Home Security And Automation Using NodeMCU-ESP8266

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***Abstract*— Protection of our personal properties is a key challenge and prior responsibility every time which affects massively on a day to day life. The current system of achieving security has plenty of drawbacks and less secure. The main goal of implementing a home security and automation system is to achieve a powerful and more secure way to handle the day to day stuff preventing from misuse hands and keeping track of usage of home electrical appliances to know the necessary and unnecessary actions. The system is built on IoT (Internet of things) to make more accurate and error-free control over the flow of the system. To make the difference from the existing system, in this proposed system we built the communication of hardware devices with a web application where devices take commands and operate it while web application rise the commands and keeps track of each transaction made so far. The combination of hardware and software will make life easier and safer for its users.**

Keywords—IoT, ESP8266, NodeMCU, Home Automation

I. INTRODUCTION

The home security system is an idea of lock/unlock and turn on/off devices of home appliances through using microcontroller NodeMCU ESP8266, fingerprint sensor, solenoid lock and web application, where it becomes more trustable and feel more secure. The direct benefit of this system is zero redundancy, no duplicate fingerprint access can happen, saving them time and cost.

The system introduced to overcome the ongoing obstacles in theft crime issues where privacy becomes very important. The home security system can be done in the simplest ways with controlling devices with limited features like controlling doors with fingerprint sensors and other devices. The implementation of the home security and automation system is kept simpler towards the end-user front-end to make it more user-friendly and easy to adapt, where the back-end process makes more complex things from managing hardware and software. This idea is not only limited to home but also can be used in various areas like offices, banks, etc.

The proposed system also includes the home automation concepts such as saving the electricity by making the light devices automated for turning on/off only when it's necessary, such as while the user is in a remote place and electrical devices in the home are un-necessarily wasting the electricity, the user can easily look into the web application and turn it off.

II. EXISTING SYSTEM WITH DRAWBACKS

The current arrangement of the existing home security systems like digital locks, mechanical locks, etc., follow a simple scenario as users have to interact physically with door locks to unlock it. The existing system looks very easy and forwarded way but lack in communication with the internet and database. Few drawbacks in the existing system include physical interaction with the components, wastage of electricity in the absence of the user, no tracks about usage of the components. For example, web applications, database, maintaining the individual track of usage and functionality are not there in the existing system.

III. PROPOSED SYSTEM

The proposed idea is to overcome the existing drawbacks mentioned above. This system offers feasible features to control the home devices efficiently and easy to adapt.

Advantages of Proposed System

- Users can control home devices through a remote place using web or mobile interface.
- Better security for garage and office use.
- Easily get notification about false inputs.
- Keeping track of users.
- User-friendly GUI which makes the user uses the devices easily.

IV. FEASIBILITY STUDY

There are three types of feasibilities performed in the system which are economic feasibility, operational feasibility, and technical feasibility.

A. Economic Feasibility:

The current economical state of the system is more efficient to use rather than the proposed system which may differ in implantation cost. In some ways this looks like extra money is being spent. While the proposed system is secure based service and demand of the proposed system will increase as an adaption of the system get an increase. Home automation boosts an increase in security and efficiency for the appliance usage.

B. Operational Feasibility:

In the current system, there are not many operational features provided to the end-user and hard to keep track of individual houses, while the proposed system can fulfill such requirements. Proposed system work more efficient and error-free manner to produce more benefits to the end-user

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and making it simpler to keep track of data transmissions as it provides user friendly interface with internet connectivity.

C. *Technical Feasibility:*

The idea of the proposed system is not only to replace the existing system but to extend the features by making it automated; the proposed system requires external hardware as well as the existing system to be responsive. The newly added IoT hardware and software are good in performance unless there is no compromise in the quality of the hardware.

V. HARDWARE AND SOFTWARE REQUIREMENTS

A. *Hardware Requirements*

NodeMCU

Fig: 1

NodeMCU, integrated with the wifi module is the cheapest microcontroller which has most several integrated features when compared to the other microcontrollers.

