

Smart Fault Detection and Home Automation System

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Abstract:- In this present world where technology has taken over everything reaching new heights and in between this tremendously growing technology the technology of IOT (Internet Of Things) has sparkled its way ahead of other fields and promises to deliver much more aspects in this world. It possesses a great potential for future applications and offers a wide range of scope for the generation to come. If we talk about controlling the world from a click of a single button then IOT has achieved its dream status. There are many standard appliances in industries and our homes that make our day to day life and work easier and therefore it becomes a necessity to control these appliances remotely. And for the same machine to work requires a secondary brain or automation (secondary machine) which does the tasks of the user as per the requirement from long distances. The proposed paper aims at designing a smart home automation and monitoring system along with smart fault detection to ensure the security parameters of the project. In this project the main component is the arduino node MCU to showcase the working of IOT. The algorithm designed is developed in the arduino programming language. The algorithm is linked to the GUI through the same environment and also with the help of an android application which is specifically used to provide IOT enabled modules and libraries that were needed to work on the proposed system. The system talks about the solution to every individual's theft fear and ensures that no problem is compromised. With the basic ideology to provide fault detections in order to increase the security of the house and also make the household appliances to work with just a single button on the smart phone device makes the system slightly different. The results also shows the same concept which is mentioned before with efficient implementation and in a much friendly manner. This paper deals with web connectivity with IOT wifi module Esp8266 and much efficient control of the home appliances. The connectivity achieved is by use of Arduino Node MCU and also acts as a bridge or an interface between the hardware and software part of the project. Overall this gives us a platform to understand and implement the working of hardware like microcontroller which gets its command from the software component (arduino programming language). In order to make the home appliances work the use of relays come into

action. The Arduino node MCU is connected to these relays and once the signal gets connectivity and the user orders a command the relays will start working and simultaneously the home appliances will get power supply and will start working in normal functioning condition.

Keywords:- Smart Home Automation, Smart Fault Detection, Arduino Node MCU, Internet of Things, Relays.

I. INTRODUCTION

In today's world technology has become an essential part of everyone's lives to such an extent that commodities like internet and smart phones have become a necessity in almost many parts of the world. Though it will reach new heights and technology is ever changing from time to time but Internet with its constant stability and support will remain the world's best invention of all time. Internet and Technology seem to go hand in hand and will continue to do so in the future generations to come. Now it's the time for automation to rise up. World is leaning on the smart machinery which can generate such potential and fulfil the tasks where once human efficiency could not deliver much. Automation simply means to operate or control a process by highly automatic machinery by electronic devices reducing the human intervention to the minimum. Although it requires the human touch in terms of thinking and planning where a knowledge base is required but manual labor has been denigrated a lot which in turn is a lot of relief for the manufacturers. The use of automation is dilated and Home Automation is one of its many factors. Home automation comes with its numerous advantages and that's why it is quite popular in smart cities. Home automation can be defined as the automation done to control and operate home based equipment or building. And the system comprising of automating the home appliances is known as home automation system. So in layman terms home automation is smart home. It may include centralized controlling of home appliances and lighting, electronic devices and security systems.

The biggest advantage that has led this system to a tremendous growth and popularity is because it can be controlled by the elderly as well as the disabled. With the growing demand for internet connectivity in every city

every house, there is a steep rise in the usage of home automation just because it provides security stability thereby completing the objective of a smart home. Also introducing the concept of “Internet Of Things” has led to the rapid popularity of this system. Nowadays, there are a wide variety of home automation systems in the world. The system ranges from cheap to very expensive system with different features and functions. Several companies that provide home automation system are competing to provide features that are useful to the society. However, the price features, and ethics become the limit of the innovations of this system. Most of the systems have many features that make the price of the home automation system expensive and non-affordable. However, if the automation system consists of small feature only, it makes home automation system less attractive and not popular in the public. And more importantly, innovation should be based on ethics, the system must not give a lot of negative impact on society and the environment. Like using a lot of components that are hard to recycle, and also the system must not reduce employment opportunities in that area, with the reason that human resources are no longer needed.

