A Synopsis on

IoT based Smart Laboratory

Submitted in partial fulfillment of the requirements
of the degree of

Bachelor of Engineering

in

Information Technology

by

Ritesh Shetty (16104048)
Prathmesh Pande (16104020)
Bhavana Kondurkar (16104066)

Under the Guidance of
Prof.Vishal Badgujar

Department of Information Technology
A.P. Shah Institute of Technology
G.B.Road,Kasarvadavli, Thane(W), Mumbai-400615
UNIVERSITY OF MUMBAI
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CERTIFICATE

This is to certify that the project Synopsis entitled ***"IoT Based Smart Laboratory"*** Submitted by ***"Prathmesh Pande (16104020),Ritesh Shetty (16104048),Bhavana Kondurkar (16104066)"*** for the partial fulfillment of the requirement for award of a degree ***Bachelor of Engineering*** in ***Information Technology*** to the University of Mumbai,is a bonafide work carried out during academic year 2020-2021

Prof.Vishal Badgujar
Guide

Prof. Kiran Deshpande
Head Department of Information Technology

Dr. Uttam D.Kolekar
Principal

External Examiner(s)

1.

2.

Place:A.P.Shah Institute of Technology, Thane
Date:

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(Prathmesh Pande, 16104020)
(Ritesh Shetty, 16104048)
(Bhavana Kondurkar, 16104066)

Date:

Abstract

Internet of Things is defined as a system wherever appliances are embedded with software system, sensors and actuators. The devices enables information transfer over a network and additionally communicate with one another. This system is incorporated in our labs to create the appliances convenient and automatic. During this epoch of Automation, it's been ascertained that a lot of of the University and faculty Labs don't have IT automation capabilities up to the present industrial trendy standards. The most recent technologies are not being enforced in faculties and so the fellow students cannot enjoy them. Automation is a section that is gaining attention progressively day by day since last few years.

The aim behind our project is to assist totally different appliances to not simply connect with one another, however with the user, in a very straightforward, friendly manner. Here we have a tendency to look forward a system which might offer the user complete management over all remotely governable aspects of the Laboratories. One will merely accomplish laboratory automation by merely connecting the appliances to a central network or cloud storage.

Contents

Introduction

Lab automation can be described as a technology which is used in the college environment to provide comfort, convenience and energy efficiency to its user and students. Automation is a concept which involves real time control and monitoring of multiple appliances.

Today, there is a n increasing demand of automated systems so that human intervention is reduced. The user can make use of this system to control switching on of lights, fan, AC, etc. automatically. The user can access complete IoT system from anywhere using Internet. Raspberry Pi is a small sized computer which acts as a server for the system. The Raspberry Pi system functions like a computer with a small setup. It contains GPIO pins and USB ports and also supports port for camera module. These pins can be toggled on/off using simple programs.

A smart laboratory is a place that has highly advanced automatic systems for controlling and monitoring lighting and temperature, laboratory appliances, and security systems and many other functions. Through IoT almost every object of our daily life in a home can be connected to the Internet. IoT allows monitoring and controlling all of these connected objects regardless of time and location IoT plays an important role in building smart laboratory.

As campus grows every year, new management problems and energy issues appear. Managing the resources in the campus has become a real problem. Monitoring and controlling the unused devices that consume power during human absence is also a major inability. In addition to this, coordinating the people participating in the daily activities of the laboratory is tedious when population of the usage of the space out numbers a manageable threshold. Another problem is power management. It is difficult to monitor all sub-systems such as lighting, projecting and air conditioning system. But if these are left indiscriminately, energy will be wasted. People cannot check the status of the subsystem at ease. In order to resolve these problems, IoT technology is a suitable method.

In our Lab, there are multiple appliances like Lights, Fans, Air Conditioners, and Projectors. The current, usual way to control the appliances in the lab is to manually toggle switches on the switch board of the particular Lab. However, that in itself is a time consuming task as a person has to be available to do so.

Our proposed system is aimed at developing an automated solution where even if the end – user/ admin is located remotely, the appliances can be turned on. The website basically converts smart phones into a remote for all appliances. The user can access complete IOT system from anywhere using Internet.

