An MQTT based IoT-RFID Attendance System using NodeMCU Firmware: A Review

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Abstract - *Taking traditional manual pen-paper attendance, which is very time-consuming, insecure and usually leads to human errors as well as prone to misconduct, as the valuable time and work gets wasted in organizing and structuring the attendance data in registers. Hence to overcome this major hectic problem, we have used relational database management system in real time with appropriate security measures to access, manipulate and represent the data on the basis of the unique RFID tags, which gets fast and easily scanned on the RFID reader. This system consists of hardware and software with most trending implementation of a lightweight MQTT protocol in IoT technology; designed to take an attendance on the basis of RFID technology with NodeMCU firmware. The main objective of this proposed system is to make the effective and efficient computerized attendance on institutes website in excel sheet format with a particular date and students can also see their particular subject attendance on the webpage.*

Key Words: **IoT, RFID, NodeMCU, MQTT protocol.**

1.INTRODUCTION

1.1 Problem Definition

Existing system is traditional and manual pen-paper work attendance, where lecturers have to take attendance every time of class or session in 3 ways, which are time wasting, ineffective, inefficient. They are

1.on register by calling roll number or name, wasting quality time of teaching.

2.on blank paper which gets circulated by students during lecture.

3.on attendance sheet which already having name, roll call need to be signed by students. Therefore, getting chance of proxy purposely, missing any student to make attendance.

As manual conventional method of traditional pen paper attendance is cost consuming requires more papers, registers and space consuming needed to put proper location, time wasting of quality teaching leads to loss of education. This conventional attendance is insecure, inefficient and leads to human error.

1.2 IoT Concept

The Internet of Things (IoT) is a concept of revolutionary change taking place to promises transform in world of interrelated computing devices by transmitting data and automate tasks without human intervention. IoT invokes opposing emotions. So, it is nothing but connecting physical devices over the internet to make communication simple and easier.

1.3 Overview of RFID and NodeMCU

RFID (Radio Frequency Identification) technology is one of the types of Automatic Identification and Data Capture (AIDC) method. As AIDC methods automatically identify objects, collect data about them, gets that data directly into computer system, with little or no human involvement. RFID technology uses radio frequency electromagnetic fields to transfer information from an RFID tag to RFID reader using 13.56MHz electromagnetic field for identification purpose.

RFID system comprises of RFID reader, RFID tags and antenna, is used to transmit and receive information through radio waves at a distance without wires. RFID reader can be grouped into three categories: low frequency, high frequency and ultra-high frequency. As per need, RFID tags maybe active or passive tags.

Compare with barcode - RFID provides fast identification, no line of sight, reusable to rewrite or update, higher data storage, higher read rate, multiple reading, durable, maximum distance reading without interference.

In comparison with other identification technologies - RFID technology offers quality, security, supply chain optimization, Better individual identification, better storage flexibility, real time information and better ergonomics.

Recently, UP state has made mandatory this technology for vehicle operating to use RFID tags along with E-way bill from 1 Nov, 2018.

NodeMCU is an open source firmware and development board with ESP8266 helps to build IoT products. ESP8266 WIFI module is a low-cost microcontroller with WIFI capability and full TCP/IP stack to make easier IoT platform. NodeMCU have built-in support for wireless networks compared to Arduino and Raspberry Pi.

1.4 MQTT Protocol

MQTT (message queuing telemetry transport) protocol is a lightweight, small in size, publish-subscribe network protocol that transports messages between devices with low bandwidth environments. So, its perfect solution for IoT applications due to its feature. MQTT uses transport layer security (TLS/SSL) encryption with bidirectional connection support. This simple messaging protocol allows to connect, disconnect, subscribe and publish to subscribed one on request with acknowledgment. We have three options for hosting an MQTT broker. Use own locally installed broker/server, which is we have used. Second use of cloud-based server or virtual server and third one by use of shared server application.

2. LITERATURE REVIEW OF LAST 15 YEARS ON RFID BASED ATTENDANCE SYSTEM

A. Qaiser et al. (2006) proposed time attendance system using RFID technology and window services to made some facilities taking parents in account, sending of SMS, email, reports with concern. This system discussed various issues like proxy, weightage, probation analysis, submission warning and teaching time loss.

