DEVELOPMENT OF VOICE CONTROLLED SMART SYSTEM FOR NON SMART DEVICES USING RASPBERRY PI3b & GOOGLE ASSISTANCE

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Abstract— *The Google assistance which recognises human speech and converts it into text along with Raspberry PI3b which is a pocket sized computer together acts as a smart system to control multiple electronic devices/ appliances such as lights, fan, mobile charger, laptop charger, fridge, TV etc., connected to it. Using Raspbian operating system on Raspberry PI3b and using python as back end programming language the GPIO pins of the Raspberry PI3b board can be programmed to control the relay switches which intern connected to the electronic devices. The benefits are energy savings, convenience, security, home automation.*

Keywords—non smart devices, smart system, voice controlled, Google assistance, Raspberry pi

1. INTRODUCTION

The IOT is enabled by the latest developments in RFID, smart sensors, communication technologies and Internet protocols. The basic premise is to have smart sensors collaborate directly without human involvement to deliver a new class of applications. The current revolution in Internet, mobile and machine-to-machine (M2M) technologies can be seen as the first phase of the IOT. In the coming years, the IOT is expected to bridge diverse technologies to enable new applications by connecting physical objects together in support of intelligent decision making.

The Internet of Things is a paradigm where everyday objects can be equipped with identifying, sensing, networking and processing capabilities that will allow them to communicate with one another and with other devices and services over the Internet to accomplish some objective. Internet, the networks of networks avails us the world at one click. This paper is a survey on Internet of Things which is believed to be the next evolution of Internet. The Internet of Things (IOT) bridges the cyber and the physical worlds. Ultimately, IOT devices will be ubiquitous, context-aware and will enable ambient intelligence.

The IoT communication technologies connect heterogeneous objects together to deliver specific smart services. Typically, the IoT nodes should operate using low power in the presence of lossy and noisy communication links. Examples of communication protocols used for the IOT are Wi-Fi, Bluetooth, IEEE 802.15.4, Z-wave, and LTE-Advanced. Some specific communication technologies are also in use like RFID, Near Field Communication (NFC) and ultra-wide bandwidth(UWB).

Another communication technology is Wi-Fi that uses radio waves to exchange data amongst things within 100 m range. Wi-Fi allows smart devices to communicate and exchange information without using a router in some ad hoc configurations. Bluetooth presents a communication technology that is used to exchange data between devices over short distances using short-wavelength radio to minimize power consumption.

Processing units (e.g., microcontrollers, microprocessors, SOCs, FPGAs) and software applications represent the ―brain‖ and the computational ability of the IoT. Various hardware platforms were developed to run IoT applications such as Arduino, UDOO, Friendly ARM, Intel Galileo, Raspberry PI, Gadgeteer, Beagle Bone, Cubieboard, Z1, WI Sense, Mulle, and T-Mote Sky. There are several Real-Time Operating Systems (RTOS) that are good candidates for the development of RTOS-based IoT applications. For instance, the Contiki RTOS has been used widely in IoT scenarios. Contiki has a simulator called Cooja which allows researcher and developers to simulate and emulate IoT and wireless sensor network (WSN) applications.

Overall, IoT services can be categorized under four classes namely Identity-related Services, Information Aggregation Services, Collaborative-Aware Services and Ubiquitous Services. Identity-related services are the most basic and important services that are used in other types of services. Every application that needs to bring real world objects to the virtual world has to identify those objects.

Information Aggregation Services collect and summarize raw sensory measurements that need to be processed and reported to the IoT application. Collaborative-Aware Services act on top of Information Aggregation Services and use the obtained data to make decision and react accordingly. Ubiquitous Services, however, aim to provide Collaborative-Aware Services anytime they are needed to anyone who needs them anywhere.

