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Smart and Interactive Home Using Raspberry Pi

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***Abstract*—** Smart Home is an approach to control the home appliances using sensors with a significant reduction in human efforts. This project represents a design of monitoring and controlling home automation from an android application based on Raspberry Pi (model 3B). The system uses Wi-Fi technology as a communication protocol to connect system components. Our home automation system can be split into 2 main constituents; the first part is android application that can give orders to the device that one wishes to control locally or remotely, and second part is Raspberry Pi (model 3B) that has a fitting hook up with all the Sensors and Appliances of a home automation system. It is possible to communicate with the Appliances via an android application through wireless technology. The home automation system plays a significant hand in lowering the total power utilized by home devices and gadgets.

***Keywords*—** *Home Automation, Raspberry Pi, Android, Security, Voice Recognition.*

I. INTRODUCTION

The main objective of making Smart Home System is the rapid increase in standard of living and to ease the complexity of life by automating the home appliances. This paper presents using an Android app which allows Appliances and User to interact securely over the Wi-Fi giving the user liberty to control any appliance as per his desire from any part of the Home (inside/outside).

A. Problem Statement And Need

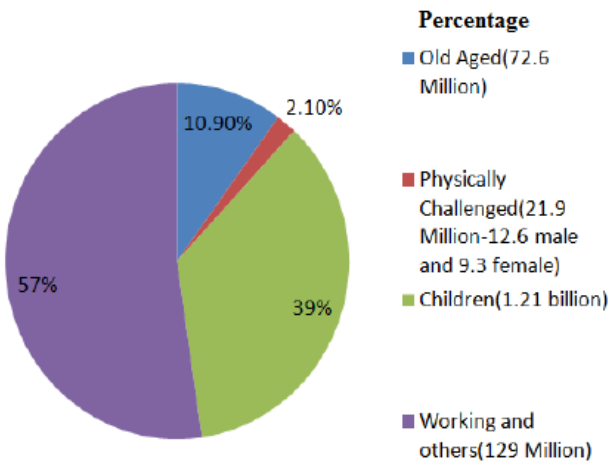

Figure 1 Source: http://www.censusindia.gov.in

The principle target of undertaking this Project is to actualize an economic (budget friendly), minimal effort, dependable, versatile and diverse home computerization framework that can be utilized to remotely switch on or off any home device.

B. Purpose

- Improve comfort and make it suitable for disabled and elderly people.
- To save the energy or power by 9% in places like office or homes where lightning is very much important for the people and provide an automated lifestyle.

Section I of the paper contains Introduction of Smart Home System., Section II contains Related Work in the field of Smart Home System(s), Section III contains Methodology of developed Smart Home System, Section IV contains System Architecture and essential steps of Smart Home System, Section V describes Result and discussions obtained from Smart Home System, Section VII concludes research work with future directions.

II. RELATED WORK

Thad Starner (2000) studied the problems faced by people at Home in their day to day activities and decided to come with a Home Automation System which can be controlled via hand gestures and proposed a wearable device to control the

Home Appliances. The wearable faced problems due to occlusion and lighting [1].

Carles Gomez (2010) surveyed the current and emerging solution based on ZigBee and IP based technology. He concluded that incorporating embedded sensors and actuators to monitor and control the home devices would be beneficial for security and reducing human effort to a minimum [2].

A.R Al-Ali (2004) presented the design to implement the controlling of Home appliances using World Wide Web based on Java. The system requires internet access to control the Home appliances [3].

N. Sriskanthan (2002) presented a design by incorporating fixed Bluetooth technique to build a framework in which devices could interact with each other. It was found that there is a tremendous amount of scope for further developments using similar facility at application level [4].

Waqas Anwaar (2015) studied and drew a comparison of Raspberry Pi with modern devices. He concluded that Raspberry Pi is faster, compact, cost and energy efficient than any other devices (ZigBee, Arduino) [5].

Ms.Sejal V. Gawande (2015) published the advantages and applications of Raspberry Pi technology [6].

