

Performance Enhancement and IoT Based Monitoring for Smart Home

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Abstract: In recent years, home automation has become so popular due to its various point of interest. The home condition has seen a fast introduction of network empowered digital technology. This technology accompanies new and energizing chances to build the connectivity of different devices within the home for the purpose of home automation.

This paper goes for outlining a basic home automation arrangement of controlling various appliances which can be observed and accessed from anywhere in the world with minimal effort. The technology uses Raspberry Pi and the web server. The Raspberry Pi and Arduino incorporated with Nrf modules are utilized to monitored the home condition appliances, and the readings are passed to the web server outlined or designed. The parameters or orders sent through web page are checked much of the time and if any threats found the mobile associated with this web server is cautioned through an alarm or message. The client can access this application from anywhere in the planet. The result created is minimal effort and low cost. Execution Analysis of various protocols (MQTT, HTTP and CoAP) is assessed by utilizing visualizations.

Keywords: Home Automation, Raspberry Pi, Web Server, MQTT, Cost Effective.

I. INTRODUCTION

Smart home technology has grown quickly from home systems and multimedia to different home automation frameworks. Especially, these technologies are utilized broadly in home vitality administration, in spite of the fact that their applications are primarily restricted to singular families. Due to the Internet of things (IoT), smart home innovations have started to coordinate different smart gadgets, running from traditional sensors and remote controllers to smart home apparatuses and robot frameworks. Thus, numerous inventive applications have been produced. As of late, smart home technologies have been coordinated with cloud-based administrations to offer some incentive included administrations, tasks, and operation management. The popularity of system network empowered home automation framework has been expanding significantly as of late because of its simplicity and substantially higher reasonableness rate. Additionally, with the quick development of the Internet administrations, there is the potential for the checking and remote control of such system empowered machines. Be that as it may, the new and energizing chances to build the availability of gadgets inside the home environment with the end goal of home automation through internet are yet to be investigated. A few definitions are accessible in the writing for Home Automation. There has been significant research into the field of home automation with many other communication protocols like blue tooth, hand gestures, DTMF etc.

In addition to energy management, home safety and health care have been explored in smart house studies. Smart home systems typically integrate various sensors and

surveillance cameras to identify and assess abnormal events regarding home safety. In home health care, smart home systems not only employ body condition-specific sensors but also combine resources from remote cloud platforms with professional medical and healthcare services.

A. Features Of The Proposed System

The paper presentations of this a novel has low-cost, remain solitary and flexible Raspberry Pi based home automation system. The proposed architecture is designed to reduce the system's complexity with minimal effort and very less cost. Hence, the framework attempt not to incorporate expensive and complex components, such as a high end personal computer (PC), where possible, as it uses only one Raspberry Pi as primary controller and Arduinos as clients for control. The system is scalable and flexible, permitting other home appliances designed by multiple vendors, to be securely and safely added to the existing home network with the minimum amount of effort. The system allows home owners to monitor and control connected devices in their home network, through a variety of controls, including a Raspberry Pi based remote control, and any Wi-Fi enabled device with Java support. Additionally, users may remotely monitor and control their home devices using any Internet enabled device which supports Java. A home gateway is actualized to encourage interoperability between heterogeneous systems and give a predictable interface, paying little heed to the getting to devices. A virtual home system pre-forms all correspondences previously they are acknowledged on the genuine home automation framework. All communications are find out or checked for security and safety reason before being allowed to continue to their respective destinations.

This paper is organized as follows: Section 2 discusses the related work on smart home systems. Section 3 discusses the developed home automation architecture, including a review of the technology used. Section 4 describes the implementation of the proposed system. Section 5 provides a conclusion.

II. RELATED WORK

A writing audit demonstrated that reviews on smart home frameworks have basically stressed three zones: shrewd gadgets, different shows, and cloud-based administrations. There are numerous meanings of home automation technology accessible in the writing. [1] Describes home automation as the technology inside the home to improve the personal satisfaction of its inhabitants, through the arrangement of various administrations, for example, telehealth, vitality preservation and interactive media excitement. There has been huge research into the field of home automation. The X10 business standard, created in 1975 for correspondence between electronic gadgets, is the most seasoned standard recognized from the creator's survey, giving restricted control over family unit gadgets through the home's power lines. As of late, investigate into the field of home automation technology has kept on accepting much consideration in the scholarly world. [2] built up a Java technology based home automation framework. An installed board physically associated all the home mechanizing gadgets and, through combination with a personal computer based web server, if remote access to the framework. The utilization of Java technology, which consolidates worked in arrange security highlights can create a safe arrangement. Be that as it may, the framework requires an intrusive and costly wired establishment and the utilization of a top of the line computer framework.

