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Real Time Environmental Data Monitoring with Help of Wi-Fi Module and MQTT Protocol

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Abstract : The main objective of this paper is develop, real time data monitoring system for particular location like, home, cities, industries, hospitals, etc., where environmental information of various factors such as temperature, air pressure, humidity, and altitude need to be monitoring and get update with specific time interval. With the help of Wi-Fi module, sensors, and MQTT protocols, we can monitoring real time environmental data over remote location and get updating with it anywhere in world if internet connection present, and if internet connection not present than we can get updating with it in local connection via TCP/IP connection.

Keywords: MQTT, TCP/IP, MQTT-SN, DHT11, BMP180, E^{2}PROM, I^{2}C, SoC, QoS, TCP,

I. INTRODUCTION

Now a day, environmental data monitoring is important for home automation, cities'climate information, hospitals' environmental condition for perticular patient room, and industries' where environmental data is most important for production of specific product which is temperature and pressure sensitive.

Our main object is that, environmental information such as, temperature, humidity, pressure and altitude, which are getting by smart sensors, and these will send to Wi-Fi module, and it will send all data to MQTT broker, in term of specific topics name with the help of internet connection, and with the help of MQTT-SN these data will be received and monitoring by subscriber/client of that topics, anywhere in world. If internet connection not present in Wi-Fi module than module send data to TCP/IP stack and from that stack all local connected device in that Wi-Fi (local connection) will receive and monitoring that sensors' data.

The rest of the paper is classified as follows. Section II describe related work and give information about component selection and explanation about specific reson for that component selection. Section III describe our proposed system and information about proposed work. Section IV describe our experimental result, monitoring environmental data in remote location and local connection, and lastly Section V concludes of this paper.

II. RELATED WORK

We are going to make real time environmental data such as temperature, pressure, humidity, and altitude from reference height, monitoring system for specific location and getting update with help of MQTT protocols around the word if internet connection present nor in local connected device.

Here our main aim is making stable system with tiny hardware size, low cost, and low power consumption system.

A. DHT11 Sensor

For humidity capture we are using DHT11 sensor, it is a composite sensor contains a calibrated digital signal output of the temperature and humidity, it is low cost, long term stability, can be operate on low power supply range 3.5 V to 5.5 V DC. In it relative humidity resolution is 16 Bit, with repeatability ±1% RH, and measurement range is 20-90% RH. [1]

Here we are interested only in humidity as per our requirement, because for temperature measurement in it is limited to measure range between 0 to 50 ºC, with accuracy ±2 ºC while BMP180 sensor's range is –40 ºC to +85 ºC and give full accuracy data between 0 ºC to +65 ºC as per specification manual of this product.

B. BMP180 sensor

For temperature, pressure, and altitude we are using BMP180 sensor, it is the new digital barometric pressure sensor of Bosch Sensortec, with a very high performance. It consists of a piezo-resistive sensor, an analog to digital converter and a control unit with E^{2}PROM and a serial I^{2}C interface. The E^{2}PROM has stored 176 bit of individual calibration data. The pressure and temperature data has to be compensated by the calibration data of the E^{2}PROM of the BMP180. [2]

After sending a start sequence for start a pressure and/or temperature measurement and after converting, the result value (pressure and/or temperature) can be read via the I^{2}C interface. Here, for calculating temperature in °C and pressure in hPa, the calibration data has to be used. These constants can be read out from the BMP180 E^{2}PROM via

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the I^2C interface at software initialization. The sampling rate can be increased up to 128 samples per second (standard mode) for dynamic measurement. [3] It is low cost, very tiny sensor device, wth three environmental data parameters capture like, temperature range between –40 ºC to +85 ºC, pressure range between 300 to 1100 hPa, and give accurate altitude changes from reference height. It also operate in low power supply range 1.8 V to 3.6 V DC as per specification manual of this product.