T. S. Lim et al. (2009) focuses on the issue of student irregular attendance. This system used RFID technology with microcontroller and tends to implemented in school, colleges and universities. It is an automated scanning system that is represented by parallel line of different width which stores information regarding an object. The proposed system uses real time clock function to gain accurate results, and viewed using software called HyperTerminal, which is connected to computer using RS232 (USB) to store the data into the database. The system tends to be vital with physical advantages as low cost, light weight, user friendly, compact design and portable.

A. Kassem et al. (2010) focuses on the factors such as reliability, time saving and easy control. This system defined prototype using RFID system. This implementation only applicable for small scale setup. The further attempt will be made to modify the RFID for completing application on a large scale. The application has three modules student faculty and administrator.

M. Kassim et al. (2012) described web-based attendance for academic performance and progress uses MySQL database, focuses on time consuming and inefficient method of conventional manual attendance. It consists of three module RFID reader, data reporter and web server module and works on TCP/IP protocol.

M. B. Srinidhi et al. (2015) developed system safe and secure four-tier architecture using biometric, GSM and RFID technology, records attendance of students and staff members and tracks their location in campus. The SMS and email facilities were proposed for lagging attendances for both students and parents. It has been developed with desktop and android version for remote access. System gives student's consistency graph throughout semester.

Sri Madhu B. M. et al. (2017) developed attendance system to reduce time consumption by traditional attendance. It's implementation of IoT through raspberry Pi 3 and RFID technology to make automated one and developed android app for students can check their attendance anywhere.

H. K. Nguyen et al. (2017) developed using RFID based on the mobile communications and IT technologies, to put into use at any gatherings such as conferences, exhibitions, training courses, etc. and scaled from small to large venues depending on the need. The system is designed to generate real time consolidated reports on attendance, which collects records and processes data on participants of any conference or event. This paper suggests to use ESP8266 for low cost WIFI chip purpose as MRF24WB0MA module were used for development, which is three times costlier.

H. U. Zaman et al. (2017) presents RFID reader as established approach for recording attendance system, used SD card and the Thingspeak API cloud server, as it provides real time data collection with ESP8266 WIFI module.

The proposal of merging the IoT and RFID technology to establish attendance system is discussed in number of researches. There are many papers presented for making advance effective, efficient and reliable system.
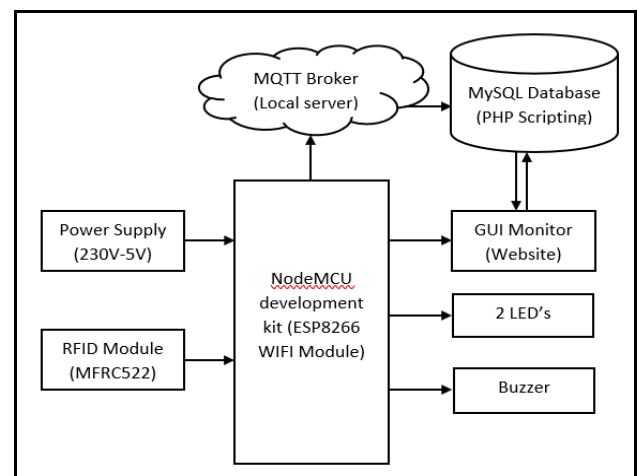
3. PROPOSED SYSTEM

Fig -1: Block diagram of proposed system

In this research project, proposed system as shown in fig - 1 consists of NodeMCU as a heart and brain of system i.e. ESP8266 WIFI module which works as IoT platform. At the input side, RFID module which is interfaced with NodeMCU, consist of RFID reader and RFID tags. This tag gets scanned in front of RFID reader. ESP8266 reads the serial number on the RFID tags, so needs to be programmed in Arduino IDE to provide access when right and valid card is detected at the same time LED blinks for confirmation of attendance. Here,

power circuitry is used as power supply. Because RFID, ESP8266 works on 3.3V for the sake of step-down transformer criteria as hardware connected to computer through micro USB cable. Now, at the output side attendance gets marked and displayed on website of institute's portal after light blinks. Website will be graphical user interface (GUI) as showed on chrome browser of computer monitor (local server) with downloadable excel sheet for faculty superior use.