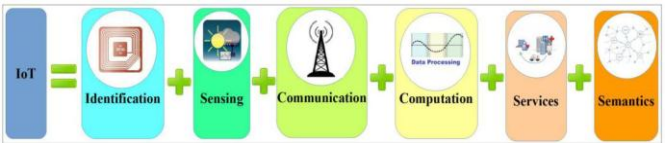

Fig. 1: Representation of IOT elements

2. LITERATURE SURVEY

In today's world, automation plays a very important role and in this paper, an automated way of controlling home appliances through human interaction as well as through self-control of the system itself is provided. The manual mode helps user to control home appliances automatically using PC or any Wi-Fi enabled Mobile phone in the same local area network. In automated mode, the system controls the appliances itself depending on some

sensor reading, thus making it fully automated. Another feature of the automated mode is the security mode. Through this mode user will be alerted if any intruder enter the main door when the system is active. [1]

It is a low cost and flexible home control and environmental monitoring system. It employs an embedded micro – web server in Arduino Mega 2560 microcontroller, with IP connectivity for accessing and controlling devices and appliances remotely. These devices can be controlled through a web application or via Bluetooth Android based Smart phone app. 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, gas sensor and motion sensors have been integrated with the proposed home control system. [2]

The design of the low cost voice recognition based home automation system for the physically challenged people suffering from quadriplegia or paraplegia (who cannot move their limbs but can speak and listen) to control the various home appliances and can actuate the bed elevation just by the voice commands according to their need and comfort. The proposed system consists of a voice recognition module, Arduino uno microcontroller, relay circuit to and an adjustable bed. The voice recognition module needs to be trained first before it can be used to recognize commands. Upon successful recognition of voice command the Arduino drives the corresponding load with the help of the relay circuit. The adjustable bed elevation can be set to the three different modes as per the user comfort and need. The accuracy of voice recognition module is also measured in different conditions. The experimental results validate the functions of the proposed system. The results show the system can provide great assistant to the physically challenged people without any third person's assistances. [3]

One of the most promising technologies to enhance the quality of life of quadriplegia patients is smart home environments. Security has a paramount importance for all health information systems, but it is generally overlooked until a major security breach occurs. Especially in an application specifically targeting people with disabilities, ignoring security might have dire consequences therefore they think that proactive measures should be taken by system designers. In this paper, they present SHA, a secure voice activated smart home for quadriplegia patients. The principal contribution of our system lies behind the security mechanisms incorporated in the proposed smart home architecture which has an integrated framework including ambient assistance and remote health monitoring. [4]

The FPGA of an ASR system is implemented in a car environment. The voice feature vectorsare extracted by using Mel-Frequency Cepstral Coefficients and compared by using FastDTW algorithms. The recognition rate of the proposed system is 81.5%. Both MFCC and FastDTWalgorithms are implemented by Verilog HDL. The target device is chosen as Altera DE2-115. [5]

Smart homes are in huge demand and have gained significant consumer awareness. Smart homes and home automation systems are generally used with reference to a wide range of solutions that includes controlling, monitoring and automating various functions inside a home. In this paper, design of home automation systems using various technologies is proposed and their performances are evaluated. The proposed work is an outcome of a funded paper and the systems proposed, designed and reported in this paper can be easily adapted for various applications such as control of machines in machining industries, automotive industry, navigating mobile wireless nodes and automating offices. [6]

The home automation improves the lifestyle of the control of home devices. Technology advancements have made the implementation of embedded systems within home appliances. The abilities and benefits are increased by the home automation. The value of our lives can be improved by automating various instruments or electrical appliances. There is always a stipulation for home automation through mobile phones. Our main objectives are to help old aged people and handicapped and to control the home appliances from remote places. Our major focus is on controlling the home appliances from both indoor and outdoor. The mobile application is created and interfaced with the device to control home appliances through Bluetooth and GSM for indoor and outdoor controlling respectively. [7]

Remote home management is one of the developing areas in current technology. This paper describes how to manage and control home appliances using mobile phone, people can use this system to do things in their home from a far place before they reach home. For instance, user may start his/her room cooler or heater so that before they reach home the condition in the room will be conducive, also appliances like washing machine and cooker can be started and if the time taken for this appliances to perform a task is known that can also be set, so that if the time elapsed the appliance will automatically switch off itself. To control an appliance the user sends a command in form of SMS from his/her mobile phone to a computer which is connected to the appliance, once the message is received the computer will send the command to a microcontroller for controlling the appliance appropriately. [8]

