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Effective Architecture for Greenhouse Controlling and Monitoring using Wi-Fi Peer to Peer Direct Protocol

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Abstract

Background/Objectives: In modern day agriculture significantly depends on finite to infinitesimal changes around it. An efficient design of embedded device architecture builds upon these changes which affects productivity and made to reduce risk on agriculture. **Methods/Statistical Analysis:** The effectiveness of any embedded device depends on the technology used, it should be latest because at final people feel flexible and reliable to use. This architecture divides into two major functional units controlling and monitoring. The Atmel base controller is used to analyze sensor values and control output devices. Wi-Fi direct protocol is used to transmit data which analyzed by the controller to Wi-Fi receivers. **Findings:** Controlling is an autonomous function carried out by controller or a processor. In the other hand, there is a lot of developments in monitoring technology are very effective in terms of technology but failed in front of the uneducated people. In agriculture field the end users are mostly uneducated. Wi-Fi is the best solution because a lot of people use too Wi-Fi access because of their smart phones. **Application/Improvement:** Greenhouse controlling and monitoring using AT Mega controller based system with advanced Wi-Fi peer to peer direct protocol enable module ESP8266 is combined for effective workings, with a frequency of 5Ghzand data transmission through the network using an IP address. No need to design receivers every device which are capable of receiving Wi-Fi act as a receiver. It made end user ease of accessing and friendly to use. This is flexible for one to one and one to many communications, but Wi-Fi direct peer to peer technology can design for one to many and many to many transmissions. This is an application of the Internet of Things (IOT).

Keywords: Arduino AT Mega 328, Embedded, Greenhouse Agriculture, Wi-Fi Peer to Peer Direct Protocol

1. Introduction

More commercialization of agriculture made products unsafe for human health. Mainly to increase production, fertilizers and pesticides used highly which are very harmful. Greenhouses are specially developed to cultivate crops without fertilizers and pesticides is proved by selecting ideal soil[2,3] and natural fertilizers to get a pure crop. Ordinary crops cultivation is pretty easy to grow in greenhouse.

Many revolutions are occurring throughout the world to improve agriculture growth. Green Revolution for agriculture, silver revolution in egg production, white revolution for dairy etc. Now days greenhouses are slowly developing in many parts of the world, the biggest problem is its cost. Compare with traditional agriculture it is too expensive to practice and gradually cost of the product is also increased. There are so many factors influencing this like building greenhouse[4], maintain resources to plants, workers etc.

The main aim of this paper is to decrease maintenance cost of the greenhouse using an automated device which take care of inside climate[5] and maintain resources for plants.

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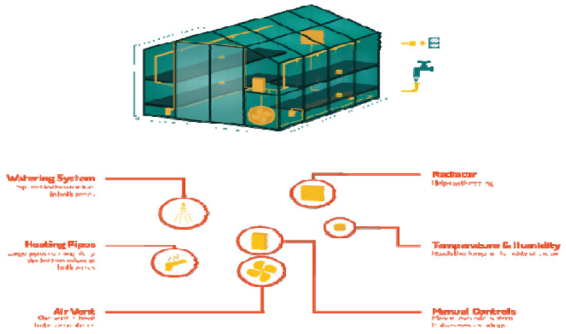

Figure 1. Prototype of a greenhouse.

If you want to practice this greenhouse of more land need too many working men to maintain. This device is completely two parts controlling resources and climatic conditions second is to communicate this data to the farmer.

2. Hardware Designing

This application is very unique in many aspects they are important to reduce costs, but introducing an automated device, easy to access by developing device to interact with smart phones and laptops it lead to reduce the design of receivers. It eventually optimized climate and resource control play a key role in crop growth.

