Home Automation using Raspberry Pi

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ABSTRACT

Evolution of the IoT technologies has enabled many sectors to evolve and optimize the operations in a smooth way as well as to optimize the power consumption and communication. Home automation is one of the best use cases of this evolution where we can optimize the power consumption, improve the security and communication which are the basic requirements of any home in today's era. Along with these basic requirements, IoT helps to implement the luxury in a home which makes it a smart home. Here in this paper, we have done the literature survey on the same fields and have proposed a novel method and implementation for a smart home using Raspberry Pi and all the required sensors and actuators for a smart home. Data analytics of the sensor data are also implemented using IoT cloud and the dashboard is created to present and visualize the data, the dashboard also provides the luxury to control the home equipment from the report place using mobile devices.

Keyword: - *Home Automation, Raspberry Pi, MQTT, Adafruit IO, Smart Home, IOT, PIN sensor*

1. Introduction

The Internet of Things is a system that allows devices to be connected and remotely monitored across the Internet around the world. In the last few years, the IoT concept has had a strong evolution, being currently used in various domains such as smart homes, medicine, industrial environments, etc. Wireless sensor network technologies integrated into the IoT enable in the global interconnection of smart devices with advanced functionalities. A wireless home automation network is composed of sensors and actuators that share resources and are interconnected to each other, is the key technology to making intelligent homes. One of the greatest advantages of home automation systems is their easy management and control using different devices, including smartphones, laptops and systems, tablets, smart watches, or voice assistants. Home automation systems offer a series of benefits; they add safety through appliance and lighting control, secure the home through automated door locks, increase awareness through security cameras, increase convenience through temperature adjustment, save precious time, give control, and save money

2. Literature Survey

The Author proposes a basic solution to enhance home network security, employing private blockchain technology and RSSI-based trilateration for localization. Through our research, we discovered that private blockchains outperform public ones in terms of security and efficiency. Furthermore, after testing different wireless technologies, we found that using WiFi-based communication yields the best results for our design. This approach aims to address the increasing security threats posed by IoT-based smart home applications, providing a cost-effective solution for homeowners to safeguard their networks.[1]

This paper examines the exponential growth of Machine-to-Machine (M2M) protocols, including MQTT, AMQP, and CoAP, within the Internet of Things (IoT) landscape over the last two decades. Particularly, we focus on

MQTT's remarkable prominence among these protocols. It tells about MQTT's prevalent application areas and conduct a quantitative analysis of recent MQTT-related research to delineate its key attributes, benefits, and drawbacks. Furthermore, we propose a taxonomy to facilitate the comparison of different MQTT implementations, such as brokers and client libraries, aiding researchers and end-users in selecting suitable options based on their specific needs. Finally, we discuss pertinent findings from our analysis and underscore unresolved challenges requiring further investigation and attention in the field.[2]

This article dives into the Raspberry Pi, a compact and affordable computer resembling a small chip. It serves as a tool for learning about computer devices and programming languages like Python and c, appealing to users of all ages. It Offers a desktop-like capabilities, it enables tasks such as internet browsing, HD video playback, document creation, and gaming. The Raspberry Pi has also been instrumental in various digital maker projects, from music players to weather forecasters, facilitating global collaboration. [3]

This article presents a home automation solution featuring a Raspberry Pi microcomputer as a key hardware component. Connected to various sensors for data collection, the Raspberry Pi executes a software system designed to organize, process, and manage this data. It enables the configuration of different home automation modes, facilitates the control and monitoring of various home devices, and provides analysis and reporting functionalities based on the collected data.[4]

This author introduces a smart home system employing Arduino as nodes and Raspberry Pi as the controller (local server). Addressing the common challenges of cost and lack of centralized control in smart home implementations, this system enables remote monitoring and control of electronic equipment within a home. By utilizing Arduino nodes and Raspberry Pi as the local server, the system allows for both local (intranet) and internet accessibility, eliminating the need for constant internet connectivity to activate smart home functionalities.[5]

The Internet of Things (IoT) integrates Internet-connected objects, sensors, and smart appliances, shaping the digital landscape. Over recent years, a surge of IoT solutions has entered diverse industries. Context-aware communications and computing play pivotal roles in this paradigm, akin to ubiquitous computing. This paper scrutinizes prevalent and innovative IoT solutions through a context-aware lens, employing established computing theories as a framework for evaluation. It serves as a roadmap for both product development and research within the IoT sphere, unveiling key trends and research directions.[6]

The article provides a detailed exploration of Raspberry Pi, a miniature computer that democratizes computing education. It connects to standard peripherals and displays, offering a full desktop experience at an affordable price. Readers learn about its versions, alternative boards, hardware components, and required software for programming. With capabilities spanning internet browsing, HD video playback, and gaming, Raspberry Pi serves as a versatile tool for learning and creativity. Its involvement in various digital maker projects underscores its global impact and accessibility. This comprehensive guide equips readers with the knowledge needed to unleash their creativity with Raspberry Pi.[7]