Therefore the main motive behind creating the system like lab automation is that you can direct and coordinate how a gadget ought to respond and why it needs to respond. Your duty is to set the schedule and the rest is automated and based off of your desired penchants hence giving control or connect with the gadgets of lab.

Attributable to the universal accessibility of WiFi all the appliances within lab can be linked together through a common gateway and devices are controlled using MQTT protocol implemented on ESP8266 using Node-RED. Raspberry Pi is a small sized computer which acts as a server for the system. The Raspberry Pi system functions like a computer with small setup.

Objectives

- To minimize, monetary costs, user discomfort, delays, utilization of resources.
- To automatize the appliance dominant of Labs.
- To reduce the power consumption by economical usage of the appliances.
- To integrate laboratory timetable with the system.

Literature Review

1] Paper title: Design and Implementation of IoT Based Smart Laboratory. Authors: M. Poongothai, A. Rajeswari and P. Muthu Subramanian.

More than half of systems remains unconnected, and don't share information with one another or the cloud. One such technology that facilitates the interconnection is eventually Internet of Things. The Internet of Things could be a communication paradigm that refers to the thought of connecting the objects of existence to the net. These objects are quite assembled with microcontrollers, transceivers to modify communication and organized with protocol stacks that may notice the interaction of the objects with each other to achieve to common goals while not human intervention. This paradigm gained its strength from the actual fact that it's interacting with a large style of devices such as: robots, drones, heating and air-conditioning systems, security alarms, family appliances, power generation systems, workplace instrumentality, school appliances then on that generate a vast quantity of information to produce new services to individuals and each public and personal sectors.

Application code written for interfacing IoT sensible hardware kit MQTT broker, and for observance temperature, wetness and lightweight intensity within the laboratory. Developed Dashboard and mobile application by using Node-RED and android STUDIO. A database set has been created for a paradigm switch to look at standing history. IOT reduces the human intervention by introducing device to device interaction. By using the projected system, the whole energy consumption is reduced in our field.

2] Paper title: IoT Based Home Automation Using Node-Red. Authors: R. K. Kodali and A. Anjum.

In this paper, an efficacious home automation system exploiting affordable Wi-Fi development boards is projected. Node-RED, that could be a visual wiring tool that helps in associating gadgets simply bringing concerning quick and easy association setups. Gadgets are connected along to ESP8266 and a mosquito primarily based MQTT broker using Node-RED and a association is setup for remote observance and management. The Internet of Things (IoT) currently doesn't simply mean 'diverse things', however has developed into 'smart things' that have aboard calculation and system associations. Node-RED could be a programming tool for wiring along hardware devices, on-line services and API's. Node-RED permits users to lock along internet services and gadgets by commutation common secret writing tasks and this could be attainable with a visible drag-drop interface. Varied parts in Node-RED are connected along to form a flow within the Node-RED editor.

Message Queuing telemetry Transport (MQTT) provides a light-weight electronic messaging protocol that uses a publish/subscribe model attributable to that it's worthy to be used on all devices from low power boards to servers. A consumer will publish or take a subject or do each. Whereas as a broker receives all the messages, filters them and send them to the signed

consumer. Node-Red is therefore an economical platform to link variety of IoT gadgets and may be controlled from any a part of the planet. With the increase within the range of gadgets on the cloud platforms, there's a demand for refreshing code fairly often.

3] Paper title: Internet of Things (IoT) for building Smart Home System. Authors: T. Malche and P. Maheshwary.

A smart home conjointly stated as a connected home or E-Home is an atmosphere for living that has extremely advanced automatic systems. A smart home appears " intelligent" as a result of its daily activities being monitored by a laptop. A smart home consists of the many technologies via home networking for enhancing better quality of living. A smart home is an area that has extremely advanced automatic systems for dominant and observance lighting and temperature, home appliances, multi-media instrumentality, and security systems and lots of alternative functions. A smart home system consists of applications designed on prime of IoT infrastructure. The sensible home applications will have following main functions: alert, monitor, control, Intelligence. Though the applying space of a smart home is solely restricted by human imagination, this paper illustrates a number of them that area unit represented below-smart lighting, sensible appliances, intrusion detection, smoke/gas detection.