2.1 Types of Greenhouses

Greenhouses are categorized in many ways depend on size, shape, and materials used to construct. Most important things in different types is the climate where one need to build the greenhouse because each place have its own climatic hazards like extreme climates[5] viz. too hot and too cold, storms, earthquakes etc. Depend on type of construction there are mainly two types: free standing and Attached models. A prototype greenhouse model is designed as shown in the Figure 1. Speed, accuracy and flexibility are key role in device working.

As shown in Figure 2 and Figure 3 the greenhouse requirements are arranged in systematic way.

2.2 Designing Controlling Unit

Controlling unit can design using any basic controller, which can capable of handling a minimum of 5 sensors and communication module. In this paper we prefer AT mega 328 microcontroller[6,7] which is used for controlling and

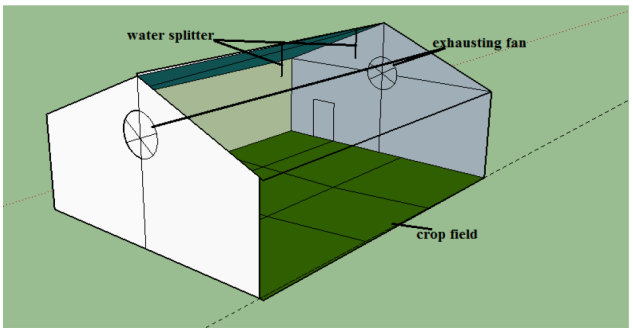

Figure 2. Prototype of water splitters and exhausting fan locations.

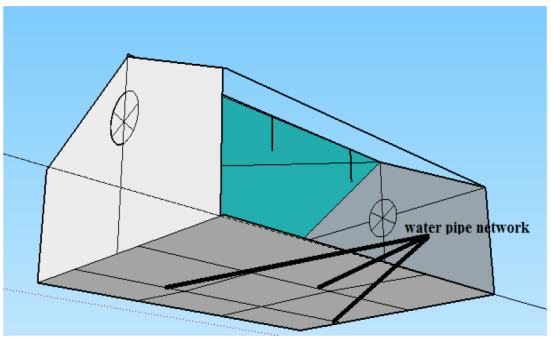

Figure 3. Network of water pipe.

monitoring. Its response is very fast compared with human response due to its oscillator frequency. Greenhouse parameters and resource control always an important aspect because these are the deciders of plant growth. Each sensor[8] is responsible to sense particular activity depends on its type.

The output accuracy always depends on its sensor working and its controller accuracy. Activities are like temperature, humidity, moisture and light.

Plant growth always depends on its resources. In other case resources used to carry out photosynthesis. Light, water and CO_2 are major resources to grow plants. An artificial light is used to generate light for plants. A network of pipes is arranged to supply water[9] for plants as shown in Figure 3. Pipe network is designed depending on its moisture sensor here I am using 2 moisture sensor for different crops and different levels of moisture is supplied. This network helps to increase the use of space in greenhouse with different crops in the same time. Help to increase production and very usable in this type of agriculture.

3. Software Tools Used

Generally embedded systems are defined with both hardware and software combination. Different software tools are used to develop the system. They are Arduino IDE, hyper terminal, Mikro-C IDE.

3.1 Sensor Value Conversion

In this paper used 4 types of sensors they are temperature, LM35, Humidity sensor (DHT-11), Moisture sensor (quality-2) and LDR sensor for light detection. These all sensors are analog sensors and for this conversion logic is used to convert analog to digital output. Then the output is compared with predefined value in the program shown in Table 1 and in Figure 4.

The pre- defined value always depends on the crop. The ~~above~~Table 1 shows the values of temperature sensor readings similarly graph is drawn in Figure 1, in the same way an experiment with light is conducted and results are shown in Table 2.

Table 1. Temperature sensor reading

Temperature (co)	Output (V)
14	0.1
25	0.2
30	0.28
45	0.41
50	0.53
75	0.8
100	1.245

The light intensity is very important because it must satisfy intensity of sunlight, which helpful the plants to carry out photosynthesis shown in Table 1 and in Figure 5.