[3] Introduced a Bluetooth technology based home automation framework, which comprises of an essential controller and various Bluetooth sub-controllers. Each home gadget (apparatus) is physically associated with a nearby Bluetooth sub-controller. The home gadgets speak with their particular Bluetooth sub-controller utilizing wired communications. From the sub-controller all communications are sent to the essential controller utilizing wireless communications. It is most alluring for each home gadget to have a devoted Bluetooth module. Be that as it may, because of the monetary cost of Bluetooth technology, a solitary module is shared among a few gadgets. This design fundamentally decreases the measure of physical wiring required and henceforth the obtrusiveness of the establishment, using wireless technology. Nonetheless, the engineering does not totally diminish the intrusiveness of the establishment because of the fuse of some wired communications. Also the sharing of a solitary Bluetooth module between various gadgets has the weakness of affliction an entrance delay. [4] presented a telephone based remote controller for home and office computerization. The

framework contrasts in that all communications happen over a settled telephone line and not over the Internet. The framework can be gotten to utilizing any telephone that backings double tone numerous recurrences (DTMF). The disadvantages of this system are threefold: users are not provided with a graphical user interface (GUI), users have to remember an access code for access, and they have to remember which buttons to press for the control of connected devices to it. [5] Proposed a novel control network, utilizing hand signals. The controller utilizes a hand glove to hand-off hand motions to the system. The issue with the system lies in the incorrectness of hand signals, with the potential for ordinary arm developments being poorly analyze as orders. Mainly there is the danger of client fatigue if redundant hand signals are required. [6] Defined a home gateway as the purpose of access between a public access network and a personal area network. They built up a web server based home gateway to interconnect IEEE1394, with a power line based home computerization system, and the Internet benefit. To make the system more alluring to home proprietors, a continuous AV transcoding capacity was additionally included. The system offers a canny investigate the improvement of a home gateway; in any case, the utilization of power lines as the correspondence media restrains the situating of gadgets inside the home in closeness to power sockets. [7] Proposed a home vitality administration centered home gateway, which interfaces the home network with the Internet.

The system was installed in twenty houses in the Tokyo area. [8] Implements the initial provisioning function for home gateway based on open service gateway initiative platform. [9] Implemented the Home Gateway and GUI for Control the Home Appliance. [10] Cloud-Based Services Regarding Household Living: To achieve high-level home automation, third-party servers and configured smart home systems are recommended to address data privacy and authentication concerns in inter-home, multiple-device smart environments. Smart home systems have been extended to intelligent building systems, with both indoor and outdoor scenarios being involved. In addition, regional environment information is used in the dynamic intermediate layers of the architecture.

III. PROPOSED SYSTEM ARCHITECTURE

A. Proposed System Architecture

The paper proposes a Raspberry Pi based home automation framework through web server and smart phones. This model uses a very easy to use interface for the entrance of the raspberry pi. This model goes for outlining an essential home automation application on Raspberry Pi through command sent through web page and the algorithm for the same has been created in python condition which is the default programming condition gave by Raspberry Pi. Hence client can get to any number of device from any place on the world. Be that as it may, utilizing Raspberry Pi

for controlling every part needs numerous Raspberry Pi modules which isn't at all practical. For this, it utilizes Arduino with Nrf module incorporated to each machine to speak with Raspberry Pi controller coordinated with Nrf module to control various apparatuses (appeared in fig.1) which make this model more cost effective. LEDs utilized to demonstrate the switching activity. Results demonstrate the efficient implementation of proposed algorithm for home automation.