Talking about this new found technology which has combined both the hardware and software aspects of a machinery system isn't that much of a complex scenario that it sounds to be. Internet of things is basically a technological method of phenomenon where the hardware devices or the electronic devices are integrated or interconnected with the physical objects to transmit and receive data. It is called as the internet of computing devices. So here the usage of internet of things facilitates the working of the microcontroller known as Arduino node Ncu which is an open source IoT platform developed especially for ESP8266 Wi-Fi Soc by Espressif Systems. It is actually a firmware. Arduino offers some good advantages which makes it slightly favourable. In simple terms, it is easy to learn and also it offers its own programming methodologies which are easily understandable. There's not much to learn in detail for getting an expertise in arduino programming. Secondly it has wide array of sensors and many third party libraries. Thirdly it has a lot of applications to start with and does easily scale between different members of the family - including changing the microcontroller family the individual boards.

The proposed system of web controlled smart home automation system comprises of three main components. These components work dependently on each other and one cannot work independently without the other and together they constitute the actual meaning of Internet of Things. The three main components include:

- The First device is the user interface controller which is an android application which acts as a GUI for the project.
- The Second component is the Arduino Node MCU microcontroller itself which acts as a bridge between the user interface and the main controller.

- Lastly the Third component is the executing controller which is further subdivided into two parts namely the fault detection part which shows the current detection by using open and short circuit methods and the home automation part which uses the working of relays to provide current through to access the home appliances (bulb, charger) in this case.

There are many projects based on home automation but what makes this a different project or an idea is the use of current detection mechanism which is exhibited by the smart fault detection mechanism. Thus this proposed system offers many advantages over the existing home automation projects. These include:

- Use of Fault detection: here the idea of using current detection is a creative and an innovative approach to design the whole system and get the current feedback.
- Easy Monitoring: This system provides options for monitoring also there is a small display that will allow to raise any kind of buzzer sound or an alarm when there is no current feedback thus giving a warning sign stating that these is some issue with the security of the household appliances.
- User Friendly Approach: Unlike most of the other home automation projects this will guarantee a user friendliness environment. The GUI is specifically designed for making it understandable for the elderly as well as the individuals having a PWD status.
- Multiple Load Outputs: Currently the system has two load (load 1 and load 2) where the home appliances are connected. Similarly to use multiple appliances or to increase the number of load outputs the system uses a driver circuit which consists of diode and transistors to increase the current gain in order to make the relays work.

This paper is organized as follows: section I provides the system overview of the Smart Fault Detection and Web Controlled Home Automation System along with the system block diagram. Section II, discusses on system working and configuration. In section III, the system connection testing along with the results is carried out. Finally, section IV is the conclusion.

II. LITERATURE REVIEW

In this section, discussed different Home Automation System with their technology with features, benefit and limitations they have.

A. Wi-Fi Based Home Automation System.

System consists of three main components; web server, which presents system core that controls, and monitors users' home and hardware interface module(Arduino PCB (ready-made), Wi-Fi shield PCB, 3 input alarms PCB, and 3 output actuators PCB.), which provides appropriate interface to sensors and actuator of home automation system. The System is better from the scalability and flexibility point of view than the

commercially available home automation systems. The User may use the same technology to login to the server web based application. If server is connected to the internet, so remote users can access server web based application through the internet using compatible web browser.

B. Cloud-Based Home Automation System

Design and implement a home gateway to collect metadata from home appliances and send to the cloud-based data server to store on HDFS (Hadoop Distributed File System), process them using MapReduce and use to provide a monitoring function to Remote user.

It has been implemented with Raspberry Pi through reading the subject of E-mail and the algorithm. Raspberry Pi proves to be a powerful, economic and efficient platform for implementing the smart home automation.

C. Arduino Based Home Automation

This system uses mobiles or computers to control basic home control and function automatically through internet from anywhere around the world globally, an automated home is sometimes called a smart home. It is meant to save the electric power and human energy. The proposed system is a distributed home automation system, consists of server i.e. Wi-Fi module, sensors. Server controls and monitors the various sensors, and can be easily configured to handle more hardware interface module (sensors). The Arduino board, with built in Wi-Fi module acts as web server. Automation System can be accessed from the web browser of any local PC using server IP, or remotely from any PC or mobile handheld device connected to the internet with appropriate web browser through server real IP (internet IP).

D. Bluetooth Based Home Automation System

In Bluetooth based home automation system the home appliances are connected to the Arduino BT board at input output ports using relay. The program of Arduino BT board is based on high level interactive C language of microcontrollers; the connection is made via Bluetooth. The password protection is provided so only authorized user is allowed to access the appliances. The Bluetooth connection is established between Arduino BT board and phone for wireless communication. In this system the python script is used and it can install on any of the Symbian OS environment, it is portable. One circuit is designed and implemented for receiving the feedback from the phone, which indicate the status of the device.