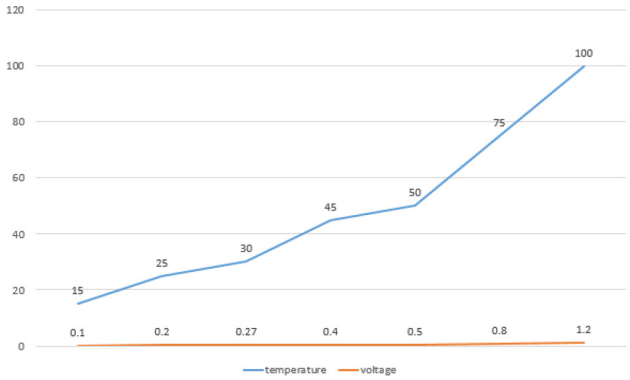

Figure 4. Temperature vs. output voltage

Table 2. Light intensity reading

Light intensity value	Voltage
0.15	3.8
0.5	3
0.9	2.81
1	2.73
1.5	2.22
5.2	1.51
10	1.27
50	1

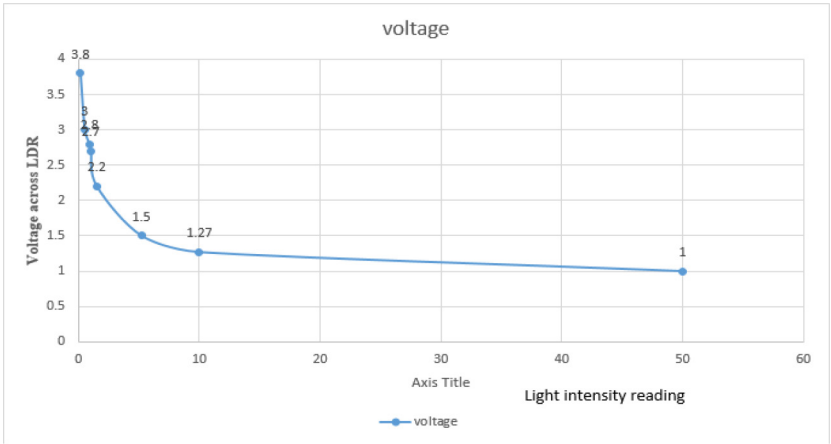

Figure 5. Light intensity (Lux) vs. Voltage (V).

3.2 Arduino IDE

Arduino, an Italian company, produces controller boards or development kits for all sorts of applications. Arduino IDE is an open source software tool used for developing applications in 2 ways developing sketch which is a program and observing in serial port. Arduino has its own pre-defined syntax for programming. Most of its definitions are pre-defined in libraries.

3.3 Hyper Terminal

Hyper terminal is the open source software which is specially designed to receive and transmit data from and to a device. This replicates the terminal program of any device which is connected using a set of rules. The hyper terminal is running on windows device and tries to connect to an Arduino device using an internet protocol like IP: 198.158.3.240 and port number is shown in Figure 6.

The access point SSID is the name of the access point and IP address which is configured by the manufacture of the Wi-Fi device.

3.4 Mikro-C IDE

To communicate Wi-Fi an Arduino Wi-Fi module is used. ESP8266 is the module which is needed to be programmed using this micro-C with the AT+Commands. In Mikro-C a serial terminal is used to send commands, these commands used to connect the module with a Wi-Fi router. This Wi-Fi router is act as a medium between PC/smart phone and embedded device. The commands used to initialize module shown in the Figure 7.