3.1 System Components

The RFID Module - It acts as input device consists of RFID reader and RFID tags with antenna. RFID reader uses radio waves to read and capture information data stored on a tag when it gets swiped over that reader. Hence, RFID technology is applied to reduce the time involved in recurrent manual attendance.

Mifare RC522 RFID module is used, which is low cost, compact size, low power consumption, portable can be installed anywhere as needed. The whole system uses the LF - passive RFID reader and tags with inductive coupling method. Students must need to enter in the class. So, passive tags are used, as it does not contain battery, the power induced by the magnetic field of reader to read to tag ID.

ESP8266 WIFI Module - It acts as IoT firmware which is NodeMCU development board helps to execute prototype to connect with database of local server with Wi-Fi credential. It needs to be programmed in Arduino IDE by installing esp8266 board with selecting proper board, baud rate and COM port when connected to local computer by micro USB cable. To interface ESP8266 and RC522 for read and write tags in database, we need to install library MFRC522, SPI and PubSubClient library for MQTT protocol.

Web Server (XAMPP) - The web server is either software or hardware that deliver content through internet accessible with the graphical user interface (GUI). It provides website functionality by accepting requests from user's browser and responds by sending back PHP files. To enable the system dynamic functionalities, the web server hosts the data collector component, a database and GUI pages enabling online interaction with the system users from client computers. To run local dynamic website, XAMPP is installed as local server platform and tested on a local computer using Apache and MySQL start-up module in XAMPP control panel

Database - A database is a structured collection of data and adds, access and process data stored in a computer. MySQL is an open source relational database management system in real time with security measures to access, manipulate and represent the data on the basis of unique RFID tags, and saves locally on SQL Web database.

Graphical User Interface (GUI) - It is nothing but to see overall output in visual indication of website with attendance table on computer. The dynamic websites have been designed and all dynamic web pages form which driven by MySQL

database. Web pages grab information from the database which is connected by PHP and inserts that into web pages each time when loaded.

3.2 Methodology

The proposed system methodology consists of four phases.

1)RFID data reading - RFID reader (RC522), RFID tag (student's ID card) and NodeMCU development board (ESP8266 WIFI module) are included in RFID data reading.

2)Data input to database - Arduino IDE sketch code programmed with ESP8266 to connect with database. Arduino code processed for data input to database by using PHP to MySQL database system of local XAMPP server.

3)Data report to web browser - CSS, JavaScript and PHP server scripting languages are used for data report to web server.

4)Hosting MQTT broker - To integrate the RFID tags in IoT, publish subscribe pattern of MQTT protocol is used. We will be using small footprint Paho MQTT as client implementation to publish and receive data from server, as it is machine to machine protocol.

4. SYSTEM DESIGN AND IMPLEMENTATION

For hardware design, RFID module and ESP8266 module are used as the main hardware component in research project. RFID tags used for registration and later on for attendance. ESP8266 Wi-Fi module has Wi-Fi feature for data transfer from RFID tag to the local website in web browser of web server. Internet connection require to establish NodeMCU connection via router, phone or any hotspot network in LAN area.
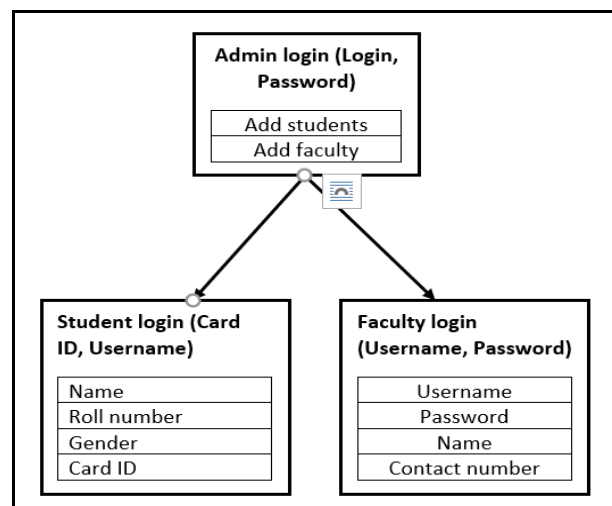

