SMART ENERGY EFFICIENT HOME AUTOMATION SYSTEM USING IOT

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ABSTRACT

Advancement in IoT based application has become the state-of-the art technology among the researcher due to the availability of Internet everywhere.

To make the application more user friendly, web based and android based technologies have gained their importance in this cutting edge technology.

In this paper, smart energy efficient home automation system is proposed that can access and control the home equipments from every corner of the world. For this system, Internet connectivity module is attached to the main supply unit of the home system which can be accessed through the Internet. For wireless connectivity, the static IP address is used.

Home automation is based on multimodel application that can be operated using voice recognition command of the user using the Google Assistant or through a web based application. Thus, main objective of this work is to make our home automation system more secure and intelligent.

1. INTRODUCTION

1.1 Aim

The aim of this application is to connect any things through the Internet that can be accessible from anywhere.

1.2 Overview

Human-machine interaction (HMI) has become, the more realistic in day-to-day life due to the advancement in the technology . Today, HMI research has moved one step ahead and switched onto the Internet, which was previously used for communication and now used for things, i.e., IoT (Internet of Things). The aim of this application is to connect any things through the Internet that can be accessible from anywhere. IoT application are not limited to one particular field. It has shown the significant contribution from small scale applications to the large scale applications such as, Ecommerce, Coal Mine, Wearable device, Smart Grid , Laboratory Monitoring , Agriculture and many other domains.

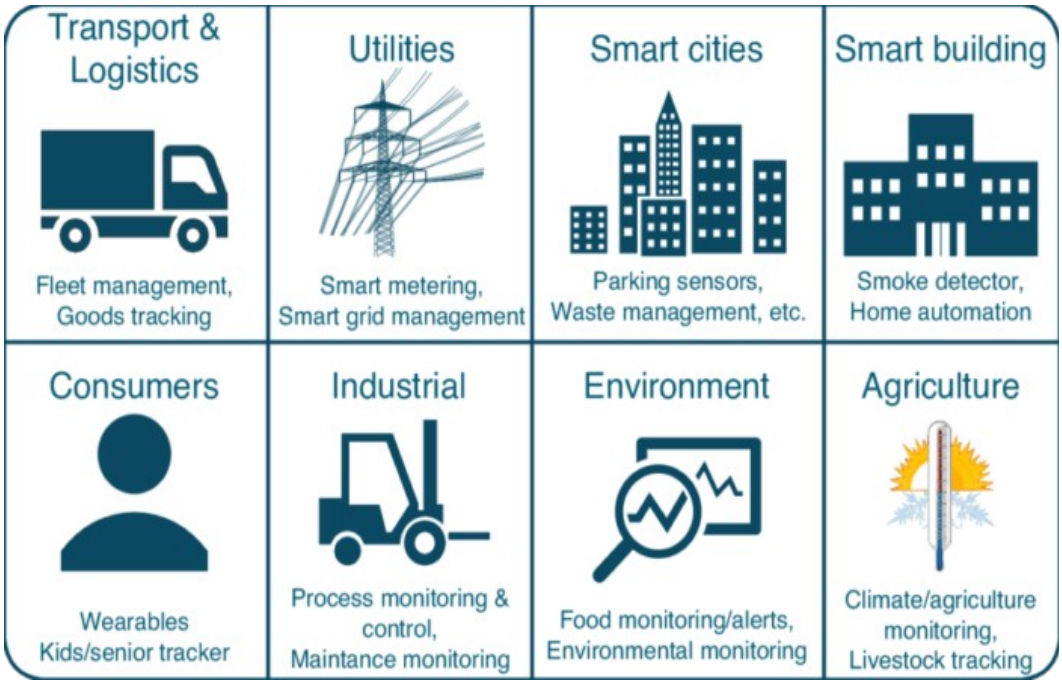

Fig-1.1 Image showing applications of IOT.

1.3 Motivation

So Though, we have received tremendous improvement in the technology, but still power consumption is one of the big issue all over the world. As per report, the Information and Communication Technologies (ICT) alone uses 4.7% of the world's electricity, which may likely to be increased to 10% as per report . India, share about the 17% of the world population has limited energy resources and share roughly 0.6%, 0.4% and 7%, for world gas, oil and coal reserves respectively . However, in India, the electricity consumption due to ICT usage has increased from 24 TWh to 31 TWh in the last five years (for the period 2009-2014). This has resulted in electricity consumption of roughly 6.5% in 2015 . Thus, saving of the power is the main concern, which is the basic aim of this project. To save the power consumption, we have proposed the smart, energy efficient home automation system using IoT. Thus, aim of this research to save the power consumption (reducing the electricity bills) and at the same time provide the safety and security of the home equipments.

1.3 Smart Home Automation Approach

In this busy life schedule everyone wants to get some comfort and secure life as well. Home Automation used to control home appliances remotely to reduce efforts. Home security system is beneficial to secure your home from fire and trespass. Wireless smart home system plays a vital role in human life and increases popularity due to its flexibility, portability and low cost installation charges. Smart home system is very beneficial in everyday life as it reduces human workload, save electricity and reduces worries about home security for working peoples. Main focus in automation is to control light ON/OFF status, fan speed and other home appliances remotely. Home security includes services like gas leakage and trace pass protection. This system is very beneficial for old ages and handicapped people as well for working people, it is a blessing as it alert the person if any nasty situation raised at home in their absence. Though there are various technologies used but in every technology mobile plays important role, to automate home appliances or to get alert in risky situations. Attractive GUI can be used for smart home system, accessible with smart phones, tablet, laptop and PC. A comparative study of smart home system based on technologies like GSM, Bluetooth, IOT and PIC Microcontroller with ZigBee modulation is discussed here.

As demand for electricity is increasing day-by-day, therefore, smart home is the upcoming area of research to provide the remote access for controlling the home appliance using IoT.

IoT based application has also provided the boom for old aged people and the person having some sort of disability. This allows the user to control the home automation device such as fan, bulb etc., without even making any physical connection. Research conducted on home automation system is reported in . Most of the previous system based on these techniques is either based on DTMF or Bluetooth system . The basic problem with DTMF based home automation require dedicated PSTN channel for communication between main supply units and controlling device. On the other hand, Bluetooth is useful for short range communication that requires the operating appliance in their range.

Home automation using MQTT is presented in for sending/receiving data from the sensor. For this Raspberry pi is used as a gateway for accessing the data from the sensor which are used to measure the temperature and humidity of the room. Another home automation system is presented in which are based on Raspberry pi and user can control their home appliance using the web-based interface.

In , home automation using mobile is reported in which system is designed using ZigBee. IoT has provided the applications to turn non-smart device into smart device, which allow users to access these devices through the Internet. It converts the home into smart home and provides a more robust method of controlling the home appliance. Also, the security can be added with the help of installed camera in the home, which can be traced through the Internet. Thus, user can monitor their home and can turn ON/OFF their appliances which will definitely going to save both the electricity and electric bills.

Other features that can be included in the smart home for security purpose is to include the sensors and cameras that can prevent the intruder from entering into your home. Also, making the system more intelligent, that can turn on the light and fan of the room as soon as it detects the presence of the person. With this motivation, we develop IoT based home automation system which uses voice as well as web-based service for controlling the home appliance. Also for security purpose, the user-define command are set which enables to operate the system.