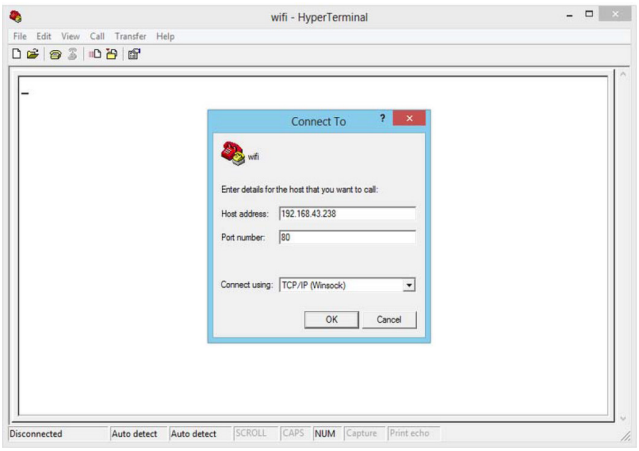

Figure 6. Hyper terminal dialog box for IP and port number

The programmer knew each command react with a response by the module. The commands shown in the Figure 8. AT+CWMODE=3 if it passes ok then command Wi-Fi device/Wi-Fi is switched on, or if it is a hotspot then turns on. AT+CWLAP show available network around the device. Next command contains AT+CWJAP = "name (network)", "password (secure pass)" of that device. After that connection is established.

3.5 AT+Commands Firmware

These commands are introduced by the AT&T Company. This is the commands highly used to control devices used to modulate and demodulate data (modems). ESP8266 is module is initialized by using these commands. Most of the GSM devices developed using these commands. This mainly used to transmit data in the form of SMS, voice calls and packet of data refers Table no 3.

Each command is used to initialize its own way. Similarly, each having its own response, as shown in the

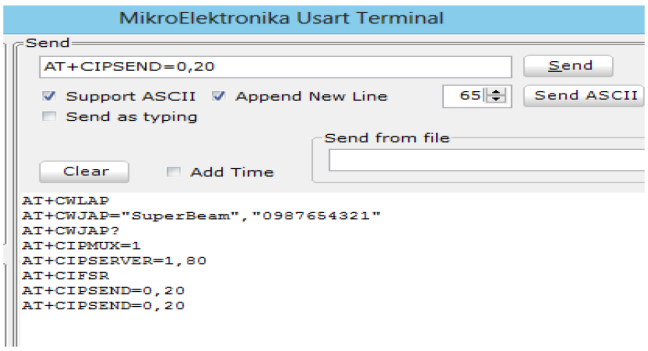

Figure 7. AT+command in Mikro-C.

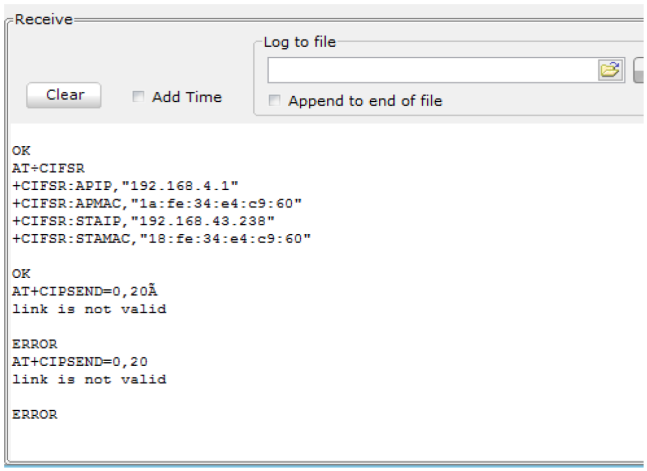

Figure 8. Command response in Mikro-C.