C. ESP 12-E Wi-Fi module

For Wi-Fi module we are using ESP8266, which is SoC (system on a chip) based produced by Espressif Systems and it is a highly integrated chip designed to provide full internet connectivity in a small package. It is also serial Wi-Fi wireless transceiver module for IoT. [4]

Here we are using ESP 12-E which is latest module of ESP8266 series, and most suitable for our requirement because it have 22 different kind of pins including UART, GPIO, I^2C, MISO & MOSI of SPI interface, RST, power supply etc., listed on specification manual of ESP 12-E. More over it is small size Wi-Fi module and operate on 3.3 V DC low input power supply, so it is suitable for interface sensors' data and send that to connected MQTT broker, if internet connection present nor it send on TCP/IP stack so, local connected device can monitoring that data.

ESP 12-E version of ESP8266 most suitable for our requirement because, it support 802.11 b/g/n, additionally built-in TCP/IP protocol stack, TR switch, power amplifier and matching network, voltage regulator and power management components, and low-power 32-bit CPU, it can double as an application processor, and so more, can be found on specification of ESP 12-E, Wi-Fi module. In short it is System on a Chip (SoC). [5]

D. CH340G

It is a series of USB bus adapters, that provides serial, parallel or IrDA interfaces over the USB bus. We are using CH340G for provide 3.3 V DC power supply at both sensors and ESP 12-E Wi-Fi module because DHT11, BMP180 and ESP 12-E can be easily operate on this power supply. More over it is USB to serial adaptor module, which is ideal for interfacing a USB to UART of ESP 12-E, so by using it we can also programming our Wi-Fi module as per our requirement. [6]

E. MQTT

We aer using MQTT (Message Queue Telemetry Transport) protocol, and MQTT-SN for transceiver environmental data over remote location and getting update with that data anywhere in world. We are using MQTT, because it is a lightweight broker-based server and client/publisher/subscriber based messaging protocol designed to be open, simple, lightweight and easy to implement as per our requirement [7] more over it support three QoS, like QoS 0 – At most once, it look like Fire and forget, QoS 1 – At least once, it means it guaranteed that a message will be delivered at least once to the receiver and duplicate message also generates as per request, QoS 2 – Exactly once, it guarantees that each message is received only once.[8] MQTT is specialy for device to device and IoT (Internet of Things) connectivity protocol. It used at session layer in IoT protocol stack, and utilize IoT paradigm, it do not need extensive use of CPU resources, that's why it is lightweight. [9]

It is broker/client based protocol, for Wireless Sensor Networks (WSN), and operate over low bandwidth, constrain WSNs. [10] This protocol built on application layer stack of the TCP and it supports for the offline messaging for get it touch with disconnected clients at online broker, broker bridge also possible. [11]

This protocol work on lower latency when number of threads increases as compare to HTTP, its power consumption of device is low as compare to HTTP, and it support more features compare to HTTP like, keep alive message, three level of QoS, etc. [12] MQTT-SN provide end to end service over IoT. [13]

III. PROPOSED MONITORING SYSTEM

As maintain above we are making stable, very low cost, light weight, low power consumption and remotely real time data monitoring system with the help of sensors, (DHT11 & BMP180) Wi-Fi module (ESP 12-E), and MQTT protocol.

This system which used for transmitting environmental information data, like temperature, air pressure, humidity, and altitude changes from reference height send by sensors to Wi-Fi module, and with the help of Wi-Fi module to MQTT protocol, we can monitoring data in internet connected devices or local connected devices. Here, given proposed monitoring system diagram.