2. OVERVIEW OF PROPOSED SYSTEM

The concept of Internet of Things (IoT) requires the seamless connectivity of millions of heterogeneous devices. In today's World, implementation of IoT based smart home has drawn a huge attraction and become a prominent area of research. This research work presents an approach for smart home automation using IoT that can be controlled wirelessly. Home automation system means monitoring and controlling of home appliances remotely using the concept of internet of things (IOT). In this method we use mobiles or computers to control the basic home appliance and make it function through the designed web page with internet connection/local area network (LAN) servers. This type of home is also known as smart home. The concept of applying automation in the sectors of housing is selling like hot cake. Western countries have welcomed the concept of automation into their homes with open arms.

Our country is keeping up with the pace of modernization too. Different approaches to automating homes have been implemented. The best among this is home automation system using IOT. IOT provides the feasibility of operating the home automation system from anywhere around the world using internet. It reduces use of excessive or unnecessary human efforts and improves the standard of living of the people in our society.

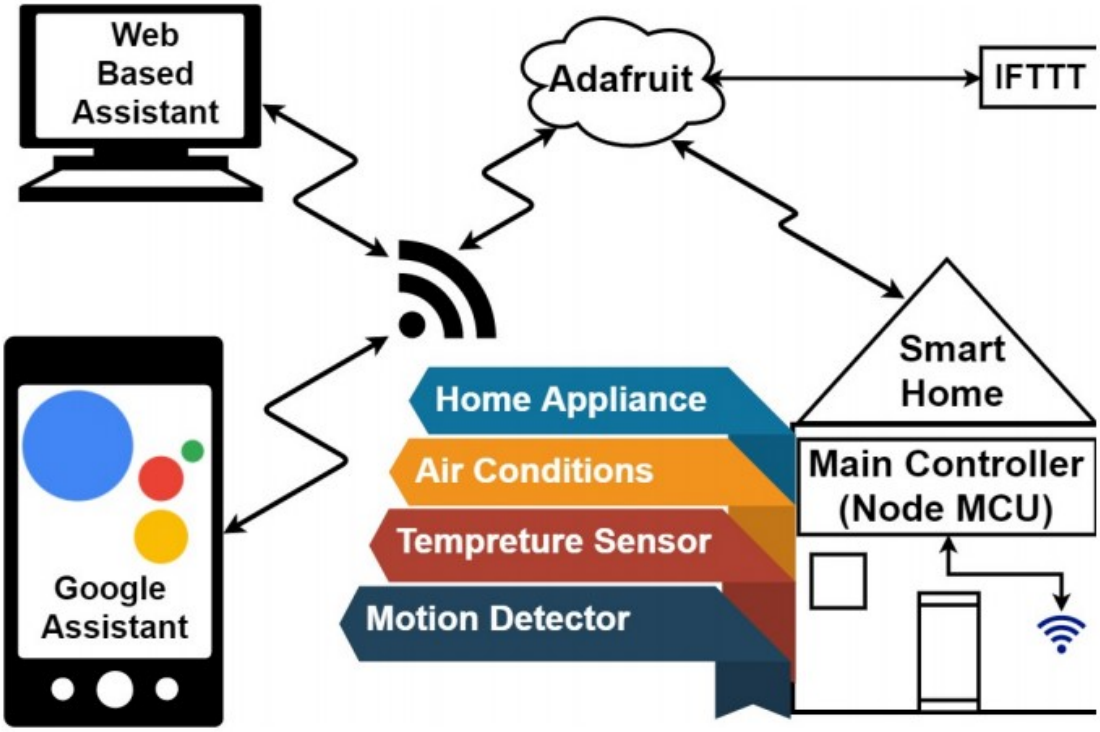

Fig-2.1 System Overview

2.1 Architecture

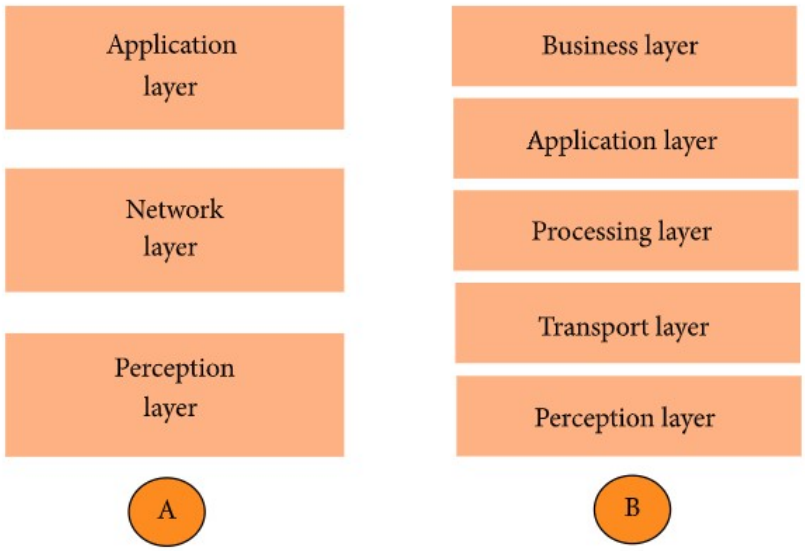

Fig-2.2 Three- and Five-Layer Architectures

The most basic architecture is a three-layer architecture shown above in the Figure. It was introduced in the early stages of research in this area. It has three layers, namely, the perception, network, and application layers.

i. The perception layer is the physical layer, which has sensors for sensing and gathering information about the environment. It senses some physical parameters or identifies other smart objects in the environment.e

ii. The network layer is responsible for connecting to other smart things, network devices, and servers. Its features are also used for transmitting and processing sensor data.

iii. The application layer is responsible for delivering application specific services to the user. It defines various applications in which the Internet of Things can be deployed, for example, smart homes, smart cities, and smart health.

2.2 Methodology

Global Romania firmly believes that software development should be a ‘no surprises’ process. We adhere to a best practices methodology which actively engages our work with the apps to ensure smooth, streamlined development processes with the highest possible degree of success.
Once we become your development partner, we begin by working with you to gain a thorough understanding of the problem to be solved, from both the business and the technical perspectives. We then build a team of technical resources that are the best fit for developing the systems that address your needs based on our initial analysis.
We are using basic client server model to achieve the communication between devices and and also to transfer the data.

2.3 Advantages

The advantages of the proposed system are:

iv. Stand alone
v. Low-cost
vi. Flexible
vii. Easy to operate
viii. Better scalability and flexibility

3. SYSTEM DESIGN

3.1 Overview

We need to use microcontroller to control the sensors and to send the data and mobile app and web app to controll or give instructions to the device . and we also need a cloud provider to act as a middle man between
Microcontroller and controlling device and also to minimize to cost. And we also need some sensors to sense the world around them and give the current state of the world