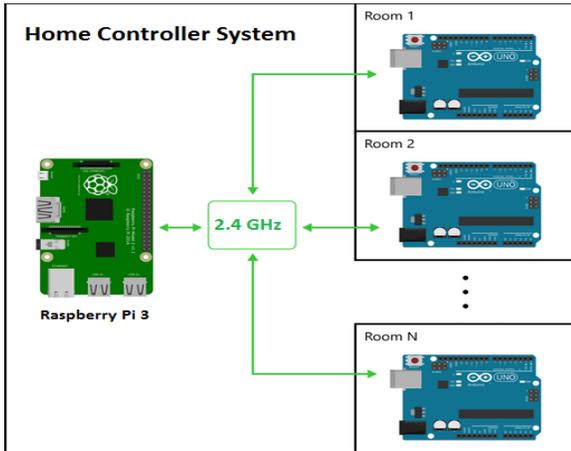


Fig.1. Raspberry Pi integrated with Nrf modules.

Moreover, incorporating cloud-based administrations with network administrations can give area based administrations [11]. Additionally, to accomplish different in-home showcases, standard interface gadgets can be utilized to isolate the rationale and user interfaces (UIs). The previously mentioned highlights were the real commitments of this examination. Based on the execution comes about, hypertext exchange protocol (HTTP) and message lining telemetry transport (MQTT) protocol were analyzed. In outline, steady with IoT attributes, the MQTT protocol can be utilized to give home control benefits in shrewd home frameworks, while HTTP can be utilized to convey area based data incorporation administrations.

B. Predefined Interfaces and Device Settings at Home

In this examination, the predefined interfaces of the home controller framework were intended to contain a neighborhood (LAN), DIO lines, RS485 wiring frameworks, and USB links. The LAN was utilized to associate the home system with the internet. The DIO lines were utilized to associate wired physical gadgets (e.g., crisis catches, magnetic switches, and gas locators and valves) and incorporate electrical cables and engine gadgets through relay gadgets, in this manner empowering the keen home framework to direct light control with on/off and dimmer choices and in addition drapery control with open/close choices. Utilizing RS485 wiring frameworks empowers interfacing RS485-related gadgets or a simple I/O converter with RS485-related gadgets, which incorporate power meters, water meters, infrared (IR)

controllers, and natural sensors (e.g., temperature, dampness, and CO2 sensors). Moreover, in the smart home controller framework, the USB slots can reach out to remote devices, for example, devices consistent with the Raspberry Pi protocol, including power plugs and PIR motion sensors. Various devices can be easily connected to the home controller system for much smart home functionality as shown in fig. 2 (e.g., energy management, security, and scenario controls).

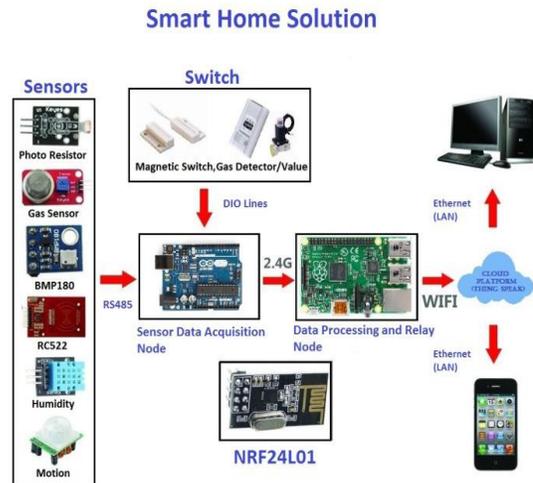


Fig.2. Integrated Home Automation System.

After the devices are matched and the connection is configured, the registration of services and reporting processes are established. Separating the configuration logic from the UI enables the various display devices to follow the arrangement for the menu and UI controls, thus creating similar UIs by selecting the managed devices and obtaining and setting the function values through the communication interfaces. Such devices manipulations are not limited to proprietary apps issued for particular devices.