Table 3. AT+Commands and there Mikro-C response

S. NO.	AT+Commands	Response
1	AT+RST	IT PASSES VENDOR NAME TRY WITH 9600 BAUD RATE OR 115200 BAUD RATE
2	AT +CWMODE=3	IT PASSES OK
3	AT+CWLAP	IT PASSES NUMBER OF AVAILABLE NETWORKS
4	AT+CWJAP="NAME","PASSWORD"	IT PASSES NAME AND PASSWORD TO CONNECT WITH THAT NETWORK
5	AT+CWJAP?	IT PASSES IF IT CONNECTED TO ANY NETWORK OR NOT
6	AT+CIPMUX=1	OK
7	AT+ CIPSERVER=1,80	OK,IF EVERYTHING IS FINE IT PASSES ONE IP ADDRESS NOTE THIS IP
8	AT+CIFSR	OK,. NOW OPEN HYPERTERMINAL AND ENTER IP ADDRESS
9	AT+ CIPSEND=0,20	CONNECTION ESTABLISHED WITH PORT 20

Figure 6 below those 9 commands is used to program the ESP8266[10] module as per application. At every command required input is submitted into it. It contains a processor to control its operation by an ASIC (Application Specific Integrated Circuit) and also it can also controlled by an external processor.

4. Communication Module

In the embedded field mostly consists on controlling device which play a key role, but it is not enough to control a device, but with time things need to change. Most of the devices in last decade used ZigBee[11], Bluetooth and Ethernet etc. The problem with such usage is a user must design a receiver depend on the transmitter, if we think the user must be a farmer and most of them are illiterates they need a more general way to communicate. Now Wi-Fi is on the promising technology in present day's communication with Wi-Fi it is high due to its high speed, high data rates. Each and every technology have its own set of rules are called a protocol. Which designed by the manufacture depends on the standards. Wi-Fi is hugely popular throughout the world due to its easy to use and high data rates.

ESP8266 shown in Figure 9 is developed by Arduino manufacture for IOT development. This is standardized by the Wi-Fi direct peer to peer protocol. This module consists of GPIO pins to controlling purpose and for In-system programming using this GPIO's. This has EEPROM (Electrically Erasable Programming Read Only Memory) to store program and re-purpose programming. Boot loader always receives data[12] from the

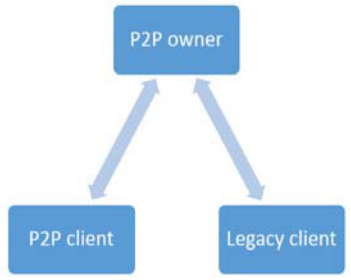

Figure 9. Peer to peer direct protocol owner and client communication.

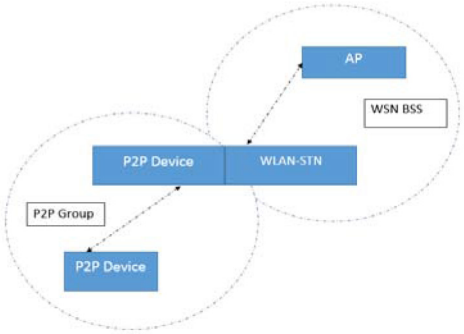

Figure 10. Wi-Fi direct supported topology.

ROM to its RAM. Programming is done by using a PC with AT+command firmware is used to program easily as shown in Figure 8. GPIO0 is set to low, then a ROM inside the ESP8266 start communicating with the UART which built inside. Then pushes the program into flash memory into boot ROM refer Figure 10.

4.1 Wi-Fi Direct Topology for P2P

It is developed using a protocol in it, which is highly efficient for communicating with few no of devices effectively. P2P technique is used to connect and communicated with the other device. Like most communication protocols this is also having full duplex communication refer Figure 11. The sender is always acting as the server and the receiver is acting as a client. Communication is done in different steps which are done internally; this is also called Wi-Fi direct go negotiation and group formation sequence.

In this network, every device tries to achieve dominating place or a group owner to transmit data. To earn this position all devices in the network generate a tie breaker bit equal to 1. In most cases more than one device start generate to acquire the position, the process becomes frail. If suppose a device become owner then the configurations on the network done through the owner channel only. There are the three process\steps to invite new clients called GAS (Generic Advertisement Service). It allows mostly to non-associate 802.11 standard devices to communicate with each other. Exchange or communication of queries between two devices, it is always occurring at higher layer protocols shown in Figure 12. In GAS data is communicated by fragmentation and reassembling methods. Because this highly effective way to transmit data without losing and very helpful to regenerating message.