The author tells about how home automation has changed over time, from basic controllers to including internet technology. It introduces IoT at home, which uses affordable parts like Node MCU and Wi-Fi for controlling home stuff with phones or laptops. It also mentions using sensors to keep an eye on home conditions for safety. Other similar projects show how important internet tech is for smart homes. The article says IoT at home could make life better in smart homes. [8]

Author tells about IoT-enabled sensors face security risks like outdated software, lack of encryption, and poor access control. They also have a large attack surface due to interoperability needs and can be difficult to monitor for intrusions. In industrial settings, IoT devices can bypass traditional security measures, posing additional challenges,[9]

The author introduces a home IoT system using low-cost embedded devices, Edge Computing and optimized speech recognition for low-resource languages. Communication occurs via Bluetooth mesh, eliminating the need for internet-connected home infrastructure. It conducts a comprehensive analysis of Machine Learning models for

Automatic Speech Recognition on edge devices and proposes optimization techniques for running these models on embedded devices.[10]

The author tells about the security issues that are being faced in an home automation system which poses threats to the used like intrusion into system, hacking , loss of personal data, If access is taken by an intruder then he can acces the device at our home which causes a potential risk.[12]

The author compare different messaging protocols considering their similarities and device diversity. Understanding protocol strengths and weaknesses is vital for cost-effective maintenance, as IoT systems often employ multiple protocols. The protocols are HTTP, CoAP, MQTT, AMQP, DDS, and XMPP identifying key communication tasks and essential characteristics for system design. Recognizing similarities offers opportunities for interoperability[13]

The authors tells about computer vision technique in raspberry pi by integrating web cams and PIR motion sensors, how we can connect and control home applications connects through an internet connection.it has SMS alerts .[14]
The authors Explains the connection of raspberry pi and pir sensors to use motion detection which can be helpful in most of the cases where there is darkness and to reduce the use of lights which must not be turned on all the time so PIR sensor is helpful.[15]

3. Proposed Method

The proposed system for home automation uses Raspberry Pi for controlling electronic devices and gadgets like fan, ac, tv, fridge. There are many IOT devices like raspberry Pi ,Arduino, Lora. The system we use is the combination of software code which is coded in python language and a set of IOT equipment and sensors are used. The protocol used in MQTT protocol

MQTT server is a device or program that inter connects the MQTT clients. It accepts and transmits the application messages among multiple clients connected to it. Devices such as sensors, mobiles etc. are considered as MQTT client. When an MQTT client has certain information to broadcast, it publishes the data to the MQTT broker. MQTT broker is responsible for data collection and organization. The application messages that are published by MQTT client is forwarded to other MQTT clients that subscribe to it. MQTT is designed to simplify the implementation on client by concentrating all the complexities at the broker. Publisher and subscriber are isolated, meaning they need not have to know the existence or application of other.

Raspberry Pi can be used for our experiment as it has an inbuilt Bluetooth and WIFI module and it can be used as a mini computer with full effectiveness. Raspberry pi connects to the cloud which we use here is Adafruit IO and also used for user interface as buttons and graph to show the temperature and humidity curve. Adafruit IO HTTP API provides access to your Adafruit IO data from any programming language or hardware environment that can speak HTTP.