C. Intrusion Detection and Security Management

Security is one of the most important concerns of the society. Every society has to be equipped with guards who do surveillance of a certain marked area by taking rounds, in some specific time intervals. This job is not only laborious for the guard but also has many chances of human error, for example let's say a person on supervision has just taken a round of any area and will return in the same after some time 't', so for that 't' time that area remains vulnerable to intrusion and anyone with little clever approach can easily beat the system. The modules involved in the system include a broker service module (i.e., gateway for service and content), and a home management module. The home management module provides administrative tools for a security guard unit to manage residential affairs and alerts. Through the use of a graphic user interface, the management system can perform emergency management

and create a history log. Therefore, daily operations (e.g., notices regarding registered mail, parcels, and fees; announcements regarding water and power service interruptions and residential council meetings; and gas meter readings) become paperless, thereby enhancing operational efficiency and saving resources. In addition, to achieve integrated and comprehensive community services, the surrounding-facility-system integrated module focuses on integrating security systems and building automation systems (e.g., central monitor and control system as well as a vehicle-charging system). We have used some algorithms and techniques of Digital Image Processing.

Threshold: It is the way to convert gray scale images to binary images. Intensity an every pixel is compared with a threshold value and that pixel is assigned either 0 or 1.

Frame Differencing: Frame differencing is a technique in which a computer checks the difference between two video frames. Any change in the pixels indicates a change in the image.

Background Subtraction: Background subtraction is a type of frame differencing in which the one frame (that does not contain object of interest) is saved and is subtracted from all subsequent video frames. The difference between them indicates any change in the frame.

Background Adaption Algorithm: This is an algorithm used for keeping the background image updated. We assumed that there are three doors and made a graphical interface so that one can set trip wire automatically, if any intrusion is greater than particular size and noticed for particular amount of time then an alarm is generated. (Fig.4)

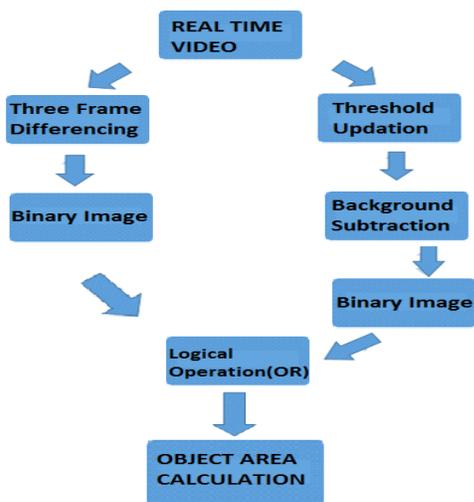


Fig.3.Flowchart of Intrusion Detection.

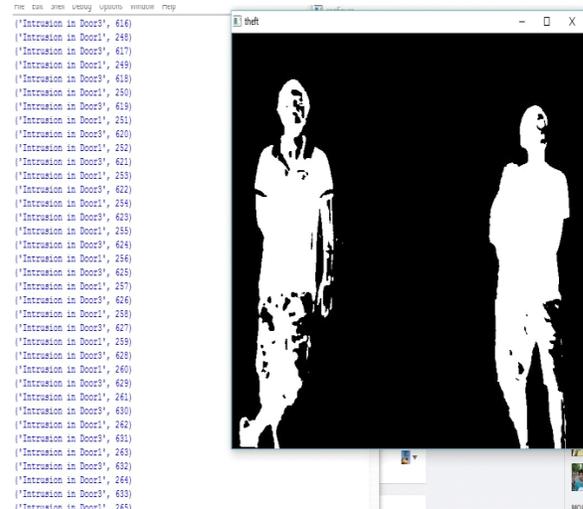


Fig.4.Alert showing Intrusion.

In summary, this study proposes a community broker that uses system integration (e.g., a schedule for door access control based on local time and weather) to provide value-added solutions such as a pop-up camera window on a local surveillance system triggered by detecting abnormal door access or security alerts reported to a guardian when residents press a home-level emergency button. Moreover, regarding long-term operations and maintenance, these integrated systems can proactively detect cross-system failures (e.g., a mail notice at the network level, a central monitor at the device level, and an alert log at the user level), thus reducing repair times.

D. Platform Services and Modules on the Cloud

In this study we considered an open data cloud-platform for the Internet of Things, Thing Speak. Thing Speak enables real time data collection with an Open API provided and sophisticated data processing and examine capabilities. With plug-ins, data visualizations and the ability to integrate data with a variety of third-party platforms, technologies and systems including other leading IoT platforms such as I/O Bridge and Arduino. Thing Speak is the perfect complement to an existing enterprise system to crack into the Internet of Things.

