, AWS, Raspberry pi, cloud storage, visualization, automation.

I. INTRODUCTION

Greenhouse farming is to provoidthe suitable environment inside the greenhouse, this allows us to grow many varieties of crops without worry about any external weather condition. It's also been helpful in growing almost any vegetables or fruits at their local grocers, regardless of whether the food is out of season. Another big advantage of greenhouse farming is it allows the farmers to take advantage of vertical farming. In normal farming the environment, the growing area is normally flat expanse, but this can be overcome in greenhouse farming by utilizing the vertical space.

Greenhouse consist of many physical parameters, handling of this parameters manually is very difficult task, thus effective automation of greenhouse is needed[1][3]][5][2][8][6][7], many of them proposed wired and wireless means of controlling greenhouse, in this approach we used very low cost wireless method, thus from any small to large scale farmers can adopt this method into their greenhouse, ESP8266 Wi-Fi module is tiny robust IOT based board, which has got all capability to read sensor values and sent over to host.

II. IMPLEMENTATION

Project is implementation is divided into under sections.
1. Sensornode section
2. Controlling and actuation section.
3. AWS (Amazon web service section).

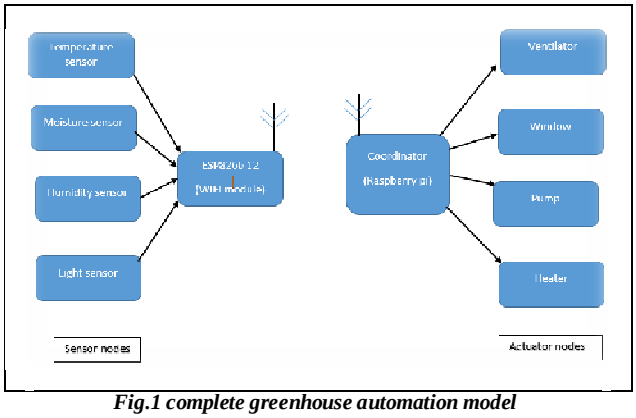

Fig.1 complete greenhouse automation model

1. Sensor Node Section

Sensor node section is deals with reading sensor values, processing it and sending to the controlling section, it mainly consist of following hardware and software things.

Hardware components
- ESP8266 -12 Wi-Fi module.
- DHT11 temperature and humidity sensor.
- Moisture sensor.
- Light sensor.

ESP module is small tiny board, which has got its own programmable memory and TCP/IP stack on it, so that it can host application on it.

Initially ESP module is updated with new binary firmware using NodeMCU flasher, now module is ready to program in Lua code, this can be done using

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ESPlorar IDE, which allows us to program module, check for its correctness and upload the lua code into ESP module. Later it is interfaced with soil moisture, DHT11 sensor and light sensor.

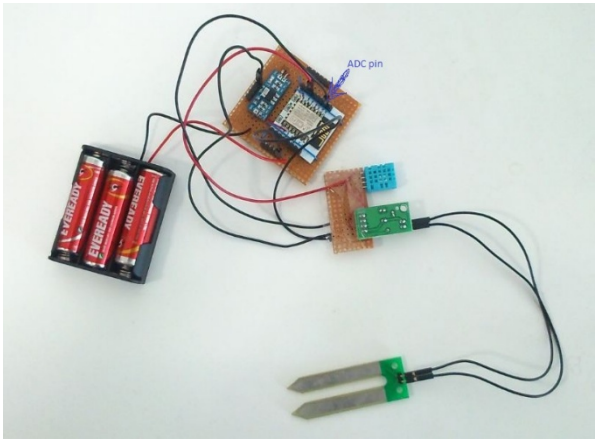

Fig 2. Sensor section

2.controlling and Actuation section

Controlling section deals with receiving sensor data from ESP module, storing it into local MySQL data base and copy of data also sent to the AWS cloud for data analytics and visualization.

Actuation part deals with checking threshold parameters with greenhouse physical parameters, if the values are not in permissible range the system will take appropriate corrective measures by controlling actuators.

Following are the hardware and software requirements used for controlling section.