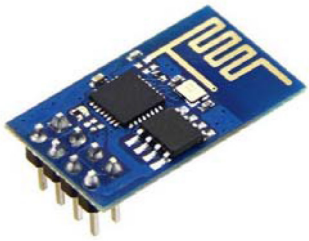

Figure 11. ESP8266 module.

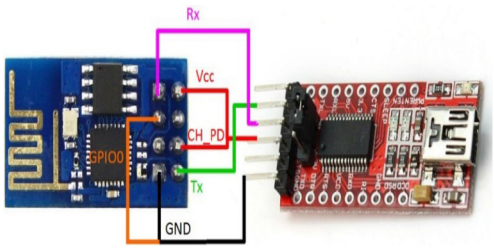

Figure 12. Programming ESP8266 with PC.

5. System Design and Analysis

Greenhouses are a precise method to practice agriculture in a closed environment. To reduce the effect of outer environment on the crops, because due to increases in greenhouse gas levels in a danger on the earth environment causes a great damage to most of the crops.

The device[13] is designed with an AT mega 328 controller, which receives data from the sensors. Received data are analyzed and controlled output devices; they are fun, light, water motors and splitter. These devices decrease extreme condition in the greenhouse to a normal condition helpful for the plants. Here two moisture sensors are used for two different crops at two different levels of water is supplied.

Other than controlling device, monitoring play a key role in modern embedded systems because monitoring through wireless communication is effective and acknowledges the conditions. ESP8266 is used to transmit data with a device connect with the access point through a particular IP address.

The system block diagram shown in Figure 13, the arrangement of sensors and output devices through the

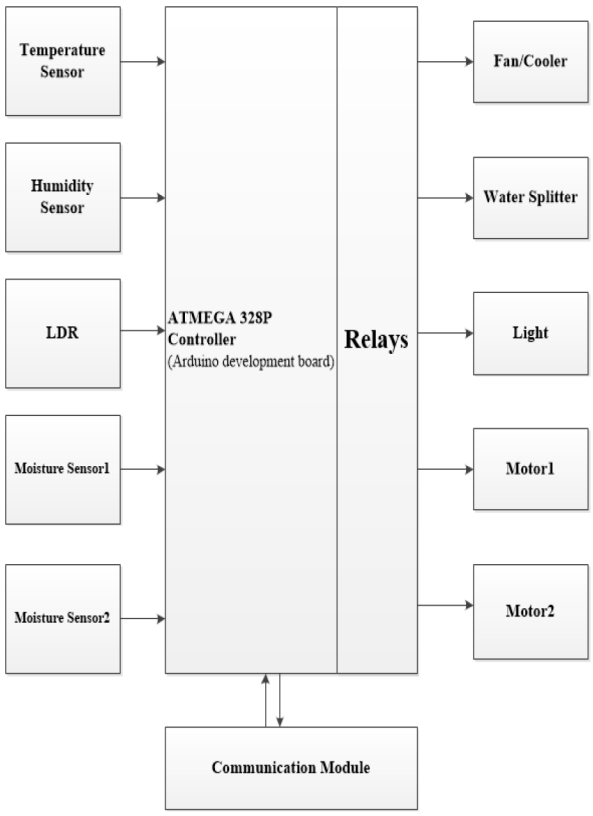

Figure 13. System Block diagram.

controller. Each output device controlled with a relay, whenever the controller sends[14] controlling signal, then relay switch on the output device.

6. Results and Discussion

The device working model, prototype, block diagram are provided.

The received data are observed in two ways, one in Mikro-C as shown in Figure14 green indicates connection establish and data received. Which is a serial data through RS-232 in this connection data is received when Receive (Rx) of the Arduino board connected to ESP8266. By disconnecting that Rx and start sending AT+commands. After completing commands the device is connected to access network IP address and port number to Hyper terminal as shown in figure 4, then data is received through Wi-Fi and observed in the terminal window.

