Design & implementation of smart home automation system for disabled persons using Wi-Fi & Zigbee.

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Abstract: Smart home system for disable people is the system called assistive domestics focuses on making it possible for the disabled to motivate them carry out the daily activity, safe and comfortable. However in our research work, we attempt to design the smart home system including the wireless controller by comparing Wi-Fi & Zigbee Protocols. Here results from both the protocols will be analyzed & compared. Many systems already exist in the market; however, they were designed without envisioning the need of residents with special needs. This work presents a framework that enables the integration and control of devices within a smart home environment for residents with disabilities. The framework focuses on comparative study of wireless protocols like Zigbee, Wi-Fi for smart home automation for users with special needs. The framework supports the integration of multiple control devices for different residents with different disabilities. Moreover, the work addresses the safety of the users by providing warnings and notifications in case of an emergency.

IndexTerms **– Smart home automation, Zigbee, Wi-Fi, Disabled persons**

I. INTRODUCTION

Concepts on smart home application and development include various implementation techniques and are never limited. Smart home systems are created based on analysis on client needs and budget to cater for the system. With technologies available today, efficient integration of this system could be achieved. Home automation, also referred to as smart home concept, is not new to consumers. It encompasses the ability to control electrical and electronic devices at home remotely thus providing ease of access to home users. This concept may be applied in various manners to fit the requirement of a smart home. Now, advancement in wireless technology introduced new ideas such as Bluetooth and Internet linking; Wi-Fi, which has been slowly replacing the conventional wired technology which requires wire bonded interconnection between electrical devices. The main advantage of wireless interlinking includes diminishing the need of wires for connection. The actual need of this system is in India, the actual number of disabled people cannot be ascertained because of problems getting the complete statistics. However, according to statistics released by the United Nations (UN), the disabled account for 10 per cent of the population in the world. 80 percent of these people are in developing countries. According to UN statistics, the disable peoples in India are estimated at 21 million persons, representing 10 percent of India's population. The groups of persons with disabilities such as elderly, patients (paralyzed), blind, handicapped and etcetera. This study, however, focuses on those who are handicapped or paralyzed from the legs up to waist level, in particular those who use wheelchairs. These groups are actually able to lead a decent life if the facilities are provided to help them be independent and solve the problems faced by this group. These networks connect many smart grid objects such as home appliances, smart meters, switches, reclosers, capacitors bank, integrated electronic devices (IEDs), transformer, relays, actuators, access points, concentrators, routers, computers, printers, scanners, cameras, field testing devices, and the list can go on to many devices. This work proposes a framework for homes to enable people with different types of disabilities the control of appliances and devices within their home environment through Wi-Fi/Zigbee as required by user. A Network is implemented and operated within houses or other small boundary offices to enable communication between user's peripheral devices to various home appliances. Such appliances are: televisions, air conditioning systems, security systems, and other devices like fax, printers, as well as small network attached storages. Moreover this technology allows the user to control and monitor many digital devices throughout the house.

The basic system includes devices such as, an access point, the home appliance(s), and a smart meter. Wireless Sensor Network (WSN) is being implemented to monitor and broadcast information from different applications. It is being developed in various fields such as homes and hospitals. WSN consists of a large number of wireless sensor devices working together to achieve a common objective. A wireless sensor device is a battery-operated device that has the capability of sensing physical quantities, provides efficient wireless communication and data storage. Moreover, a WSN has one or more base-stations that gather information all the sensor devices. This work designs and implements a wireless sensor network inside a house that provide users with special needs essential and basic control within a home environment. The proposed work enables the user to perform his/her daily activities by remotely monitoring and controlling home appliances without depending on others. The input and output are automatically adjusted depending on the user's special needs and environment. Users can monitor and/or control their appliances remotely and within the house using smart phones or control panels. However, most of the monitoring and control system in this technology are not feasible to people with disabilities such as visually impaired, deaf, and handicapped. A blind person cannot see whether the window is open/close, similarly a deaf person cannot hear the fire alarm. A handicapped person (with hand disability) one the other hand cannot use his/her phone to check if the refrigerator door is open or closed. Hence, most of the existing smart home automations are aimed at healthy people. Other specialized devices are developed; however, the devices operate only based

on one specific disability. This framework provides comparison between Wi-Fi &Zigbee protocols for the data communication. It provides comparative study of wireless protocols in smart home automation for multiple disability persons.

II. SYSTEM DESIGN & IMPLEMENTATION

This model provides smart home automation system for disabled persons as well as to residents who were outside their home. This smart home automation system consists of Transmitter Unit & Receiver unit.

