Implementation of Home Environmental Conditions Monitoring System by Multiplexing Technique on NodeMCU.

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Abstract— An integral part of home automation is to have each home equipped with monitoring systems to automate homes. Using Wifi as a backbone to connect all the devices would be cheaper as each household is equipped with Wifi. Here comes the requirement of a low cost Wifi enabled controller to collect data and publish it to server. NodeMCU is one such great option. Most of the sensors operate as analog sensors which is a barrier for NodeMCU. We are implementing a system by multiplexing sensors to a single analog pin thereby reducing number of Wifi modules and a cheaper system as well. Using this system home environmental conditions can be monitored and the data is communicated through MQTT protocol and it is published through server to clients. The data can be stored in a database and using that data one can predict the environmental conditions

Keywords: Home automation, Node MCU, MQTT, Multiplexer HC4051, Analog Sensors.

1. Introduction

Increase in the usage and availability of Internet in our daily lives, rendered the path to use innovatively. One such trending and revolutionary usage is Automation. Automation is nothing but completion of a task without human intervention. In this concrete Jungle everyone are bus with their daily works and can't find time to complete each and every task at home. So home automation is a best Solution for this generation people where we can operate and control our home devices. Home Automation requires devices on which we operate (like heaters, Washing machines refrigerators etc..),sensors ,and a tablet, phone or a Computer.in our project we determined the physical variables like Temperature, ambient light and also some of the gases usually present in our home.

This Home automation is achieved by using Internet Of Things. In simple IOT is nothing but the integration of the physical devices, sensors over the network of cables and tablets, phones and Computers. This not only enables the accuracy, efficiency but also renders a high level of security. Usually IOT has four major components including sensing, heterogeneous accessing, information processing, application services and additional component like security and privacy.

In general home monitoring systems could monitor parameters such as temperature, gases such as methane, NH4, and ambient light .For this purpose various sensors that are being used are thermistor, MQ2, Light Dependent Resistor. All these sensors are analog in nature. The problem with the existing systems is that multiple analog sensors cannot be connected a single Wifi module wherein this requires number of NodeMCU modules as a single node can be accessible to only one analog sensor

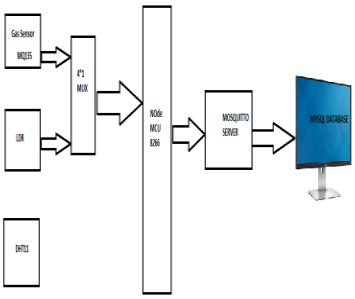


Fig 1 Basic Block Diagram

2. Components Description

2.1 NODEMCU

Node MCU is an open source IOT Platform. It has got its origin from ESP8266. The advancement in the ESP module resulted in the outcome of Node MCU. It is a spectacular combination of ESP with Wifi. Node MCU refers to firmware. Many IOT projects are widely dependent on this module. It is designed for easy programming with USB capability. It provides access to GPIO (General Purpose Input /Output) as it consists of ten GPIOs. The programming part constitute of simple arduino programming which can be typically written in c or c++ programming language. Node consists of one analog pin which can be extended for further requirement as we did in this project.

Espress if Systems planned a smaller scale controller named as ESP8266. The ESP8266 itself is an independent WiFi organizing arrangement offering as a scaffold from existing smaller scale controller to WiFi and is additionally equipped for running independent applications. This module accompanies an implicit rich grouping of stick outs and a USB connector. With the assistance of a smaller scale USB link, you can associate Node MCU development kit to your PC and blaze it with no inconvenience, much the same as Arduino. It is additionally instantly breadboard agreeable.

Specifications:

- Voltage:3.3V
- Wi-Fi Direct (P2P), delicate AP.
- Current utilization: 10uA~170mA.
- Flash memory connectable: 16MB max (512K ordinary).
- Integrated TCP/IP convention stack.
- GPIOs: 17 (multiplexed with different capacities).
- Analog to Digital: 1 contribution with 1024 stage determination..
- +19.5dBm yield control in 802.11b mode
- 802.11 help: b/g/n