3.2 Micro controller

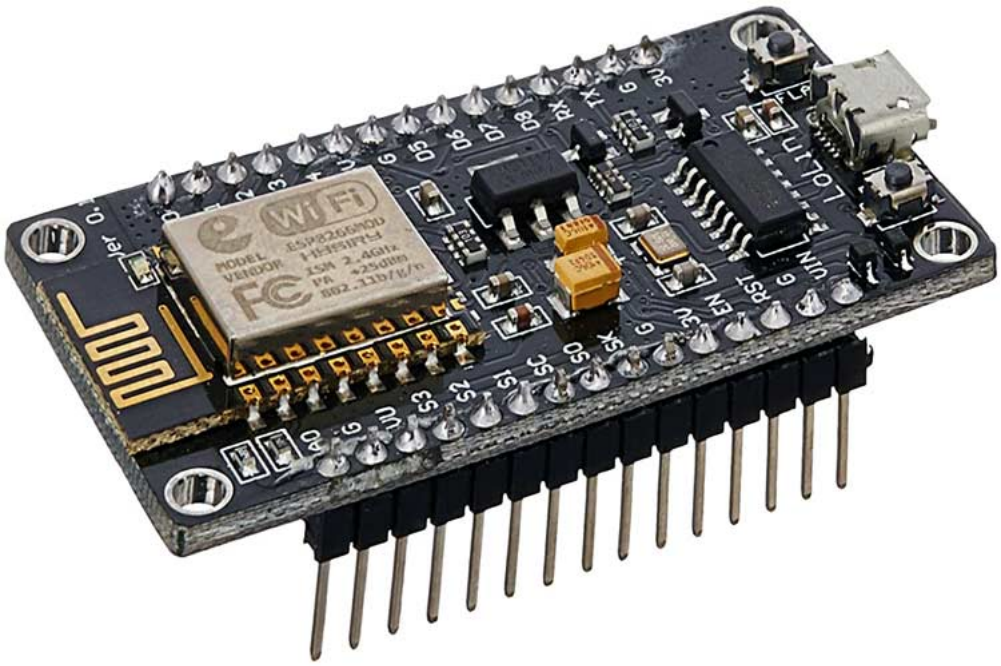

Fig-3.1 Node MCU micro controller

The NodeMCU ESP8266 development board comes with the ESP-12E module containing ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency. NodeMCU has 128 KB RAM and 4MB of Flash memory to store data and programs. Its high processing power with in-built Wi-Fi / Bluetooth and Deep Sleep Operating features make it ideal for IoT projects.

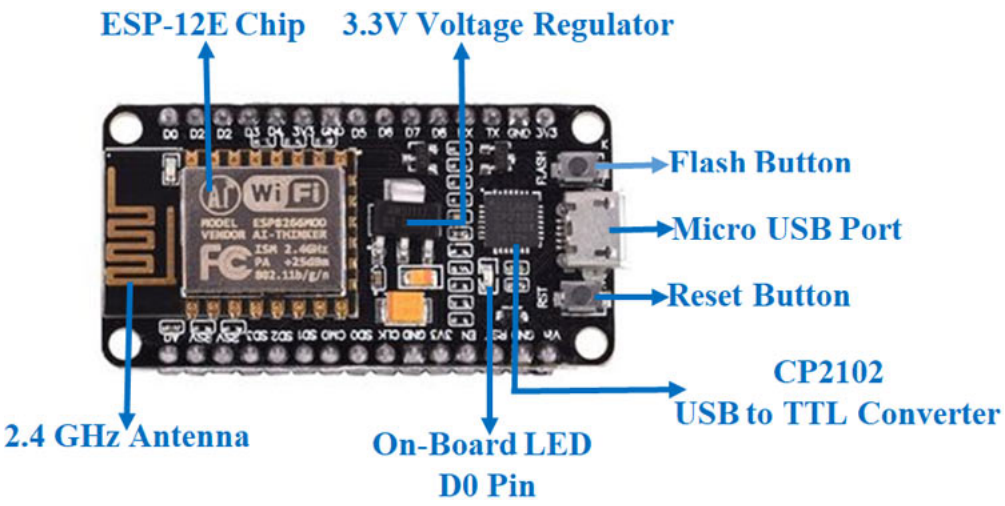

Fig 3.2- Specifications of Node MCU micro controller

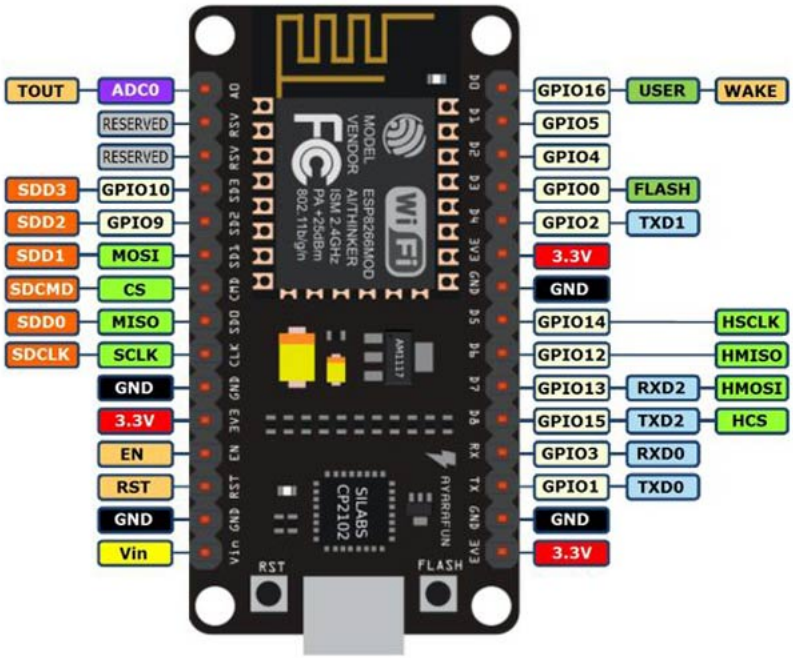

Fig 3.3- Pin configuration of Node MCU micro controller

Applications of NodeMCU

1) Prototyping of IoT devices
2) Low power battery operated applications
3) Network projects
4) Projects requiring multiple I/O interfaces with Wi-Fi and Bluetooth functionalities

3.3 Controlling of IoT devices

In order to switch on or off the micro controller we have to give it instructions if we have to remotely do this i.e with out having physical interaction with the micro controller we need some kind of controlling device which talks over the internet and gives the command to the micro controller , so for this purpose we are going to use mobile app , web app and voice commands

