# IoT based Home Automation Using Raspberry-PI

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***Abstract*— The concept of IoT (Internet of Things) gives an idea of remotely connecting and monitoring real world objects through the Internet. When it comes to our house or offices, this concept can easily be incorporated to make our house much smarter, safer and automated. This IoT project mainly focuses on developing a smart and wireless home automation system which can easily sends some alert messages to the owner by using Internet like if any unauthorized persons are entering in our premises the action can be detected and raises an alarm optionally by making use of the some set of sensors connecting to the controller. The leverage obtained by preferring this system over the similar kinds of existing systems is that the alerts and the status sent by the WI-FI connected microcontroller managed system can be received by the prescribed user anywhere, any time and from any distance through the use of IoT API (Application Program Interface). The microcontroller used in the current prototype is the Raspberry pi board which comes with an embedded micro-controller and an onboard Wi-Fi shield making use of which all the electrical appliances inside the home can be controlled and managed.**

***Keywords*— Home Automation, Internet of Things, Raspberry-Pi, Sensors, API, WI-FI**

## I. INTRODUCTION

Homes of the 21st century will become more and more self-controlled and automated due to the comfort it provides, and also it's growing very rapidly because the system is used to provide ease to disabled and elder peoples. A home automation system is a means which allows users to control electric appliances of varying kind wirelessly through Internet via the concept of Internet of Things.

The term Internet of Things (IoT) is coined by person Kevin Ashton in the year 1990. Actually IoT consists of 2 words namely Internet and things, where Internet is precisely a worldwide network of interconnected networks and things is nothing but objects, in simple terms IoT means the things which are going to talk with each other's by using some standard protocol. [2]

The aim of this project is to make home as a fully automated using IoT. Here various sensors will be interfaced to the home. Data of those sensors will be uploaded to the cloud and also we can monitor the home appliances remotely by using Iot-API.

The design and development of home automation system can be achieved by using a single microcontroller which has the ability to control and monitor different interconnected appliances such as lights, temperature and humidity sensors, smoke, gas and fire detectors as well as emergency and security systems [1]. One of the biggest advantage of home automation system is that it can be controlled and managed easily from many devices such as smartphone, desktop tablet, and laptop.

This paper describes the implementation and working principles of IoT based home automation system. Where the IoT-API used here is Ubidots which is free platform to monitor real time sensor values from anywhere.

The rest of this paper is organized as follow. In section II, some related works based on home automation systems are discussed. Section III highlights about problem definition associated with home automation system. Section IV elaborates about our proposed system. Section V we have discussed about algorithm used and simulated result of our design. Finally, in section VI we have concluded about our project.

### *A. Architecture*

The proposed system is a distributed home automation system, consists of server, sensors. Server controls and monitors the various sensors real time values, and can be easily configured to handle more hardware interface module (sensors).


Fig. 1. Architecture of Home Automation

Automation System can be accessed from the web browser of any local PC in the same LAN using server IP, or remotely from any PC or mobile handheld device connected to the internet [1]. Wi-Fi technology is selected to be the network infrastructure that connects server and the sensors. Wi-Fi is chosen to improve system security (by using secure Wi-Fi connection), and to increase system mobility and scalability.

## II. Related Work

*1) Bluetooth based home automation system*

Here in bluetooth based home automation system the communication between user and system may occur through bluetooth and it uses smartphone, Arduino board and Bluetooth technology proposed by R. Piyare and M . Tazil [3]. The problem with this system is that the Arduino BT board has very less range i.e between 10 to 100 meters, 3 Mbps data rate and 2.4 GHz bandwidth.

*2) Voice recognition based home automation*

Here home automation systems uses smartphone, Arduino board and Bluetooth technology proposed and implemente by researcher.[4] Here Android OS has a built-in voice recognizing feature which is used to develop a smartphone application which has ability to control the home appliances from user voice command. This application converts the user voice command into text, then it transmit that text message to Bluetooth module HC-05 which is connected with Arduino UNO. This system also faces short distance commuication problem.