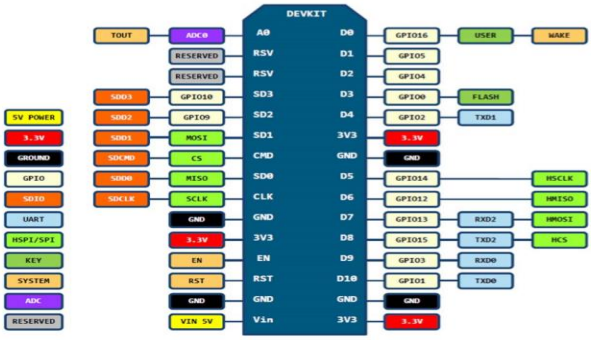


Fig 2.1 Pin description of Node MCU

2.3. SENSORS

2.3.1. GAS SENSOR

Gas Sensor (MQ2) module is valuable for fuel spillage area (home and undertaking). It is fitting for perceiving H2, LPG, CH4, CO, Alcohol, Smoke or Propane. Due to its high affectability and quick reaction time, estimation can be taken as quick as could sensibly be normal. The affectability of the sensor can be adjusted by potentiometer

Gas sensor formula:

```
SensorValue = AnalogRead(A0);
SensorVoltage=SensorValue/1024*5.0;
```

Fig. 2.2 Gas Sensor (MQ2)

2.3.2. THERMISTOR :

Thermistor, a sort of resistor whose protection relies upon temperature. In our project we used a Negative temperature Coefficient Thermistor whose resistance decreases with increase in temperature and thereby it acts as a temperature sensor. Because of its high sensitivity it is capable to sense even small changes in the temperature

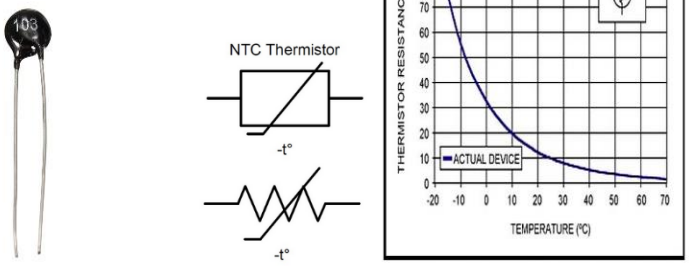


Fig. 2.3 Thermistor

Fig 2.4 NTC electrical Symbol and graphical representation of NTC Thermistor resistance and temperature.

Formula:
R2 = R1 * (1023.0 / (float)Vo - 1.0);
logR2 = log(R2);
Temp = (1.0 / (c1 + c2*logR2 + c3*logR2*logR2*logR2));
Temp = Temp - 273.15;
Temp = ((Temp * 5.0)/ 9.0 - 70.0);

where R1 =10k ohms ;
c1= c1 = 1.009249522e-03, c2 = 2.378405444e-04, c3 = 2.019202697e-07;

2.3.3 LDR

Light Dependent Resistor or photocell is a light-controlled variable resistor whose protection diminishes with the expansion in the force of light: Photo Conductivity. Because of their low cost,ease of manufacturing they are widely using in many applications. They are made from semiconductor materials to enable them to have light sensitive properties

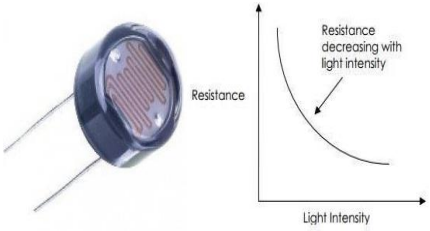


Fig. 2.5 A LDR and its resistance Vs light intensity graph

2.3.4 MULTIPLEXER:

The MC54/74HC4051, MC74HC4052 and MC54/74HC4053 use silicon door CMOS innovation to accomplish quick engendering delays, low ON protections, and low OFF spillage streams. These simple multiplexers/ de-multiplexers control simple voltages that may fluctuate over the total control supply go (from VCC to VEE).

The HC4051, HC4052 and HC4053 are indistinguishable in pinout to the metal– entryway MC14051B, MC14052B and MC14053B. The Channel– Select inputs figure out which one of the Analog Inputs/Outputs is to be associated, by methods for a simple change, to the Common Output/Input. Whenever the enable pin is HIGH, all simple switches are off. The Channel select and Enable sources of info are good with standard CMOS yields; with pullup resistors they are good with LSTTL yields. We can connect 8 analog sensors to it at a time.