Breadboard

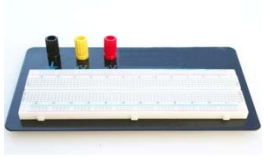

Fig: 2

A breadboard is used in constructing electronic prototypes; the breadboard is the solderless connection of pins.

Relay channel

Fig: 3

The Relay channel is considered as the electronic switch which amplifies the power throughout the system, the relay channel is used as the amplifier in electronic circuits to amplify the power from one node to another node.

USB cable

Fig: 4

Universal serial bus (USB) is used to connect the peripheral devices such as laptops, desktop with other input/output devices like printers, mobiles, etc. which work as transmission medium of data among the devices.

Led lights

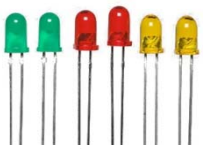

Fig: 5

Led lights are smaller in size which is often used in home decoration and electrical devices, most of the time led(s) are used in a system where the conditional result is to be shown visually as turning them on/off.

Jumper wires

Fig: 6

Jumper wires are electronic wires which are solderless and most preferable in the prototyping of electronic devices; it connects the device parallel with having soldered fewer pins at both ends.

Single-core solid copper wires

Fig: 7

Single-core solid copper wires are likely preferable over the jumper wires which works the same but reduces the physical issue of size and avoids the problems of getting a mess.

Solenoid Lock

Fig: 8

Solenoid Lock is electronically driven device used for Lock/Unlocking.

Fingerprint sensor

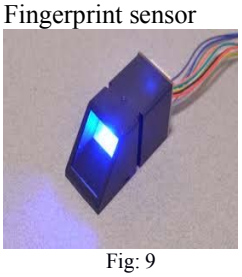

Fig: 9

Fingerprint sensor takes biometric inputs.

B. *Software Requirements and Programming Languages*

The proposed system is built on the IoT concept which requires software that works for embedded programming and those are

- Arduino programming application.
- Arduino embedded application.
- Live Database.
- A various set of Arduino libraries to support platform independence such as android.

The programming languages used in IoT concepts are embedded language(s) which have a different workflow. And those are.

- Embedded C programming.
- Object-oriented Programming concept.
- Google Firebase and Google Firestore.

VI. DESIGN

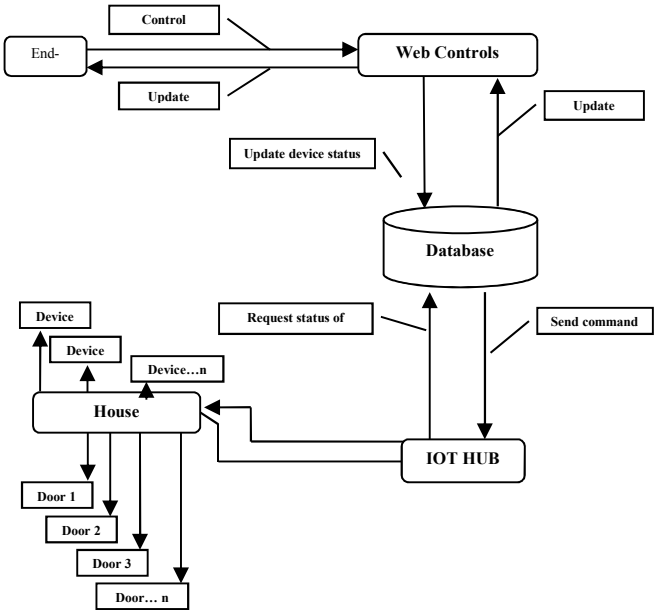

Fig: 10 Block Diagram of the proposed System

The above Block diagram is used to describe all the individual participants involved in the system

- End-User**:**

The end-user, for whom the system is built, is the participant in the block diagram with communication with web application and physical interaction. The end-user simply can interact with the application GUI (Graphical User Interface) to control the system devices using a web application.

- Web controls**:**

The home security system provides the user with a well understandable and user-friendly web interface to access the controls over the houses, office, and school devices. Here, in this system which is specifically built on IoT concept includes two types of user interactions to the system.