The main objective of this paper is to develop a home automation system using an Arduino board with Bluetooth being remotely controlled by any Android OS smart phone. As technology is advancing so houses are also getting smarter. Modern houses are gradually shifting from conventional switches to centralized control system,

involving remote controlled switches. Presently, conventional wall switches located in different parts of the house makes it difficult for the user to go near them to operate. Even more it becomes more difficult for the elderly or physically handicapped people to do so. Remote controlled home automation system provides a most modern solution with smart phones. In order to achieve this, a Bluetooth module is interfaced to the Arduino board (ATMEGA 328) at the receiver end while on the transmitter end, a GUI application on the cell phone sends ON/OFF commands to the receiver where loads are connected. [9]

The research work investigates the potential of 'Full Home Control', which is the aim of the Home Automation Systems in near future. The analysis and implementation of the home automation technology using Global System for Mobile Communication (GSM) modem to control home appliances such as light, conditional system, and security system via Short Message Service (SMS) text messages is presented in this paper. The proposed research work is focused on functionality of the GSM protocol, which allows the user to control the target system away from residential using the frequency bandwidths. [10]

The concept of serial communication and AT-commands has been applied towards development of the smart GSM-based home automation system. Homeowners will be able to receive feedback status of any home appliances under control whether switched on or off remotely from their mobile phones. PIC16F887microcontroller with the integration of GSM provides the smart automated house system with the desired baud rate of 9600 bps. The proposed prototype of GSM based home automation system was implemented and tested with maximum of four loads and shows the accuracy of ≥98%. [11]

Automation is a trending topic in the 21st century making it play an important role in our daily lives. The main attraction of any automated system is reducing human labor, effort, time and errors due to human negligence. With the development of modern technology, smart phones have become a necessity for every person on this planet. Applications are being developed on Android systems that are useful to us in various ways. Another upcoming technology is natural language processing which enables us to command and control things with our voice. Combining all of these, our paper presents a micro controller based voice controlled home automation system using smartphones. Such a system will enable users to have control over every appliance in his/her home with their voice. All that the user needs is an Android smartphone, which is present in almost everybody's hand nowadays, and a control circuit. The control circuit consists of an Arduino Uno microcontroller, which processes the user commands and controls the switching of devices. The connection between the microcontroller and the smartphone is established via Bluetooth, a widespread wireless technology used for sharing data. [12]

Nowadays, the remote Home Automation turns out to be more and more significant and appealing. It improves the value of our lives by automating various electrical appliances or instruments. This paper describes GSM (Global System Messaging) based secured device control system using App Inventor for Android mobile phones. App Inventor is a latest visual programming platform for developing mobile applications for Android-based smart phones. The Android Mobile Phone Platform becomes more and more popular among software developers, because of its powerful capabilities and open architecture. It is a fantastic platform for the real world interface control, as it offers an ample of resources and already incorporates a lot of sensors. No need to write programming codes to develop apps in the App Inventor, instead it provides visual design interface as the way the apps looks and use blocks of interlocking components to control the app's behavior. The App Inventor aims to make programming enjoyable and accessible to novices. [13]

Each and every part of our life is somehow linked with the embedded products. Embedded systems are the product of hardware and software co-design. Embedded system is becoming an integral part of Engineering design process for efficient analysis and effective operation. From data analysis to hardware work, everywhere embedded products are the main interest because of its reliability and time bound perfection. There is not much time with anyone now a day to give enough in all aspects, so demand of embedded products which serve as we want is high on demand. The present paper describes the design of an embedded system for the control of Temperature &Light intensity with continuous monitoring in a single system using sensors, microcontroller and LCD. It describes the controlling action incorporated in the hardware to control any device connected when specific conditions are met. Further set up is made such that data can be stored for future offline analysis.[15]

3. EXISTING SYSTEM

The web based home automation system in which user can interact with the system through a web-based user interface over the Internet. Home appliances like lights, door locks, air conditioners and gates are remotely controlled through a user-friendly web page. Functions of web based system.

