iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** IX **Month of publication:** September 2021

DOI: https://doi.org/10.22214/ijraset.2021.38193

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue IX Sep 2021- Available at www.ijraset.com

Industrial Monitoring Using Internet of Things -A MQTT Paradigm

Madhuri Bagewadi[1], Ashok Kusagur[2]
[1, 2]Electrical and Electronics Department, University BDT College of Engineering

Abstract: Internet of things (IOT) has taken a very pervasive role in our technological advancement. Today we find development in medical, schools, industrial sectors using IOT to enhance their operations. IOT is used in medical to gather information about patient's health records, in schools' teachers are able to track attendance of students in the campus, in industries motor controls, maintenance, and predictive fault analysis are some of application. The architecture of IOT is setup in such a way that sensors and actuators are connected to the internet. The devices on which interface to internet are small embedded modules such as microcontroller which have limited resources and processing power at the edge. Hence an efficient and reliable communication protocol is needed which fulfills the design criteria. MQTT is implemented using client and broker network entities. In this paper a hardware system is developed which tracks and monitor the parameters like temperature, RPM, vibration, load current and voltage of induction motor. A Dashboard is developed which illustrates the various parameters on IOT cloud platform which can be accessed remotely.
Keywords: MQTT-Message Queuing Telemetry Transport, edge computing, Industrial IOT.

I. INTRODUCTION

IOT technology started to be developed as a means to support autonomous, and remote monitoring and control of industrial machines. Today we see widespread adoption in cities, homes, shopping malls, hospitals. The increasing miniaturization of microprocessors and low-cost storage has facilitated the growth of IIOT. Logistics firms constantly rely on IOT for stocks inventory, resource allocation and delivery, route planning. Medical hospitals and institutes use patient monitoring to track patient's health in real time. Smart cities are using LDR sensor to switch street lights, track traffic flow on roads, cameras to provide surveillance and keep tab on criminal activities. All these activities can be boiled down to two main process namely process control and monitoring(acquisition) of data. The common communication protocol used are HTTP and MQTT protocol. HTTP is suited for web application whereas it is insufficient for hardware data acquisition and deployment. MQTT is light weight and sits on top of the TCP/IP protocol as an application layer protocol.

In industries wired communication technology is predominant used. However, closed loop through wired technologies are having additional cost associated with them. Thus, wireless multi-hop technologies offer better manageability and connectivity. some of the technologies in this domain include WirelesHART, ZigBee and ISA100.11a. But a caveat with such technologies is that it is mainly used for non-critical applications.

II. LITERATURE SURVEY

The energy cost of sharing GPS location using MQTT, HTTP as application protocol in their standard mode is presented in paper [1]. An android application was developed to share the location. This application is tested using HTTP and MQTT protocol to study the energy behaviour. The studies conclude reduced energy consumption in MQTT when compared with HTTP.

Web protocol and challenges of web latency is discussed in the paper [2]. A study of the application layer protocol HTTP/1.1 and HTTP/2 on the performance and latency of web application. The framework of HTTP network is consisting of servers and other mesh connected computer which can be bottle necks, as a result come in to factor of the latency of the protocol and thus the overall IOT system. However, the results of the study show improvement at the server level and nothing significant performance gain at the client side.

In the context of industrial internet of things understanding the target system is an important pre-requisite for choosing the most appropriate messaging technology. MQTT still fill in this role as light weight and interoperability between MQTT publisher and subscriber can be guaranteed. Asynchronous communication coupled with publish and subscribe message exchange is useful for systems that need communication over the internet. MQTT is simple and light weight solution.

A comparison of different messaging protocols for industrial internet and IOT is discussed in paper [3]. The challenges and features of each protocol is presented. MQTT and CoAP used broker to route message to the receiver.

Thus, they both face similar issues of reduced performance due to latency; throughput drops. MQTT dependents on TCP/IP transport whereas CoAP works on UDP. MQTT provides a rich QoS services whereas CoAP provides rudimentary message delivery QoS.

A comparison of energy efficiency of message transport between CoAP and MQTT in the context of health level seven (HL7) is studied in [3]. Power consumption of COAP reduces with increase of polling interval. It concludes that under similar CPU and polling interval MQTT uses less resources in comparison to CoAP.

This paper [4] developed a middleware based on MQTT and CoAP protocol for transport of aggregated sensor data at the gateway node to the backend server or broker. The authors developed the middleware to accommodate different application protocols based on the "publish-subscribe" architecture gateway and also study the performance of the two protocols. It found MQTT showing better performance results.