A. Transmitter Unit

The Transmitter unit consists of 2 modes of operations

1. Manual mode 2. Sensor mode.

The manual mode will help disabled persons to control home appliances independently & this system can be controlled automatically through sensor mode. In the manual mode the inputs are provided through keypad to processor & then they are sent to receiver unit through Zigbee transmitter. The keypad can control various home appliances at a time.

In Sensor Mode, the home appliances can be controlled automatically through signals provided by sensor node. The sensor node consists of LDR (light dependent resistor), DHT-11(Humidity & temperature Sensor), and Smoke Sensor Module.

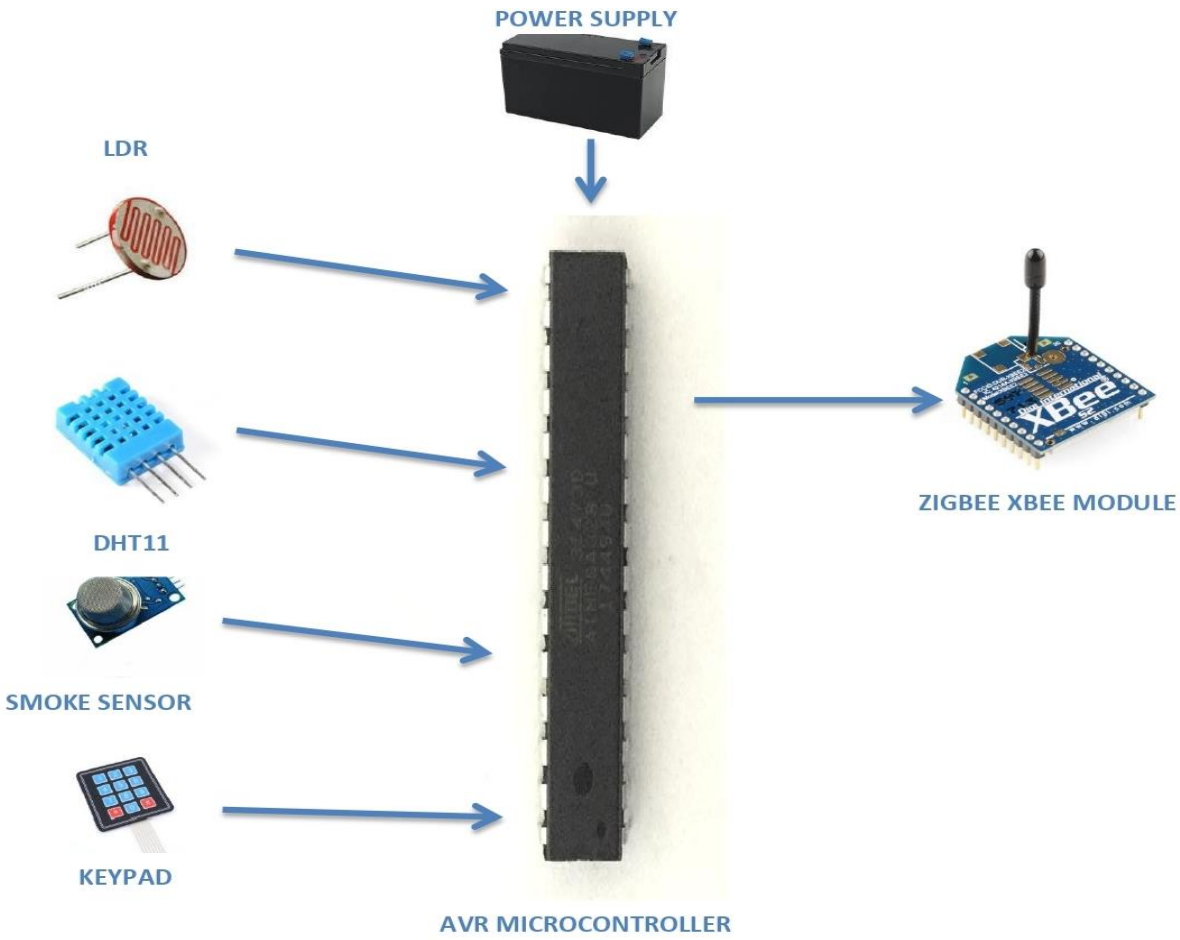

Fig 1. Transmitter Unit

The LDR will monitor light intensity level inside room & will provide appropriate signal to processor unit. The DHT-11 sensor will monitor Temperature & Humidity level inside room & it can provide information to processor so that it can turn on/off the home appliance. The smoke sensor module will provide information regarding smoke level inside region.