## III. Problem Definition

Home automation systems faces four main challenges; these are poor manageability, high cost of ownership, difficulty in achieving security, and inflexibility. The main objectives of this project is to design and implement a home automation system using IoT that is capable of controlling and automating most of the house appliances through an easy manageable internet interface. The proposed system has a great flexibility by using Wi-Fi technology to interconnect its distributed sensors to home automation server. This will decrease the deployment cost and will increase the ability of upgrading, and system reconfiguration.

## IV. Proposed System

The block diagram of home automation system is shown in Fig 2. The model consists of different sensors like temperature, gas, motion and humidity.

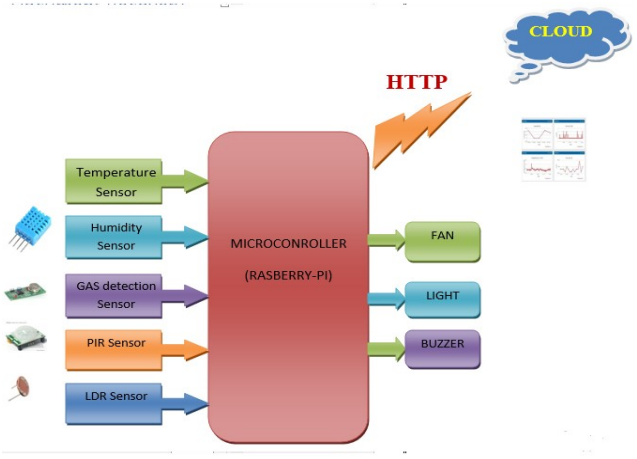


Fig. 2. Block Diagram of Proposed Home Automation System

When the connection is established it will start reading the parameters of sensors. The threshold levels for the required sensors are set. The sensor data are sent to the web server and stored in the cloud. The data can be analyzed anywhere any time. If the sensor parameters are greater than the threshold level then the respective alarm will be raised and the required actuation is done for the controlling of the parameters. In the proposed model the temperature, gas leakage, motion in the house is monitored. The temperature and the motion detection are stored in cloud for analysis. If the temperature exceeds the threshold level then the cooler will turn on automatically and it will off when the temperature comes to control. Similarly when there is a leakage of gas in the house alarm is raised giving the alert sound. The required lights are turned on/off automatically by detecting the light outside the house. The user can also monitor the electric appliances through the internet via web server.

### *A. Hardware Requirements:*

1. Raspberry Pi
2. PIR Sensor
3. Temperature Sensor
4. Humidity Sensor
5. Gas Sensor
6. Lights and Fans

### *B. Software Requirements*

1. Programming Language – Python
2. IoT API – Ubidots

*C. Hardware Requirements:*

*1) Raspberry Pi*

For this project, of course Raspberry Pi board shown in Fig 3 acts as main controller. The model A or B doesn't really matter, but we have to be very careful because board have to be connected to local network. Here we had used Model B because it has inbuilt WI-FI/Ethernet connectivity. Hence we call Raspberry Pi is a credit-card-sized single-board computer. It does not include a built-in hard disk or solid-state drive, but uses an SD card for loading your OS and long-term storage. It also has 4 USB ports, 1 Micro USB power source, Full size HDMI, CSI camera port, DSI display port and Bluetooth Low Energy (BLE) on board [5].

Fig. 3. Raspberry-Pi Board

Raspberry Pi board has 40 GPIO (General Purpose Input Output) pins which is integrated on Raspberry Pi board, the details of which is shown Fig 4.

GPIO capabilities may include:

- GPIO pins can be configured to be input or output
- GPIO pins can be enabled/disabled
- Input values are readable (typically high=1, low=0)
- Output values are writable/readable
- Input values can often be used as IRQs (typically for wakeup events)

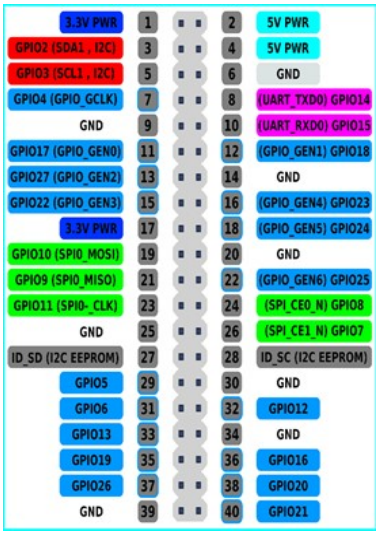


Fig. 4. GPIO Pin Setup

*2) GAS Sensor (MQ-6)*

The MQ6 (LPG Gas Sensor) is a simple-to-use liquefied petroleum gas (LPG) sensor. It can be widely used in detection of gas leakage in consumer and industry applications. [6]