E. Zigbee Based Home Automation System

To monitor and control the home appliances the system is designed and implemented using Zigbee. The device performance is record and store by network coordinators. For this the Wi-Fi network is used, which

uses the four switch port standard wireless ADSL modern router. The network SSID and security Wi-Fi parameter are preconfigured. The message for security purpose first process by the virtual home algorithm and when it is declared safe it is re-encrypted and forward to the real network device of the home. Over Zigbee network, Zigbee controller sent messages to the end. The safety and security of all messages that are received by the virtual home algorithm.

F. GSM Based Home Automation

Because of the mobile phone and GSM technology, the GSM based home automation is lure to research. The SMS based home automation, GPRS based home automation and dual tone multi frequency (DTMF) based home automation, these options we considered mainly for communication in GSM. The system use transducer which convert machine function into electrical signals which goes into microcontroller. The sensors of system convert the physical qualities like sound, temperature and humidity into some other quantity like voltage. The microcontroller analysis all signal and convert them into command to understand by GSM module. Select appropriate communication method among SMS, GPRS and DTFC based on the command which received GSM module.

G. RF Based Home Automation System:

The important goal of Home Automation System is to build a home automation system using a RF controlled remote. Home Automation using remote implements an easier solution with RF technology. In order to accomplish this, a RF remote is combined to the microcontroller on transmitter side that sends ON/OFF signals to the receiver where devices are connected. By operating the stated remote switch on the transmitter, the loads can be turned ON/OFF globally using wireless technology.

H. Android ADK Based Home Automation System

The devices of home are associate to the ADK and the Connection is established between the Android device and ADK. The devices of house are link to the input/output ports of the board (EMBEDDED SYSTEM) and their current situation will have passed to the ADK. The microcontroller board (Arduino ADK) is based on the ATmega2560. It has a USB host connection to associate with Android based phones, and that is based on the MAX3421e IC. The two important features of Android Open Accessory Protocol 2.0(AOAP) are as follows: It has audio output that is from the Android device to the component and it also support for the component serves as one or more Human Interface Devices (HID) to the Android device. Including motion sensors for safety systems will detect an unauthorized action and it will automatically notice the user through cell phone or the security system.

III. SYSTEM OVERVIEW

This system consists of three main components or controllers which facilitate the working of this system. These are:

1. The User Interface Controller
2. The Main Controller Node MCU
3. The Executing Controller

A. The User Interface Controller

The First component acts as the user interface which will provide the user friendly environment. The android application which is used as the interface will display the current status as the system projects the working of the closed and short circuit methods which will be defined in the next component. In future many new features could be added to enhance the appearance of this application but for now what is designed is for the best and one can operate without any hesitation.

B. The Main Controller Node MCU

The next component is the main controller called the Arduino Node MCU which is the source of

automation. It is the secondary brain that does all the main work including transferring of the signals, maintaining the connectivity with the Wi-Fi module ESP8266, processing the commands given through the arduino programming language. It is like the CPU of the whole system.

C. The Executing Controller

Third part is the executing controller which performs two functions. Firstly there is smart fault detection which includes the method of short circuit and open circuit. The concept of current detection is used specifically for this purpose. Once there is any breakthrough of current passage the user interface will display some sort of alarm that there is a connection problem as the arduino isn't getting any current feedback so there is a warning to check for any error that are causing the alarm to start. The other part capitalizes on the home automation mechanism. The appliances are connected with the relays and once we give current to both the loads which we have used the appliances will automatically start working.