A number of applications require the use of sensors for data collection and making use of MQTT and CoAP [4 -6]. The rapid pace of development of web has necessitated the need for real time and low latency response. But the traditional web protocol HTTP/1.1 is reaching its limits. The introduction of HTTP/2.2 is helping ease of problem. As well as being low latency, it is able to multiplex a greater number of channels over a single connection. Application such as instant messaging and online presence using XMPP and SIP [10] have support over the new HTTP/2.2 protocol. web server application using RESTful client/server-side protocol are designed in HTTP and CoAP [5,7].

A study based on existing product "OneCare" to monitor patient Pulse oximeter, ECG data and transmit data to remote receiver which stores the acquired data is presented in paper [8]. An efficient transmission algorithm is developed which transmits data between monitoring device and remote receiver. The application of such a technology has implication in health care for individuals in remote or rural areas have access to doctors in geographically distant regions.

MQTT For Sensor Networks (MQTT-SN) Protocol Specification Version 1.2. 2013. MQTT-SN protocol is designed specific to address the issues of the wireless transmission. Compared to wired communication wireless transmission faces issues of packet loss, interferences, and fading. The Wireless sensor network based on IEEE 802.15.4 provides maximum bandwidth of 250kbits/s in the 2.4 Ghz band. The packet length supported by IEEE 802.15.4 is 128 bytes. MQTT-SN is optimized for energy efficiency keeping in mind devices powered by battery and with limited processing and storage resources.

MQTT-S a publish/subscribe protocol for wireless sensor is studies in this paper. MQTT-S is an extension of MQTT. Some of the features of this protocol are low power and low cost when deployed in WSN networks such as Zigbee or TinyOS based network. ZigBee is non-TCP/IP network protocol. Zigbee follows IEEE 802.15.4 protocol for wireless personal area network. (WPANs).

MQTT finds applications in robotics [10], medical [8], education [9]. With the help of sensor network MQTT-S protocol fill in the gap for low bandwidth and low power application. Nevertheless, both MQTT and MQTT-S provide QOS along with different mode of publish and subscribe service. A deeply embedded wireless device name "mica" presented in [12]. It consists of microprocessor with network capabilities in small 1.25x2.25 inches form factor. A Realtime OS TinyOS operating system is used for scheduling I/O and communication capabilities. Mica behaves as a data route, sensor interface and control point.

New approach for securing communication over MQTT protocol A comparison between RSA and Elliptic Curve. The security of data transmitted by MQTT nodes has always been an important basic issue. Literature [13] compared the application of RSA encryption algorithm and elliptic curve encryption algorithm in MQTT, and proposed to use two kinds of RSA and elliptic curve for processing in the encryption/decryption stage. To address the issues of security and very low latency response MEC paradigm is presented in the paper [14]. Vehicular networks, smart health services require high degree of reliably and responsiveness. Such critical system failure can lead to death of individuals. The mobile edge computing (MEC) paradigm provides a heretical architecture which mitigates data tampering, eavesdropping, and replay attacks through the use of cryptography.

MQTT client is used to connect to the MQTT broker [15]. The client should support basic features such as publish, or subscribe to topics. While these features are standard but when testing feasibility among a wide availability of MQTT clients a comprehensive parameters list is considered. Some of these features are listed below.

1) Supporting client authentication, configuring certificates and encryptions connections.
2) Cross platform support under different operating systems
3) Simple and institutive interface and debugging mechanisms.
4) Payload conversion support.

Some of the various MQTT client tools are MQTT X, Mosquito CLI, MQTT.fx, MQTT Explorer, MQTT Box, MQTT-spy, MQTT Lens, MQTT WebSocket Toolkit.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue IX Sep 2021- Available at www.ijraset.com

III.DESIGN AND IMPLEMENTATION OF PROPOSED SYSTEM

The hardware description and software description are detailed in the following sections.

A. Hardware Section

The entire document should be in Times New Roman or Times font. Type 3 fonts must not be used. Other font types may be used if needed for special purposes.

1) Raspberry pi

Figure 1:Raspberry pi

The raspberry pi is embedded system device consisting of 64-bit quad core processor. Additionally, it consists of 40 GPIO's which are used for interfacing with sensors. WIFI module present on the board allows to connect to internet.

2) Temperature Sensor

Figure 2: Humidity and temperature sensor

The DHT11 is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin.

3) Current Sensor

Figure 3: Current sensor

The ACS712 Module is a Hall Effect sensor to measure current. The range of ACS712 module current range of up to 20A. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer.

4) Relays

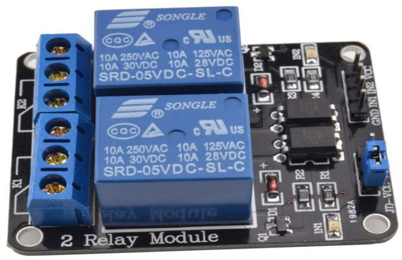

Figure 4: Relay

The main purpose of a relay is to switch between high voltage line without interfering with low voltage circuit. The relay module shown in figure 3.11 is relay module with an optocoupler. The advantage of using an optocoupler is isolating the relay driving circuit from the microcontroller. Because mechanical switches use solenoid coil to magnetize and demagnetize contacts, they end to generate back EMF which can cause voltage spikes and damage the controller.