R. Piyare (2011) presented the design of a Smart Home using mobile based on a stand-alone Arduino. The wireless interaction of the mobile with Arduino was limited to less than 50m range in concrete building [7].

Nathan David (2015) presented an economic and self-adapting control for environmental monitoring system using Arduino. He suggested using Google speech recognition system and thus eliminating the need for external voice recognition module [8].

Amruta Patil (2017) used SMS as a medium to communicate with the home devices using Arduino with GSM for the convenience of physically handicapped people [9].

Prashant Rathod (2017) who implemented Smart Home System designed on Raspberry Pi using Wi-Fi, Internet of Things& Application (Android based). His system had many drawbacks like the system was electricity and Wi-Fi dependent and required minimum 2hrs to condition itself before anything can be operated/regulated [10].

Mayur Khatpe, (2016) presented a similar paper on remote controlled home automation system using android application via Wi-Fi connectivity [11].

III. METHODOLOGY

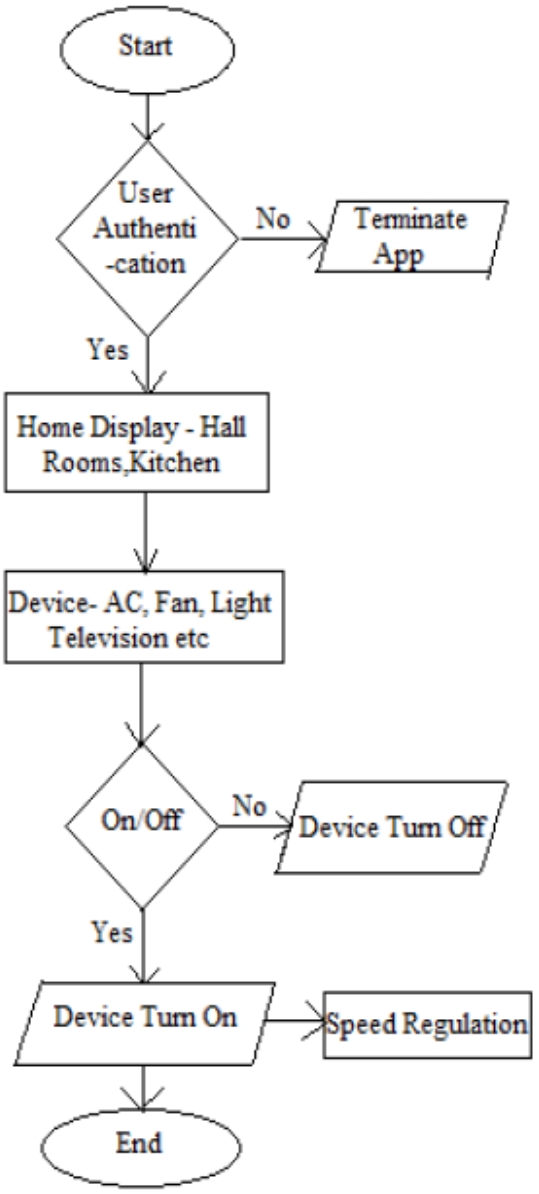

Figure 2

Note: It is considered that the Raspberry Pi is powered up, Initiated and ready to use.

Step 1: The user is given a unique username and password which he can reset as per his desire. The user is given 5 attempts to provide the right username and password .On successful confirmation he is navigated to the Home Screen.
Step 2: The User can choose to control any device of any part of the home either manually via app or through his voice command.

Step 3: The Raspberry Pi receives and processes this information and simultaneously activate the GPIO pins to carry out the desired activity.
Step 4: The user can follow the step 2, 3 to control any device-to either switch on/off or regulate the speed, intensity of a particular appliance.
Note: The Sensors will automatically tune itself to the Users taste and environment and will suggest the best activity over a period of time.
The smart mirror is calibrated such that it informs the user about his daily schedules/meetings/tasks, weather and update him about the News of what is happening in the world.