➤ System Block Diagram

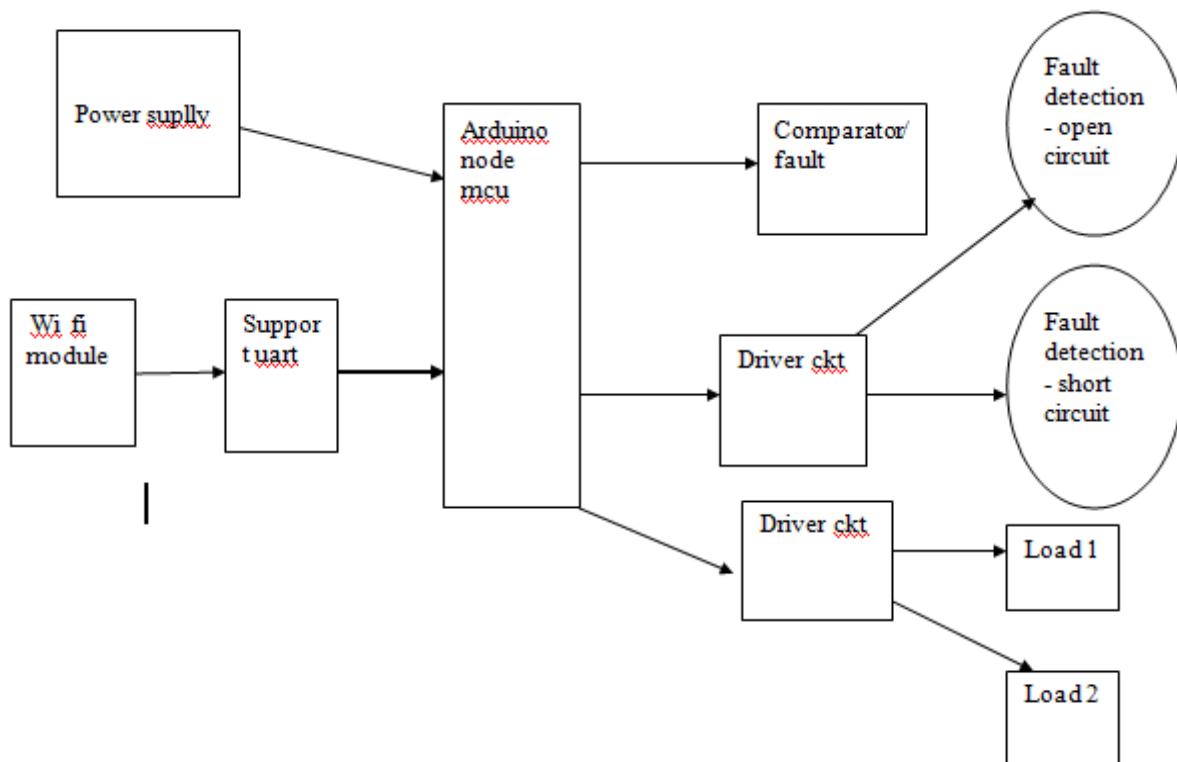


Fig 1:- Block Diagram

The Web Controlled Home Automation System involves the above discussed three controlling system. The primary controller is the main controller unit, and the secondary controller is the android application controller. The error monitoring or error detection is monitored by the working mechanism of fault detection system which implies current feedback from the home

appliances and forward it to the main controller as an input signal and display it on the android application to inform the user. Shown in figure 2 below are the working flow details on the controlling and monitoring processes of this Smart Fault Detection and Smart Home Automation System.