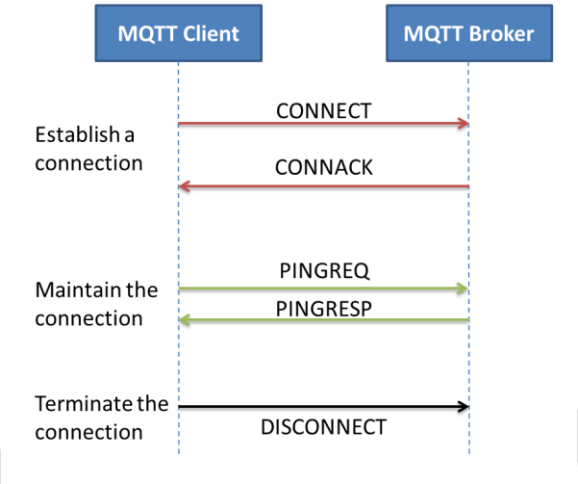

Fig -1: Establishing, maintaining and terminating MQTT connection

3.1 Hardware Implementation

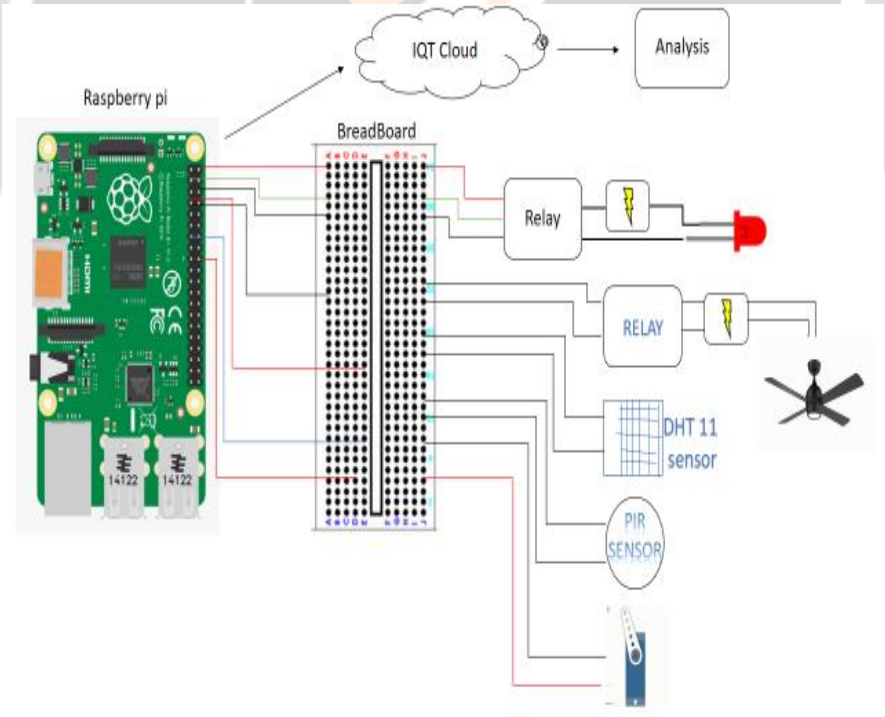

Fig -2: smart home architecture

we connect the raspberry pi with the electronic equipment using a relay and the relay acts as switch and does not allow 240 v power to effect the Pi

The hardware part include 2 channel 5V relay,DHT11 sensor, PIR sensors Raspberry Pi these are connected using jumper wires for small scale setup
PIR motion sensor is used for motion sensor Lights which turns on only when there is motion and turns off after a few second of motion detection .this helps us to reduce electricity consumption and also abstract the accidents in dark
For the security purpose of the gate which we use it can be accessed only of the otp is entered a otp is sent to registered mail once the otp is validated only the gate access is given.

3.2 Software Implementation

Adafruit io is used as a dashboard which is a free website to create dashboards and it follow MQTT protocol to send and receive data connecting to the python code uses the AIO Keys which is generated in the website.
To authenticate the python code to the dashboard we use AIO key which is provided by the Adafruit.io website as we create a login in the Adafruit account. Once it gets connected we can send and receive data from the raspberry pi which sends it back to the cloud or to the sensors.

Fig -3: Adafruit dashboard

The Adafruit dashboard can we created by dragging and dropping the required items from the given set of items like buttons graphs meters. Feeds can be created which helps to connect the each data signal set from the website to the code which thereby helps to turn on or off each devices that are linked to a particular feed in the program

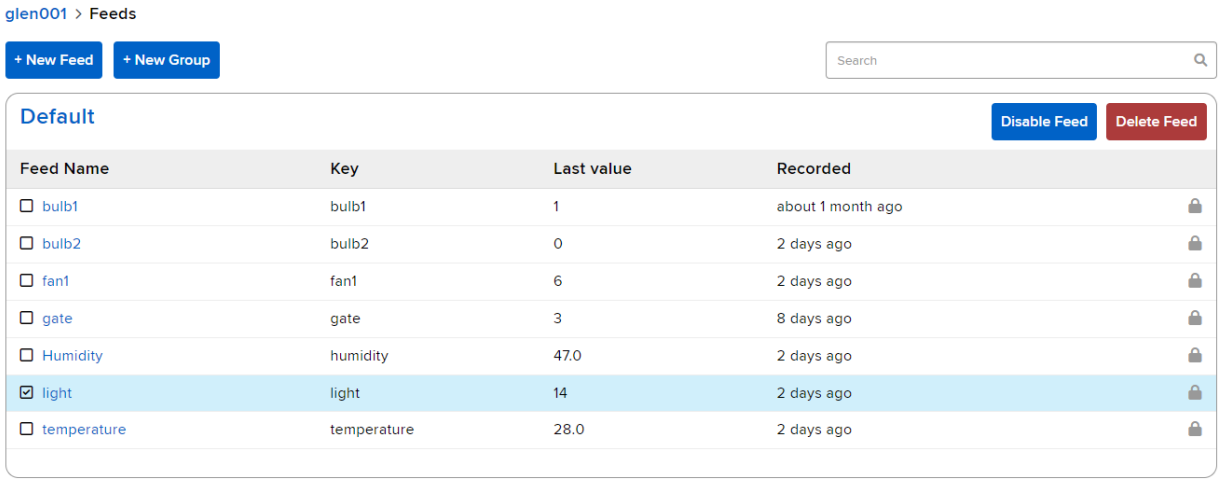

Fig -4: feeds of the system at Adafruit Dashboard

4. CONCLUSIONS

This research investigates on how to make a smart home automation system in our home for personal use by using IOT equipment. the idea to create a fully working home automation system with facility to control and monitor appliances like fan ac lights and electric gates has been finally realized. The output of this is an array of home appliances that are controlled over the internet with the help of an online dashboard. It helps to ease the peoples life by controlling devices with a mobile phone. We can have safety by using authentication for the Adafruit website which has an authentication login credential and more over to make the equipment control more personalized and secure we use an OTP that has been sent to the registered email and only after validation the gates can be opened.

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