- Database:

The database used for the system is hosted on live server. The database is provided by Google firebase. The database works as middleware access between web application control and the IoT devices implemented in the system. In this system, we've used online live data storage provided by the Google Inc. The database which is provided from Google Inc. is named as Google firebase and Google fire store.

The Google firebase is an open-source platform used to build live hosted systems with real-time database storages, which provides extended features like machine learning, artificial intelligence.

The Google fire-store is an open-source platform similar to the firebase which provides real-time live access to the storages, in the debate to the firebase the fire-store gain the plus points in storage capacity and speed of querying.

- IOT Hub:

The IoT hub is a set of all hardware devices connected together to make the system built on IoT. Simply in this system hardware includes NodeMCU ESP8266, various sensors, and Led lights. IoT hub makes the connection with the database and keeps interaction with the database to make the tracking of transactions successfully, IoT hub and real-time database keep synchronously connected and transfer the information.

- House:

In this system, we worked in a house where there are still other areas where this system can cover such as offices, parking lots, hospitals, and schools, etc. Here, in this system house contains of hardware devices such as door locking, lighting and other home appliances.

Data flow diagram.

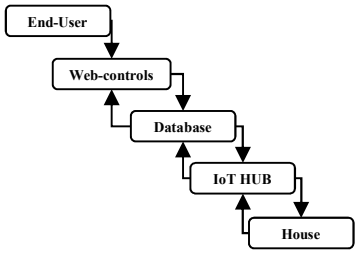

Fig: 11 Data Flow Diagram

VII. IMPLEMENTATION

A. Software Implementation.

In this system, the software is implemented in two ways, one is for the hardware applications and another is for end-users.

Programming languages used in IoT concepts are embedded languages, C or C++. Programming is done in two sections in this system and those are, front-end and back-end.

- HTML: The front-end GUI is developed using the HTML and CSS to provide well and understandable design. The responsive GUI makes the webpage run on all platforms such as desktop, laptop, tablets, and mobile phones with being well aligned with screen sizes. This system is being developed using the advantages of the latest HTML 5. Which supports responsive interface in nature.

- CSS: The cascading style sheets are the minimized programming language that supports the designing of the website. Html is used to include the elements whereas CSS is used to align the elements. CSS works on tracking the HTML elements through their id(s) and class(s) and applying the styles, either an internal or external way.

- Embedded C and C++: Embedded programming languages are the core of making the system work efficiently with the software, hardware and system

functionalities. Embedded languages are widely used in devices, such as mobile phones, traffic signals, remote controllers, digital cameras, washing machines, etc.

- Extended Functions in Embedded C programming: With access to the same principles of C programming, the embedded programming makes the program to communicate with the hardware efficiently; this type of programming is used to program the microcontrollers which are mostly used in standalone system such as traffic signals.

  The Arduino provide a large amount of functions. In this system we made use of functions like
  - digitalRead(), analogRead(), digitalWrite() used for reading and writing the Input/Output.
  - The pinMode in arduino programming defines pin to behave either in as an input or output.
  - Time: The time library is set of functions included which facilitate the programmer to hold the execution of the code for the particular time.
  - delay(): This method of the Time provides the developer to hold the execution of the program with specified time duration in milliseconds where parameters are only can take in milliseconds (1000 milliseconds is equal to 1 second).

B. Workflow Description

During the initial setup to this project we simply followed the documentation given by IoT hubs and firebase, whereas IoT hub describes the libraries for networking. Firebase needs prior setup to connect with the database where it requires HOST and AUTH details. Host is usually will be the website domain name or IP address and AUTH contains the database secrets. After the setup of all libraries first we need to connect with wifi using ssid and password provided.

Once the project is connected to firebase, our next step is to communicate the IoT hub with fingerprint sensor which is done by Adafruit libraries. Adafruit library call the construction to find the fingerprint sensor and return the same. Once the fingerprint sensor found, it requires the user to put their thumb to scan, fingerprint sensor takes the input and sends it to the Adafruit library to process it, the result of given input is converted to image file and compare with already stored fingerprint templates, if the fingerprint matches with given input then it communicates with firebase database with template id to find the user details stored in the database with the same.