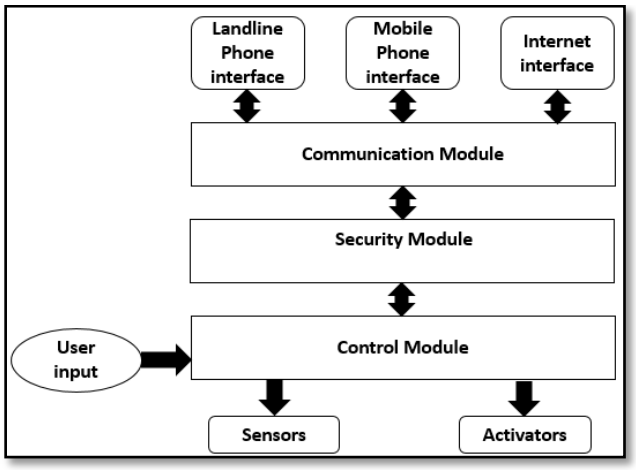

Fig 2: Existing System 1 Design

Lights and doors are displayed through a web page that can be controlled through web browser and system monitoring of the house in real-time. If a threat is detected, with the help of appropriate wired and wireless motion sensors alarm system will be starts. Alarm system will alerts the user and security personnel through Short Message Service (SMS) messages which is highly extensible and customizable.

The system connected to home appliances. This system is developed as a custom-designed processor in Field Programmable Gate Array (FPGA). The system is implemented on a Nios development board cyclone II edition components and interfaces. The main processor interacts with external components, viz. sensors, appliances and devices by using C programming language. User interface is developed by using socket programming, hypertext mark-up language (HTML), JavaScript and Personal Home Page (PHP).

The user is able to communicate directly with the board through a web browser.

Home automation is working on cloud principle. With the help of different sensors, monitoring is done. A computer is kept permanently active at home. That computer is there to control the operations with home appliances. Home PC is kept to continuous monitor sensor output. If there is any problem found with the output given by sensors, Home pc is going to report that problem to Cloud Server.

Home PC is responsible for conveying messages towards cloud server. Cloud server will store the information into the database and will take actions according to output. Working of cloud server is to mine the data from database, and convey the relevant message to the HAS owner by a initiating a call/ SMS, and the intelligence part in this system is to call and send SMS to the Technician and report the detailed problem occurred in the appliances.

This system as stated it is energy efficient but it takes lots of energy in sensing the environment as well as to kept a Home PC continuously ON, energy supply to PC is required. As this system required cloud server, one Home PC the system is also more costly than other HAS. This system can be more useful for that who are more living outside and who need to access the appliances from remote location. Functions of cloud based system.

System is using number of sensors to monitor different parameters like light, temperature, humidity to get information about current surrounding area. One computer at home is kept continuously ON to observe the output given by sensors. This computer will give the information to Cloud server side. For storing the phone numbers and relative contact details of the User and the technical persons, their work address, work time, and services they offered there is one module for Registration which helps to store data at server side.

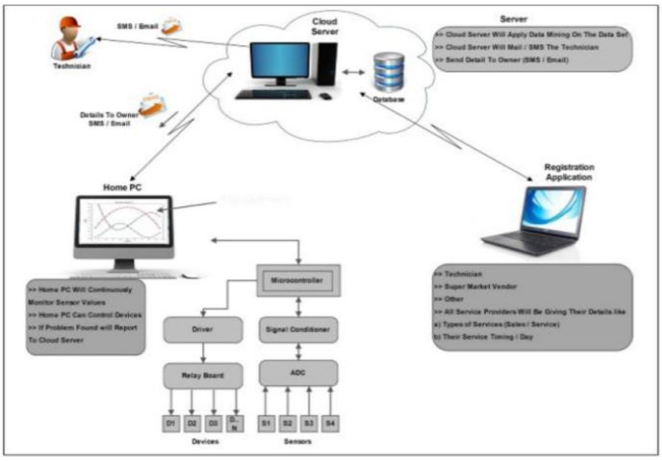

Fig 3: Existing System 2 Design

In operational state Cloud server is going to mine the Data gathered from no of sensors, and going to perform the actions like Sending mail/SMS/call to HAS User. This system basically works via a cloud server which is responsible for taking actions on the basis of results provided by sensors situated in home. This system doesn't require any remote like machine for e.g. Mobile Phone or remote controller to give actions to system, instead of that it acts automatically according to the conditions specified in it which is more useful to have a device free walk and have actions performed by the controller by taking decision by their own.