IV. SYSTEM ARCHITECTURE

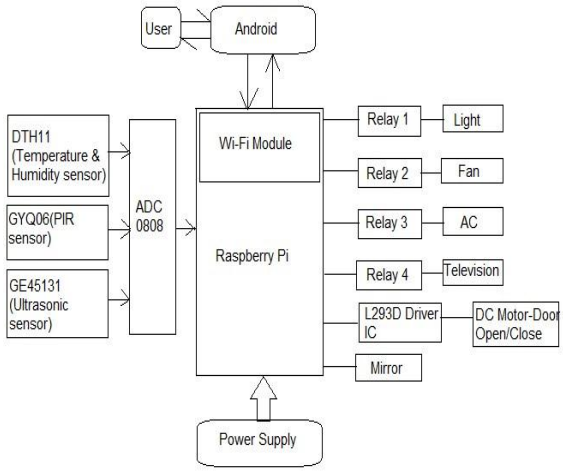

Figure 3: Architecture of Home Automation System

A. Controller used Raspberry-Pi

The Raspberry Pi (model 3B) is a fully operational palm computer that is very small, light and has dimensions almost equivalent to a credit card. The Raspberry Pi (model 3B) despite its size is very powerful, platform independent, multi-tasking and easy to operate. Raspberry Pi (model 3B) uses a number of software(s) which can be easily downloaded with help of a single software NOOBS (New out Of the Box Software). Python is used as the main programming language for coding and functioning as it is fully compatible and supported by the Pi. Raspberry pi (model 3B) is very easy to connect to the internet and can be programmed using a variety of programming languages which makes it more diverse. Another advantage of Raspberry Pi (model 3B) is its low power consumption which requires only 5v continuous supply. Raspberry pi Processor speed is 700 MHz compared to Arduino having processor speed of 16MHz.

1. Features of Raspberry pi

- Model – Raspberry pi model 3B.
- CPU: 64 bit Quad-core clocked at 1.20 GHz, 1 GB RAM memory.
- GPU: Supports 400MHz Video core IV multimedia and has a 3D graphics core.
- Uses wireless LAN (802.11n) for networking having a speed in the range of 10-100 mbps
- Low energy Bluetooth 4.10
- Power source: 5 V via GPIO header or Micro-USB.
- 4 USB ports, 40 GPIO pins, and a full HDMI Port (video output) for connection with peripherals.
- Audio jack of 3.50mm.
- Camera and Display Interface (CSI and DSI), Memory card slot.
- Size: 85.60mm × 56.5mm.
- Weight: 45.0g (approximately).

B. Software Used

1. Android

For this home automation system we have focused and targeted on Android platform mainly because of its colossal market and public accessibility. The Operating System (OS) of Android is based on Linux. Android Software Development Kit (SDK) incorporates Eclipse software where Java programming is used.
Eclipse software is used to write the codes for the application under Java Platform. Raspbian OS is used for the Raspberry Pi (model 3B) and a server is established at the Pi. Python language is used to write the codes of server, and to control the GPIO pins.

2. Software Design

As talked about before we are building an Android Application. The Application is a medium to control the switching on or off of the home devices like fan, light, television, air-conditioner and control the intensity, speed and temperature of the same as and when desired. The application starts with authentication of user/client, and only once confirmed he is directed to the home screen. The home screen is a rundown of all the activities/operations to be performed. The client can select any one activity which he desires to control. The reflection of his operation is seen as a current status of a specific appliance. The user can even control the switching on or off and powering of an appliance if he wishes. The Home System is so programmed in a way

to automatically turn on/off lights amid late night hours. The system uses temperature sensors to involuntarily regulate the speed of fan/AC as per the temperature of the body or surroundings. It has voice recognition activity which is designed to aid the visually impaired, physically challenged and old people.

3. Software Environment

- Android Developer Tools (ADT) - To build the android application to receive the feedback from the sensors and control the home appliances.
- RPI-GPIO library - GPIO interface library for the Raspberry Pi.