The main processing unit is the ATMEGA 328P-PU (Arduino). The ATMEGA controller is connected externally to the 5V power supply. It manages and optimizes all the system input and output. The input data is coming from both sensor node as well as keypad. The inputs provided by keypad are collected by processor & send to the Zigbee transmitter. Various keys can control respective output appliance at receiver. The LDR sensor sense light intensity level & when the threshold level is obtained then light are turned on/off.

The DHT-11 sensor sense humidity & temperature level value & turns ON/OFF fan & subsequent devices accordingly when threshold level is reached. The sensor mode or manual mode can be selected through mode selection switch. The sensor values are continuously monitored & are displayed on LCD display.

B.Receiver Unit:

The receiver unit consists of 2 communication protocols i.e Wi-Fi, Zigbee. The Zigbee receiver accepts signals from transmitter unit & sent to the processing unit. The processing unit then turns on/off appliance accordingly through relay. The current status of appliances can be seen on LCD display. The output devices can be controlled through Wi-Fi with the use of Feature of android Google Assistant. The Node MCU will accept the signals from cloud server through Wi-Fi & sent to the processor. The IFTTT server helps to connect to the Google assistant & Adafruit.io creates buttons for appliances.

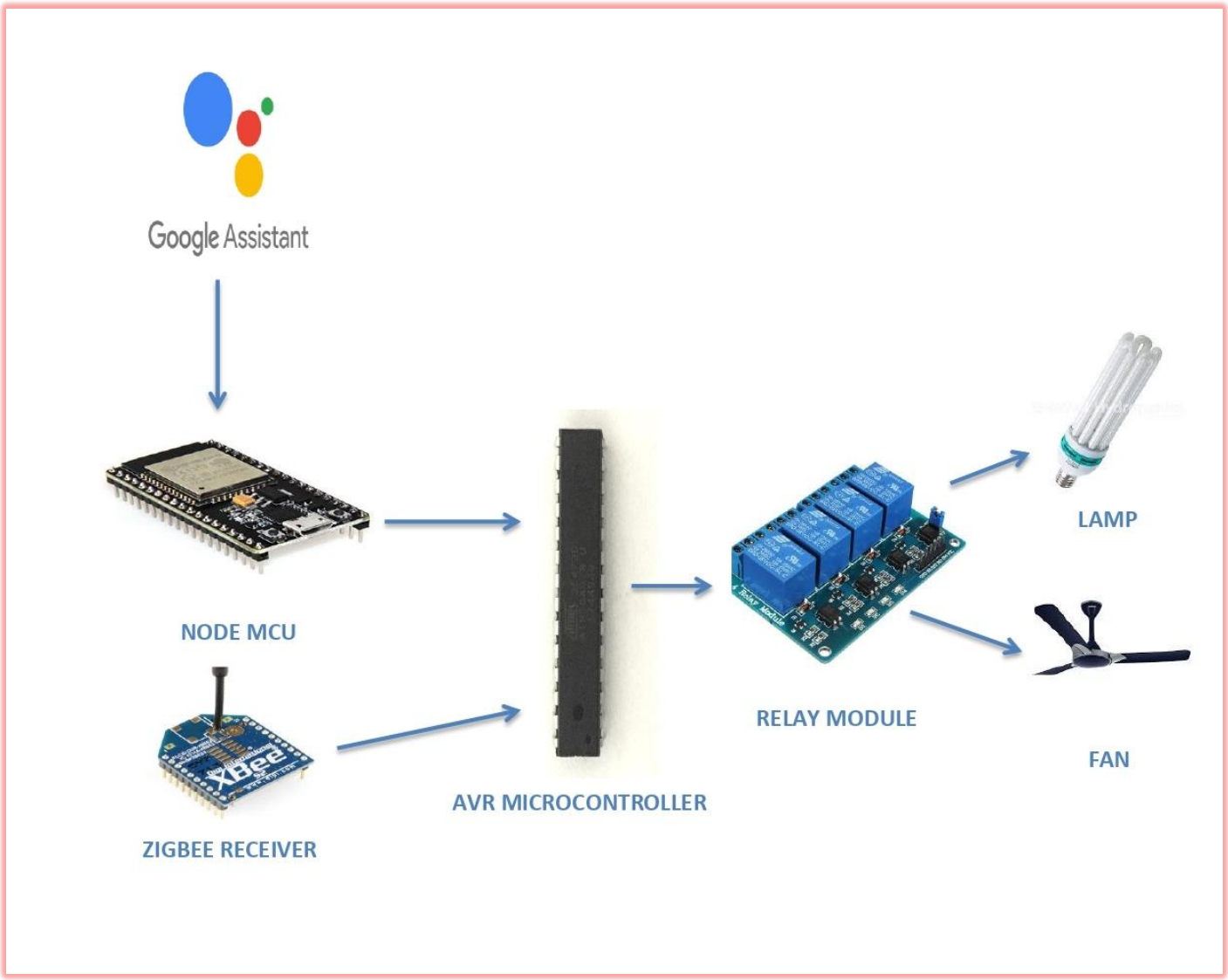

Fig 2. Receiver Unit

III. Hardware Implementation:

A. AVR Microcontroller-ATMEGA 328P-PU

The ATmega328 is a single-chip microcontroller created by Atmel in the megaAVR family (later Microchip Technology acquired Atmel in 2016). It has a modified Harvard architecture 8-bit RISC processor core. The Atmel 8-bit AVR RISC-based microcontroller combines 32 kB ISP flash memory with read-while-write capabilities, 1 kB EEPROM, 2 kB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external

interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughput approaching 1 MIPS per MHz.

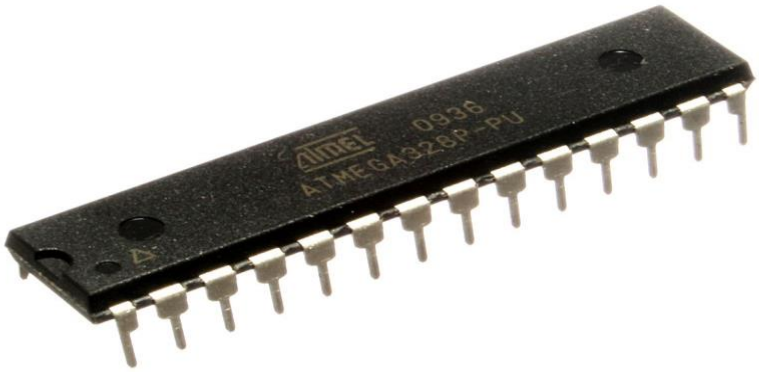