B. Software Section

1) Node Red programming

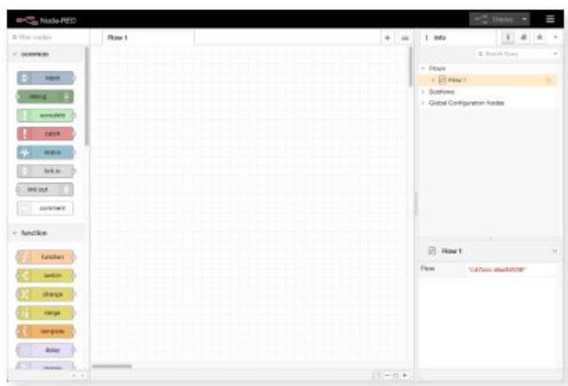

Figure 5:Node-Red editor window

Node-RED is a model-based programming tool. It abstracts away the need for writing code by the use of functional blocks. These functional blocks are then wired together with the hardware devices. The functional blocks provide different functionality and easy API interface for transmission using the internet protocols. There is no special software to be installed as It can be open in a browser. The editor wide range of nodes in the palette that can be deployed to its runtime in a single-click.

2) *Thingspeak IOT:* Thingspeak is an IOT aggregator platform. It consists of many features such as graphs displays, dashboard, secure communication using read and write API keys. API interfacing is relatively simple to implement on the microcontroller. It also publishes this online or keep the dashboard view private. Data from different sensors can be pushed on the platform and it gets stored in the cloud. Historical data analysis is possible by pulling the data from cloud. Using mathematical and machine learning algorithm it is possible to derive insights. An additional feature of the Thingspeak is that it is able to set threshold values for the parameters so when there is overflow it is able to send a alert to the mobile phone. This is particular important for operators in industrial environment to be instantly alerted if something is operating properly in their absence.

IV.RESULT AND DISCUSSION

The webserver we use in this report is ThingSpeak. The Dashboard is updated in real time as and when the devices or sensors sends the data. As the data can be view form any computer or phone, as long as it has access to internet. Here in the figure below is the view of sensors reading of different parameters and their timeline. Every time instance when the value is uploaded is recorded. The type of graph can also change to display mean, median or mode values as well. The webserver we use in this report is ThingSpeak. The Dashboard is updated in real time as and when the devices or sensors sends the data.