IV. IMPLEMENTATION RESULTS & DISCUSSION

A configuration summary and device deployment in the various layers of the proposed architecture is explained here. At the home end, a home intranet was formed by integrating a fixed touch panel with a home controller system as well as various sensors and devices to deliver energy, scenario, information, and security functions. The cloud platform that can be connected through the internet comprises a core management server farm and global solution server farm, and is used to connect third party servers. According to the proposed architecture, consumers can access smart home services and multiple display

services over the Internet through various fixed and mobile carriers.

A. Screenshots of Implemented Results

The screenshots exhibit the various functions of the proposed fixed touch panel of the home controller. The Homepage mainly displays the function menu, calendar, time, weather information, and temperature. It enables single-touch control of the curtains and lights, and presents an integrative scenario control. The Security page presents statuses of the aforementioned magnetic switches and emergency buttons; this page can be used to enable a security mode when no resident is at home, which activates a real-time alarm upon detecting an intruder. Weather information is presented in the Weather page, which aids residents in deciding what clothes match the weather conditions and whether rain gears are necessary. The proposed smart home system allows users in offices to access home and community information through remote web pages. Moreover, employing the smart home system enables users to check home security and control scenarios on their smart phones when they are not at home. Therefore, the discussed scenarios are implemented in ThingSpeak platform. For example temperature feature of the proposed smart home system shown in fig.5.

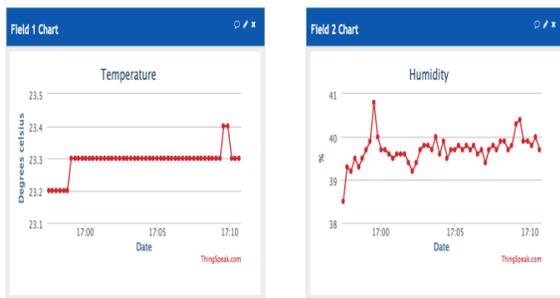


Fig.5. Monitoring of Temperature alert systems.

B. Service Protocol and Performance Evaluation

The proposed framework engineering can utilize regular HTTP and the IoT impacted MQTT convention. Past investigations have thought about the power utilization, dormancy, and information movement of the two conventions. For instance, with respect to keeping up association activities, an association set up utilizing the MQTT convention devoured less vitality than a HTTP association. In addition, when the MQTT convention and HTTP were connected to proxy servers independently, the MQTT based proxy servers created bring down inactivity contrasted and that of the HTTP-based proxy servers. What's more, when tried in a worldwide situating framework condition, the MQTT-based proxy servers brought about lower information movement than the HTTP based proxy servers did. MQTT is quick and lightweight. It takes not very many bytes of information to interface with the server and association can be kept open constantly. Correspondence expends less information and time than the

HTTP convention, which is an extraordinary preferred standpoint. The MQTT framework comprises of numerous customers and one agent. Our gadgets go about as customers. Customers can be our PCs or PDAs as well. Every customer speaks with a dealer just, customers don't impart among themselves. The entire framework depends on distribute and buy in strategy for correspondence. Every customer can be a distributor which distributes (sending) messages, supporter which tunes in to approaching (getting) messages, or both in the meantime. Representative is a sort of server whose assignment is to acknowledge distributed messages from distributors and forward them to separate endorsers.

To productively assess the plausibility of the proposed engineering for use in various situations, this investigation looked at the information activity and inertness created by the MQTT (Mosquitto) and HTTP (REST) based models. In general, interestingly with the HTTP-based engineering, the MQTT based design delivered bring down information activity and lower dormancy in the charge mode. Furthermore, MQTT is portrayed by the idea of themes and spotlights on gadgets. Along these lines, the quantity of and home IDs in the design relies upon the size of administrations gave. Be that as it may, the quantity of home gadgets can fluctuate by time, which may incrementally influence the quantity of points and the resulting productivity of the servers. In this way, this investigation concentrated on one administration situation and proposed two types of abstract MQTT process to reduce the number of topics in the processes.

