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Internet-of-Things (IoT): Distinct Algorithms for Sensor Connectivity with Comparative Study between Node MCU and Arduino UNO

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Abstract

Now days, with evolving technology, internet grows rapidly. IoT i.e. Internet of things is a technology which connects everything to everything. This paper presents optimistic solutions,that how any object or anything can be connected over the network with IoT technologies and achieves a desired output. We proposed some algorithms which shows that how different sensors connected with physical devices and provides desired solutions and an approach in the form of algorithm (step by step solution) to connect Node MCU ESP 8266(development board or firmware) with Arduino IDE which provide low power battery operated applications or prototyping of IoT devices.This paper also provides a comparative analysis between NodeMCU development board and Arduino UNO microcontroller board. These are the development boards to generate IoT based applications.

Keywords*: Internet of Things, Arduino UNO, Node MCU,IR Sensor, Ultrasonic Sensor, DHT11*

1. Introduction

IoT provides a technology based applications which connects and communicates physical devices or physical objects with other physical objects via internet. There are four main components of IoT i.e. Sensors, Connectivity, Data Usage and User Interface. The first component is sensors, Sensor is a device which produces some physical characteristics after sensing its surrounded environment. Such as temperature sensor and pressure sensor produces observed result of pressure or temperature by its surrounded environment. Second component is connectivity, with sensor and web, there are some protocols and technologies used to resolve this issue. Some IoT enabled technologies are BLE(low power Bluetooth),RFID(Radio frequency identification), LPWAN(low power wide area network).Third component is the data usage i.e. all the pertinent data are on cloud storage and need some processing on it, therefore physical objects which is connected with the internet via development board(Node McU or Arduino UNO) to Arduino IDE.

In other words we can say that IoT hardware (sensor and development kit) interacts with IoT software(e.g. Arduino IDE) with the help of internet and data processing will be done using cloud storage. Fourth component of IoT is user interface; it defines how and when the user gets the alert messages.

Internet of things uses different wireless technologies to connect anything to anything and produces desired output and compare it with the predefined output.

Following are the brief description of Arduino Uno and NodeMCU development board specifications.

1.1 Arduino UNO

Arduino UNO is a microcontroller board based on 8 bit ATmega328P microcontroller.it has 14 digital pins and 6 analog pins. Analog pins accept analog inputs such as temperature, pressure etc. analog variables represents continuous or physical quantity.Arduino UNO microcontroller board operating voltage is 5 Vand range of the input voltage is 6-20 V. therefore this development board is useful for low voltage devices and suitable for IoT enabled devices.

1.2 Node McU

Node McU is a software that comes installed in a ESP 8266 and uses the LuA programming language but the ESP 8266 that comes with Node MCU can be programmed. Here node represents node as physical objects which is connected with the sensor and MCU refer as microcontroller unit.

It consists of circuit board(with 30 digitalpin and 1 analog pin), which can be programmed byreadymade software

Node MCU board size is 49mm*26mm and pin spacing is 0.9’’(or 22.6 mm) , clock speed is 80 MHz. its temperature range is -40Cto -125 C. there are total 12 pins , 11 digital pins and 1 analog pin.

Node MCU development board contains 2.4 GHz Antenna, ESP 12E chip, 3.3 voltage regulator , micro USB port , CP 2102 USB to TTL converter and reset button.there are 4 power pins. Generally node MCU operating voltage is 3.3 Volt .

1.3 Sensors

Sensors is an equipment used to compute or measure the physical properties such as distance, pressure, humidity, temperature and provide desired accurate or sometimes approximate result.

Various sensors such as automotive sensor, fluid property sensor, digital component sensor, flow sensor, force sensor, humidity sensor, mass air flow sensor, photo optic sensor, piezo film sensor, position sensor, pressure sensor, rate and inertial sensor, speed sensors, temperature sensor, torque sensors, traffic sensors, ultrasonic sensor, vibration sensor, water level sensor etc. One of the real time examples of sensors applications is in military aircraft. In the military aircraft there is a feature of an autopilot mode, in which computer is attached to the various sensors(such as position, height, speed, temperature, location etc.) and then as desired aircraft engine ill be automatically on and flaps motors, wings and other equipment will automatically enabled.