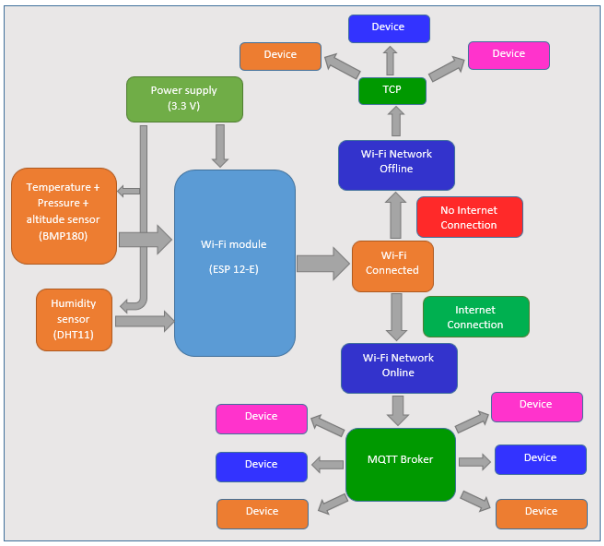

Figure 1: Proposed Monitoring System

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As shown in above proposed monitoring system diagram, required power supply provide by CH340G to both sensor and Wi-Fi module, now real time environ-mental data like temperature, air pressure, humidity, and altitude changes from reference height, transmit from both sensors (DHT11 and BMP180 via GPIO pin and I2C pin), to the Wi-Fi module, and it will connected to the provided Wi-Fi connection. Now, Wi-Fi module (ESP12-E) will check for the internet connectivity.

If internet connectivity present than it will connect to the MQTT broker and send all that real time data, and with the help of MQTT communication system, client can receive (monitoring) that data anywhere in world, in smart phone via My MQTT apps, and/or in the computer, by installing/configuring MQTT, and/or install web browser extensions of MQTT.

Now, if client have not internet connection than client must be in local connection where Wi-Fi module is connected, and it can also monitoring that data via TCP/IP connection in its mobile device, and/or computer by configure MQTT in local connection IP address.

This system worked in both mode, online and offline; for monitoring real time environmental data send by sensors. We can monitoring this real time environmental data in remotely client, if that client have internet connection in its mobile and/or computer, if client is stable and have not internet connection, than it will be monitoring that data in local connection

IV. EXPERIMENT RESULT

For programming, writing code, debug, and upload to Wi-Fi module via UART of CH340G, we use open source Arduino IDE. Now testing and establishment both sensors' real time environmental data (humidity, temperature, altitude changes from reference height and absolute pressure,) monitoring system with ESP 12-E over online with help of MQTT protocol and IoT.

Here given 3.3 V from CH340G to DHT11 sensor's VCC pin; BMP10 sensor's VCC, and 3.3 V input pin and ESP 12-E's VCC pin. Given ground supply from CH340G to GPIO 0, GPIO 15, and GND of ESP 12-E; DHT11's GND pin and BMP180's GND pin.

For receiving real time data from both sensors; for DHT11 sensor, connect DATA pin of DHT11 to GPIO 2 pin of ESP 12-E, and for BMP180 sensor, connect SCL pin of BMP180 to GPIO 5 of ESP 12-E and SDA pin of BMP180 to GPIO 4 of ESP 12-E. Now, Wi-Fi module send all real time data to online MQTT broker with help of IoT, and other client around world can receive that data by subscribing topics.

Here, given capture snapshot of real time data monitoring of both sensors data in serial terminals, as well as in android phone via My MQTT app (client/devices) in online mode. We can monitoring that data anywhere in world with help of MQTT and IoT, by subscribing created topics, in which real time data send by ESP 12-E to MQTT protocol.

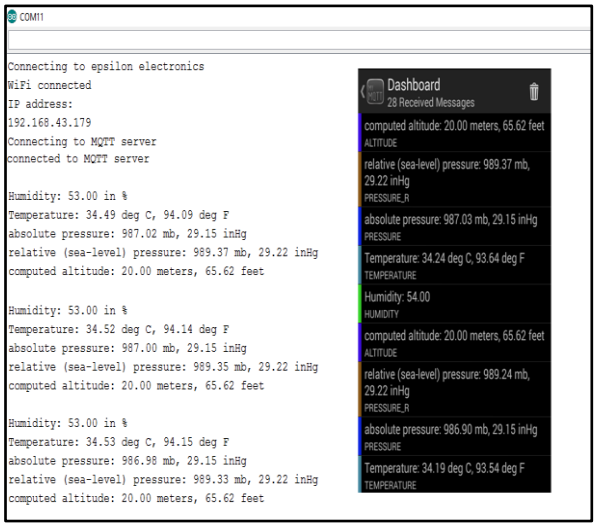

Figure 2: Real time data monitoring in serial terminal and in My MQTT app (client)

Here, we can monitoring that data in different devices, like smart/android phones, any web browser by installing in MQTTLens. For offline monitoring as maintain above connection are same, but when internet connection not found in ESP 12-E module than it will send all data to local connected TCP/IP stack, and from serial terminal and local connected devices like, PC/Laptop, smart phone moblie, we can monitoring that data by installing and configure MQTT in local connected IP address.

