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**RESEARCH ARTICLE**

# RASPBERRY PI HOME AUTOMATION WITH WIRELESS SENSORS USING SMART PHONE

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***Abstract: The project presents a low cost and flexible home control and monitoring system using an embedded microprocessor and microcontroller, with IP connectivity for accessing and controlling devices and appliances remotely using Smart phone application. The proposed system does not require a dedicated server PC with respect to similar systems and offers a novel communication protocol to monitor and control the home environment with more than just the switching functionality. To demonstrate the feasibility and effectiveness of this system, devices such as light switches, power plug, temperature sensor and current sensor can be integrated with the home control system.***

***Keywords: Personal Computer (PC), Internet of Things (IoT)***

## I INTRODUCTION

The Internet of Things (IoT) can be described as connecting everyday objects like smart-phones, Internet TVs, sensors and actuators to the Internet where the devices are intelligently linked together enabling new forms of communication between things and people, and between things themselves. Building IoT has advanced significantly in the last couple of years since it has added a new dimension to the world of information and communication technologies.

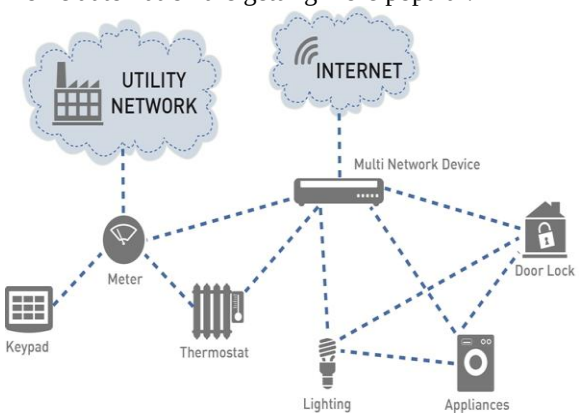
The Internet has come a long way over the last 30 years. Old-fashioned IPv4 is giving way to IPv6 so that every device on the Internet can have its own IP address. Machine-to-machine (M2M) communication is on the rise, enabling devices to exchange and act upon information without a person ever being involved. The scope and scale of the Internet have changed as well: industry leaders predict that the number of connected devices will surpass 15 billion nodes by 2015 and reach over 50 billion by 2020. The challenge for the embedded industry is to unlock the value of this growing interconnected web of devices, often referred to as the Internet of Things (IoT), describing it as the ultimate tool in our future surveillance. This network has the power to reshape our cities.

At the edge of the IoT are the appliances and equipment we use every day. These “things” are interconnected across an infrastructure or backbone using combinations of ZigBee, sub-GHz, Wi-Fi or power line communications (PLC) connectivity to provide a robust bi-directional communications link with relatively long range, low latency for fast responsiveness, low power and a sufficient data rate to aggregate information from many

connected devices. This infrastructure also serves as the gateway to the Internet and enables remote monitoring and control of devices by other networks, utility companies and end users.

Home automation or Smart Homes can be described as introduction of technology within the home environment to provide convenience, comfort, security and energy efficiency to its occupants. Adding intelligence to home environment can provide increased quality of life. With the introduction of the Internet of Things (IoT), the research and implementation of home automation are getting more popular.




Fig(1): Home Appliances connected to Network

**The rest of the paper is organized as follows: Section II gives an insight of IDS. Section III states the problem. Section IV gives an overview on the proposed protocol. Section V gives the simulation results and analysis. Finally section VI VII gives concluding remarks and future works.**

## II HOME AUTOMATION

The introduction of home automation in the 1970s failed to improve the lifestyles of users for several reasons. Firstly, determining economic benefits of home automation technologies is difficult. Secondly, the costs of implementing smart home technology must be justified by the effects brought about by their installation. There is a need for home automation technologies to be cost effective, easy to install and flexible with many network infrastructures and appliances.

In 2003, Housing Learning & Improvement network published a smart home definition offered by Interetec which states that a smart home is "a dwelling
incorporating a communications network that connects the key electrical appliances and services, and allows them to be remotely controlled, monitored or accessed". The following section includes a brief summary of previous research into smart homes within the past decade.