Fig 3. ATMEGA 328P-PU

B. SENSORS

Sensors plays very vital role in home automation systems. In this system Temperature/Humidity Sensor, LDR, Smoke Sensor

B.1 DHT-11 Sensor:

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

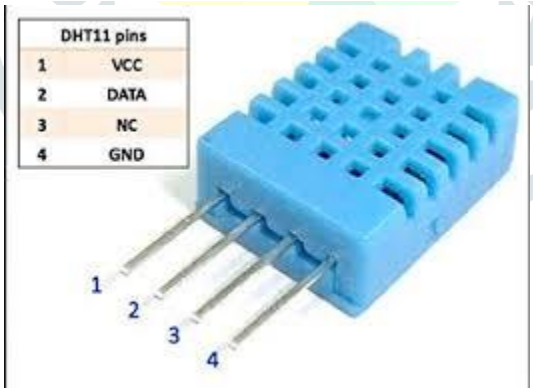

Fig 3. DHT11

Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmes in the OTP memory, which are used by the sensor's internal signal detecting process. 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, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users' request.

B.2 Light Dependent Resistor

It is light sensitive device. It is low cost sensor, used in street light in the farm during night. The most common type of LDR has a resistance that falls with an increase in the light intensity falling upon the device (as shown in the image above). The resistance of an LDR may typically have the following resistances:

Daylight= 5000Ω
Dark= 20000000Ω

Parameter	Conditions	Min	Typ	Max	Unit
Cell resistance	1000 LUX 10 LUX	- -	400 9	- -	Ohm K Ohm
Dark Resistance	-	-	1	-	M Ohm
Dark Capacitance	-	-	3.5	-	pF
Rise Time	1000 LUX 10 LUX	- -	2.8 18	- -	ms ms
Fall Time	1000 LUX 10 LUX	- -	48 120	- -	ms ms
Voltage AC/DC Peak		-	-	320	V max
Current		-	-	75	mA max
Power Dissipation				100	mW max
Operating Temperature		-60	-	+75	Deg. C

Table 1.Specifications of LDR

B.3 Smoke Sensor Module:

A smoke sensor is a device that senses smoke, typically as an indicator of fire. Commercial and residential security devices issue a signal to a fire alarm control panel as part of a fire alarm system, while household detectors, known as smoke alarms, generally issue a local audible or visual alarm from the detector itself. The Analog Smoke/LPG/CO Gas Sensor (MQ135) module utilizes an MQ-135 as the sensitive component and has a protection resistor and an adjustable resistor on board. The MQ-135 gas sensor is sensitive to Air quality and smoke. It could be used in gas leakage detecting equipments in family and industry. The resistance of the sensitive component changes as the concentration of the target gas changes.