Firebase returns the user details with respect to given template id, and then our code checks the status of user access for the particular device, If the status returned from firebase is such as “allow” then the device will be accessible else, it will reject to work.

Once the user got access to the particular device such as door, then IoT hub collect the user details fetched from firebase and again communicates with database and store the details of device status against the user activity which helps to keep track of the usage with respect to each device and user.

C. Database collections.

Example: the mapping of devices through the code may look like below table:

Table : 1

Control Center[3][ ] All Devices[ ][2]	Kitchen Devices	hallDevices	Doors
	ktbtn1	hbtn1	Door1
	ktbtn2	hbtn2	Door2

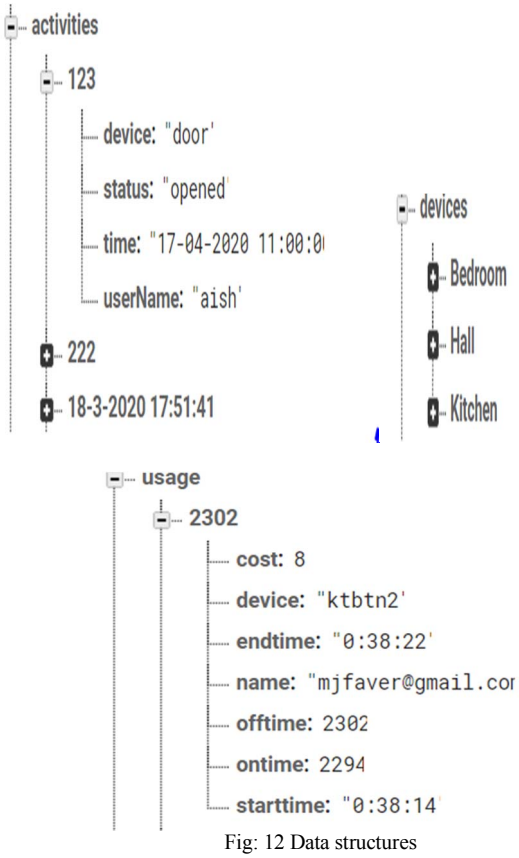

Fig: 12 Data structures

The Fig. 12 describes the structure of the data stored in database in the form of trees, where the root directory is database name having first root parent node as activities / devices / users which further contains three child nodes and each child node contains pairs of attribute and its values.

After fetching the value of the devices into variable named status, the program continues to apply the C style if condition to check whether the retrieved value of the device status is turned ON or OFF. As per the return statement’s result, the fetched status from the database about the particular device is true (in this case ON) then we simply turn the device ON with using digitalWrite() method of the arduino system or else turning the device OFF as it declares that the retrieved status from database is OFF.

D. Connecting the hardware.

Connecting the hardware require the knowledge of the circuit diagrams, more often connection circuits are different for various devices.

➢ NodeMCU pin mapping:

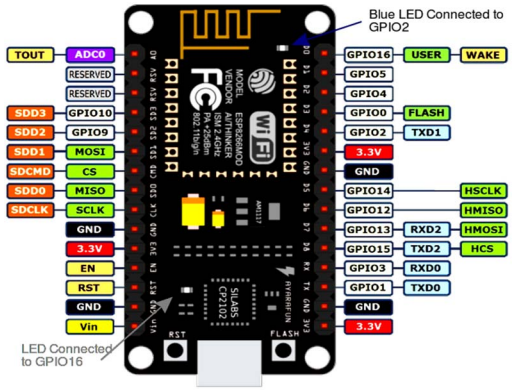

Fig: 13: Node MCU pin mapping.
(Source : https://circuits4you.com)

ESP8266 is highly durable, compact, power saving architecture and uses L106 32-bit RISC Tensillica microprocessor. ESP8266 uses 4Mb of flash memory in which 20% is reserved for Real Time Operating System(RTOS) and 80% for application development.