In 1995, Welfare TechnoHouses were constructed in Japan. The purpose of these experiments was to provide health monitoring for elderly and disabled person at home by using fully automated measurements to support daily health care and improve quality of life. The University of Texas at Arlington has conducted the MavHome project over the past 7 years. The MavHome (Managing an Adaptive Versatile Home) is a home environment that detects environment states through sensors and intelligently acts upon the environment though controllers. The sensors in the home form an adhoc network with interconnect together to make appropriate decisions.

## III PROBLEM STATEMENT

The focus of my project is on helping users to operate home appliances with their own smartphones and to help elderly or handicapped people live a more independent life as long as possible. The objective of our system is to take care of several domestic systems that may normally be difficult for those who are handicap or elderly to take care of. The proposed idea will allow a user with any android enabled device to run a piece of downloadable software on any mobile device such as a smartphones. This application will allow the user to control a device that is connected to any home appliance that is Pi enabled. The focus of this application will be to direct a security system with webcam surveillance, door sensor notification and a light control system. Sensors will be connected to the home appliances with Pi so that they can be monitored and controlled.

Suppose an employee who has gone to work and during this period a thief sneaks up into the house breaking through a window. The proposed system would enable the client to monitor his home when a door or a window sensor triggers the alarm. Client monitors his home with webcam and could immediately inform local authority or a policeman.

The Client could also check the status of the outside light and turn on and off the light without the need to get out of bed. These devices would also benefit users with limited mobility that may have a difficult time getting to or even reaching their light switch. These objectives require a large amount of technology. The user interface must be as simple and powerful as possible and operate in a selforganized way.

## IV EXISTING SYSTEM

SAP laboratories in Canada with researches from the University of McGill present a wireless solution for monitoring people in need of medical assistance. The application relies on the use of cell phones and inexpensive sensors and is best suited for the elderly and homebound people. The main functions of the project is to collect signals through a wireless sensor network using API's and the analysis for data through an adaptive architecture that produces realtime heath monitoring system to improve medical support for people in their homes and in assisted living environments.

Several groups have done extensive research into the use of smart home devices for the support or elderly and handicap people. The University of ErlangenNuremberg, Germany has described the challenges regarding smart homes, especially for supporting the elderly and handicapped. The purpose is to compensate for handicaps and support the individual in order to give them a more independent life for as long as possible.

The paper does however reinforce the advantages of using a wireless standard. Bluetooth is a global standard for connecting a wide range of devices, it is available on most handheld devices, the technology is very easy to use and set up, and it provides security by encrypting data using a 128bit long shared key but the disadvantage of system is that it has a very short range of communication.

Radio Frequency (RF) systems have become increasingly popular recently with the advancements in RF technology such as Bluetooth and ZigBee. These products offer a much more reliable short range network then previous Infrared devices which had interference and security issues. But RFID tags are more expensive, less reliable and are application specific i.e. no one tag fits all.

This project will focus on Smartphones enabled systems for the smart home with focus on the Raspberry Pi applications. Although many systems have been researched and proposed, very few if any have been implemented. This project aims to build on the previous research described to implement a wireless sensor network to monitor appliances in the house. These appliances will be controlled via a smartphone running Android OS. This approach provides an easy to operate and cost effective approach that will benefit users to interact with Home appliances remotely.

## V PI ENABLED SMART HOME DEVICES

**Raspberry Pi:** A microprocessor will interface with the android module to perform the automation. A simple microprocessor will receive signals from the smartphone and it will be processed.

**Develop Software Interface Mobile Device:** An android application to be developed using the ADT (Android Developer Tools) java platform for programs running on mobile devices that communicates between pi and home devices easily.

**Integrate the Sensors to a Device:** The Raspberry Pi needs to be integrated with the lighting, door sensors and webcam control systems at a low cost with easy installation.

After extensive research into the products and solutions currently available, the following were chosen to meet our application specific requirements.

### 5.1 RASPBERRY PI DEVELOPMENT BOARD

The Raspberry Pi is a credit card sized single board computer developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools. The Raspberry Pi is manufactured in two board configurations.