7. Conclusion and Future Scope

In coming future food becomes a valuable resource due to changes in climate. Global warming[15] has become a great thread to many spices end. Responsibility for future generations are needed to be taken by developing agriculture practices independent of climatic conditions. More intelligent machines are needed for the observation of greenhouse and for taking their own decision like humans.

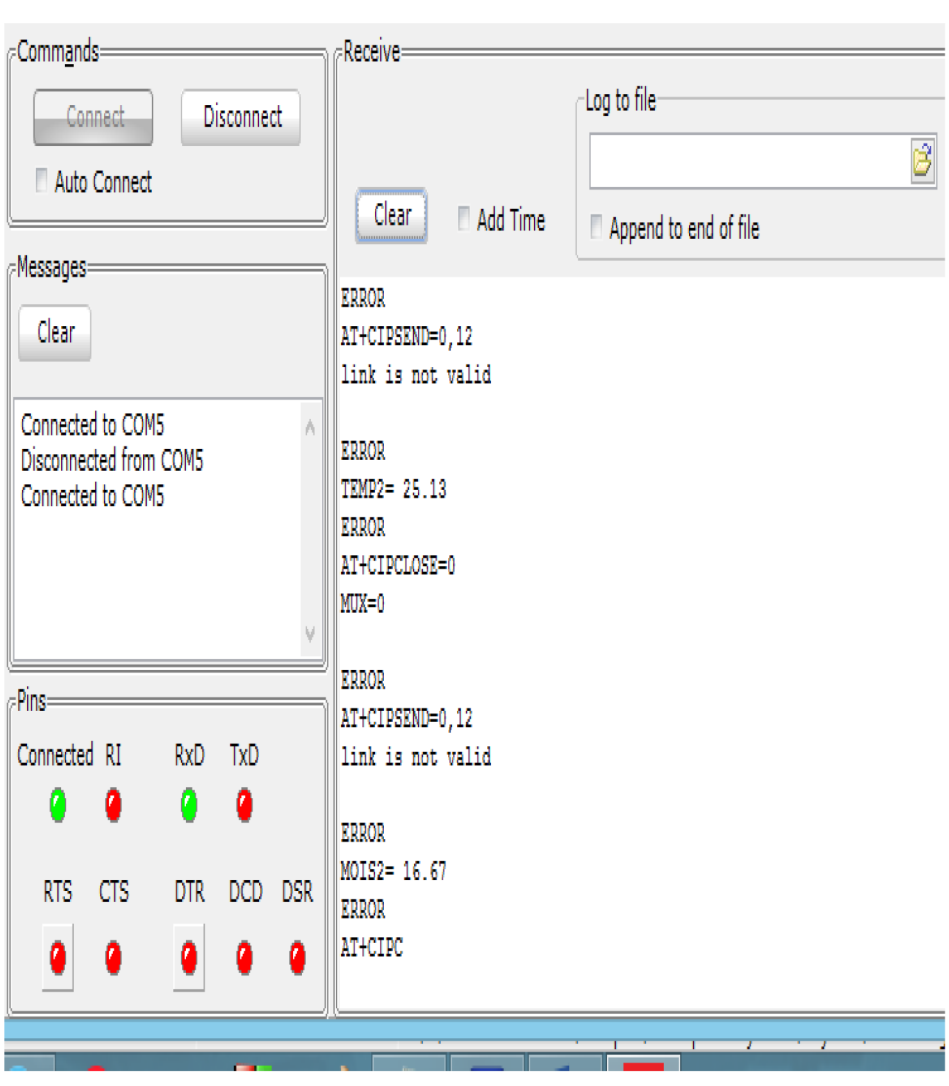

Figure 14. Output values observed from sensors.

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