Computer takes data from sensor then it provide control signals to different ports of aircraft and then it run on autopilot mode.

1.4 Programming Node MCU ESP 8266 with Arduino IDE

The Node MCU ESP8266, development board can be easily programmed with ArduinoIDE(Arduino integrated

Node MCU ESP 8266 microcontroller development board gives one more capability i.e. it have automatically enabled WiFi solution whereas Arduino UNO microcontroller board does not have inbuilt WiFicapability.

2. Literature Review

IoT can be described as interconnection and communication between the different physical and electronic objects .all objects require connectivity. It does not required that every objects should be able to handle internet.

In other words, internet capability of objects, which is connected with IoT development boardiis always not necessary.[1]

As IoT data is very sensitive data, so many web applications attacks possible and we have to protect our device and physical objects from it[3]

Although there are so many protocols which provides services and resolve connectivity issues between user interface and physical objects.

Actually till now, Internet of Things have not any common architecture or standard architecture that's why some security vulnerability occurs in different layers in IoT architecture. Even though there are layered architecture which contains 4 or 5 layers but still it is not universally accepted.

Therefore finding and overcoming the attacks of IoT devices is a major challenge for researchers and scientists both.[4]

There is a complex relationship between user, service provider, physical object. Iot enabled development board (NodeMCU or Arduino UNO), therefore identity identification is the measure challenge while developing IoT based applications. The measure security measures such as authentication, integrity, confidentiality and non-repudiation required to handle security vulnerabilities.[5]

IoT based applications are connected with small devices. These devices may be electrical, electronic or mechanical devices or any other physical object. Therefore it is required that low power technologies should be used .low power , low energy set of rules required which can be processed with very low power and provide a desire outcomes. Zigbee, BLE(Blue tooth Low Energy), RFID,6loWPAN(IPv6 Low power wireless personal area network). Provides low power connectivity solutions.[6]

3. Comparative Analysis of Node MCU and Arduino UNO Development Board

- Node MCU ESP 8266 is an open source firmware and Arduino UNO development board is

microcontroller board based on 8 bit ATmega328P.

- Current consumption in deep sleep mode in NodeMCU is 0.5 µA while in Arduino UNO is 35 mA.
- In both the boards power supply is 7V to 12V.
- RAM size in node MCU is 128KB and in Arduino UNO RAM size is 2KB.
- Node MCU uses 4MB ROM as a flash memory (which tells about program space) and in Arduino UNO flash memory size is upto 32kB.
- Arduino UNO have USB type B connector and in Node MCU micro USB port.
- Arduino UNO board size is bigger than node MCU.
- In node MCU there are 11 or 13 digital I/O pin pins while in Arduino there are 14 digital I/O pin.

IV. Proposed Solution

In these proposed approaches, we are trying to connect and implement different types of sensors via Node MCU development board with Arduino IDE and create some IoT based applications.

Following proposed approach is used toanalog signals by through digital pin mode using nodeMCU.delay can be set as1000.

4.1Digital to Analog Write

Proposed algorithm shows how to connect Node McU to internet through the computer and set analog signal in Node MCUusing IoT. This particular algorithm describes the connection between NodeMCU and Arduino IDE with initialization of digital pins and converts the input signal into analog signal.

Analog write() function is used to generate steady square wave of the specified duty cycle until the next call occurred.

4.1.1 Algorithm for Glowing LED

- Start
- Set digital pin mode (Node McU) as output
- Initialize the variable
- Set max limit 255
- (As 2^8=256(it takes 0to 255))
- Update analog pin by digital pin by using analog Write function()
- Delay can be set as 1000

Explanation: In this proposed algorithm, first step describes the port connectivity via USB microcable to connect Node MCU to the computer. Here syntax of the analogWriefunction is analogWrite(pin, value), user can take any of the pin from D0 to D10. And if the pin value is 0 that means LED is always off and if its value is 255 , it means LED is always on. Delay 1000 means, it can wait for a second. By using this generalized algorithm we can simply on and off the Led. The negative portion of the LED is connected with GND (ground)pin of Node MCU and positive side of LED is connected with 3.3

V pin.