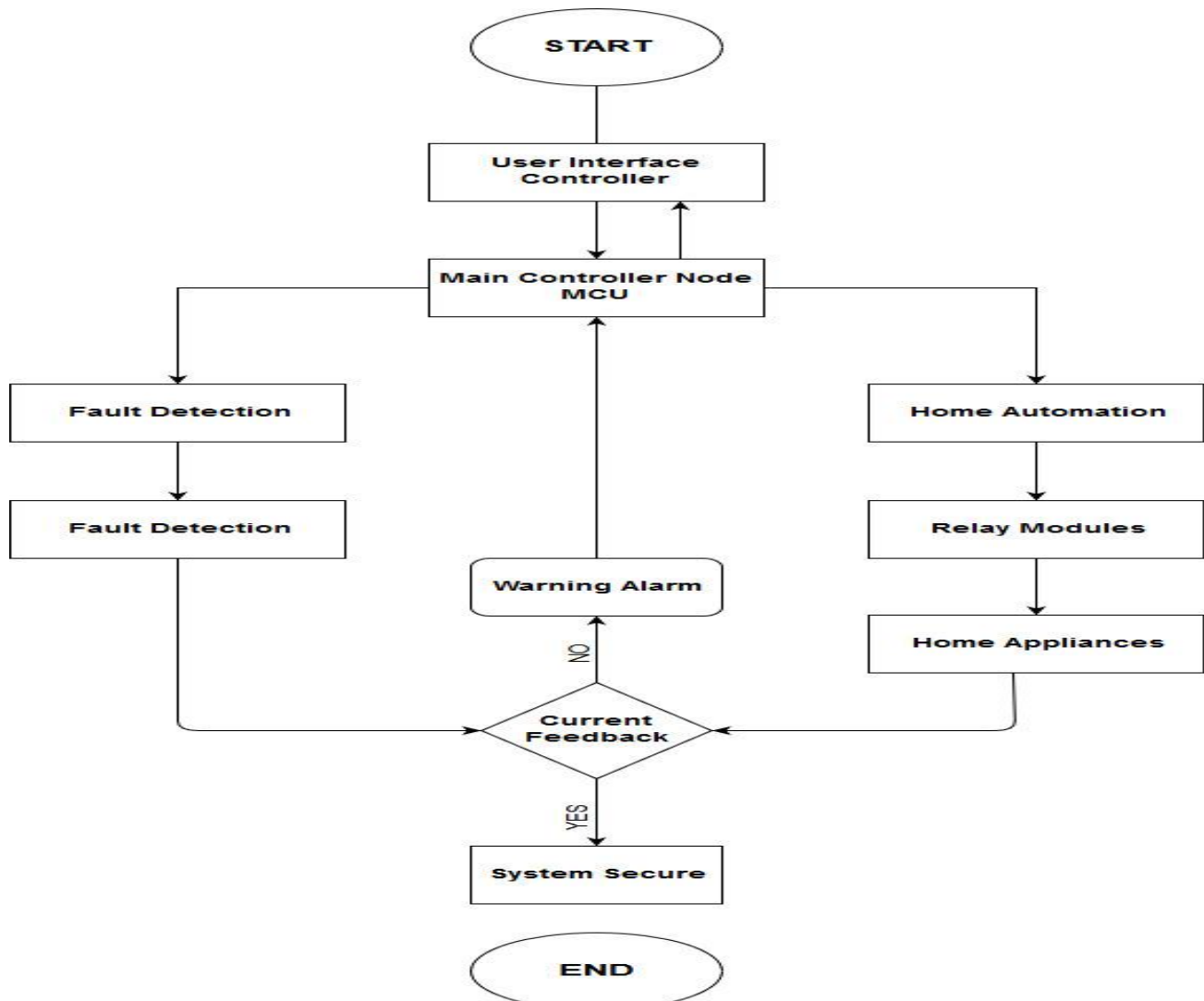


Fig 2:- Working Flow Chart

IV. SYSTEM WORKING AND CONFIGURATION

The working of the above shown system is as follows:

- First of all for power supply we take 220V AC current from the power source.
- Next there is a step down transformer which will convert the 220V input voltage to 12V power supply. Using 220V will damage the products.
- The transformer will still generate 12V AC current so there was a need for a rectifier which will convert the 12V AC current to DC current.
- During rectification there is a chance of noise coming so in order to cancel the noise factor we have used the 1000 µF capacitor.
- Now a need to make the 12V supply to 5V we have used a regulator IC 7805.
- During regulation the noise will be present so for the same we installed a 100 µF capacitor. Resistor and LED are taken to check the power supply.
- Input Voltage pin Vin which takes the supply for the Node MCU. Positive and negative connectors are also taken.

- Comparator IC is used which is important to show the working of fault detection. From the comparator IC we have deduced two logics namely the open circuit method and the short circuit method.
- Till the time the circuit is closed and current is flowing there is no breakage as soon as the circuit is opened or there is a short circuit there will be no current feedback so a warning will be sent to the Node MCU and the user will be notified through the display.
- For the working of the fault detection the comparator IC (LM358) is used and a variable resistance is used to provide reference voltage.
- Till the time there is proper current feedback with respect to the resistance the IC will take that as a yes and as soon as there is a breakage in circuit there will a difference in the voltage and automatically the IC checks will give an indication in the form a red signal LED signifying that there is a fault.
- These signals are then transferred to the connector pins of the Node MCU.
- As soon as the signals are sent to the Node MCU it performs the required actions which we have

programmed and notifies the user interface about these signals through the Wifi module ESP8266 and automatically the user is notified through the display.