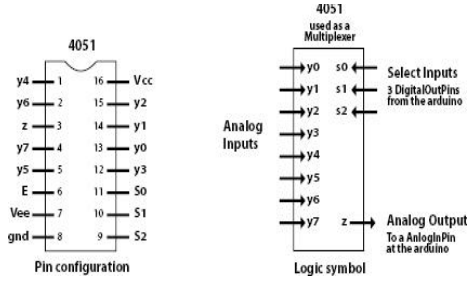


Fig. 2.5 HC4051 MUX pin diagram and logic symbols

2.3.4 MOSQUITTO SERVER:

Mosquitto is an open supply message broking that implements the MQTT Protocol. It is a light-weighted technique of carrying out messaging the usage of publish/subscribe version designed for extremely constrained devices. It helps in machine to machine communication and also in the IOT contexts. In MQTT , MQ stands for Telemetry Transport. It's been in usage since 1999. The main motto in designing this protocol is to minimize the network bandwidth and device resource requirements.

It uses publish/subscribe model (it has high scalability) which is an alternative to the client-server model . Here ,neither the publisher nor the subscriber know their existence. Still they can be able to communicate with the help of a broker who knows the existence of both. Here we used MQTT as broker which receives the incoming messages and distribute them accordingly. The main theme of publish/subscribe is the decoupling of publisher and receiver which is an event-driven process and is achieved in 3 different ways. Also there are many ways of filtering like Subject-based , Content-based and Time Based. MQTT uses the Subject based filtering and it does synchronization decoupling in such a way that they just know the hostname/IP and the port for publishing.

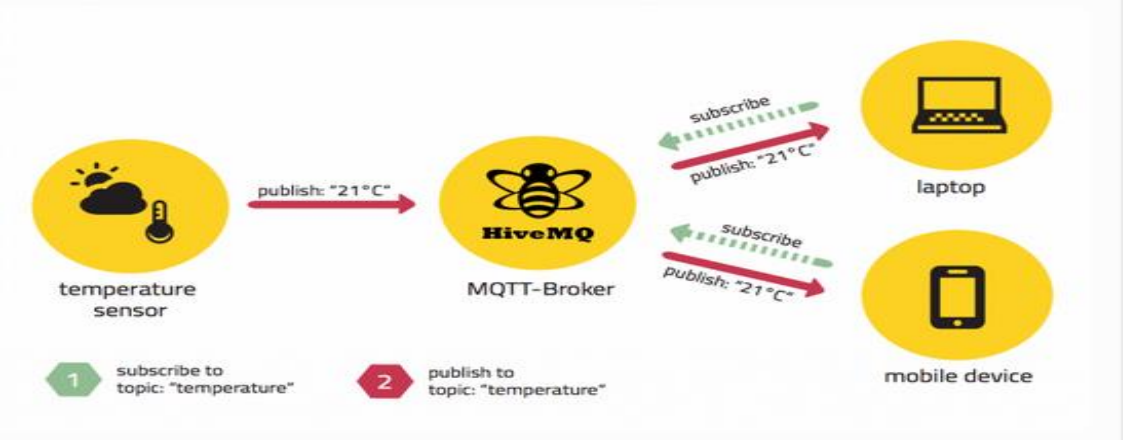


Fig. 2.6 Basic MQTT publish/subscribe model.

So a connection of any client will be always with a broker .Any device from a microcontroller up (here we used NodeMCU) to a fullfledged server and has MQTT libraries running can act as a MQTT client. Provided it should be connected to an MQTT broker over any kind of network. This broker decides who is interested in receiving those messages and then sends the messages to all subscribed clients. Also authentication and authorization of clients must be taken care by the broker. These two will communicate using MQTT protocol which is based on the top of TCP/IP .Prerequisites are both the client and broker need to have a TCP/IP Stack.

2.3.5 MYSQL DATABASE:

A Database is primarily used to access, update and store the data. It helps to manage and organize the data easily. It consists of many tables and each table consists of rows and columns. A column in a DB is the datatype (like varchar, Integer, data etc.) that is included in our Program. The rows of these tables consists of the values we enter for each of these datatypes. It is indexed so that a particular record can be found easily. In general DB are present in mainframe systems but now-a-days they are also present in smaller workstations and midrange systems.

There are many types of DBs like distributed DB, Relational DB, Cloud DB, Object-oriented DB etc.. In our project we are using a relational DB. A relational DB is scalable, fast, reliable and ready to use because rather the conventional DBS it uses separate DBs to store the data One of the Relational DBS is MYSQL.