Features of ESP8266

- 16 GPIO pins
- 4 GND pins
- 3 3.3V power outlet pins
- 1 Analog input pin
- 1 RST pin
- 1 EN pin
- 2 Reserved pins
- Reset and Flash Buttons

➢ NodeMCU Circuit diagram to breadboard LED(s):

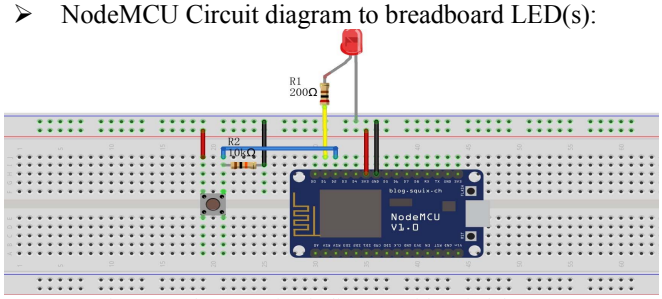

Fig: 14 Node MCU circuit diagram with switch button.
(Source: https://osoyoo.com)

➢ Node MCU to fingerprint:

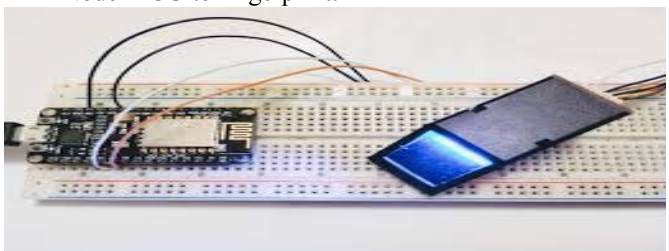

Fig: 15 NodeMCU to fingerprint connections.
(Source: https://www.geekering.com)

The Fig. 15 is the connection between the NodeMCU to fingerprint. Here fingerprint is used to scan the data. There are 6 wire connections in the fingerprint sensor. We are using 4 wires for the connection between NodeMCU and fingerprint sensor.

➢ NodeMCU to relay:

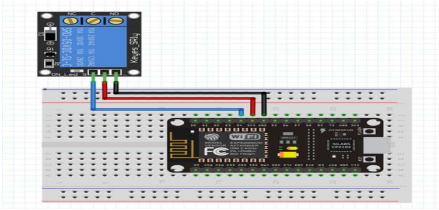

Fig: 16 NodeMCU to relay connection
(Source : https://www.instructables.com)

Relay is used to control the voltage of adapters in our project we used 5v adapter. It controls the high voltage and rescue people for the danger accidents by the current supply.

➢ Solenoid lock:

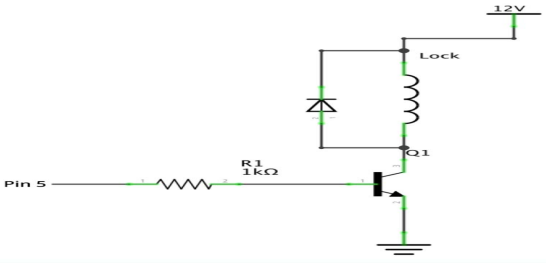

Fig: 17 circuit Diagram for solenoid lock.

It takes input from the fingerprint sensor, reads it and depends on the fingerprint input, it takes the action.

VIII. RESULTS AND DISCUSSION

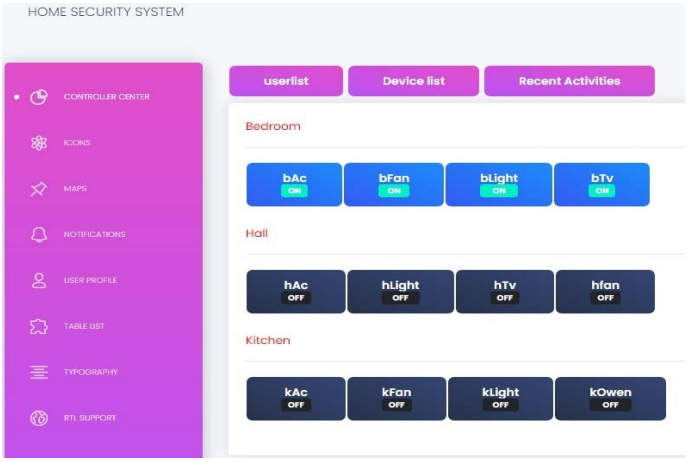

Fig: 18 Responsive web system on PC/laptop.