An IoT primarily based smart home is rising as a very important a part of the sensible and intelligent cities that are being projected and developed round the world. the aim of a wise house is to boost living customary, security and safety still as save energy and resources. The smart home plays a very important role in development of society. The aim of this paper is to propose such system supported FLIP. The projected system is enforced as per user demand.

4] Paper title: IoT Based Smart Security and Home Automation. Authors: S. Somani, P. Solunke, S. Oke, P. Medhi and P. P. Laturkar.

This paper focuses on a system that gives options of Home Automation looking forward to internet of Things to control simply, additionally to it it includes a camera module and provides home security. The android app essentially converts Smartphone into a far off for all home appliances. Following are the most important parts of the system: Raspberry Pi, sensors, appliances. at first the user logs in to our android app by getting into default credentials. there's facility for admin access to add/remove users and alter the default username and password. A socket runs at server (Raspberry Pi), that is open perpetually and waits for request from user.

When user clicks on login a client socket is formed in android app and association begins between Raspberry Pi and also the android device. The encrypted information is seasoned this socket to Raspberry Pi. At Raspberry Pi aspect coding of the info takes place. This decrypted information is verified with the entries available in Raspberry Pi memory itself. If correct details is provided a response is distributed back to device that starts a replacement activity. This new activity will then be accustomed to manage any home appliances with an

easy on/off button UI. The requests are handled at server aspect by Raspberry Pi. Enhance the IoT's network security mistreatment coding and coding of the user's information.

5] Paper title: A step towards Home Automation using IOT. Authors: H. K. Singh, S. Verma, S. Paland and K. Pandey.

The aim of this paper is to develop home automation system supported IOT exploiting Wi-Fi primarily based microcontroller. As scope of technology is widening a day, we tend to start creating our school advance in mobile, robotics, Machine Learning, then why an exception for our home. NodeMCU (ESP8266) microcontroller together with Relays is employed to manage electrical switches remotely from the server that is constructed on Node.js. User will manage switches employing a internet Application when authenticating. The projected system consists of internet server, internet interface, database, NodeMCU and Solid-State Relays. Server controls and monitors appliance state and user command, and might be simply designed to handle additional hardware interface module. The web server is running on NodeJS that in turn running on AWS (Amazon web Services). Fantastic thing about this Automation System is that it may be accessed from the net browser remotely from any laptop or mobile handled device connected to the net. Wi-Fi is chosen to improvise system security, quality and suppleness.

In this work, a real- time home automation system has been with success enforced that is kind of effective in terms of performance and technology. The log file been generated as a results of dynamical state of appliances. It may be accustomed track the user's behaviour i.e. the time of dominant the appliances. Using this log file, we will apply Machine Learning to the system, through that the system can learn the way the user operates the appliances in his house as per the results provided by the milliliter, the system will mechanically amendment the state of the appliances supported the behaviour of the user.

Proposed Technology Stack

• Node-RED: For wiring along all the devices and services with the help of its browser-based editor. To create a GUI dashboard for managing and controlling the ecosystem.

• MQTT (Message Queuing telemetry Transport): For communication protocol. Its features like small code footprint low power bandwidth consumption, pub/sub pattern, makes it suitable for this use case.

• Mosquitto: Eclipse Mosquitto is an open source (EPL/EDL licensed) message broker that implements the MQTT protocol.

• Raspberry Pi: For its price to performance ratio and its versatility as an overall package.

• SQLite: For backend data management.

Problem Definition

Our institute has an abundance of laboratories and therefore, more staff. Naturally most of the faculties have totally different operating patterns than others. Every time if a lab session ends, usually the machines and appliances are left running.Physically toggling the individual lights, fans and systems within the starting of a lab session adds to the wastage of your time of the session.To combat this, we want to create a system for our college where the labs can be controlled remotely to save time, power consumption and energy in terms of manpower.

Proposed System Architecture/Working

Figure 1 shows the projected system design of IoT enabled smart laboratory layout at our Institute. All the appliances within the laboratory are connected to the good IoT hardware kit which has Node-RED, SQLite for info and MQTT broker that is exclusive board solely designed for college laboratories.