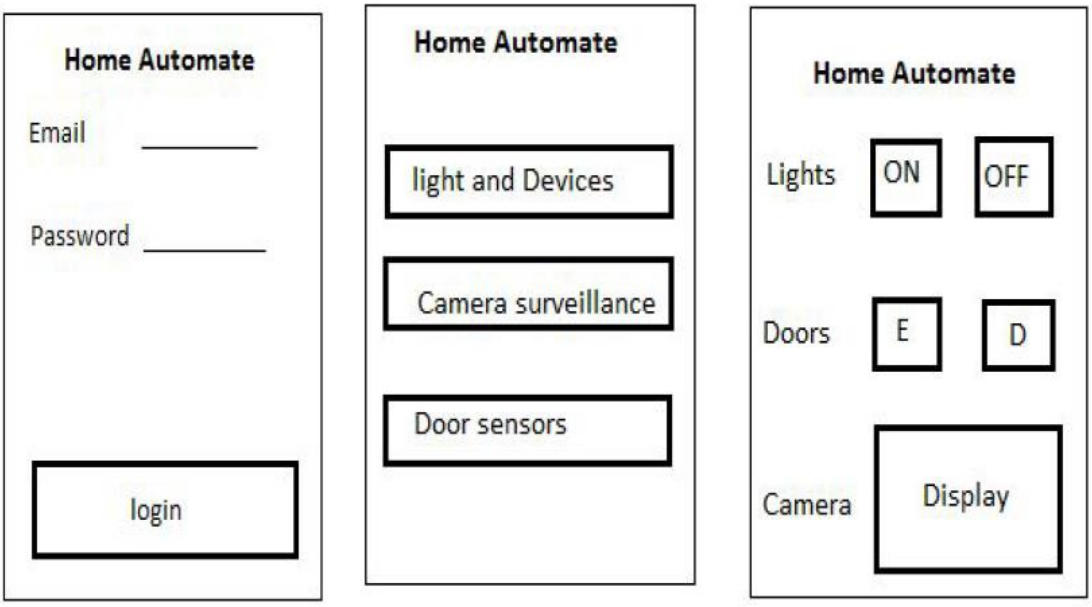
The Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZFS 700 MHz processor, Video Core IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded to 512 MB. It does not include a builtin hard disk or solid state drive, but it uses an SDcard for booting and persistent storage. The Foundation provides Debian and Arch Linux ARM distributions for download. Tools are available for Python as the main programming language.

### 5.2 MAGNETIC DOOR SENSORS

This Magnetic Door Sensor is essentially a reed switch, encased in an ABS plastic shell. Normally the reed is 'open' (no connection between the two wires). The other half is a magnet. When the magnet is less than 13mm (0.5") away, the reed switch closes. They are often used to detect when a door is open or close.

### 5.3 WEBCAM SURVEILLANCE

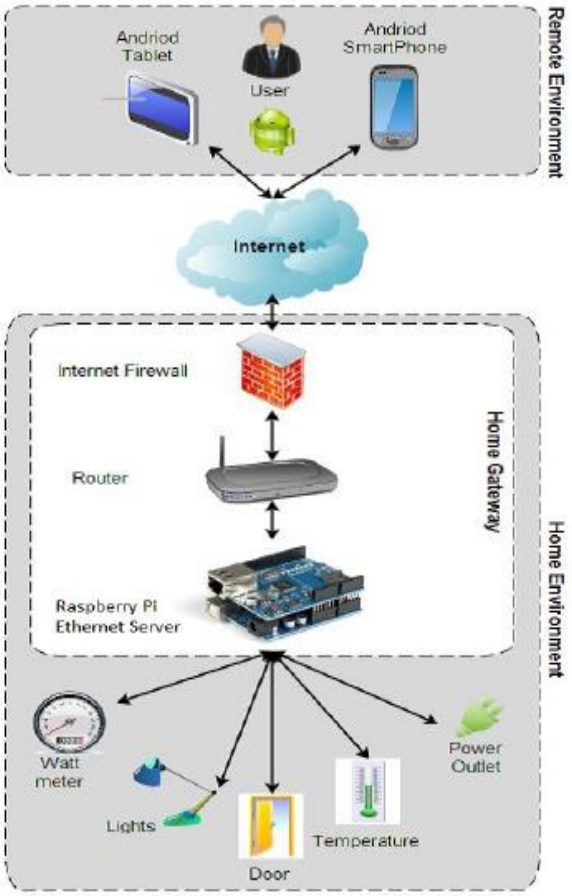
A webcam is a video camera that feeds or streams its image in real time to or through a computer to computer network. When "captured" by the computer, the video stream may be saved, viewed or sent on to other networks via systems such as the internet, and email as an attachment.