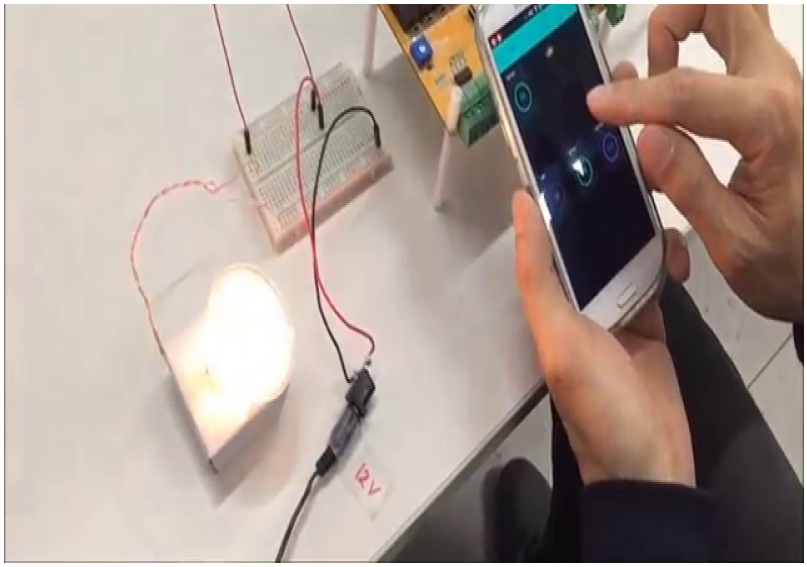

Fig 3.4- Controlling micro controller with mobile app

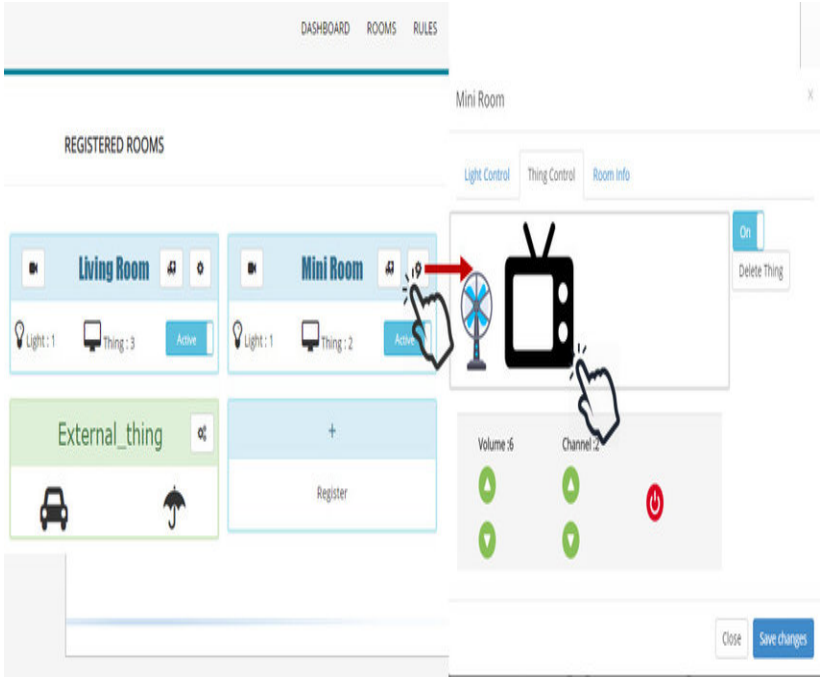

Fig 3.5- Controlling micro controller with web app

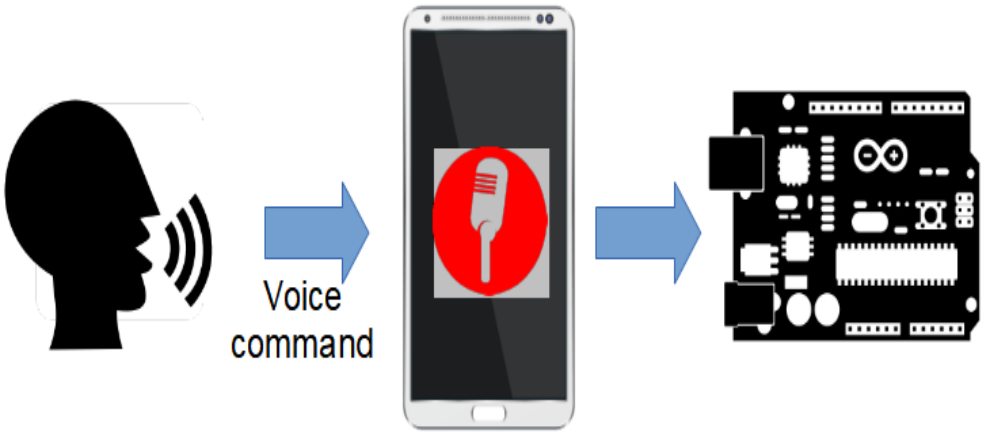

Fig 3.6- Controlling micro controller with voice commands

3.4 Cloud

Fig 3.7- Capability of cloud

Cloud computing and the IoT both serve to increase efficiency in everyday tasks and both have a complementary relationship. The IoT generates massive amounts of data, and cloud computing provides a pathway for this data to travel. Many Cloud providers charge on a pay per use model, which means that you only pay for the computer resources that you use and not more. Economies of scale is another way in which cloud providers can benefit smaller IoT start-ups and reduce overall costs to IoT companies.

Another benefit of Cloud Computing for the IoT is that Cloud Computing enables better collaboration which is essential for developers today. By allowing developers to store and access data remotely, developers can access data immediately and work on projects without delay.

Finally by storing data in the Cloud, this enables IoT companies to change directly quickly and allocate resources in different areas. Big Data has emerged in the past couple of years and with such emergence the cloud has become the architecture of choice. Most companies find it feasible to access the massive quantities of Big Data via the cloud.

Fig 3.8- Top cloud providers for IOT

Above figure shows the all possible cloud providers in current market they provie very wide services which will be very use ful to extract the insights from the data we receive from the sensors and it also has scallable storage spaces and serves so that they can manage huge traffic as well , we could also use our own server but it is very costly as we have to manually check and scale for the traffic.

3.5 Different type of Sensors

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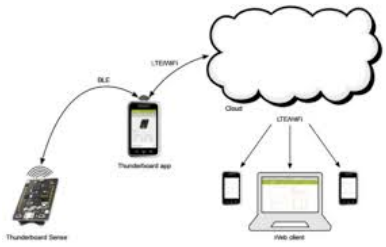
Some common types of IoT sensors

1. Temperature sensors
2. Humidity sensors
3. Motion sensors
4. Gas sensors
5. Smoke sensors
6. Pressure sensors
7. Image sensors
8. Accelerometer sensors
9. IR sensors
10. Proximity sensors

Fig 3.9- Different types of sensors

3.6 System configuration



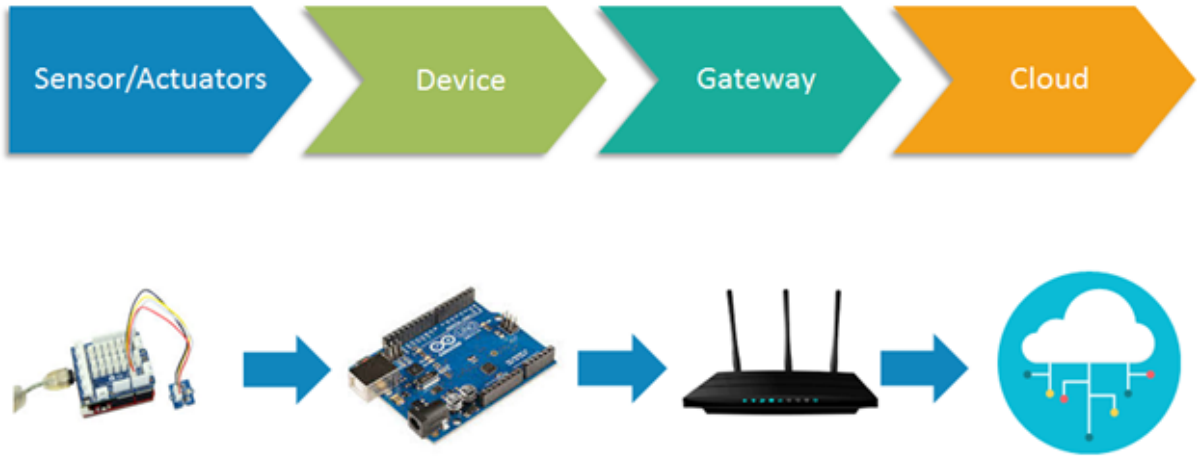


Fig 3.10-Connection of all the components

4. LIMITATIONS IN THE SYSTEM

1. **Compatibility**: As of now, there is no standard for tagging and monitoring with sensors. A uniform concept like the USB or Bluetooth is required which should not be that difficult to do.

2. **Complexity**: There are several opportunities for failure with complex systems. For example, both you and your spouse may receive messages that the milk is over and both of you may end up buying the same. That leaves you with double the quantity required. Or there is a software bug causing the printer to order ink multiple times when it requires a single cartridge.