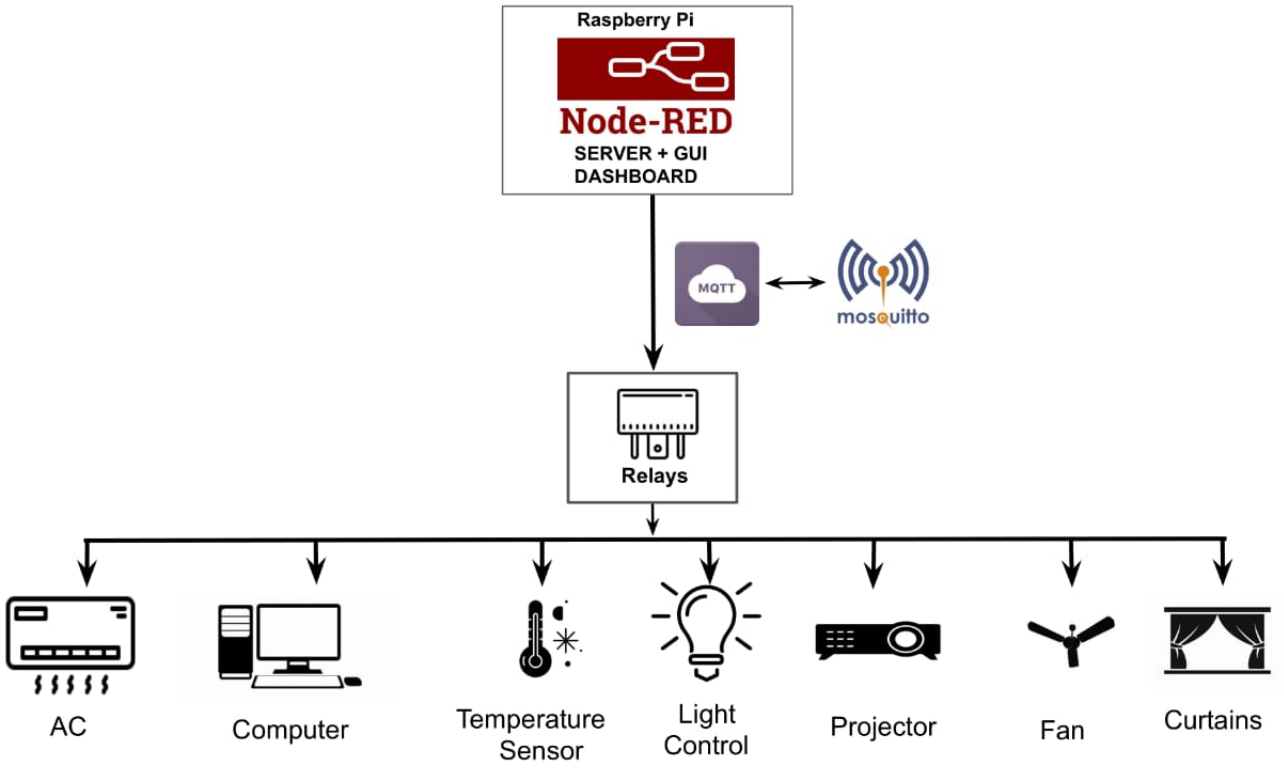

Figure 1: Proposed System Architecture

Node-RED: Using Node-RED various hardware devices, API's and online services are wired together. Node-red for front end, programming and hosting.Flows can be then deployed to the runtime in a single click.

MQTT Broker: MQTT Broker is the channel that made this system flexible when transferring data or commands which was done by the user.The systems are connected to ESP8266 which act as MQTT clients. An online server acts as an MQTT broker. SQLite for storing IoT data.

Web application: The web server will host the required Web application which will be connected to all the lab devices and can be easily managed and controlled via a user-friendly GUI.

IOT interface: The required components such as embedded processors like NODE MCU, Relays, Arduino and Raspberry Pi will be used for interfacing the lab automation system with the electrical appliances .

Remote Devices: Desktops and mobiles will be useful for managing the lab which will be further connected to the main web server via internet medium.Here both web based GUI as well as an android application will be developed for more flexibility.

As we are using a free open source platform for our system,many labs can be automated using the same architecture at a very feasible price. Node-RED, MQTT broker, Raspberry Pi and Arduino allows you to automate your IT infrastructure.