MYSQL is an open source DB that helps anyone to use and modify the software. It can be used in laptops , phones and also in tablets. Its name is a mix of "My", the name of kindred sponsor Michael Widenius daughter and "SQL",

the abbreviated shape for Structured Query Language. Moreover it is a Client/server system which has many multi-thread servers that supports different backend. In this paper, the database is used to store the characteristics obtained at the mosquitto client**.**

3. Implementation

3.1 CONNECTING SENSORS WITH MUX*:*

Since Node MCU has only one analog sensor pin it's difficult to connect all the sensor pins to the Node. So we multiplexed the analog sensors using HC4051 Mux. It is an 8*1 mux where we can have 8 analog sensors connected to the mux and thereby it can be connected to the only analog pin of the node. . Since in our project we have considered only 3 sensors, we connected them to the 13,14 and 15 pins respectively. We know that any 8*1 mux will have 3 selector pins. .Here 11,10 and 9 are the select pins .since our project confined to only 3 sensors we used only 2 select lines. .But this can be extended to 8 analog sensors using 3 select lines.

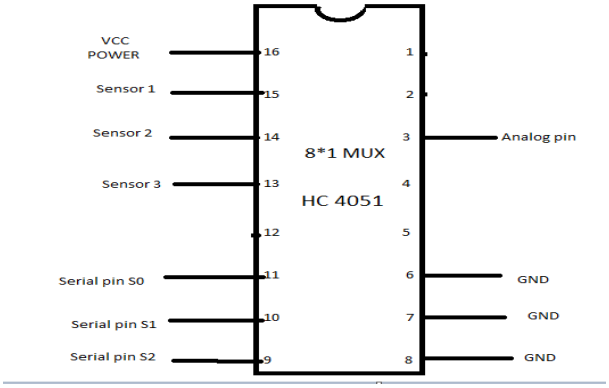


Fig. 3.1 HC4051 mux to sensors connection.

The output is taken at the 3rd pin and is given as the input to the NOdeMCU.16th pin is fed with the IC Voltage and 6,7 and 8 pins are grounded.

3.2 INTERFACING OF MUX TO NODE

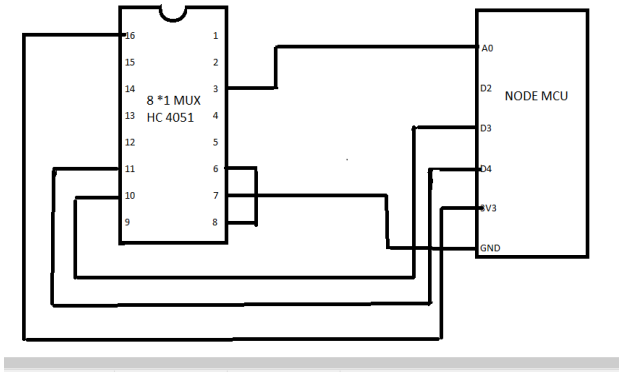


Fig. 3.2 Interfacing HC4051 mux to Node MCU.

The output of the mux is connected to the analog pin of node .Ground pins of the mux and node are connected. Similarly the voltage pins of the mux and node are connected. The key feature is the connection of the select lines. Since we used only 2 select lines. Those are connected to the digital pins D2 and D3 of the mux.

3.3 NODE TO MQTT:

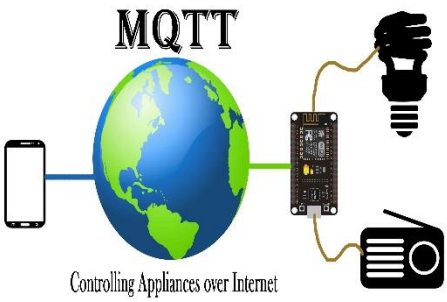


Fig 3.3. Connecting Node to MQTT for publishing the data

Here in the Node MCU interfacing with multiple analog sensors logic we have included the logic of MQTT connection establishment. We have to mention the hostname/IP and port of the broker .Also the broker and the client should be connected over same kind of network. Prior uploading the logic into Node MCU mosquito server and client libraries should be installed and the MQTT broker should be kept ready to publish and subscribe the sensor values.