Fig -2: Simplified navigation flow of dynamic website

Fig-2 describes simplified navigation flow of dynamic website. Website designed in such way that consists of mainly 3 modules. 1)admin module has login credential and has right to add students by card ID and faculty member by details

with login credential. 2)faculty module can see student's attendance record with easily downloadable excel sheet. 3)student module can see own attendance for better academic purpose.

Working Principle

New student ID card swiped over RFID reader to capture and recognize the card's unique ID by admin. The captured ID is then used to register as student's ID into the database and gets allotted. Once registered, the student can record the own attendance by swiping ID over reader. As per flowchart (Fig-3), the student's marked attendance when it's ID get matched with database of system.

Initially, the system starts when student's ID gets swiped near to the RFID reader. It receives unique ID because every RFID tag of student has unique ID number. It starts to search that ID in the system database. If unique ID is found and matched with database, then it marks attendance of that session i.e. theory or practical or tutorial. So, that particular student allotted and marked the attendance is updated for that session. Likewise, all attendance of class and session are marked and saved to the database on server with downloadable excel sheet on the account of MQTT protocol. On the response of ESP8266, localhost publishes useful data to subscribed one. Localhost server which is website of institution works as MQTT client. RC522 client publishes data to ESP8266. ESP8266 MQTT broker publishes that data on subscribed computer IP. Paho client implementation will run in python coding to publish data to broker. At the last, faculty can see attendance record of student, also can able to see date wise attendance by particular session or lecture by selecting date. Student can also see their attendance by roll number to improve academic performance.
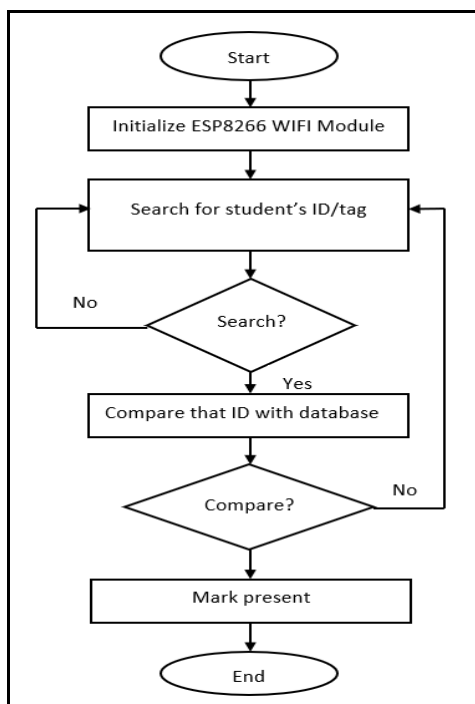

Fig -3: Attendance flowchart

5. CONCLUSION

Our aim is to get effective and efficient time-saving automated computerized attendance in real time with ready excel sheet to maintain attendance records in IoT trends has been done with implementing local Paho MQTT properly for communication and interfacing. The system provides more accurate identification. Identifies candidates in seconds in quick and rapid way. I conclude that this user-friendly proposed system would prove to be easy to use and implement, cost efficient, time saving, less tedious, portable. To overcome unreliable and inaccurate manual work, this proposed system gets improved with less effort and yet generates the results with high accuracy and qualitative one. Ultimately, improves academic performance with encourage as time saves. This paper has presented the proposed system with MQTT implementation successfully accompanied with booming RFID technology.

6. FUTURE SCOPES

Nothing is perfect in this world. We all are also no exception. Although, I have tried to present system in modern technology with small scale and smart way. Yet, there can be further enhancement by developing mobile app. According to hardware need, we can use GSM modem to send SMS for notice alert. Thingspeak can be used for data analysis. Use of unique identity with biometric technology like iris sensor or fingerprint sensor or image processing improves more authorization for RFID tag misuse. SD card modem for memory.

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