As shown in above Fig. 18 the system will understand the configuration of the device whether it is running on a desktop, laptop, mobile or any tablet and change its design as per the limits of the devices screen size, touch or keypad.

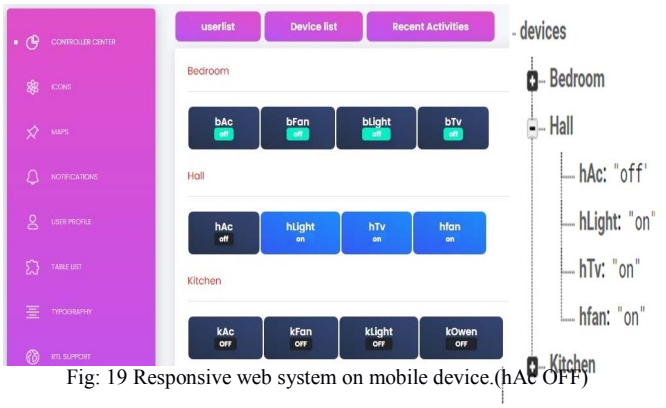

Fig: 19 Responsive web system on mobile device.(hAc OFF)

After turning ON hAc in the Hall the status in mobile and database is shown in the Fig. 20.

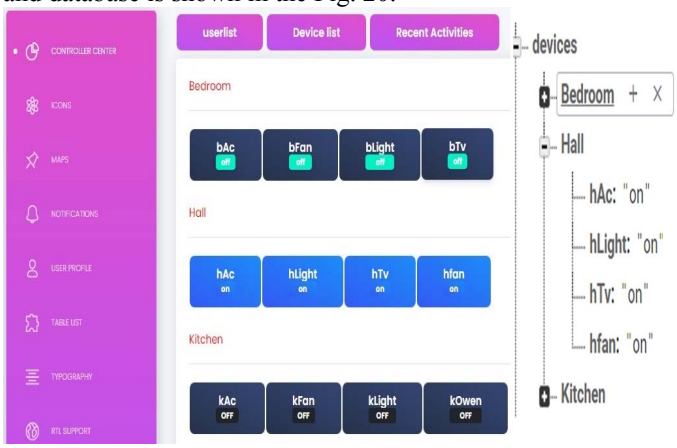

Fig: 20 Responsive web system on mobile device.(hAc ON)

Remarks: The results after performing the tests, the expected output is matched with actual output, which states that the functionality is tested individually and well defined in a good workable state.

The system has been implemented using the small scale model of the house. The Appliances used are simulated using the LEDs which can be converted into appropriate appliance and controlled by the Relays connected to NodeMCU.

The Door is fixed with the solenoid lock which can be operated using the fingerprint sensor and microcontroller NodeMCU.

Fig:21 Model House.

IX. CONCLUSION

The Home Security System using IOT has experimentally proven satisfactory and an efficient approach to develop the automation system for house, office and schools. The overall project is built on IoT concept which is already made the day to day life easier with automation systems. This system satisfies the user experience from different perspectives with physical interaction, keeps track about the data. Making the system to work on different platform was a key challenge but the technologies available in the recent years made the development easy and efficient.

X. FUTURE ENHANCEMENT

Today most of IoT prototyping is limited to remotely turning on/off the system's components connected remotely from any web application or mobile phones using the wireless or wired networks. In future there are possibilities of making the system to work with artificial intelligence and include facilities of machine learning which will make the system more widely usable and more efficient. In future banks, hospitals, home, office and school automations will consider this technology as a necessary part of their infrastructure.

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