3.4 MQTT TO DATABASE:

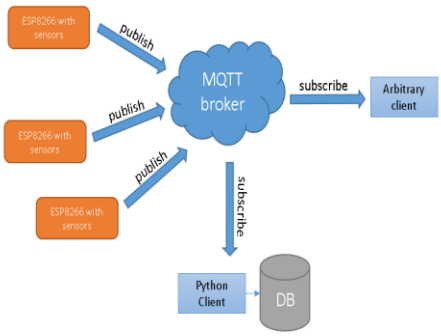
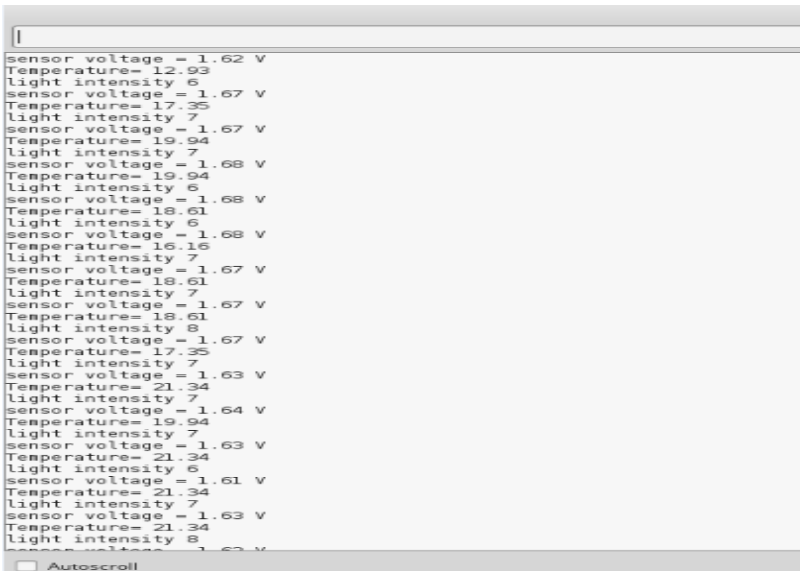


Fig 3.4 Storing the MQTT published values into DB using the python Scripts

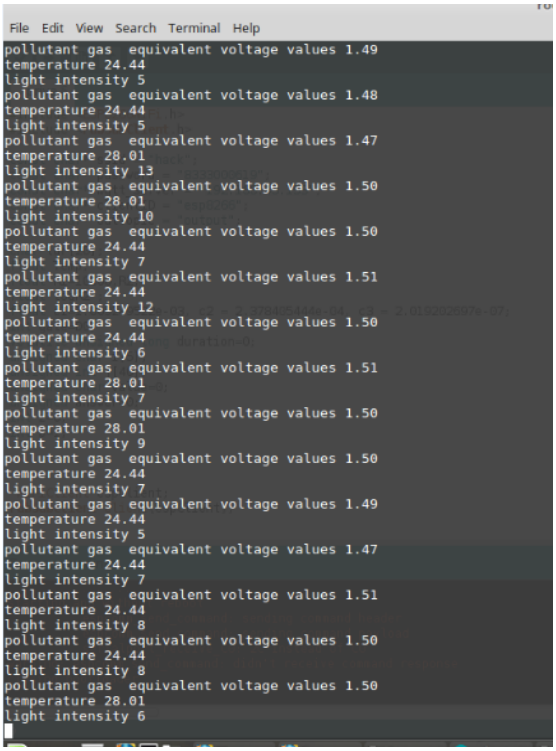
The obtained sensor values at the Mosquitto client, they are directly stored into a log file using python scripts. Next MYSQL database has to be installed at the server side and username and password are to be created to avoid authentication and authorization problems. Next a database and tables depending our requirement are to be created to store the log files Tomake this backend process to occur automatically we again used python script files where we mention all the credentials to store and update the DB.

4 Results:

4.1 SERIAL MONITOR OUTPUT DISPLAYING TEMPERATURE, LIGHT INTENSITY PARAMETERS



4.2 OUTPUT AT MOSQUITTO SERVER RECEIVED FROM NODEMCU OVER WIFI USING MQTT PROTOCOL



5. Conclusion:

In our Project we have mainly implemented the connection of multiple sensors to Node MCU through MUX and thereby using it for Home Automation This data is then published using Mosquitto and thereby pushed in to a Database. With the

increase in the data we can also distribute the stored data. For true redundancy to prevent site failures and downtime caused by natural disasters. It also provides the availability, scalability and reliability of a single server.

6. Future Scope:

This can also be extended to 8 analog sensors and we can achieve get more devices connected through the network. It even gives us the more chance to control and operate many devices. By using Machine Learning, the data stored in the database can be plotted and analyzed. Here we considered only one Node MCU which confines the weather of only one place. It can be extended to many Node MCU in order to determine the weather at many places and even analyzing them gives the weather at many different places.

7.References:

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