

# An Automation System by Using Raspberry Pi as a Sensor Web-Node

<sup>#1</sup>Mr. Lavhkare Dnyandeo S. , <sup>#2</sup>Prof. S. Pratap Singh

<sup>1</sup>dnyaneshlavhkare@gmail.com  
<sup>2</sup>pratap.singh.s@gmail.com

<sup>#12</sup>Samnavay Pratishthan's Institute of Knowledge-College of Engineering, Pimple Jagtap, Pune.



## ABSTRACT

The world of home automation is an exciting field which becomes more and more popular and day by day it becomes useful and important for local networking as well as remote networking through “The internet of Things”(IoT)its vision is reality. Its main goal is to make a device as a part of internet, it can be used for the interaction and communication for the advanced system to provides the safety, comfortness, security, and energy-savings. In this paper we proposes an implementation of the sensor as a web node as a part of internet of things by using Raspberry Pi Model, which is not expensive but fully customized and easy for programming and also support for maximum number of peripheral devices for network communication. The role of this technology is to provide real time use in the world for example – Monitoring, Detection, Energy –savings, Security.

**Keywords:** Internet of things, Buffer, Home automation, Motion detectors.PIR sensor, Raspberry Pi, Relay, RESTful

## ARTICLE INFO

### Article History

Received :31<sup>st</sup> December, 2015

Received in revised form :

2<sup>nd</sup> January 2016

Accepted : 3<sup>rd</sup> January, 2016

**Published online :**

**4<sup>th</sup> January, 2016**

## I. INTRODUCTION

Raspberry Pi is a credit-card sized computer manufactured and designed in the United Kingdom by the Raspberry Pi foundation with the intention of teaching basic computer science to school students and every other person interested in computer hardware, programming and DIY-Do-it Yourself projects. The Raspberry Pi is manufactured in three Board configurations through licensed manufacturing deals with Newark element14 (Premier Farnell), RS Components and Egoman. These companies sell the Raspberry Pi online. Egoman produces a version for distribution solely in China and Taiwan, which can be distinguished from other Pis by their red coloring and lack of FCC/CE marks. The hardware is the same across all manufacturers.The Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU and was originally shipped with 256 megabytes of RAM, later upgraded (Model B & Model B+) to 512 MB. It does not include a built-in hard disk or solid-state drive, but it uses an SD card for booting and persistent storage, with the Model B+ using a MicroSD. The Foundation provides Debian and Arch Linux ARM distributions for download. Tools are available for Python as the main programming language, with support for BBC BASIC (via the RISC OS image or the Brandy

Basic clone for Linux), C, Java and Perl. As of February 2014, about 2.5 million boards had been sold. The board is available online in India at a price of Rs. 3000.The role of this small credit-card size computer device as a Internet of Things (IoT), can be dynamic use and widely used for distributed networking system. It is a system which can interact with the peripherals and able to communicate with end users or other things which will be available in the network [1].The Smart home automation is the way of using smart devices that devices sense physical activity occurrences and translate them into the data or information as a stream to provide highly safety, security, comfort, and also convenience and very important is energy-savings which is very useful for today's world environment [1, 2]. The main element for smart home automation is the sensor or web sensor i.e. part of Internet of Things (IoT), now days the way of communication is rapidly changing from older system to advanced system and also same thing happening in the home automation it becomes soul anywhere and everywhere in the world.The home automation can be introduced as a new way to removing a much human interaction of the system through the new technology with the help of programmed advanced electronic systems, it is the system that monitors and control the household activity that becomes part of the internet of things (IoT), or telephone.

Generally this system was used for the control purposed like - Fire safety, heating, ventilation as well as Air-conditioning with security and controlled by a computer system called as central computer system [3]. In our proposed system with the help of modern technologies we are going to provides the lots of features for security, lighting, energy-saving, access control, surveillance, interfaces as well as entertainment-appliances. The home automation system becomes very easy to understand and operation, it also becomes easy for expansion users depending on the requirement of individual users needs, it also provides the facility of energy consumption reduction also reduce costs and provides high convenience [3].