4.2 Wireless solution for IOT

IoT uses several wireless network technologies to connect with internet such as Bluetooth smart, Bluetooth low energy, Bluetooth classic, Zigbee IP, Z wave, Ant +, wireless HART, LoRa, sigfox and 6LoWPAN. All wireless networks having specific features. Universal port number for wifi is 80 .Here we proposed wireless solutions to connect the things with internet. Actually Node MCU ESP8266 microcontroller have Wi-Fi capability, with this algorithm we discuss how Wi-Fi can be enabled using above said development board.

4.2.1 Algorithm to set Wireless Solution for IOT

To achieve a wireless solution through Node MCU and ArduinoIDE , we divide the algorithm in two modules first is Initial Module an second is Set UP Module.

Initial Module:

- Set Wi Fi module as an ESP 8266
- Set the input variable as a network ssid i.e. user Wi-Fi connection identification module.
- Set the input variable password as Wi-Fi connection security variable
- Simulate the Wi-Fi client with the talkback id.
- set input variable talk back key identification number which is unique with time.

Setup Module

- Set digital pin as a output with pin mode
- initialize the serial input as 9600.(i.e. The baud rate for serial input)
- Connection module
- Is Wi-Fi connected with the connection set up
- Establishing the connection with connection module.
- Data transfer will be started,
- Terminate the connection
- Otherwise, recheck the connection, goto step 2.

Explanation: As we already discuss that Node MCU having a inbuilt WiFicapability. Therefore at the starting point we have to establish a connection between Node MCU and Arduino IDE software by initialising the port module. After that call the ESP8266 header file as it is a inbuilt feature of Node MCU development kit. After that set the connection by enabling the wifi mode on then call the serial println() function. Output can be seen using serial monitor..delaycan be set as 5000 ,means displaying of the result will be after 5 second.

4.3 Connectivity with IR Sensor

Here we are proposing that how to connect infrared sensor with internet using node

MCU.Infrared Sensor is used for object detection. If any physical object (such as human or any physical thing) comes in front of IR Sensor then it detects that physical thing.

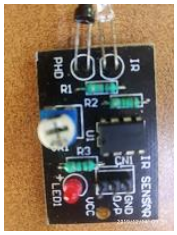

Fig 1: IR Sensor

4.3.1 Algorithm to Connect IR Sensor with NodeMCU

- start
- set D2 pin as output in Node MCU
- set D1 pin as input in node MCU
- call digitalWrite function (S)
- if S=high , then set D2 pin as high
- else set D2 pin as Low

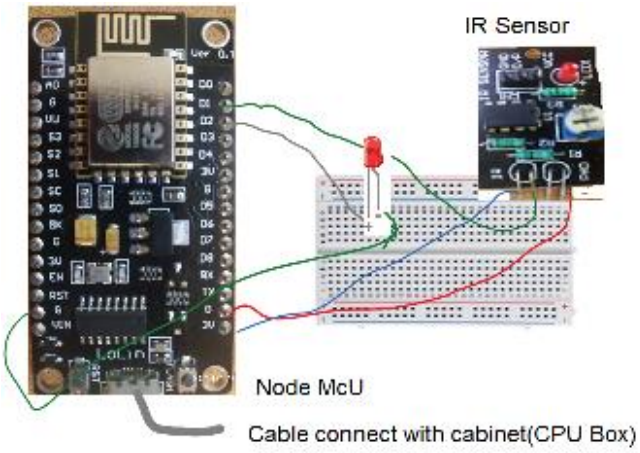

Fig 2: IR Sensor Connected with Node McU

Explanation: Node McU have 3.3 V , so this pin is connected with IR Sensor. Node MCU digital pin is connected with IR sensor and and D2 pin is connected to LED +ve pin. The –ve pin of LED is connected with the ground in node MCU circuit board.When the Node MCU is connected with the internet through the cable then after desired output will be achieved.

4.4Algorithm for Analog input with Light Dependent Register(LDR)

This algorithm shows how to connect light dependent resistor to internet via Node MCU board.LDR is also called photoresistors and it detects light. Light dependent resistor, resistance is inversely proptional to intensity of light.

LDR resistance = 1/ intensity of Light

It means when intensity of light decreases then resistance value of LDR sensor will increases.