Fig(2): Android Application Prototype

Figure shows the prototype design of android application development. The initial design had to be kept in mind the functional and nonfunctional requirements listed above.




Fig(3): Hardware Block Diagram

Their most popular use is the establishment of video links, permitting computers to act as videophones or videoconference stations. Other popular uses include security surveillance, computer vision, video broadcasting, and for recording social videos. Webcams are known for their low manufacturing cost and flexibility, making them the lowest cost form of video telephony

## VI IMPLIMENTATION

### INTERFACE

Once the template was produced, it was time integrate all the development work to make a complete interface. The python code manages the list of controls that are to be displayed to the user. The software package provides various views to control different aspects of the controls, such as how they are managed and how they appear on specific client software. The Servlet application runs on OpenShift PAAS wherein the Raspberry Pi microprocessor and the users are clients to it. Since OpenShift can provide more powerful applications, a more advanced user interface was created.

### SOFTWARE

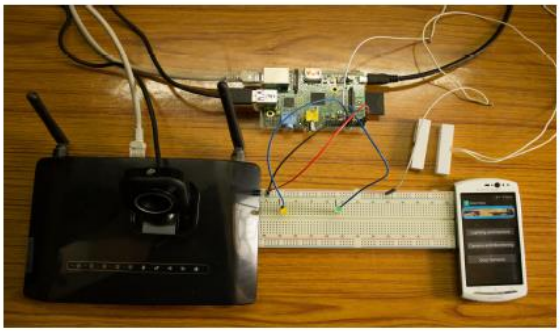
The backend code that we produced for the applications is explained in the next section. The code flow charts will help describe the flow of the code. The server and client application is written using Python code as the interface for Raspberry Pi to connect to lights and sensors. The software produced utilizes both the built in functions as well as user defined methods.

**HARDWARE**

The next step was the integration of the electronic components into our Raspberry Pi and setting it up for remote access. Here we use a DLink 2750u router that has a ISP connection. The hardwares interaction takes place through WiFi wherein all devices are connected to the RPi through Ethernet. The Android Application Controls the Integrated peripherals such as Camera, Door Sensors and Lighting Devices.

The Integrated Hardware with software application for client side in android is as shown below



Fig(4): Screenshot of Integrated Device

## VII CONCLUSION

The devices produced enable the user to control the appliances using pre-existing devices such as their Smartphone or home computer. The interfaces are intuitive and easy to use and provide the user with a more accessible interface then those found in the home. The devices are also very easy to integrate into existing applications and require only a small amount of expertise to install.

Our research shows the many types of applications for implementing home automation and the applications are not limited to those discussed in this paper. The technology used could be implemented in a wide variety of applications that require the use of sensors and appliances. This project successfully designed a system that communicates with a mobile device such as a Smartphone or laptop via Raspberry Pi to control a door sensors and a light switches and a camera to stream live video, but has many possible applications that could benefit from this work.

## VII FUTURE WORK

Although the final products were very successful at accomplishing the objectives, it must be kept in mind that the products produced are simple prototypes and much more work would need to be done to create a marketable product. Several areas that need to be improved are the size of the devices, the cost of the devices, the power sources used and the range of communication.

Currently, the Raspberry device is too large to fit easily into a pre-existing wall switch electrical box. There are several ways this could be improved in future work. The use of surface mount components would dramatically decrease the overall size of the components. Surface mount components are also often less expensive as they require less material to produce. This would help reduce the overall cost of the devices as well as the size. Another area to help improve the size is the circuit board that is used. Currently for the prototype, a generic breadboard style board was used.

If this device were to be commercially produced, a more compact circuit board could be designed.

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