In SMS based Smart home concept has the main control which implements GSM to provide remote access from PC/laptop. The design consists existing electrical switches and with low voltage activating method provides more safety control in the switches. The switches status is synchronized in all the control system whereby the real time existing switches status is indicated by every user interface. The purpose of system is to control electrical appliances. This design of the system contains the mechanical switches with the modified low voltage activating method, in order to provide safer control to the user. The connection in this system is established by GSM module. This GSM module directly receives / transmits commands from/to PC/Laptop.

The System is placed and deployed on the wall or any empty area in user's surrounding. The system is capable with communicating with the user's computer/laptop/smart phone using the Bluetooth

wireless connection. Deployed system comes with GUI which is installed on the one of this device

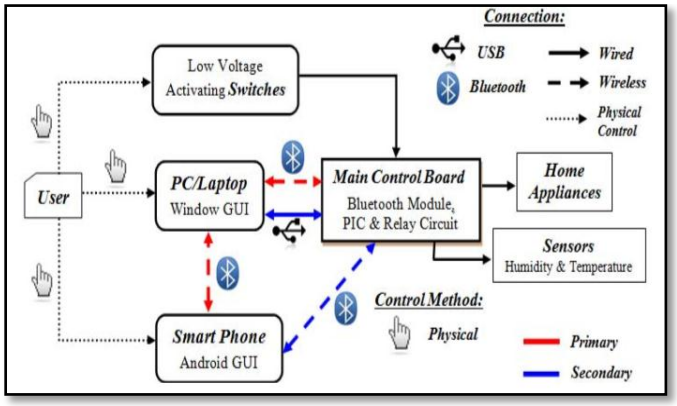

Fig 4: Existing System 3 Design

- Existing system works only with specific proprietary applications
- No voice control
- No Unified Access to electrical devices
- Works only on smart devices
- Need same Communication Network to ensure proper communication
- Doesn't work with unified access devices viz., Google Assistant, Amazon Echo DOT, etc..

The paper aims at developing a Voice controlled smart System prototype which mainly focuses on monitoring and controlling non smart devices over wired and wireless networks.

The system consists of two main parts: A hardware interface module and a software communication module. The Hardware interface module consists of: Raspberry pi 3b, Wi-Fi module and relays. The Software Communication module is built using python scripting and using cloud servers.

The central device is the Raspberry pi 3b that connects to the Wi-Fi module and receives instructions from Google Assistance to monitor and control the non smart devices.

The proposed work will enable to use the non smart devices as smart device by controlling them over voice commands.

4. System Design

The backbone of any software is the architecture. The figure 5 shows the architectural design.

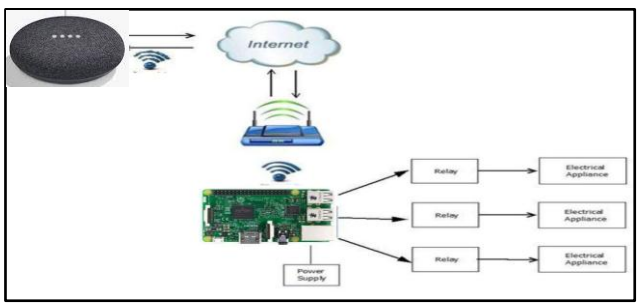

Fig 5: System Architecture

The components of the architecture include Raspberry PI3b, which is the main computing device of this work. It contains GPIO pins, Wi-Fi module, Bluetooth modules which are used to communicate to the relay.

User provides the Voice Command through the voice processing devices like Amazon Eco Dot and Google Home. Then the voice Command is sent to the server over internet and sent to the destination device for action. The command is recognized by the PI board and sends the appropriate signals to the respective devices through relay ports.

Initially user through Google assistance gives the voice instructions which are received by the IFTTT server. Depending on the instructions it will perform the actions respectively and send the data configured to the feed connected to the Adafruit server.

Once the Adafruit server receives the data from the IFTTT server the value will be logged in its public cloud which is accessible to the Raspberry pi, where a program is written to access the values from the Adafruit cloud server.

After receiving the values from the Adafruit service cloud it is sent to the respective GPIO pins to perform the action on the electrical appliance connected the respective relay.