3. **Privacy/Security**: Privacy is a big issue with IoT. All the data must be encrypted so that data about your financial status or how much milk you consume isn't common knowledge at the work place or with your friends.

4. **Safety**: There is a chance that the software can be hacked and your personal information misused. The possibilities are endless. Your prescription being changed or your account details being hacked could put you at risk. Hence, all the safety risks become the consumer's responsibility.

5. IMPLEMENTATION

We are going to implement as per below steps

1. Process implementation
2. Application development
3. integration

5.1 Process Implementation

• Process Specification
• Domain Model Specification
• Information Model Specification
• Service Specifications
• IoT Level Specification
• Functional View Specification
• Operational View Specification
• Device & Component Integration
• Application Development

5.1.1 Process Specification

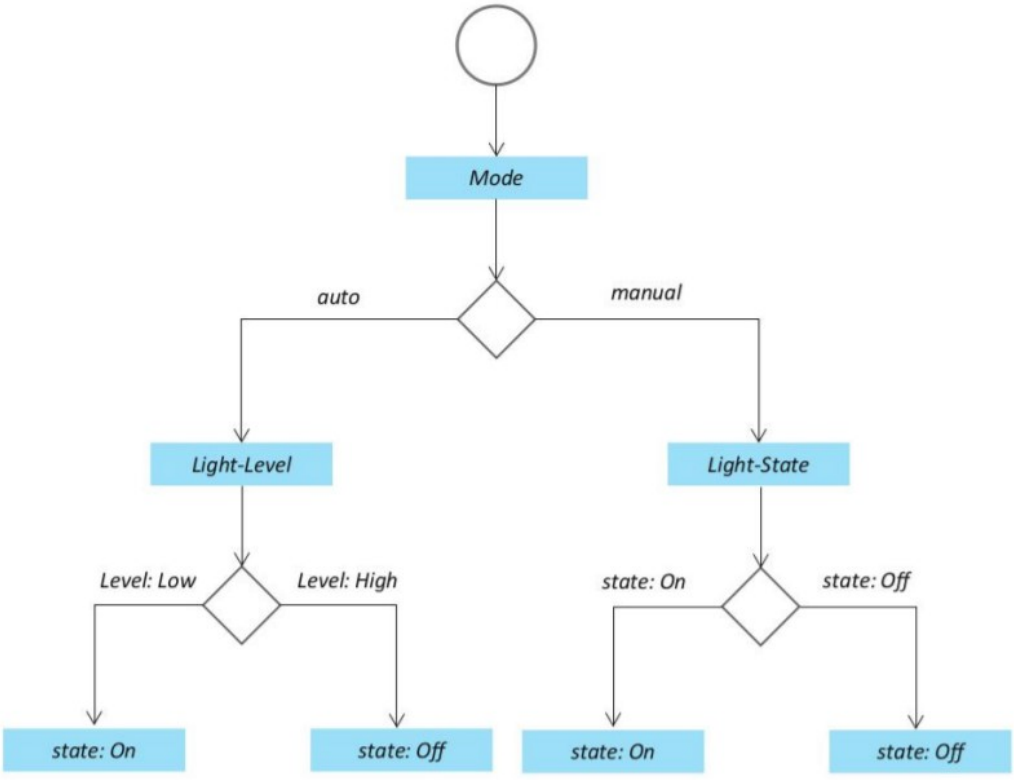


Fig 5.1- Process specification

5.1.2 Domain Model Specification

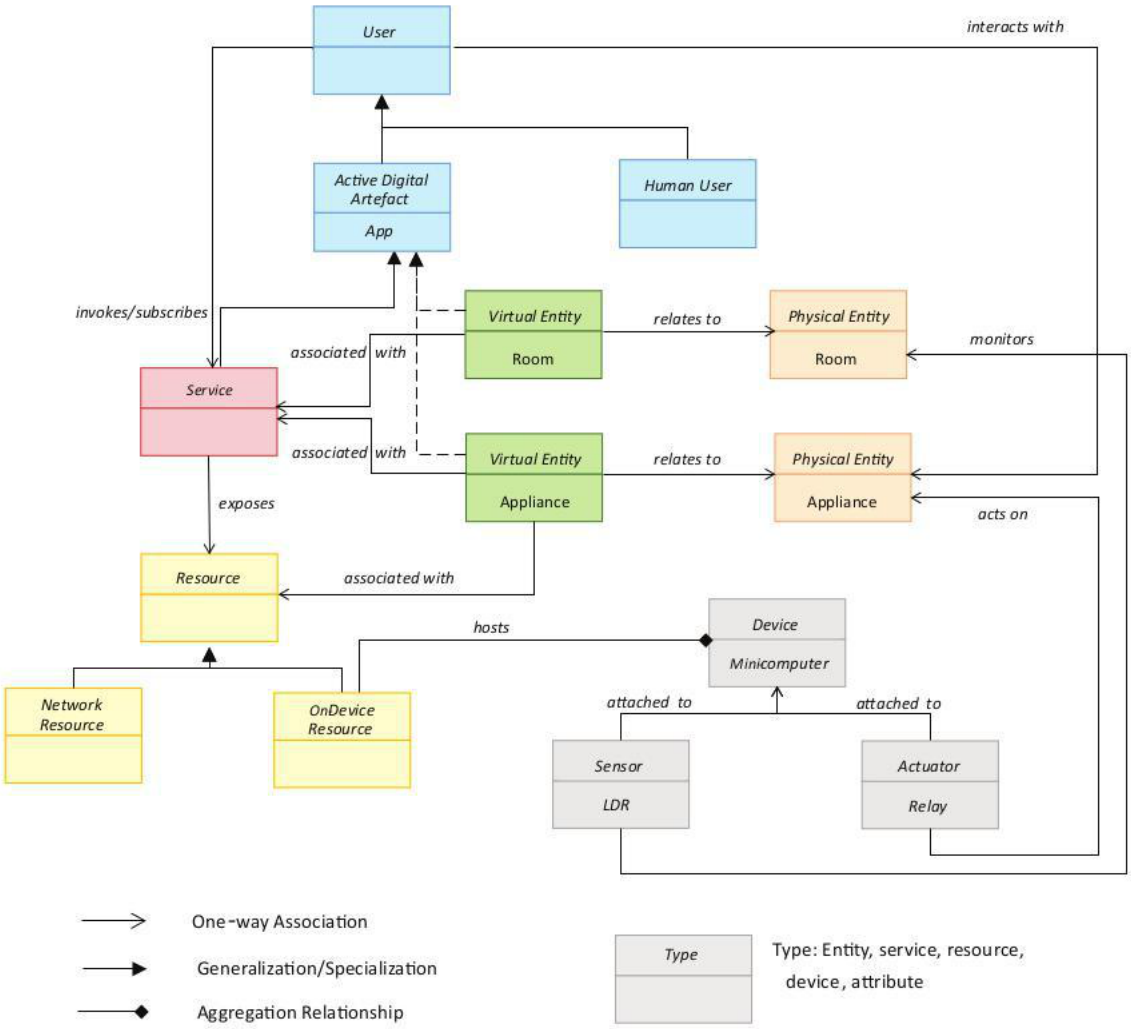


Fig 5.2 - Domain model specification

5.1.3 Information Model Specification

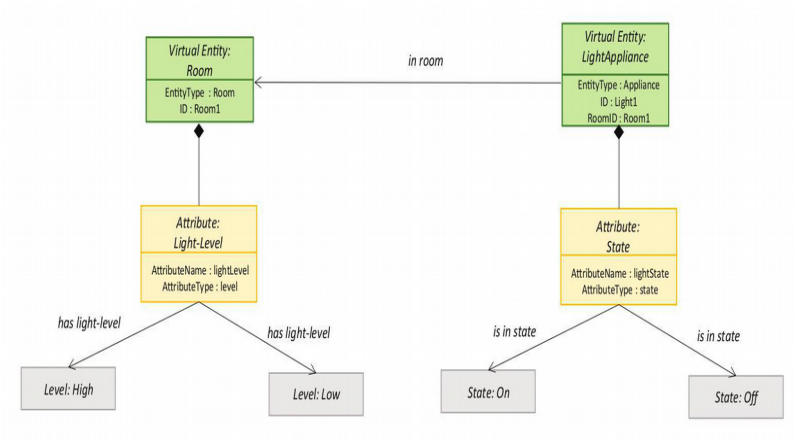


Fig 5.3- Information model specification

5.1.4 Service Specifications

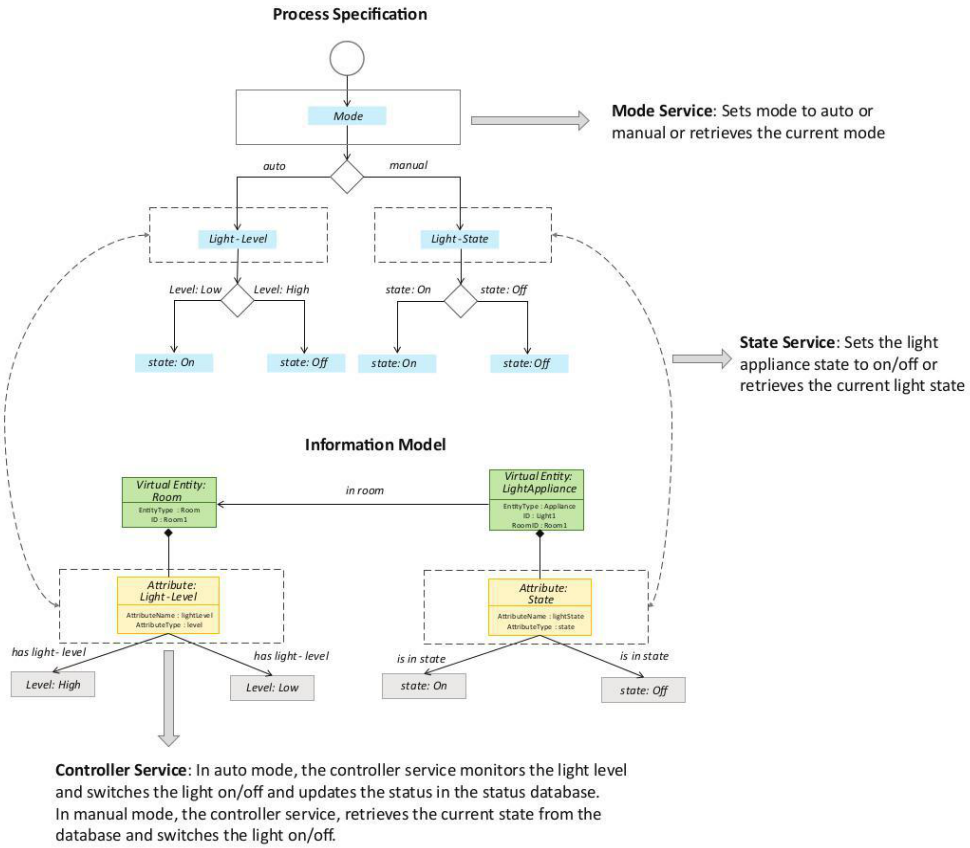


Fig5.4 - Service specification

5.1.6 Functional View Specification

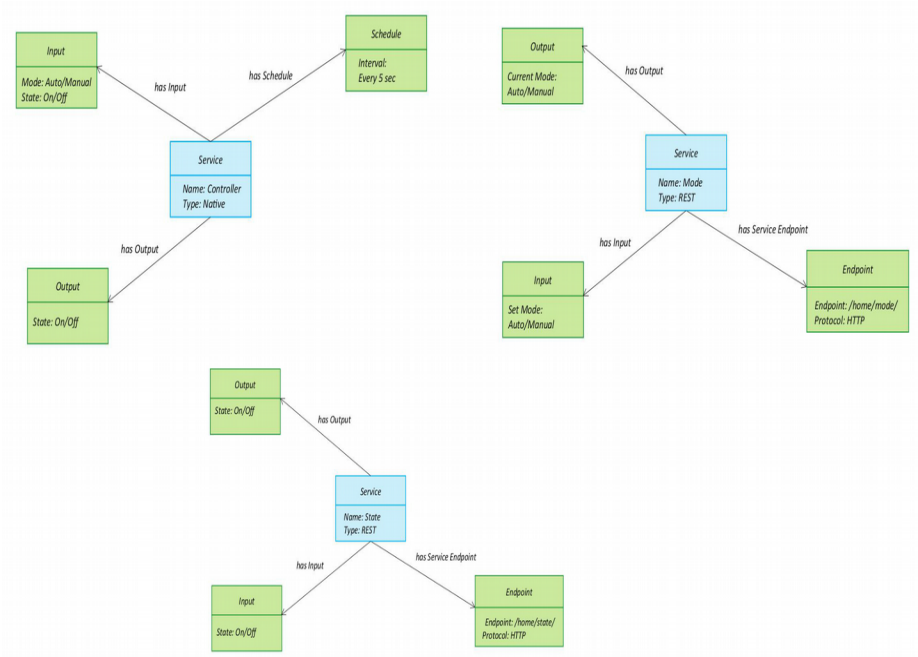


Fig 5.5 - Functional View Specification

5.1.5 IoT Level Specification