- Now for home automation we have used the same microcontroller. The input pins are connected to the relays for transmission of signals.
- Relays are used to start the home appliances and to use the relays we have designed a small driver circuit also known as the darlington pair consisting of two bipolar transistors whose sole purpose is to amplify the current gain
- The need for this driver circuit is due the fact that relays work on high voltage and high current and for the same we need to maximise the current gain to drive the relay.
- Node MCU isn't sufficient to provide the suitable voltage so use of these darlington pair IC comes handy. Moreover this circuit will work on low voltage and produce high voltage.
- For the driver circuit mechanism we used two bipolar transistors and immediately Node MCU will give a negative voltage which will be converted to positive voltage by the PNP transistor and simultaneously the 12V will get transferred to the negative terminal of the relay.
- By doing this the relay gets energised which is confirmed by the relay sound and this is further connected to the load where we have connected the load (home appliances).

➤ *Configuring the Network*

This part explains the set up and configuration settings for the software component of the project system. For programming, arduino IDE is used and the first step is to configure the arduino to the same network for transmitting and receiving of signals. To configure the arduino with our smart phone we have used the same network access point of that of the smart phone with the same ssid and ssid password. This is shown in the following figure

```

Home_automation.ino  ReadMe.doc
8 char ssid[] = "project";
9 char pass[] = "project007";
10
11 int readValue1; // Place to store read PIR Value
12 int readDetected1 = 0;
13
14 int readValue2;
15 int readDetected2 = 0;
16
17 void setup()
18 {
19   // Debug console
20   Serial.begin(9600);
21
22   pinMode(rled, OUTPUT);
23   pinMode(load1, OUTPUT);
24   pinMode(load2, OUTPUT);
25
26
27   lcd.clear(); //Use it to clear the LCD Widget
28   lcd.print(1, 0, "**IOT BASED**");
29   lcd.print(0, 1, "Auto. & Security..");
30
31 }

```

Fig 3:- Access Point Configuration

➤ *Graphical User Interface*

This section provides the user interface information and the design of the first component controller called as the user interface controller. The following figure shows the Graphical User Interface of the project system.

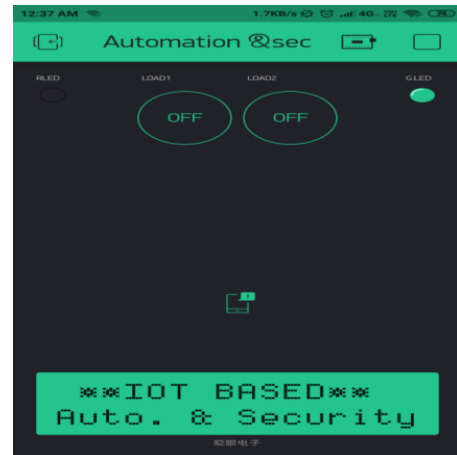


Fig 4:- System GUI

As shown by the figure the user interface is quite simple and easy to understand. There are two off buttons which show the condition of the home appliances. Currently they are in off state. As soon as either one of them is on the switch is turned on and the led buttons will function similarly. The Green portion is the display which will notify the user for any error or breaking of the circuit. Notifications will make a buzz sound when there is any issue with the current detection and no feedback is detected the system will inform the user. This user controlling interface was made by keeping in mind the objective of this system to be used both by the elderly and the disabled. Thus the system is subject to any modifications in the future to enhance the appearance.

V. SYSTEM CONNECTION TESTING AND RESULTS

This section defines the testing done on the software as well as on the hardware part. This is done after all the set up and configuration settings were done and programming part was also completed. Upon checking the available hardware components all were found to be in proper working condition and this was marked as the first testing observation. After the circuit was made we used the LEDs to ensure that the main controllers were in normal functioning condition. When given the power supply the Red LED near the capacitors were turned red ensuring that there is proper power supply and the transformer, rectifier were working absolutely fine. This is further confirmed in the following figure.



Fig 5:- Power Supply Testing

D. Short Circuit Method Testing

Short Circuit method shows the warning stating about the security of the appliance is compromised and there is short circuit and the system will ask to take appropriate action. This will also happen in the case of open circuit. So after testing this will imply that system is working fine and warning signals are issued as soon as there is any breakage.

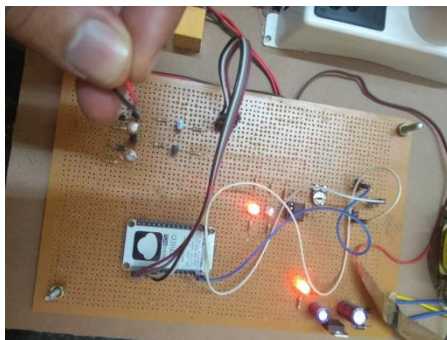


Fig 6:- Short Circuit Testing

E. Open Circuit Method Testing

The case for open circuit gives the same results. In both the cases the LED turns red indicating about the circuit breakage and the comparator IC identifies this and forwards the signal to the main controller and thus through internet connectivity the user gets informed.