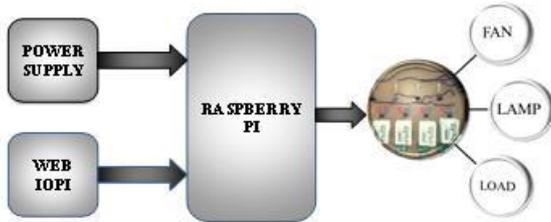


Fig. 1. Block Diagram of HAS

The survey of the home automation system and way of its use depending on the needs at the end of 2012, in the countries EU27 + 2, there were a total of 1.06 million Smart home systems in use. This demonstrates that the European market for smart home systems is approximately three years behind North America in terms of penetration and market maturity. Berg Insight forecasts that the installed smart home systems in EU27 + 2 will grow and reach 17.4 million systems by 2017 (Fig. 2). [3, 4].

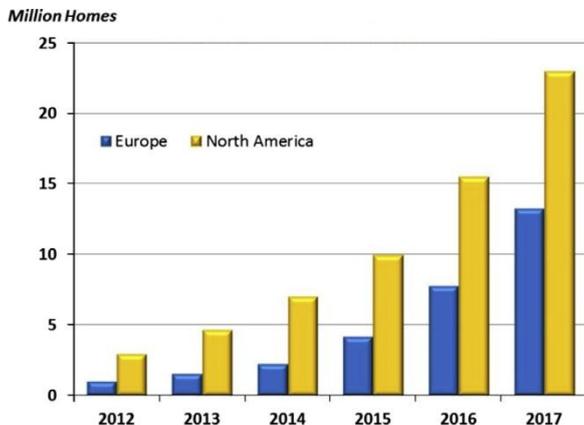


Fig. 2. The total no of smart home automation system (Europe and North America 2012- 2017)

### Home Automation System Categories

1. Centrally Controlled Automation System,
2. Distributed Controlled automation system and,
3. Individual Controlled Automation system.

A centrally controlled automation system can be useful which communicate routes, signals between a central computer system device controllers or sensors the main goal of this system is to control some of the “Dumb” appliances, but the main disadvantage of this automation system is, if controller fails, and then the whole system becomes fails [5]. A distributed-controlled automation system allows for particular single appliances for communication internally

with each other with the existing available electrical wiring without a central controller instead that the keyboard entry is possible by personal computer systems or telephones. An individual controlled automation system can be used for controller only one peripheral or appliance, as well as programming thermostats, photocell lighting controls and timers.

## II. Related Literature Survey

An home automation system is not a new terms for computer science and engineering society, it is an old term, that can provide very simple thing to connecting and grouping of appliances, it can also controlled appliances anywhere and everywhere which are plugged into the power supply for remotely controlled, there are so many products are available today that provides the facility to control the appliances automatically, by using remote controller or voice command with programming, but the way of commercial automation system are expensive because costs are included with lots of equipments, furniture and components as well as installation and it is difficult to modify to the user in the existing system, but in case if we are going focuses on other end as a open source software that are inexpensive then we can easily modify and controls as well as no need more equipments for automation system. It is an importance of hardware and open source software any user to Do-It-Yourself (DiY) in automation system and satisfies the need instead of commercial home automation system. In this way it is possible to use open source software and hardware for smart home automation system, therefore it provides techniques to the users and it also beneficial for user and developers. In this paper we are presents raspberry Pi as a sensor web node for home automation system with monitoring, controlling and detection. The raspberry pi computer introduced in 2012, and now it is a main component for home automation system, it is very small and powerful tool it enables the home automation system, with the help of sensor and software [2]. In this way raspberry Pi used as a practically within home automation system. The raspberry Pi is very powerful as compare to the other available tools in the market for home automation system. It also provides high capability to connect maximum number of appliances for input and output and hence this makes perfect interaction with different devices and its wide range use and applications when we use raspberry Pi with Wi-Fi, then it can communicate remotely in the network, therefore it is suitable for wireless sensor nodes and sensor web nodes.