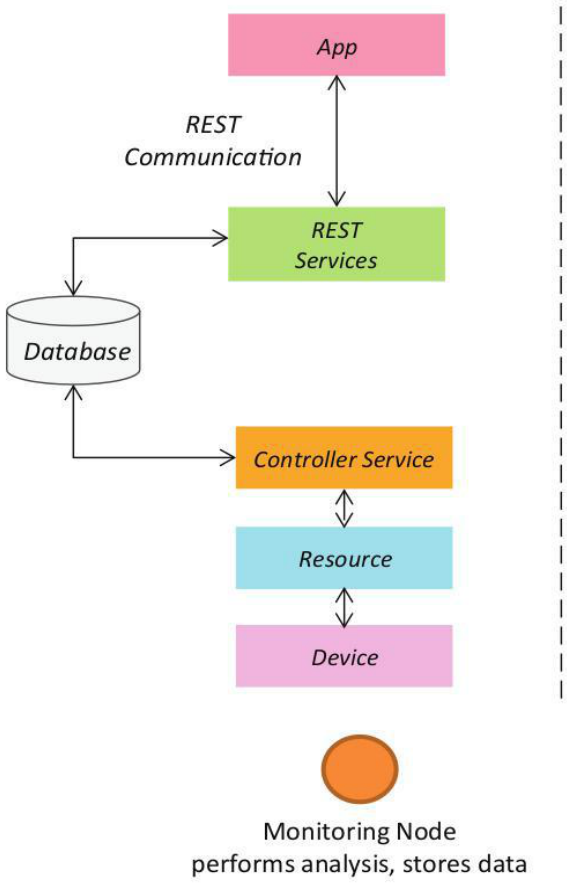


Fig 5.6-Iot level specification

5.1.8 Device & Component Integration

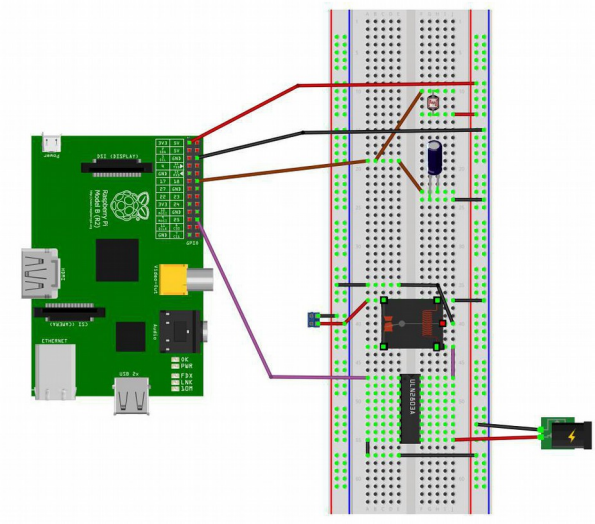


Fig 5.7-Connection demonstration

5.2 Application Development

1. Auto :
    1. Controls the light appliance automatically based on the lighting conditions in the room

2. Light:
    1. When Auto mode is off, it is used for manually controlling the light appliance.
    2. When Auto mode is on, it reflects the current state of the light appliance.

Fig 5.8-dashboard

5.2.1 REST Web Services

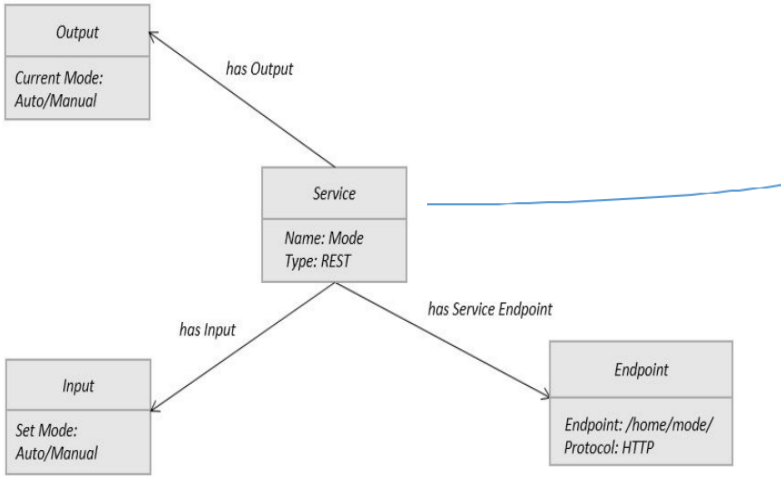


Fig 5.9-Restful API services

Screen shot of browsable rest api

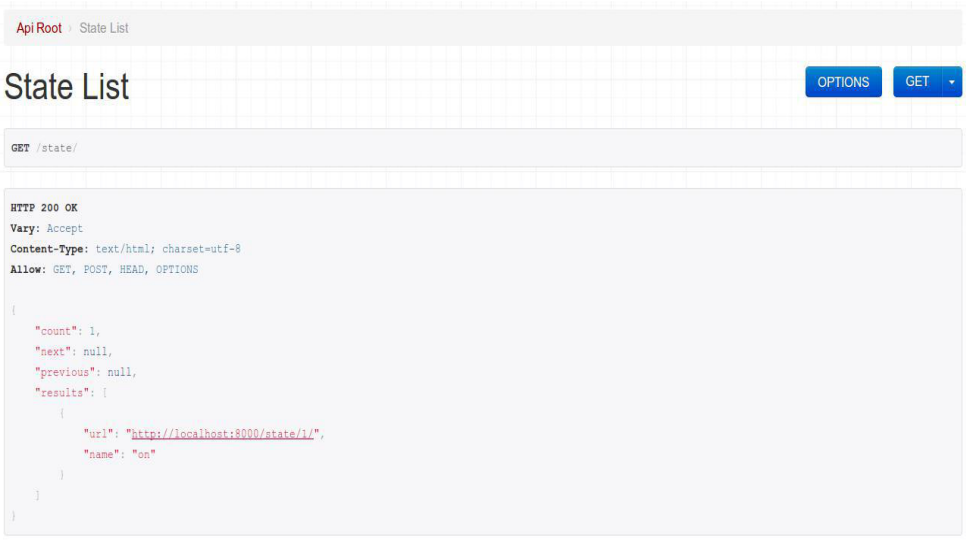


Fig 5.10 Browser rest api dashboard

5.2.2 : Django web app implementation

1. Implement Django Application View

```
<div class="app-content-inner">
<fieldset>
<div class="field clearfix">
<label class="input-label icon-lamp" for="lamp-state">Auto</label>
<input id="lamp-state" class="input js-lamp-state hidden" type="checkbox">
{% if currentmode == 'auto' %}
<div class="js-lamp-state-toggle ui-toggle " data-toggle=".js-lamp-state">
{% else %}
<div class="js-lamp-state-toggle ui-toggle js-toggle-off" data-toggle=".js-lamp-state">
{% endif %}
<span class="ui-toggle-slide clearfix">
<form id="my_form11" action="" method="post">{% csrf_token %}
<input name="auto" value="auto" type="hidden" />
<a href="#" onclick="$(this).closest('form').submit()"><strong class="ui-toggle-off">OFF</strong></a>
</form>