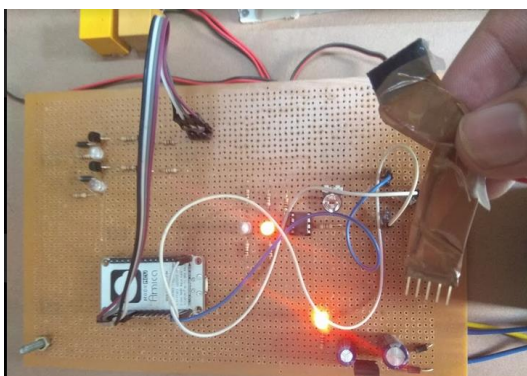


Fig 7:- Open Circuit Testing

F. Results

After both the cases were tested results were captured and screenshots of the user interface are taken.

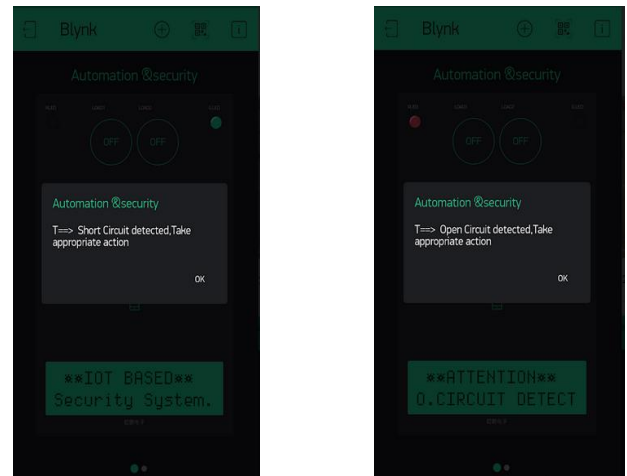


Fig 8 :- a & b Short and Open Circuit testing Result

The system generates the alarm signal as can be seen in the above illustrations. The user gets notified thus making the system a success and safe to operate.

G. Home Automation Testing and Result

Apart from the above testing the system was designed to operate the home appliances automatically through the main controller with the help of relays. Testing for the load inputs were done. When the button load1 was turned on the relays started working and immediately the home appliance showed that it was working normally. Here a small bulb is used to demonstrate the working. The bulb glows when the load button is switched on and vice-versa thus making the system testing successful.

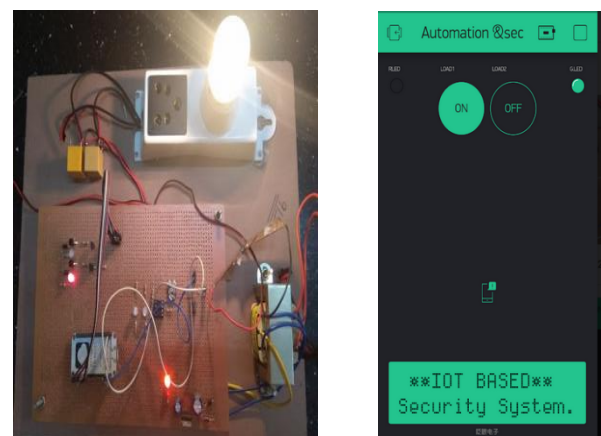


Fig 9:- a&b Home Automation Testing

The above two figures demonstrate the working of Home automation system. The bulb glows when the switch is on and automatically in the similar fashion will be switched off when the same button is tapped. This shows that the whole system is tested and functioning normally.

VI. CONCLUSION

This paper presents design, configuration, fault detection using open circuit and short circuit methods, and user interface customization on the Smart Fault Detection And Smart Home Automation System in order to achieve a new and easy way to implement an android application controlled smart home system using cheap and easily available components that are easy to install for better performance and features. The proposed automation system is practically implemented and thus the results are obtained.

This system could detect the appliances problems through current detection feedback using comparator IC LM358 current and display it in the smart phone to inform the user about the error. Though this system is complete and successful but still it has a great potential for future scopes and modifications. Altercations can still be made in the user interface controller as well as in the hardware controller. New possibilities can arise which could make the system even more secure and more advanced than the current version.

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