Raspberry Pi also useful for processing purpose in Wireless Sensor Network (WSN), not only the sensor but also as a controller, it also provides facility for data processing and decision making in the artificial intelligence.

## III. HARDWARE ARCHITECTURE

In the paper we proposed a state of the art of raspberry Pi, it is small computer with the dimensions; 85.60 mm × 53.98 mm × 17 mm, weighing only 45g and affordable for 25–35\$. This makes it perfect for home automation, where a small device can easily be placed in a case and mounted inside an

electrical box, or replace an existing thermostat device on a wall [2]. The Raspberry Pi board contains a processor and graphics chip, program memory (RAM – Random-Access Memory) and various interfaces and connectors for external devices. Some of these devices are essential, others are optional, but all Raspberry Pi models have the same processor, a system on a chip (SoC) named BCM28351. It is cheap, powerful, and it does not consume a lot of power [8]. The unit of Raspberry Pi can be powered using a range of power sources (assuming they are able to provide enough current~700 mA) [9]

1. Computer USB (Universal Serial Bus) Port or powered USB hub (will depend on power output),
2. Special wall warts with USB ports.

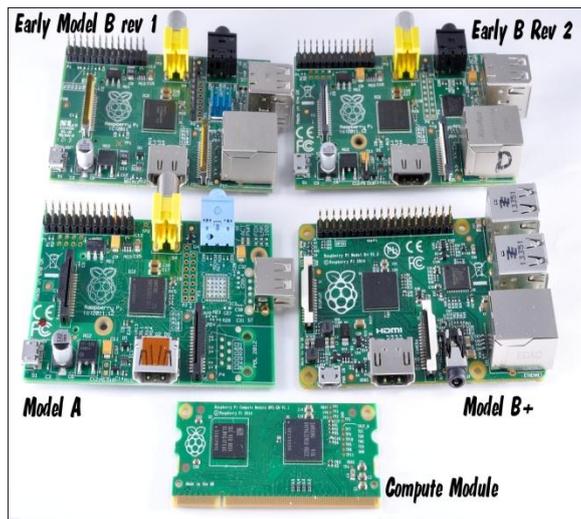


Fig. 3. Raspberry Pi Model

Mobile Phone Backup Battery (will depend on power output), Solar charger for cell phone. The Raspberry Pi can be also powered from alkaline batteries. The most suitable pack, which fulfils the relatively high power requirement, is made of six rechargeable AA batteries and a voltage regulator.

The Raspberry Pi has four distinct power modes.

The run mode – the central processing unit (CPU) and all functionality of the ARM11 core are available and powered up.

The standby mode – the main core clocks are shut down (the parts of the CPU that process instructions are no longer running) although the power circuits on the core are still active. In this mode, known as “Wait for Interrupt” (WFI) mode, the core can be quickly woken up by a process generating a special call to the CPU called an interrupt. This interrupt will stop any current processing and do what the calling process has asked for.

The shutdown mode – there is no power.

The dormant mode – the core is powered down and all caches are left powered on.

The Raspberry Pi can be also powered from alkaline batteries. The most suitable pack, which fulfils the relatively

high power requirement, is made of six rechargeable AA batteries and a voltage regulator [10].

The Raspberry Pi has four distinct power modes [11]:

The run mode – the central processing unit (CPU) and all functionality of the ARM11 core are available and powered up.

The standby mode – the main core clocks are shut down (the parts of the CPU that process instructions are no longer running) although the power circuits on the core are still active. In this mode, known as “Wait for Interrupt” (WFI) mode, the core can be quickly woken up by a process generating a special call to the CPU called an interrupt. This interrupt will stop any current processing and do what the calling process has asked for.

The shutdown mode – there is no power.

The dormant mode – the core is powered down and all caches are left powered on.