V. RESULT

A. *Security (User Authentication)*

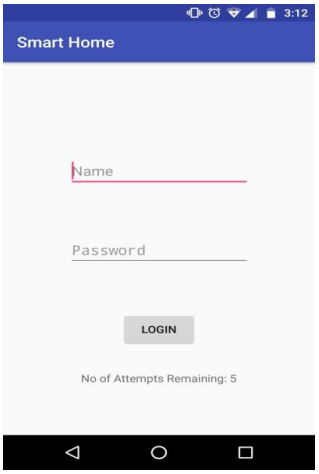

Figure 4(a)

B. *Switch Mode*

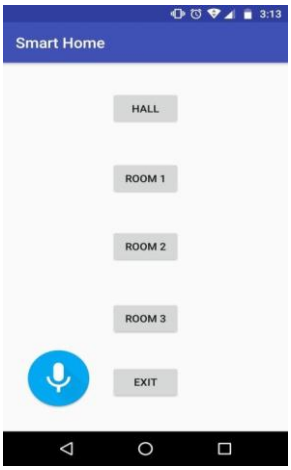

Figure 4(b)

C. *Voice Mode*

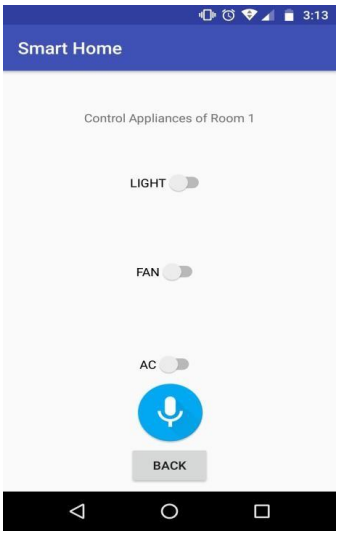

Figure 4(c)

VI. CONCLUSION

The Smart Home System is very cheap, fast and responsive which makes it reliable and user friendly. It is easily scalable into larger places like Universities, Industries, and Hospitals. A camera can be used to add more security to the system but adding extra cost to the system. Despite of all the advantages of Raspberry Pi it has some limitations, it requires time to power up and has a limited memory which cannot be expanded and thus it is important to keep only the program required to run and perform the specific task(s) at hand. It also requires a good Wi-Fi or Internet connection at all time for its operation.

After successful implementation of the project and observing it for a period of 2 months it was found that the energy (electricity consumption) was reduced significantly, nearly by 9%, from 600 units to 546 units.

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Authors Profile

Viral Mehta, a student of NMIMS Shirpur who is currently pursuing his bachelor's degree in engineering, specialising in Mechatronics.He is a resident of Mumbai and has worked on materials and has even published a paper on the same. He is now working on Smart Home Sytem as his final year project and aims to start his own company and offer these services and reach the masses with his product idea.

Bhanu Walia, a student of NMIMS Shirpur who is currently pursuing his bachelor's degree in engineering, specialising in Mechatronics.He is an ASME member and has made valuable contributions in various college projects like BAJA, HPVC, and Eco-Kart(2017). He is an inquisitive person and is always restless and trying new things.

Vineet Rathod, a student of NMIMS Shirpur who is currently pursuing his bachelor's degree in engineering specialising in Mechatronics.He has a sound knowledge in Computers and Android Development and has contributed in development of App for various college Projects like Eco-Kart(2017) and won many prizes for his innovations and out of box thinking. With inclusion in this project he gained proficeincy on Raspberry Pi and aims to make a future out of it in the near future.

Mayank Kothari, did Bachelor of Engineering in Electronics & communication in 2009 and M.Tech (Embedded System) in 2012. He is Associated with ISTE, IEI and IETE professional organization. Currently, He is woking as assistant professor in SVKM's NMIMS, MPSTME Shirpur (MH.). His research interest is in Embedded System and Digital signal processing.