The 220v that comes from the main power supply is reduced to 5v by step down transformer. It is then regulated and given to the Arduino UNO and ESP8266. If user wants to turn on /off devices, command is sent from mobile phone to MQTT server. The server then publishes the command to the respective ESP8266 module present in an IoT kit to which that the particular device is connected. After the reception of the command by ESP8266 relay gets turned on, thereby providing the supply to that device and the device gets turned on . . Current transformer is used in the IoT kit which checks the actual flow of current. It sends the actual status of device (ON/OFF) to the Arduino which is determined by the amount of current flow. Arduino, then sends that device status to ESP8266 through serial port. ESP8266 sends that data to MQTT server and actual device status can be viewed in Node-RED dash board.

Raspberry pi 3 is connected to a network, and run this application in it . The control signals can be sent from any device connected in the network to the MQTT broker. And, clients publish the status of the devices and energy consumed by individual appliance to the broker and can be viewed in the dashboard. Thus all devices can be controlled universally, and the status of the devices can be visualized.

Design and Implementation

Figure 2 shows the planned system architecture style of IoT enabled smart laboratory system. All the appliances among the laboratory are connected to the IoT hardware kit that has Node-RED, SQLite and MQTT broker.. In this system rather than building an android application,

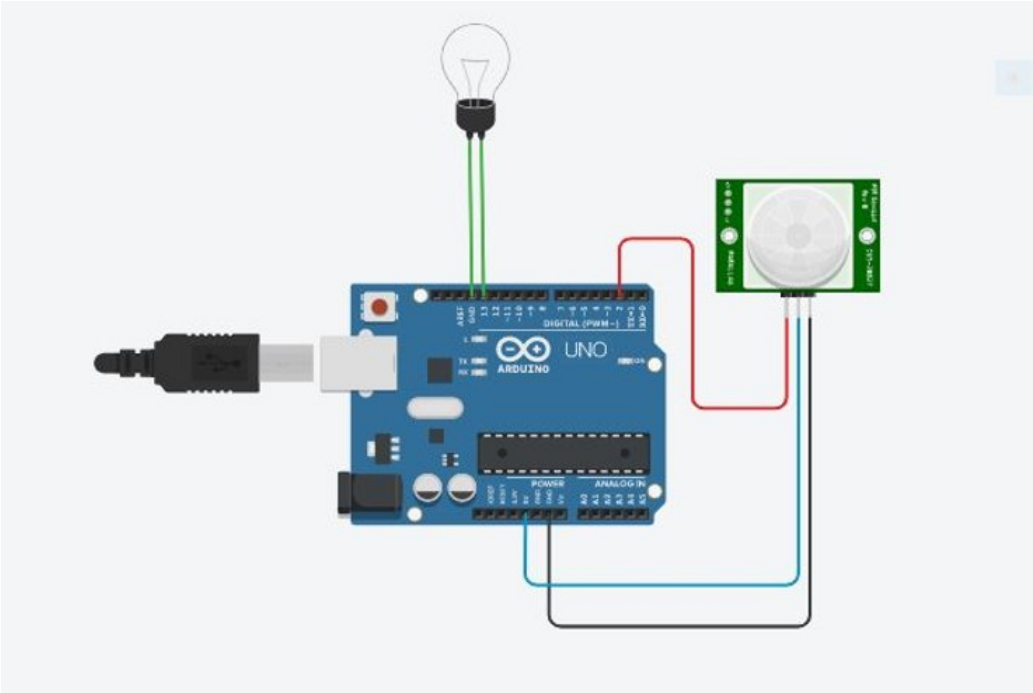

Figure 2: Circuit diagram of Light control using Arduino and PIR sensor.

Node-RED is used, that is a programming tool for wiring along hardware devices, APIs and online services. It provides a browser-based editor which simplifies wiring along flows using the big selection of nodes within the palette that may be deployed to its runtime during a single-click. Flows could also be then deployed to the runtime in a very single click. NodeRED also will facilitate providing a web-browser primarily based dashboard interface for managing and controlling the devices..