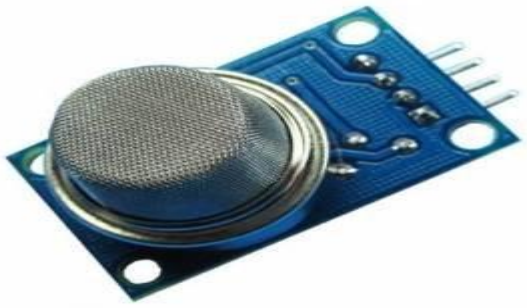

Fig 4. Smoke Sensor Module

C. NodeMCU:

The NodeMCU (Node MicroController Unit) is an open source software and hardware development environment that is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266 is designed and manufactured by Express, contains all crucial elements of the modern computer: CPU, RAM, networking (wi-fi), and even a modern operating system and

SDK. When purchased at bulk, the ESP8266 chip costs only $2 USD a piece. That makes it an excellent choice for this system design. The NodeMCU aims to simplify ESP8266 development.
It has two key components.

i. An open source ESP8266 firmware that is built on top of the chip manufacturer's proprietary SDK. The firmware provides a simple programming environment based on eLua (embedded Lua), which is a very simple and fast scripting language with an established developer community. For new comers, the Lua scripting language is easy to learn. And to add on NodeMCU can be programmed with the Android IDE too.

ii. A development kit board that incorporates the ESP8266 chip on a standard circuit board. The board has a built-in USB port that is already wired up with the chip, a hardware reset button, Wi-Fi antenna, LED lights, and standard-sized GPIO (General Purpose Input Output) pins that can plug into a bread board. Figure 2 below shows the NodeMCU development board.

Fig 5. Node MCU

D. Relay:

Relay is electrically operated switch that use to open and close circuits electro-mechanically or electronically. Relays control electrical circuit by opening and closing contacts in another circuit. Relays can isolate high power rating devices from low power rating devices. That's use to turn ON or OFF the circuit using voltage/current. In this project 4 channel 5v relay is used. It has four channels to operate motor and bulb/light in the farm. Each channel has 3 connections namely NC (normally closed), com (common) and NO (Normally open).

Fig 6. Relay Board

IV. SOFTWARE IMPLEMENTATION:

A. IFTTT Application:

IFTTT derives its name from the programming conditional statement "if this, then that." IFTTT is both a website and a mobile app that launched in 2010 and has the slogan "Put the Internet to work for you". The idea is that you use IFTTT to automate everything from your favourite apps and websites to app-enabled accessories and smart devices. What the company provides is a software platform that connects apps, devices and services from different developers in order to trigger one or more automations involving those apps, devices and services. Here, IFTTT application is used to bridge the gap between the Google Assistant commands and the Adafruit.io IOT platform. Setting up the IFTTT application first requires logging in after which we need to create an applet and then "This", i.e. the trigger, here we select Google Assistant and then we will type in the commands to which the Google Assistant should respond and to this command it should control the appliance/relay associated with it. The response

command from the Goggle Assistant can also be typed in as desired. After configuring the trigger, i.e. “This” of the application we need to configure the “That”. What should be done once the Google Assistant hears the command which we just configured? This is decided by setting “That” of the app. We click “That” and then select adafruit.io and click connect. Adafruit.io will allow us to send commands to the Adafruit Server. This creates the action for the trigger i.e. the Google Assistant command. The action taken by it is simply sending a message to the Adafruit.io to either turn ON or OFF the concerned connected device. Finally, the microcontroller is programmed with the actions it needs to do once it receives the signal from the Adafruit.io application. Before that, the Blynk and the microcontroller should communicate and the communication is done via the internet and since the microcontroller, NodeMCU comes with inbuilt Wi-Fi module, it is programmed to connect to the desired network once plugged in. ‘C’ language is used to program the microcontroller and is programmed in the Arduino IDE.