Hardware requirements:

- Raspberry pi model B+
- USB Wi-Fi module
- Water pump
- ventilator

Software Requirements:

- MySQL database
- MQTT protocol
- Python programming

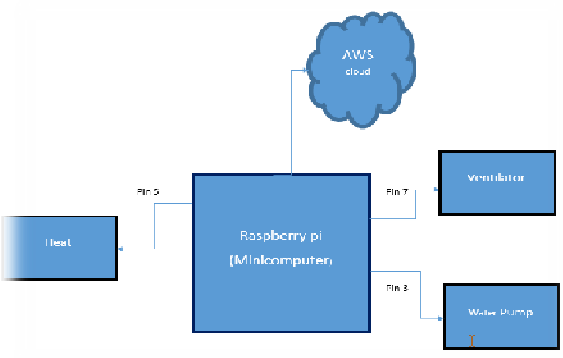

Fig. 3. Controlling and actuation section

3. AWS (amazon web services) integration

Amazon web services is providing separate cloud storage IOT applications for remote computing etc. for our application we used Dynamo DB for data storage, SNS for short service notifications like Email, SMS etc. and S3 for data visualization. As shown in Fig.4.

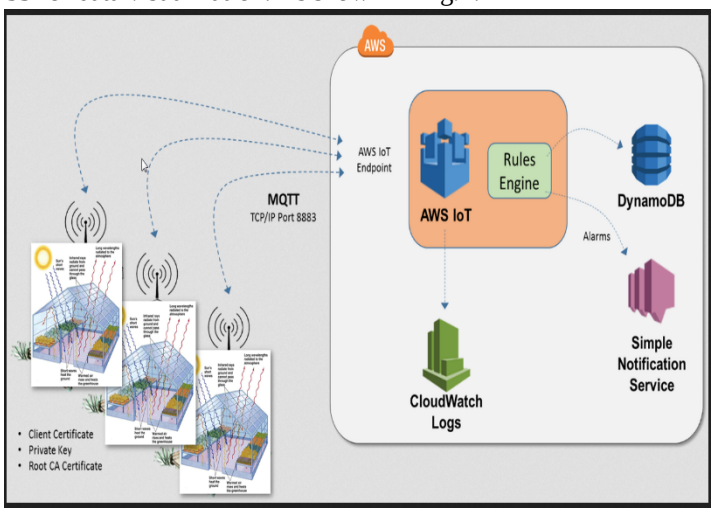

Fig 4. AWS integration

III. RESULTS

This section demonstrates various results obtained during implementation of project.

A. Application on Raspberry pi.

Main automation application is runs on raspberry pi, below fig shows the running application where data received from ESP module, threshold parameters checking and data sending to AWS is shown on Screen.

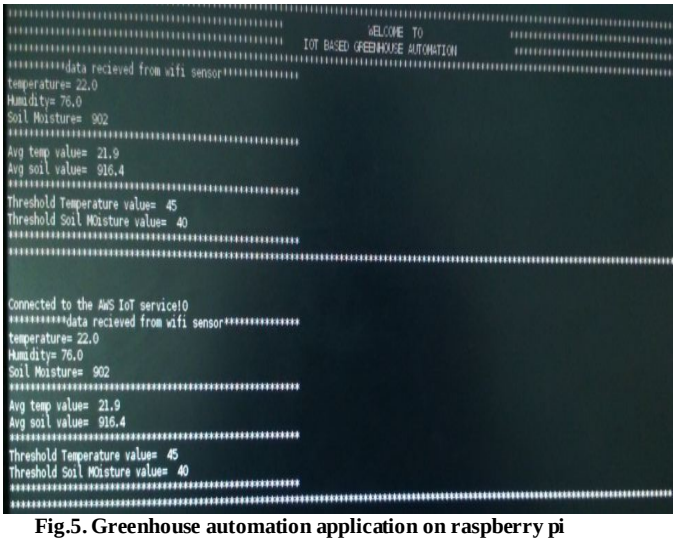

Fig.5. Greenhouse automation application on raspberry pi

B. Threshold mismatch

one of the condition for temperature threshold voilation is shown in Fig.6. whenever there is missmatch in the tempreature threshold, system take the necessary

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corrective action to make temperature inside the greenhouse within proper value.
Similarly any soil moisture and light values threshold values mismatch occurs system will auto detect and take necessary actions to combat the threshold value inside the greenhouse.