Raspberry Pi operates as a standard personal computer (PC), requiring a keyboard for command entry, a display unit and a power supply, and as a Web Server, when peripherals (keyboard and display) are not needed. In other words, Raspberry Pi fits perfectly as a server device which is working with whole network of single purpose clients’ devices. Secure Digital (SD) flash memory card is configured in such a way that it mirrors a hard drive to Raspberry Pi’s processor. Although large SD cards holding 32 GB, 64 GB or more are available, they are often prohibitively expensive, but the minimum required size of an SD card is 2 GB depending on the distribution demands of the operating system. If possible, the SD card class 10 should be used. The storage can be expanded, by using devices that provide an additional hard drive upon using the USB ports. These are known as USB Mass Storage (UMS) devices and can be physical hard drives, solid-state drives (SSDs) or even portable pocket-sized flash drives [10]. It is also important to note that the Raspberry Pi Model A has 246 MB of RAM while the Models B and B+ have 512 MB.

Internet connectivity may be via an Ethernet/LAN cable. Model B has a standard RJ45 Ethernet port, while Model A does not, however it can be connected to a wired network through an USB Ethernet adapter. The Raspberry Pi Model B Ethernet port is auto-sensing which means that it may be connected to a router or directly to another computer (without the need for a crossover cable). Wi-Fi connectivity via an USB dongle is an alternative option [13]. Using such a device, the Raspberry Pi can be used for creating ad-hoc networks or to connect to a wide range of wireless networks, including those running on the latest 802.11n high speed standard [12].

The Raspberry Pi, like any other computer, also uses an operating system (OS) and the “stock” OS is a flavor of Linux called Raspbian. Linux is a great match for Raspberry Pi because it is a free and open source. On the one hand, it maintains a low price for the platform, but on the other hand

it is easier to hack. There are also a few non-Linux OS options [10]. One of the positive aspects to the Raspberry Pi is that it is very flexible and can be used for a variation of purposes. For example, it can be used for general purpose computing, learning to program or integration with electronics projects [11].

The following core components enable the wide range of its usage [2] (Fig. 4):

- Two USB 2.0 ports allow connecting peripherals and storage devices while one micro USB serve for powering the device.
- The 3.5 mm analog audio jack allows for the connecting of headphones and speakers to the Raspberry Pi, which is particularly useful for audio and media player based projects.

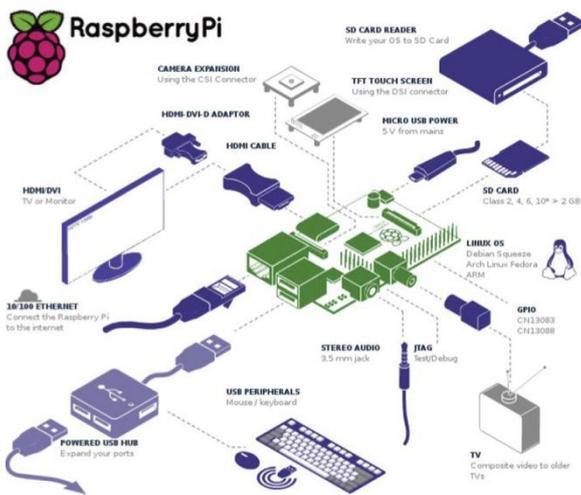


Fig. 4. Raspberry Pi Model B components

- Composite RCA port for attaching the yellow video cable from TV allows using TV as a monitor.
- The High Definition Multi-media Interface (HDMI) port allows the Raspberry Pi to be hooked up to high-definition televisions and monitors. It is also used for streaming video and audio from the web to TV.
- Support for DSI (Display Serial Interface) Raspberry Pi can be expanded with display.
- Support for CSI (Camera Serial Interface) Raspberry Pi can be expanded using camera.
- The GPIO (General Purpose Input and Output) pins on the Raspberry Pi are the principal manner for connecting with other electronic boards. Raspberry Pi Model B, which is used in this paper, consists of 26 pins arranged in two rows containing 13 pins each. The first row contains the even-numbered