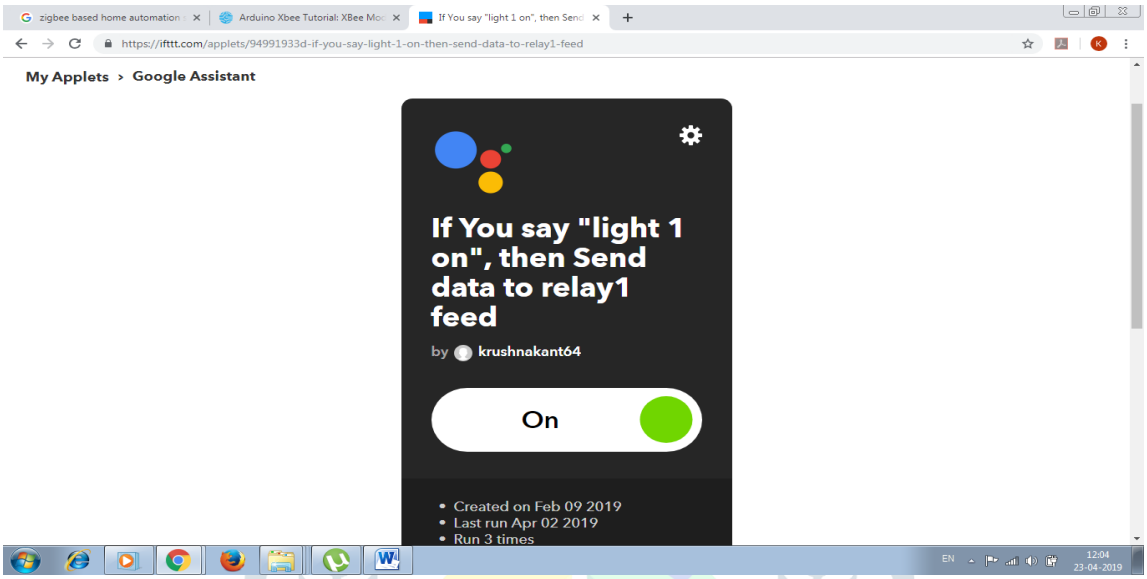

Fig 7. IFTTT Application

B. ADAFRUIT.IO SERVER

Adafruit.io is a Platform with iOS and Android apps to control Arduino, Raspberry Pi, NodeMCU and several other boards over the Internet. Adafruit.io was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things.

For using Adafruit iot platform we need to set up platform by following steps:

1. Create an account with your name & Email id
2. A confirmation mail will be sent to email id & account will get verified.
3. Create a dashboard with the blocks. We can choose various types of blocks.
4. Choose the feeds required for the blocks.
5. Get the AIO key from dashboard & include in code.

Fig 8. Adafruit.io

v. RESULTS & DISCUSSIONS:

The implemented system was evaluated both quantitatively and qualitatively. To demonstrate the feasibility and effectiveness of the proposed system, four devices, a light switch, radiator valve, safety sensor and ZigBee remote control have been developed and integrated with the home automation system. These systems were subjected to a cycle of strenuous operations to simulate a high level of everyday usage. The light state was changed 20 times using the ZigBee remote control and 20 times using the Wi-Fi controller. Similarly the radiator valve state was changed 20 times using the ZigBee controller and 20 times using the Wi-Fi controller. The experiments showed the correct functionality of the devices 100% of the time. From the above experimentation we can conclude that Wi-Fi controller takes slightly much delay in operating device.

VI. CONCLUSION:

This paper has reviewed the existing state of home automation systems, and identified and discussed five areas that have hindered consumer adoption of such technologies. Briefly, the areas include: the complexity and expense of the architectures adopted by existing systems, the intrusiveness of the system installations, the lack of interoperability between different home automation technologies, and the lack of interoperability between systems developed by different manufacturers that utilise the same technology. Interface inflexibility and the inconsistent approaches adopted towards security and safety are also problems.
The implemented system focusses on system which will be useful for disabled persons & for their environment through use of Wi-Fi & Zigbee protocols. It enables them to perform their daily activities by remotely monitoring and controlling their home appliances without having to depend on others. The potential for successful co-existence and interoperability of Wi-Fi and ZigBee has been practically proven with implementation with a real home automation system. The implemented system is programmed so that it can be configured to adjust to the customer's disability providing them with better and convenient lifestyle. It is worth mentioning that the implemented system will be scalable and can be extended to include more and different services and tools. This system will focus on portability, compactness, affordability and easy to use.

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