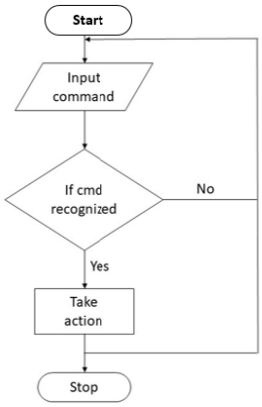

Fig 6: Flow Chart

In fig 6, the commands are given as input for the voice recognizer device if it is valid it processes the command and carries out the required steps else it goes to waiting state again to receive commands.

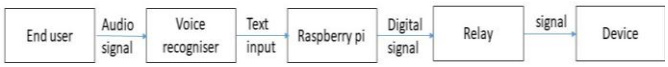

Fig 7: Data Flow Diagrams

In fig 7, the commands given by the end user is in the form of audio signals which when received by echo-dot (voice recognizing device) converts it into text format and sends it as input to the raspberry pi board then the raspberry pi processes the input and sends the output to relay module in the form of digital signals either as 1 or 0 that is either 5V or 0V. Depending on the digital signal it either makes or breaks a circuit which in turn makes a

device to turn or off. The relays act's as mechanical switches to turn or off the devices.

Operating System	Raspbian OS, UBUNTU
Programming language	Python,Python Script, JSON
Integrated Development Environment	Pycharm IDE, Thonny
Application Server	IFTTT, ADAFRUIT, VNC
IoT Processor	Raspberry PI 3 model B+

TABLE 1: Software Requirements

5. IMPLEMENTATION

Initially an account has to be created in www.ifttt.org with the same Gmail id which is been logged in the mobile phone used to give instructions.

After creating an account; in the drop down menu an applet has to be created for every instructions given through the Google assistance from the mobile phone which has to be performed on the electrical devices viz.- "Turn on the light".

IFTTT stands for "IF THIS THEN THAT". There are two parts in this "THIS" and "THAT" both has to be configured. First let's configure "THIS" part. If the instruction is turn on the light then an applet needs to be created by searching for Google assistance for this instruction and configure "THIS" with the different three ways of giving instruction which will be recognized and corresponding action to be configured in the second part "THAT".

In the second part of IFTTT applet configuration i.e. the "THAT" part, Adafruit service has to be searched and configured. Here a value has to be specified corresponding to the instruction given in the first part which will be sent to the Adafruit server's corresponding feed created in the Adafruit.

Similarly for each and every instruction to be performed on the devices corresponding configuration has to be done individually.

Initially an account has to be created using the same email id which is used in mobile & IFTTT so as to synchronize all the activities.

After creating the profile in the "www.io.adafruit.com" in the feeds section create a feed which will be accessible by the IFTTT's Adafruit configuration in the second part. This feed will receive the data/value which is sent by the IFTTT after recognizing the instruction in the first part from the Google assistance of the mobile. A log will be created of feeds value received along with the time stamp and location if configured.

This value is of our interest to perform the task on the devices. In the raspberry pi this particular value is fetched from the Adafruit cloud service and corresponding signal is sent to the relay where the devices are connected through the GPIO pins of the raspberry pi.

Connect the 4 module relay to the 4 GPIO pins of raspberry pi. Power up the relay and do the circuit connection as shown in the figure 8.

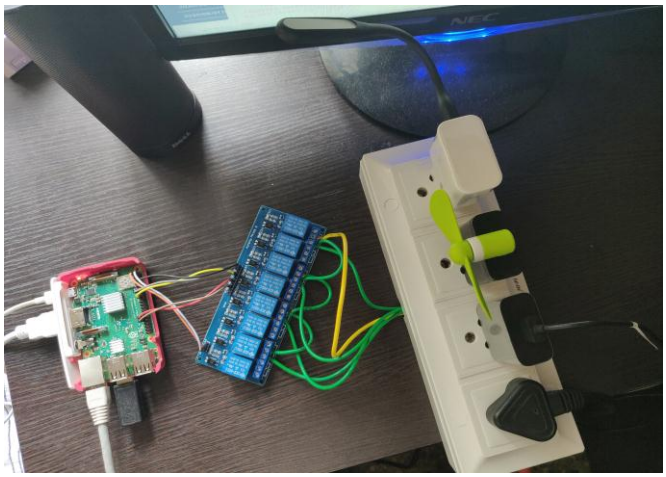

Fig 8: Connection Setup

The wiring between raspberry pi, 8 channel relay module and the socket assembly are done as shown in the fig 8.