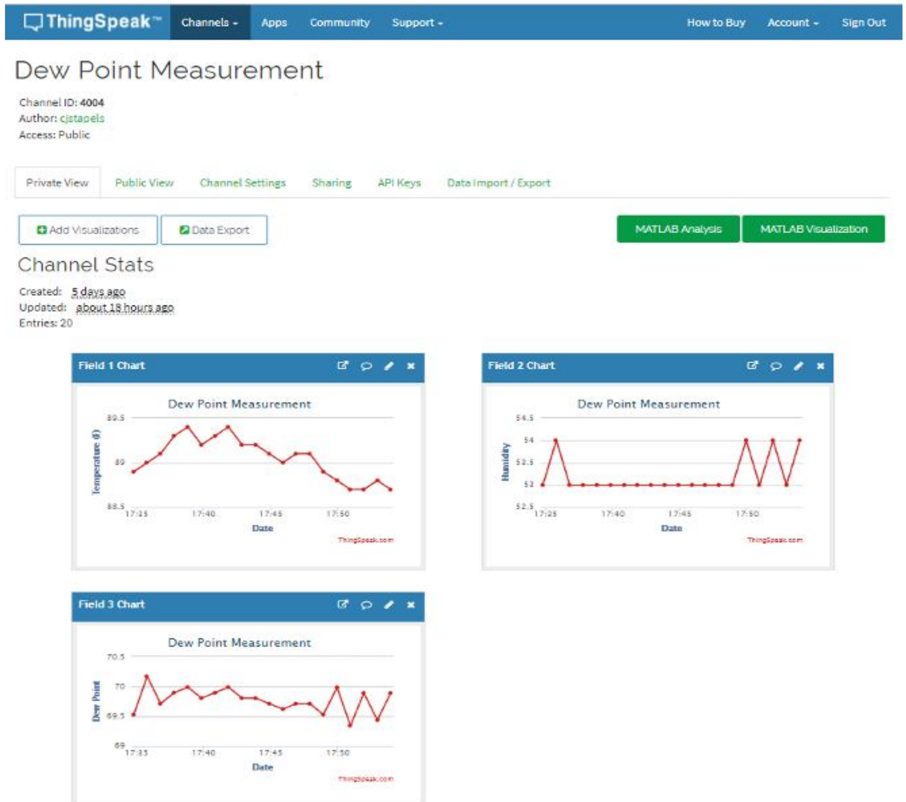

Figure 6:Field Window of Industrial Sensor

As the data can be view form any computer or phone as long it has access to internet sensor whether it is connected ThingSpeak automatically charts the data that you send it, so you can remotely monitor your devices or equipment from anywhere. View your data from any web browser or mobile device. Share read-only views of your data with the clients and colleagues that you specify. Alternatively, you can use ThingSpeak to manage your data, and you can build your own front end for your clients and customers to log in to.

V. CONCLUSION

In this paper MQTT was implanted and sensor data of induction motor was implemented using MQTT and the aggregated data was hosted on IOT ThingSpeak website. The Dashboard was used to display the real time value of sensors. The relay was controlled by a button that was embedded on the webserver UI. Whenever the button is pressed a command is send from the server to the raspberry pi to turn off the relay.

REFERENCES

[1] Jon Vergara E, Prihodko M, Nadjm-Tehrani S. Mobile Location Sharing: An Energy Consumption Study.
[2] Naik N, Jenkins P. Web protocols and challenges of Web latency in the Web of Things. In: International Conference on Ubiquitous and Future Networks, ICUFN. IEEE Computer Society, 2016, pp. 845–850.
[3] Faruk Çoban H. AN EXPERIMENTAL COMPARISON OF MESSAGING PROTOCOLS MQTT AND COAP, https://open.metu.edu.tr/handle/11511/26444 (2017, accessed March 22, 2021).
[4] Thangavel D, Ma X, Valera A, et al. Performance evaluation of MQTT and CoAP via a common middleware. In: IEEE ISSNIP 2014 - 2014 IEEE 9th International Conference on Intelligent Sensors, Sensor Networks and Information Processing, Conference Proceedings. IEEE Computer Society, 2014. Epub ahead of print 2014. DOI: 10.1109/ISSNIP.2014.6827678.
[5] Bandyopadhyay S, Bhattacharyya A. Lightweight Internet protocols for web enablement of sensors using constrained gateway devices. In: 2013 International Conference on Computing, Networking and Communications, ICNC 2013. 2013, pp. 334–340.
[6] de Caro N, Colitti W, Steenhaut K, et al. Comparison of two lightweight protocols for smartphone-based sensing. In: IEEE SCVT 2013 - Proceedings of 20th IEEE Symposium on Communications and Vehicular Technology in the BeNeLux. 2013. Epub ahead of print 2013. DOI: 10.1109/SCVT.2013.6735994.
[7] Grigorik I. Making the web faster with HTTP 2.0. Communications of the ACM 2013; 56: 42–49.
[8] Barata D, Louzada G, Carreiro A, et al. System of Acquisition, Transmission, Storage and Visualization of Pulse Oximeter and ECG Data Using Android and MQTT. Procedia Technology 2013; 9: 1265–1272.

[9] Prada MA, Reguera P, Alonso S, et al. Communication with resource-constrained devices through MQTT for control education. IFAC-PapersOnLine 2016; 49: 150–155.
[10] Amaran MH, Noh NAM, Rohmad MS, et al. A Comparison of Lightweight Communication Protocols in Robotic Applications. In: Procedia Computer Science. Elsevier B.V., 2015, pp. 400–405.
[11] Stanford-Clark A, Truong HL. MQTT For Sensor Networks (MQTT-SN) Protocol Specification Version 1.2. 2013.
[12] Hill JL, Culler DE. Mica: A wireless platform for deeply embedded networks. IEEE Micro 2002; 22: 12–24.
[13] Mektoubi A, Hassani HL, Belhadaoui H, et al. New approach for securing communication over MQTT protocol A comparaison between RSA and Elliptic Curve. In: Proceedings - 2016 3rd International Conference on Systems of Collaboration, SysCo 2016. Institute of Electrical and Electronics Engineers Inc., 2017. Epub ahead of print January 23, 2017. DOI: 10.1109/SYSCO.2016.7831326.
[14] de Rango F, Potrino G, Tropea M, et al. Energy-aware dynamic Internet of Things security system based on Elliptic Curve Cryptography and Message Queue Telemetry Transport protocol for mitigating Replay attacks. Pervasive and Mobile Computing 2020; 61: 101105.
[15] Hunkeler U, Truong HL, Stanford-Clark A. MQTT-S - A publish/subscribe protocol for wireless sensor networks. In: 3rd IEEE/Create-Net International Conference on Communication System Software and Middleware, COMSWARE. IEEE Computer Society, 2008, pp. 791–798.