- start
- initialize the serial input as 9600.(i.e.the baud rate for serial input)
- set A0 pin as input
- set S as analogRead with input pin A0
- output displayed on serial monitor
- Delay can be set as 500.

Explanation: Node McU as only one analog pin while Arduino IDE circuit board contains 6 analog pins.

In Node McU , when user required to read analog input , user have to use analogRead() function. And get result on serial monitor.

As we discussed earlier Node MCU circuit board has only one analogpin , here it will be connected with input.

We can also set the delay function. so that achieved output will not be displayed continuously.

4.5 Humidity and Temperature Sensor

DHT11 humidity and Temperaturesensor, operating voltage is 3 to 5Volt and current consumption is 2.5mA.this sensor detects humidity and temperature of the surrounded environment and produces output on serial monitor(arduino IDE).

Fig 3: DHT 11 Humidity Sensor

4.5.1 Algorithm for Humidity and Temperature Sensor

- Set digital pin D2 as DHT11
- Initialize serial input with 9600 baud.
- Initialize DHT
- Read temperature with serial input
- Read humidity with dht variable with serial input
- Delay can be set till 3000

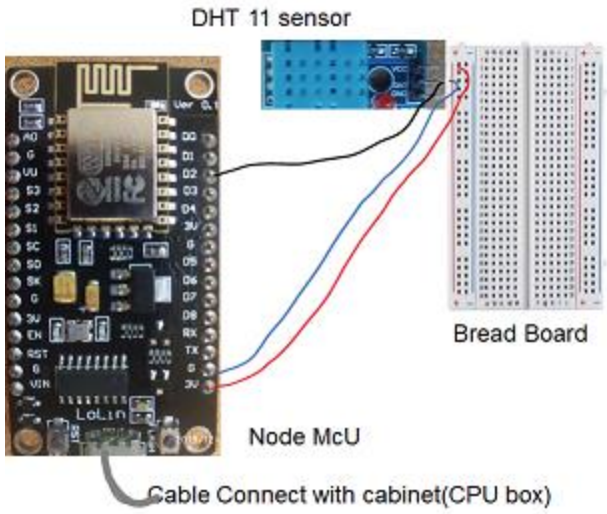

Fig 4: humidity Sensor Connected with Node McU

Humidity and Temperature is also called DHT 11 Sensors.

Explanation: In this proposed algorithm we describe how the Humidity and Temperature sensor works. For the connection, Node MCU 3V pin is connected to the V (Voltage) pin of DHT 11 sensor. Ground of DHT11 pin is directly connected to the Node MCU ground pin using Breadboard. Digital pin D2 of Node MCU circuit board s connected to theDHT11 sensor.

Output can be display in serial monitor while connecting Node MCU to computer via cable.

Delay can also be set. Therefore user can get the current room temperature and humidity measurement.

4.6Algorithm for Ultra Sonic Sensor for Measuring Distance

When Sound waves emitted by ultrasonic sensor travels and reach the object and reflect to the original source, then by calculating of the total distance travels will be the actual distance from sourceobject to destination object.

4.6.1 Algorithm

- Initialize set up
- Initialize serial input with 9600 baud
- Initialize D2 pin as output and D4 pin as input
- digitalWrite as D2 pin set as Low
- delay can be set in microseconds
- duration variable set as HIGH with D4 pin.
- Distance variable set as duration/29/2
- Call serial monitor by using Serial.println ()

Here we used air speed as 29 microsecond/cm.

V. Conclusion

This paper presents different algorithms for the connection between different types of sensors (such as IR sensor, Ultrasonic sensor, Temperature and Humidity sensor) with arduino IDE by using Node MCU. We also provide the wireless solution for IoT enabling devices.This paper also provides a brief description of Node MCU and Arduino UNO development board and explain the brief introduction of sensor and its types.In this paper we are trying to write the step wise step method to provide connectivity with IoT technology and development board Node MCU. Proposed algorithms are algorithm for glowing LED, algorithm to set wireless connection , algorithm for infrared sensor(IR Sensor), algorithm of connect light dependent resistor, algorithm for humidity and temperature Sensor(DHT11) and algorithm to connect ultrasonic sensor via Node MCU board.

There is also a comparative analysis of Node MCU ESP 8266 and Arduino UNO ATmega328P development board used for developing IoT based applications.

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