In the raspberry pi four GPIO pins along with 3.3v and 5v VCC pins and ground pin are connected to the relay module respectively. On the other side four socket assemblies is connected individually with the 1, 3, 5 & 7 channel of relay respectively.

The voice instructions over Google assistance is communicated through IFTTT and Adafruit services to the raspberry pi which sends the signals through the respective GPIO pins to the respective channel of the relay module controlling the respective socket in the socket assembly.

6. RESULTS AND SNAPSHOTS

The result of the implementation shows that the non smart devices such as light, fan, mobile charger, laptop charger are controlled successfully based on the voice instructions given by the user through Google assistance. Fig 9 shows the snapshots of the result in a nutshell.

CONCLUSIONS

In today's smart world everyone needs smart devices to enjoy the benefits it provides. But the problem is what to do with the existing non smart devices which don't provide any of the features of smart devices. The need for voice controlled smart system which will enable to use the non-smart devices as smart device is achieved successfully.

A cost effective approach to find a solution to the non smart devices which can be controlled over voice instructions will enable all our existing non smart devices at our home to be controlled and used in a smarter way.

Fig 9: Snapshots

REFERENCES

[1] SubhajitDey, "Web based real-time home automation and security system", International Journal of Electrical and Electronic Engineering & Telecommunications, Volume 4, No 3, July 2015.

[2] Nathan David, AbaforChima, AronuUgochukwu, "Design of a Home Automation System Using Arduino", International Journal of Scientific & Engineering Research, Volume 6, Issue 6, June-2015

[3] Mukesh Kumar, Shimi S.L," Voice Recognition Based Home Automation System for Paralyzed People",International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 4, Issue 10, October 2015.

[4] Y Uzunay and K Bicakci, "SHA: A secure voice activated smart home for quadriplegia patients," 2007 IEEE International Conference on Bioinformatics and Biomedicine Workshops, Fremont, CA, 2007, pp. 151-158.

[5] DF Syu, SW Syu, SJ Ruan, YC Huang and CK Yang, "FPGA implementation of automatic speech recognition system in a car environment," 2015 IEEE 4th Global Conference on Consumer Electronics (GCCE), Osaka, 2015, pp. 485-486.

[6] Manikandan J., "Design and evaluation of wireless home automation systems," 2016 IEEE 1st International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES), New Delhi, India, July 2016.

[7] Anandhavalli D, Noorul S. Mubina ,Bharathi P, "Smart Home Automation Control using Bluetooth and GSM.", International Journal of Informative and Futuristic Research, Volume 2, Issue No. 8,April-2015.

[8] Ahmad, B. I., Yakubu, F., Bagiwa, M.A and Abdullahi, U. I., Remote Home Management: An alternative for working at home while away.World of Computer Science and Information Technology Journal (WCSIT), 1, 4, 144-147, 2011.

[9] Syed Mujeeb Patel, Syed Jilani Pasha, "Home Automation System (HAS) using Android for Mobile Phone."International Journal of Scientific Engineering and Technology Research, Volume.04, IssueNo.25, July-2015, Pages: 4844-4849.

[10] Erik Brynjolfsson and Andrew McAfee, "The SecondMachine Age: Work, Progress and Prosperity in a Time ofBrilliant Technologies", 2014.

[11] RozitaTeymourzadeh, Salah Addin Ahmed, KokWai Chan, and MokVeeHoong, "Smart GSM Based Home Automation System", 2013 IEEE Conference on Systems, Process & Control (ICSPC2013).

[12] SonaliSen, ShamikChakrabarty, RaghavToshniwal, AnkitaBhaumik, "Design of an Intelligent Voice Controlled Home Automation System", International Journal of Computer Applications (0975 – 8887) Volume 121 – No.15, July 2015.

[13] Mahesh N. Jivani, "GSM Based Home Automation System Using App-Inventor for Android Mobile Phone", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Issue 9, September 2014.

[14] Brian W Evans, "Arduino Programming Notebook", First Edition, Publisher Lulu.com, August 2007.

[15] A. Goswami, T. Bezboruah and K.C. Sarma, "Design of An Embedded System For Monitoring and Controlling Temperature and Light", International Journal of Electronic Engineering Research, Volume 1 Number 1 pp. 27–36, 2009.