<strong class="ui-toggle-handle brushed-metal"></strong>
<form id="my_form13" action="" method="post">{% csrf_token %}
<input name="manual" value="manual" type="hidden" />
<a href="#" onclick="$(this).closest('form').submit()"><strong class="ui-toggle-on">ON</strong></a>
</form></span>
</div></div>
<div class="field clearfix">
<label class="input-label icon-lamp" for="tv-state">Light</label>
<input id="tv-state" class="input js-tv-state hidden" type="checkbox">
{% if currentstate == 'on' %}
<div class="js-tv-state-toggle ui-toggle " data-toggle=".js-tv-state">
{% else %}
<div class="js-tv-state-toggle ui-toggle js-toggle-off" data-toggle=".js-tv-state">
{% endif %}
{% if currentmode == 'manual' %}
<span class="ui-toggle-slide clearfix">
<form id="my_form2" action="" method="post">{% csrf_token %}
<input name="on" value="on" type="hidden" />
<a href="#" onclick="$(this).closest('form').submit()"><strong class="ui-toggle-off">OFF</strong></a>
</form>
<strong class="ui-toggle-handle brushed-metal"></strong>
<form id="my_form3" action="" method="post">{% csrf_token %}
<input name="off" value="off" type="hidden" />
<a href="#" onclick="$(this).closest('form').submit()"><strong class="ui-toggle-on">ON</strong></a>
</form>
</span>
{% endif %}
{% if currentmode == 'auto' %}
{% if currentstate == 'on' %}
<strong class="ui-toggle-on">&amp;nbsp;&amp;nbsp;&amp;nbsp;&amp;nbsp;ON</strong>
{% else %}
<strong class="ui-toggle-on">&amp;nbsp;&amp;nbsp;&amp;nbsp;&amp;nbsp;OFF</strong>
{% endif %}{% endif %}
</div>
</div>
</fieldset></div></div></div>
```