Fig. 5. Gas Sensor

The sensor consist of 4 pins as shown in Fig 5, where first pin is dedicated to +5v Supply Voltage here power is driven from raspberry pi board, second pin is Ground, third pin is Digital Out pin and fourth is Analog Out. Here depending on our code we can assign output pins to raspberry pi board. Here in our project if gas detector output goes high then in turn it triggers alarm where the leak is occurring and gives them the opportunity to leave.

*3) PIR Sensor (HC-SR501):*

PIR (Passive Infrared Sensor) allows us to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power and easy to use. [7]

Fig. 6. PIR Sensor Module

PIR modules have a 3-pin connection as shown in Fig 6, one pin will be ground, another will be signal and the final one will be power. Power is usually 3-5V DC input but may be as high as 12V.

*4) Temperature and Humidity Sensor (DHT11)*

This DHT11 (Digital Temperature & Humidity Sensor) used to measure temperature & humidity of the surrounding area, here certain threshold value of temperature has been fixed. If the sensor value goes beyond the threshold value then the respective fan automatically switches ON. [7]

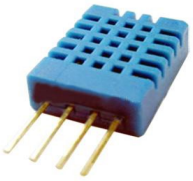

Fig. 7. DHT11 Sensor

The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20 meter signal transmission making it the best choice for various applications [8]. For this initially we to install Adafruit DHT11 library and also we need to install all other required libraries too. It has 4 pins as shown in Fig 7, where first is Vcc, second is Data pin which is connected to assigned GPIO pin in our code, third pin is NC (Not Connected) and fourth pin is Grounded.

*5) LDR:*

A Light Dependent Resistor (LDR) is a sensitive to light, i.e. when light falls on it its resistivity changes. There are many different symbols used to indicate a LDR**,** one of the most commonly used symbol is shown in the Fig 8. The arrow indicates light falling on it. [7]

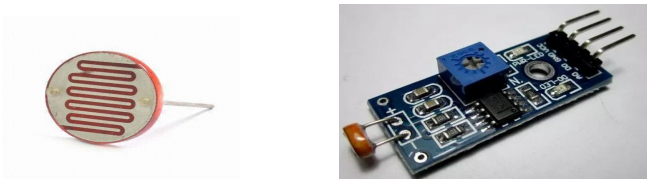

Fig. 8. LDR Sensor Module

If modules light intensity reach the set threshold, the modules digital output goes high, when the external ambient light intensity exceeds a set threshold, the module Digital output goes low. It also has 4 pins, first is connected to Input voltage, second and third pins are Digital and Analog output pins and fourth pin is Grounded.

*D. Software Requirements:*

*1) Python Language:*

Python is interpreted high level language for general purpose programming. Python interpreters are available for many operating systems. C Python, the reference implementation of Python, is open source software and has a community-based development.

Some of the features of python includes:

- Easy to Learn and Use
- Large Standard Library
- GUI Programming Support
- Free and Open Source
- Cross-platform Language.[8]

*2) IoT API-UBIDOTS*

Ubidots offers a platform for developers that enables them to easily capture sensor data and turn it into useful information. Use the Ubidots platform to send data to the cloud from any Internet-enabled device. You can then configure actions and alerts based on your real-time data and unlock the value of your data through visual tools. Ubidots offers a REST API that allows you to read and write data to the resources available: data sources, variables, values, events and insights. The API supports both HTTP and HTTPS and an API Key is required. [9]

Below are the steps required to start with Ubidots:

**Step 1:** Initially we have to create an account on the Ubidbots platform by filling all the required details.

**Step 2:** Click on devices and select add device or click on plus icon then provide the name for your device/project as shown in the Fig 9.


Fig. 9. Ubidots device/project Creation

**Step 3**: Click on the device/project which you have created and add the necessary variables required for your design. There you get the variable ID after creating the variables and its API label. Which have to paste in your program to observe the changes as shown in the Fig 10.