pins, and the other row contains the odd-numbered pins (Fig. 5). There is a specific difference between the orders of the GPIO pins in Model A to the order of those in the Raspberry Pi's Model B. The GPIO pins can accept input and output commands and thus can be programmed on the Raspberry Pi. They can be accessed for controlling hardware such as LEDs, motors, and relays, which are all examples of outputs. As for inputs, Raspberry Pi can read the status of buttons, switches, and dials, or it can read sensors like temperature, light, motion, or proximity sensors (among many others) [8]. Some of GPIO pins can be used as digital inputs/outputs and as interfaces for embedded protocols. Two of the most important protocols based on their widespread use are:

- I2C – low-speed interface – Inter-Integrated Circuit (I2C) is a serial bus interface, which supports multiple devices and only requires two wires for communication. It's work on relatively low speeds.
- SPI – Serial Peripheral Interface Bus (SPI) is a synchronous full-duplex (two ways) serial connection.
- Extended GPIO – in addition to standard GPIO port Raspberry Pi Model B Rev 2 has an expanded set of connectors. It is important to mention the P5 header which is made up of 8 pins (+3.3 V, +5 V, two ground pins and four GPIO pins that can provide the second I2C protocol) and the P6 header with two pins their short-circuiting allows for the soft reset of
- BCM2835.

It is important to note that in July 2014, a Model B+, the higher-spec variant of the Raspberry Pi is presented. Compared to the Model B used in this paper it has: more GPIO (40 vs. 26) (Fig. 5), more USB (4 USB 2.0 ports vs. 2), micro SD, better audio, neater form factor and the most important: lower power consumption and the same price.

Raspberry Pi B Rev 1 P1 GPIO Header			Raspberry Pi A/B Rev 2 P1 GPIO Header			Raspberry Pi B+ B+ J8 GPIO Header					
Pin No.	Pin No.	Pin No.	Pin No.	Pin No.	Pin No.	Pin No.	Pin No.	Pin No.			
3.3V	1	2	5V	3.3V	1	2	5V	3.3V	1	2	5V
GPIO0	3	4	5V	GPIO0	3	4	5V	GPIO0	3	4	5V
GPIO1	5	6	GND	GPIO3	5	6	GND	GPIO3	5	6	GND
GPIO4	7	8	GPIO14	GPIO4	7	8	GPIO14	GPIO4	7	8	GPIO14
GND	9	10	GPIO15	GND	9	10	GPIO15	GND	9	10	GPIO15
GPIO17	11	12	GPIO18	GPIO17	11	12	GPIO18	GPIO17	11	12	GPIO18
GPIO21	13	14	GND	GPIO27	13	14	GND	GPIO27	13	14	GND
GPIO22	15	16	GPIO23	GPIO22	15	16	GPIO23	GPIO22	15	16	GPIO23
3.3V	17	18	GPIO24	3.3V	17	18	GPIO24	3.3V	17	18	GPIO24
GPIO10	19	20	GND	GPIO10	19	20	GND	GPIO10	19	20	GND
GPIO8	21	22	GPIO25	GPIO8	21	22	GPIO25	GPIO8	21	22	GPIO25
GPIO11	23	24	GPIO8	GPIO11	23	24	GPIO8	GPIO11	23	24	GPIO8
GND	25	26	GPIO7	GND	25	26	GPIO7	GND	25	26	GPIO7
								DNC	27	28	DNC
								GPIO5	29	30	DNC
								GPIO6	31	32	GPIO12
								GPIO13	33	34	GND
								GPIO19	35	36	GPIO16
								GPIO26	37	38	GPIO20
								GND	39	40	GPIO21

Key:  
 Power + (Red)  
 GND (Black)  
 UART (Blue)  
 SPI (Yellow)  
 PC (Green)  
 GPIO (Orange)

Fig. 5. Raspberry Pi model A, B and B+ GPIO connectors

We can identify techniques for using the raspberry Pi with sensor, display and so on. A Raspberry Pi is used for the purpose of reading inputs of sensor, store records in database for future use. There are different alternative projects that can be used raspberry pi.