Performance Indicators:

- **thttp**: execution time of the HTTP Protocol
- **tmqtt**: execution time of the MQTT Protocol
- **tcoAP**: execution time of the CoAP Protocol

Speedup of MQTT over HTTP:

$$S = \text{tmqtt} / \text{thttp}$$

Speedup of CoAP over HTTP:

$$S = \text{tcoAP} / \text{thttp}$$

The energy usages of the MQTT, CoAP and HTTP processes were investigated. The battery used in each process were calculated, as shown in figs. 6 & 7.

- Energy consumed by HTTP is much larger than MQTT protocol.
- We can send 100 times more messages with MQTT than HTTP by using same battery percentage in both.

The MQTT convention just gives rules to association security yet does not stipulate basic techniques. Along these lines, this investigation inspected the bandwidth of the

spine systems and the preparing limit of the cloud stage by joining the MQTT convention and the one time watchword (OTP) capacity of HTTP to improve the security of the proposed benefit design. The assessment aftereffects of the utilization of the center assets demonstrated that, interestingly with customary customer server structures, the proposed design coordinated and spared vitality by dealing with the bandwidth of the spine systems and the handling limit of the cloud stage.

TABLE I: Performance Analysis Of Different Protocols

	HTTP	CoAP	MQTT
Messages /Hour	3628	134235	263314
% of Battery/Hour	18.43%	6.58%	3.45%

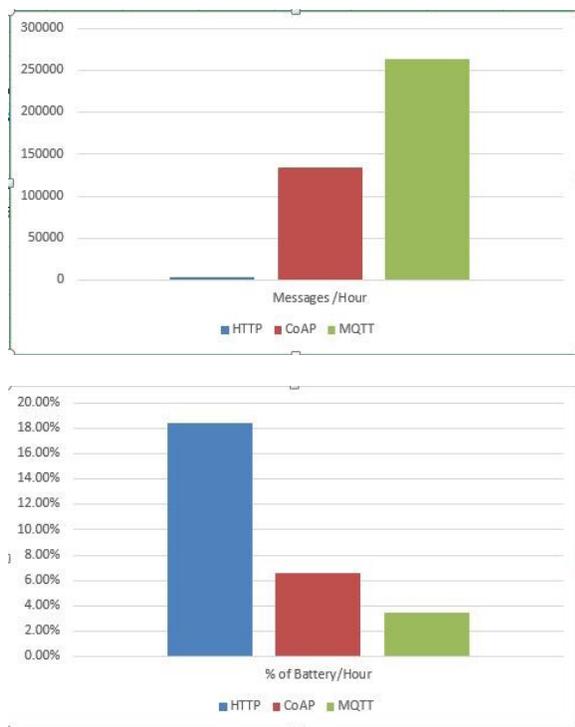


Fig. 6 &7. Performance Analysis of different protocols.

This investigation had confinements and could be enhanced by actualizing follow-up measures. For instance, when the Data movement and inertness produced by the MQTT-and HTTP based structures were looked at, the distinction in the MQTT and HTTP instruments brought about the actualized models working in an unexpected way. The correlation might not have been reasonable on the grounds that distinctive benchmarks were utilized. In follow-up contemplates, an abnormal state of consistency in the correlations could be accomplished by arranging and contrasting usage situations (e.g., summon based situation versus data based situation). In addition, this investigation could be stretched out by including an examination of data Investigation applications.

V. CONCLUSION

This examination initially proposed a various leveled, smart home administration engineering, which utilized standard interface devices at the home end to isolate the logical and user interface UIs, and accomplishing different in-home display.

Accordingly, an entire and coordinated smart home framework can be accomplished. Furthermore coordinating cloud-based administrations with network administrations Gave area based administrations. Along these lines, to examine the impacts of two application conventions (i.e., common HTTP and the IoT-affected MQTT convention) on the proposed engineering, the data movement and latency created by the HTTP-and MQTT-based models were analyzed. The utilization of center assets by significant design parts (i.e.,backbone networks and the cloud Stage) was assessed and shown that, conversely with ordinary customer server structures; the proposed progressive engineering can spare assets by dealing with the data transfer capacity of backbone networks and the preparing limit of the cloud stage. This examination prescribes that subsequent investigations utilize data examination applications and client points of view in planning UX based interfaces. This proposed progressive Architecture is expected to transform smart home Frameworks into basic and simple to-work homeAutomation arrangements.

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