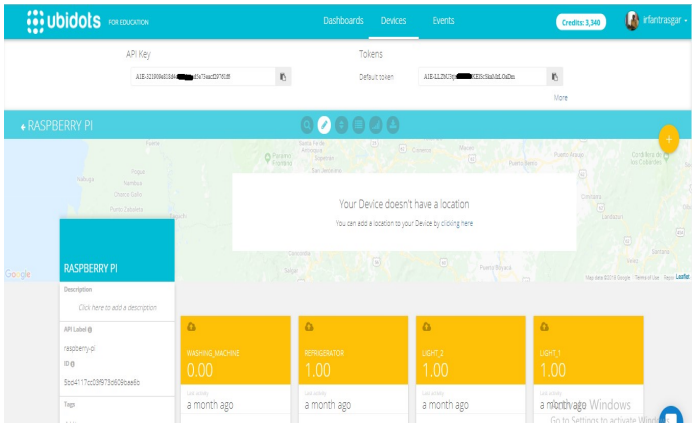


Fig. 10. Ubidots variable Creation

## V. Algorithm Used For IoT Based Home Automation And Its Simulated Results

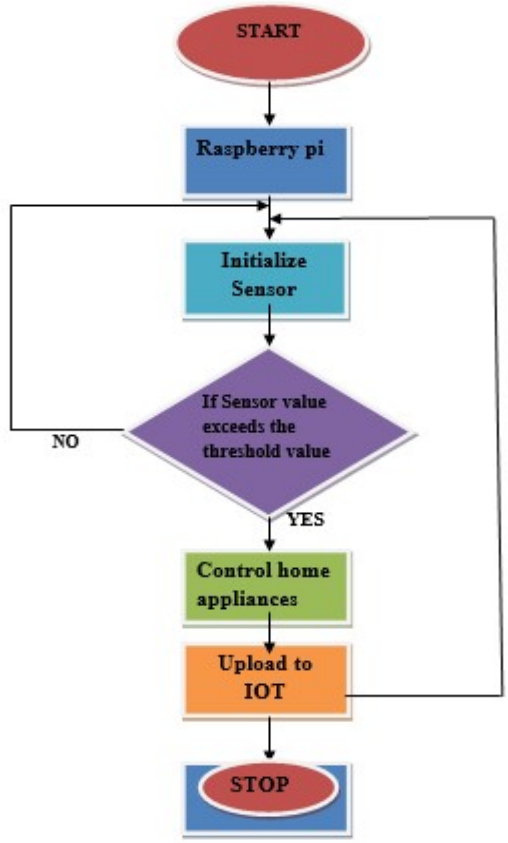


Fig. 11. Flowchart of work carried

The above Fig. 11 shows the flowchart of work carried out during the designing and development of our IoT based home automation system. Initially we need to boot the OS in SD card and insert it into Raspberry Pi board, and required hardware and software setup is done, by use of python coding we need to initialize all sensors, if sensor value crosses its threshold value then we need to control home appliances and need to send the real time sensor values to Internet where user can observe the data and can take required action through it.