- Temperature sensor project,
- Webcam surveillance Project,
- Home Alarm Project.

#### IV. Raspberry Pi as a RESTful Service

The key component of home automation application as a sensor web node for web services for the construction of a raspberry Pi based sensor web node is a processing unit. The ability of processor unit is to run or execute web server on the basis of requested web services that will be deployed. In this way we can introduce work of REST (Representation State transfer) based services, which is mediator between sensor driver and end user.

A RESTful is a model for the purpose of how home automation applications are distributed and hence it can be used for the three different aspects. i.e. Representation, State, Transfer.

- Representation: Data or resources are encoded as representations of the data or the resource and these representations are transferred between the clients and servers.
- State: All of the necessary state required to complete a request must be provided with the request. The clients and servers are inherently stateless. A client can't rely on any state to be stored in the server, and the server can't rely on any state

stored in the client. This doesn't, however, pertain to the data stored by servers or clients, only to the connection state needed to complete transactions.

- Transfer: The representations and the state can be transferred between client and servers.

#### V. Conclusion

The home automation systems are required because human can make mistakes and forget to switch off the appliances when there is no use and in this case, they are useful in order to utilize the power effectively and also in secured manner. The home automation application means integration of all electrical appliances and their controlling, monitoring, and its use was not possible before. In this paper we work to provide many advantages including, safety, security, comfort, energy savings as well as cost savings. In this way we can address the some issues of flexibility and functionality and low cost home automation controlling as well as monitoring system using RESTful based web services as an interoperable application layer for the purpose of communication between the remote user and

home devices and experimental results can be shown by using Raspberry Pi and open source software which are used in home automation application. Here we concluded the system design and architecture and basic level of home appliance controlling and remote monitoring while required goals and objectives of home automation system.

#### VI. Future scope

In future intent to provide a wireless relay connection and wireless sensors which can be movable and can be operable and which can be used in company and instates for security to the whole building with single system this will provide a full security support for homes again, we can move to raspberry Pi usage to outdoor such as the monitoring etc. for this purpose we can use GSM/ GPRS module with Raspberry Pi.

#### VII. References

- [1] Miorandi D, Sicari S, De Pellegrini F, Chlamtac I. Internet of things: vision, applications and research challenges. *Ad Hoc Netw* 2012;10:1497–516.
- [2] Dennis AK. Raspberry Pi home automation with Arduino. USA: Packt Publishing; 2013.
- [3] Dupree J. Integrating fire and security systems with home automation; 2010  
<<http://hiddenwires.co.uk/resources/articles2010/articles20100705-02.html>> [25.12.13].
- [4] Kurkinen L. Smart homes and home automation, Berg Insite M2M Research Series;  
<<http://www.berginsight.com/ReportPDF/ProductSheet/bi-sh2-ps.pdf>> [16.01.14].
- [5] Ashi, Home automation system. Reporter, vol. 19, no. 2, February 2002.
- [6] Vujovic V, Maksimovic M. Raspberry Pi as a wireless sensor node: performances and constraints. The 37th International ICT Convention – MIPRO 2014.
- [7] Schmidt M. Raspberry Pi – a quick start guide. The Pragmatic Bookshelf; 2013.
- [8] Home automation. <<http://www.leviton.com>> [07.01.14].
- [9] Monk S. Raspberry Pi Cookbook. CA: O Reilly Media; 2014.
- [10] Horan B. Practical Raspberry Pi. USA: Apress; 2013.
- [11] Upton E, Halfacree G. Raspberry Pi user guide. Wiley; 2012.
- [12] Richardson M, Wallace S. Getting started with Raspberry Pie. USA: O'Reilly; 2013.
- [13] Monika M Patel, Home automation using Raspberry Pi, IJIERE, 2015.