Fig 5.11 Django view Template code

5.3 Integrate the System

1) Setup the device
2) Deploy and run the REST and Native services
3) Deploy and run the Application
4) Setup the database

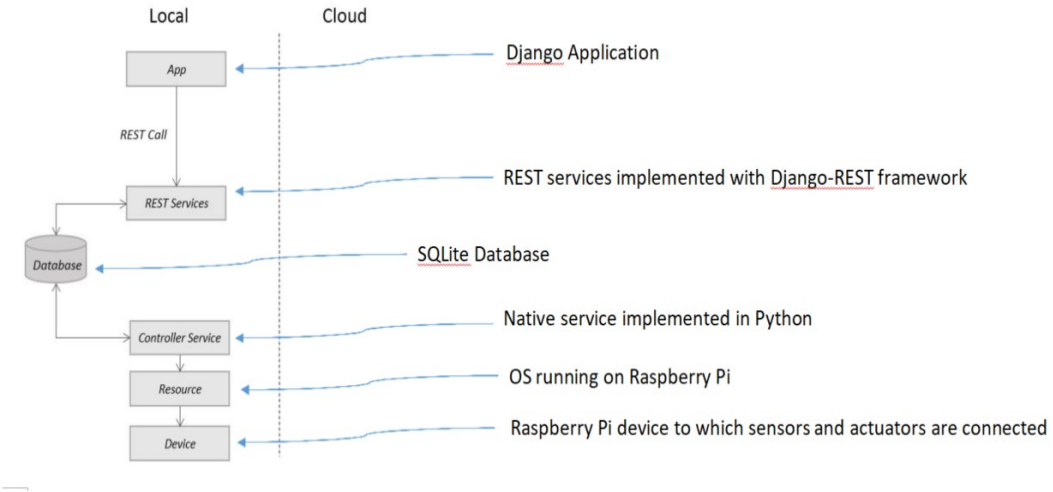


Fig 5.12 Final integration of system

6. RESULTS

The micro controller is connected to power supply and the censors are connected to the micro controller and the .Data is transferred from sensors to micro controller and from there it is sent to the cloud to store and the micro controller is controlled by mobile and web app and voice commands.

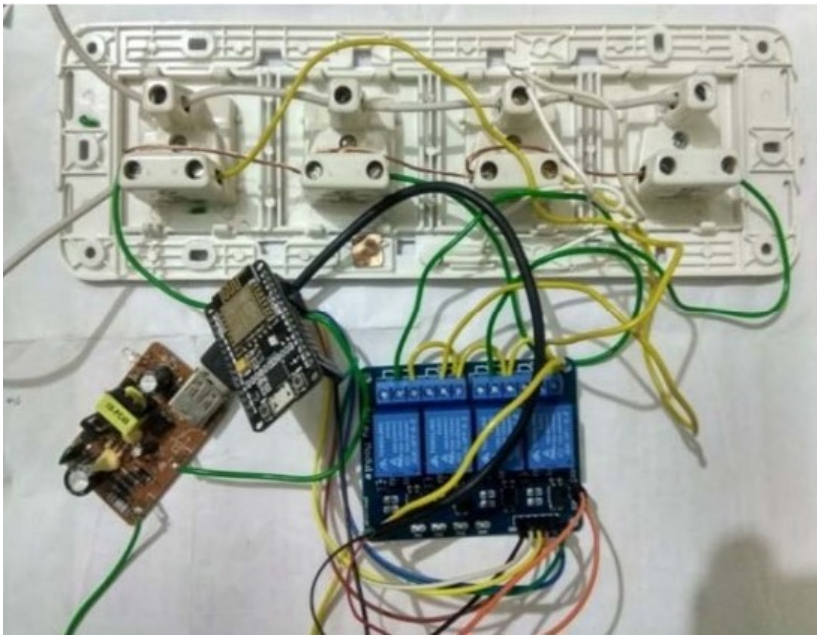


Fig 5.13 Micro contoller is connected to the power supply

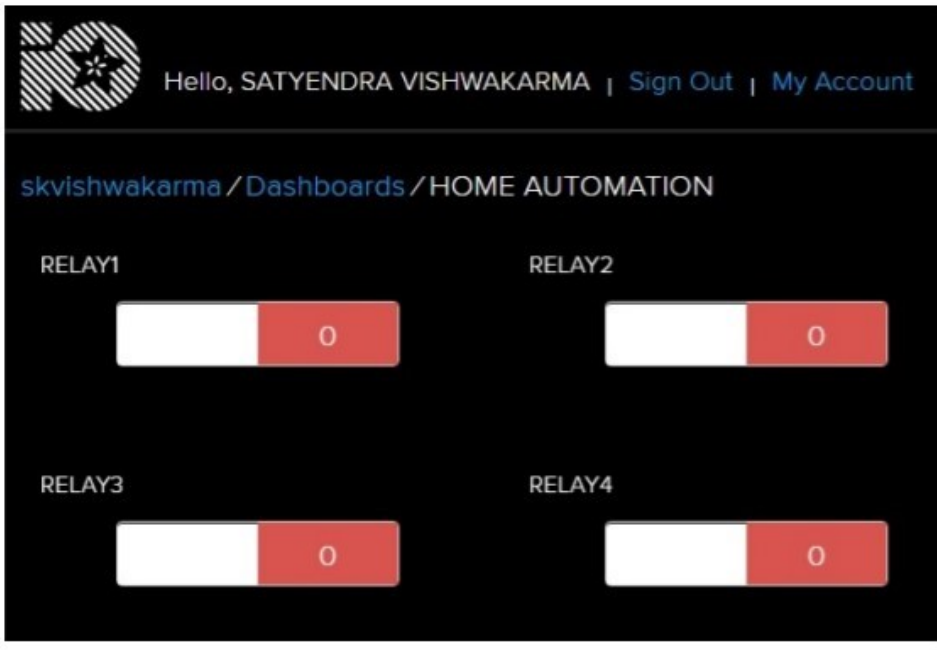


Fig 5.14 Controlling microcontroller with mobile app

Fig 5.15 Home appliances are connected to microcontroller and power supply

7. CONCLUSION

The IoT has the potential to dramatically increase the availability of information, and is likely to transform companies and organizations in virtually every industry around the world.

As such, finding ways to leverage the power of the IoT is expected to factor into the strategic objectives of most technology companies, regardless of their industry focus.

The number of different technologies required to support the deployment and further growth of the IoT places a premium on interoperability, and has resulted in widespread efforts to develop standards and technical specifications that support seamless communication between IoT devices and components. Collaboration between various standards development groups and consolidation of some current efforts will eventually result in greater clarity for IoT technology companies.

Using the IoT connectivity, we can monitor and access our smart home easily from anywhere, which will definitely will prove to be energy efficient
It act has a helping hand for the old age and differently abled person
We can easily extend our existing systems The system may be employed in many places like banks , hospitals etc.

8. FUTURE WORK

A quick look back shows where IoT devices are going. Consider: In 2016, there were more than 4.7 billion things connected to the internet, according to IOT Analytics. Fast-forward to 2021? The market will increase to nearly 11.6 billion IoT devices.

So for future work we would like to add up more controlling units that can make our smart home more intelligent andj secure so that can be practically deployed in the real time situation.and we can also extend this to industrial usage.And we can also use this for disabled persons this could be a very good solution for these people and installing this solutions at emergency exit place could be very helpful.

And also introducing artificial intelligence and machine learning in to the algorithms can give customized customer experience and better security and can work more efficient than ever before.

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