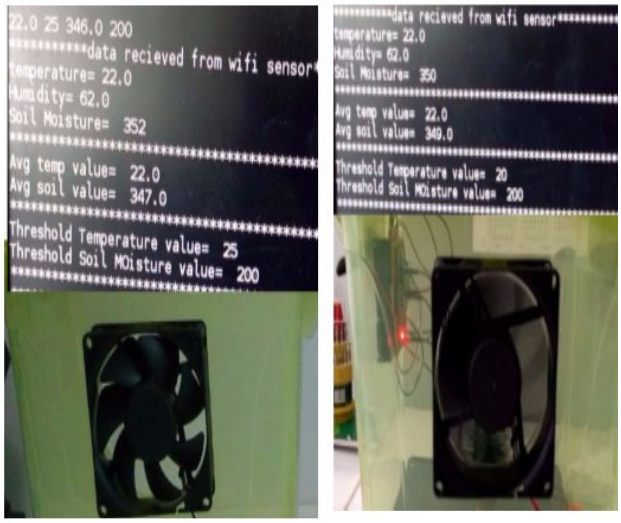

Fig.6.Temperature threshold change

C. Data visualization in AWS

Below Fig.7. shows the data visualization on amazon, chart shows rows for sensor value for temperature, soil moisture and humidity sensor values.this data can be exported to xls format for data analytics. This data is retrieved from Dynamo DB. In case any panic conditions system will automaticaly send SNS notifications for registered user.

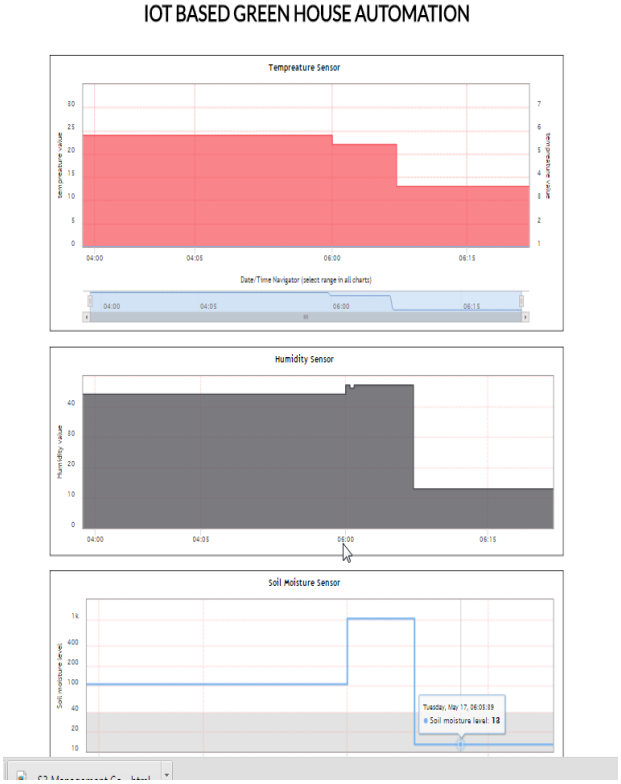

Fig.7. data visualization in AWS

D. Comparision of different wifi modules.

Fig.8. shows comparisions of different wifi moduels in current market, ESP8266 is one of best module for IOT applications, has own programmable memory, microcontroller, TCP/IP stack on.

	WIFI shiled	Wifi shield	Huzzah cc3000	ESP-01	ESP-12
Company	Sparkfun	Arduino.cc	Adafruit	Espresso	Espresso
Packets	TCP and UDP	TCP and UDP	TCP and UDP	TCP and UDP	TCP and UDP
Concurrent sockets	-	4	4	5	5
Size	66*53mm	66*53mm	26.22*40.45mm	21*11mm	25*38mm
Interface	SPI	SPI	SPI	TTL	TTL
Transmit current	215mA	-	350mA	210mA	210mA
Receive current	60mA	-	-	~60mA	~60mA
Analog pins	4	0	0	0	1
Digital pins	8	0	0	2	9
Programmable microcontroller	NO	YES	NO	YES	YES
Cost	$69.95	$84.95	$34.95	$2.75 to $3.75	$9.95

Fig.8. comparison of different Wi-Fi modules

IV. CONCLUSION

ESP8266 Wi-Fi module low power consumption module, which has built-in programming memory, controller and more than 15 GPIO pins, this enable us to build a wireless sensor network with very low cost and low power consumption.
Raspberry pi is also called minicomputer which supports wide range of programming languages, MySQL Database storage and internet connectivity, all this features at very low cost compared to personal computer.
AWS also provide us to store in cloud database, Visualizations, data analytics and SNS notifications.
Using all this features gives us completely automated system and also future data analysis.

V. FUTURE SCOPE

Future work for using this module in different fields has to look through. Some of them are given here

- AWS IOT provide many more IOT features, those features can boost the system for more real time handling of system and data analytics.
- This module can also be used for cold storage, sericulture and many more remote monitoring applications.
- Current system is battery operated, thus battery has to be replaced periodically and this can be improved using solar power.

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