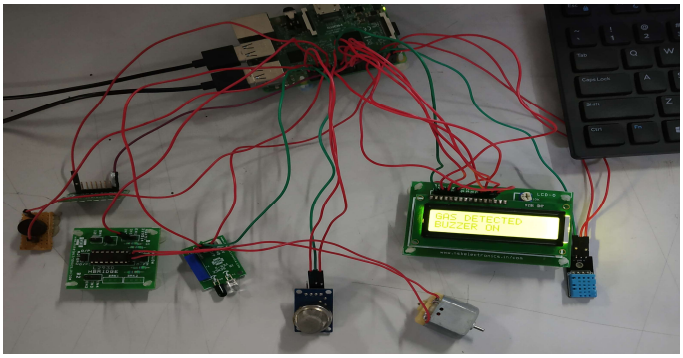

Fig. 12. Snapshot of model during testing

*Simulated Results:*


Fig. 13. ON/OFF Different Appliances

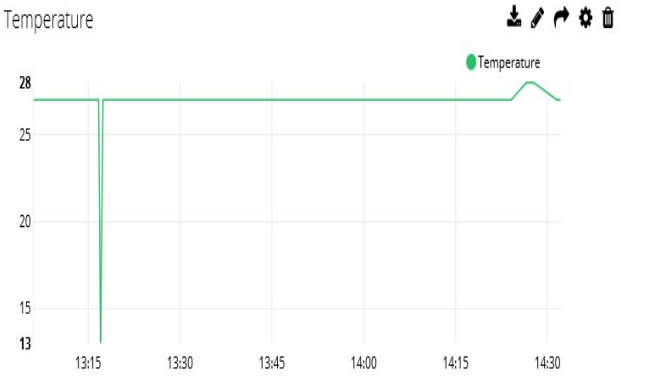


Fig. 14. Temperature Variations

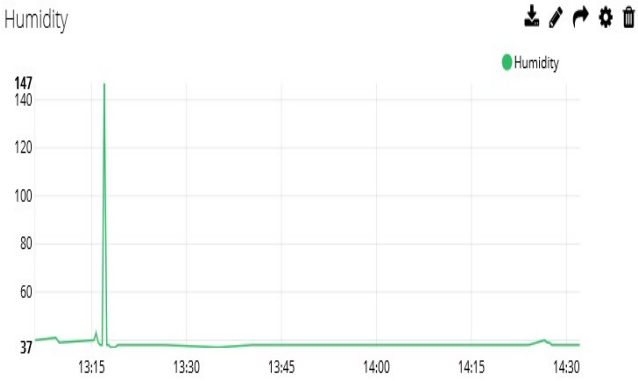


Fig. 15. Humidity Variations

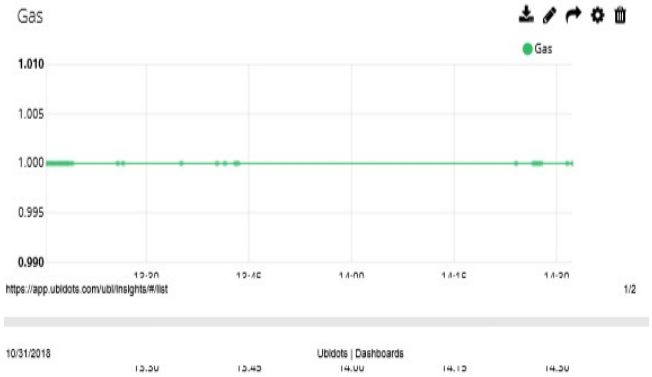


Fig. 16. Gas Detection

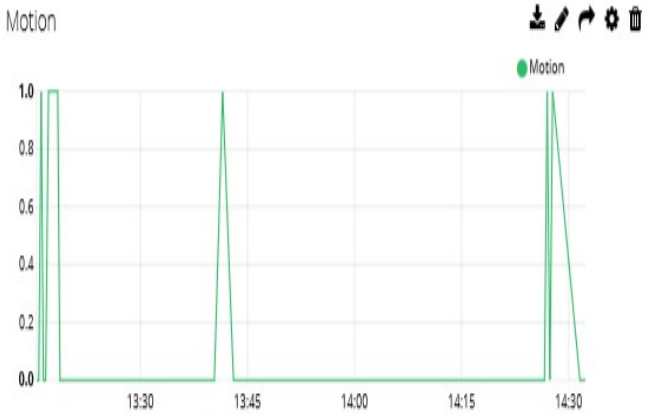


Fig. 17. Motion Detection

*DISCUSSION:*

The proposed home automation system has the capabilities to control the following components in users home and monitor the following alarms:

- Temperature and humidity as shown in Fig. 14 & 15.
- Fire and smoke detection as shown in Fig. 16.
- Motion detection as shown in Fig. 17

The proposed home automation system can control the following appliance:

- Lights on/off
- Fan on/off
- On/off different appliance as shown in Fig. 13

## VI. CONCLUSION

The home automation using Internet of Things has been experimentally proven to work satisfactorily by connecting simple appliances to it and the appliances were successfully controlled remotely through internet. The designed system not only monitors the sensor data, like temperature, gas, light, motion sensors, but also actuates a process according to the requirement, for example switching on the light when it gets dark. It also stores the sensor parameters in the cloud in a timely manner. This will help the user to analyze the condition of various parameters in the home anytime.

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