MQTT Broker is that main server which is able to be hosted on Raspberry Pi, which will receive all messages and command from the client devices like lights, AC, Computers, Fan, curtains, etc. (called as MQTT Clients). SQLite for storing IoT data.

In Fig 3. If we want to turn on the lights in the lab, you will publish a message using node red saying ON and ESP8266 will be subscribed to same message, so it will receive the same message and finally turn on the lights. And MQTT Broker is responsible for receiving,filtering

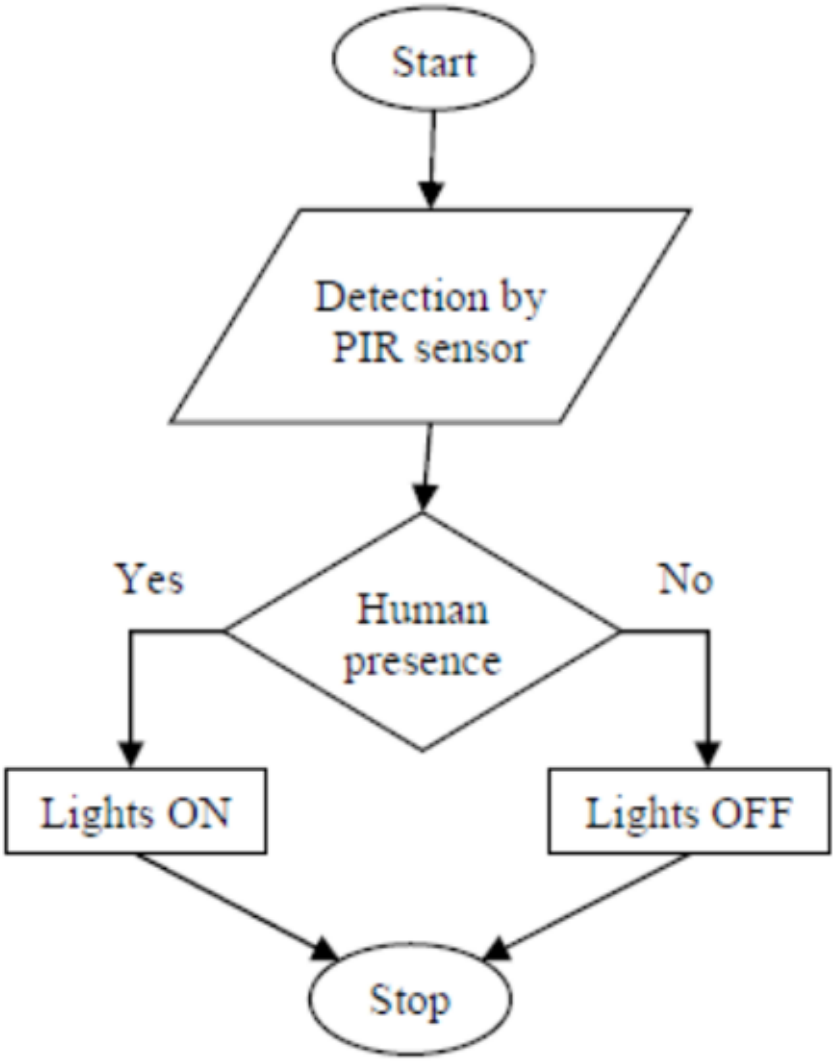

Figure 3: fLOW OF WORKING

and publishing the messages to all subscribed clients.We will use mosquitto broker which we will install in Raspberry Pi.

Summary

Considering the same issues in our university, we've listed the problems and located out the solutions to reduce the employment for the research lab assistants and college members to the utmost. The node-red user interface dashboard is accessible via browser, it ensures cross-platform compatibility. Adding some 'smarter' parts to our life makes our lives easier, and a lot of versatile in terms of day to day usage. the main objective of our project is to cut back the human efforts in labs, that we predict will be achieved using laboratory automation. The Expected system can ease the complete automation method in labs and create the lab management easily. The projected system cannot solely be used for schools and universities, however conjointly at homes, studios, and plenty of different places. Security are our next main focus once implementing the core system within the future. Integration of research lab plan programing with our project beside inclusion of further options like controlling of laptop switches, curtains, fireplace detection, will be looked upon.

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1 Publication

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