V. CONCLUSION & FUTURE WORK

In this paper, we describe environmental data moni-toring system, which are low cost, low power consumption and tiny size of hardware used. In this system we can monitoring all required data over internet connection or offline connection mode. Here we use QoS 0 of MQTT, it is fire and forget type, can't store and resend data.

As a part of our future work, we continue to work for provide all three QoS of MQTT, by using QoS 1 we can get specific data of particular time and we can also receive duplicate data as per our requirement, by using QoS 2 we can get data exactly once, it will store data when client offline or not available, and send only once.

REFERENCES

[1] Temperature and humidity module DHT11 Product Manual, [Online]Available:https://akizukidenshi.com/download/ds/aosong-/DHT11.pdf (accessed on June 13, 2016)

[2] BMP180 Digital, barometric pressure sensor, [Online] Available: https://aebst.resource.bosch.com/media/_tech/media/product_flyer /Flyer_BMP180_08_2013_web.pdf (accessed on June 14, 2016)

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 9, September 2016

[3] Data sheet BMP180 Digital pressure sensor, [Online] Available: https://cdn-shop.adafruit.com/datasheets/BST-BMP180-DS00009.-pdf (accessed on June 14, 2016)
[4] ESP8266 Wi-Fi Module, [Online]. Available: http://www.esp-ruino.com/ESP8266 (accessed on June 15, 2016)
[5] ESP-12EBriefSpec,[Online]. Available: http://www.seeedstudio.-com/wiki/-images/7/7d/ESP-12E_brief_spec.pdf (accessed on June 15, 2016)
[6] CH340G USB to UART Interface Datasheet, [Online] Available: http://cdn2.boxtec.ch/pub/diverse/ch340g-datasheet.pdf (accessed on June 17, 2016)
[7] Dave Locke, "MQ Telemetry Transport (MQTT) V3.1 Protocol Specification" [Online]. Available: http://www.ibm.com/-developerworks/library/ws-mqtt/ (accessed on June 18, 2016)
[8] MQTT Essentials Part 6: Quality of Service 0, 1 & 2 [Online]. Available: http://www.hivemq.com/blog/mqtt-essentials-part-6-mqtt-quality-of-service-levels (accessed on June 18, 2016)
[9] Home of RF and Wireless Vendors and Resources, "What is MQTT in IoT" [Online]. Available: http://www.rfwireless-world.com/ Terminology/MQTT-protocol.html (accessed on June 18, 2015)
[10] Hunkeler, U.; Hong Linh Truong; Stanford-Clark, "MQTT-S — A publish/subscribe protocol for Wireless Sensor Networks", A Communication Systems Software and Middleware and Workshops, 2008. Cited by: Papers (35) | Patents (1) IEEE Conference Publications COMSWARE 2008. 3rd International Conference on Year: 2008 Pages: 791 - 798, DOI: 10.1109/COMSWA-2008.4554519
[11] Collina, M.; Bartolucci, M.; Vanelli-Coralli, A.; Corazza, G.E. Internet of Things application layer protocol analysis over error and delay prone links, IEEE Conference Publications, Advanced Satellite Multimedia Systems Conference and the 13th Signal Processing for Space Communications Workshop (ASMS/SPSC), 2014, Year: 2014 Pages: 398 - 404, DOI: 10.1109/ASMSSPSC-.2014.6934573
[12] Hsiang Wen Chen; Lin, F.J. Converging MQTT Resources in ETSI Standards Based M2M Platform, IEEE Conference Publications Internet of Things (iThings), 2014 IEEE International Conference on, and Green Computing and Communications (GreenCom), IEEE and Cyber, Physical and Social Computing(CPSCom), IEEE Year: 2014 Pages: 292 - 295, DOI: 10.1109/iThings.2014.52
[13] Govindan, K.; Azad, A.P. End-to-end service assurance in IoT MQTT-SN, IEEE Conference Publications Consumer Communications and Networking Conference (CCNC), 2015 12th Annual IEEE Year: 2015 Pages: 290 - 296, DOI: 10.1109/CCNC.2015.7157991