A Smart Approach towards Home Automation and Security System Based on IoT Platform

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Abstract:- The introduction of the twenty-first century has started to automate and digitize different sectors to reduce human effort and ease day-to-day life. The recent advancement has introduced various technologies that offer a variety of services and applications. The Internet of Things (IoT) is a new and emerging technology that allows items to connect, perceive, and control each other remotely from anywhere in the globe. The integration of sensors and software in home appliances can play a crucial part in realizing smart cities, which rely on IoT to supply services without manual intervention while keeping the cost minimum. This paper represents a cost-efficient smart home automation system based on IoT technologies. The work integrates a NodeMCU and an Arduino-based microcontroller board that can incorporate cloud computing, networking, and wireless communication to access users' home appliances to monitor and store sensor data through online servers or virtual assistants like virtual assistants Goggle assistant. As it allows a range of devices to be linked and controlled, this system is designed to be affordable, economical, and expandable.

Keywords:- *Internet of Things (IoT), Home automation, NodeMCU, Arduino, wireless communication, Google Assistant, Smart cities.*

I. INTRODUCTION

Researchers and large-scale chip manufacturers are improving the performance cost ratio of integrated chips with each iteration. The devices that incorporate them are becoming more capable and cost-efficient [1-5]. As a result, mobile telecommunication is becoming more feasible and low costing day year by year. And so, incorporating wireless technology through the internet in our daily lives has become an obvious thing. Internet of Things or IoT is a rapidly evolving technology that allows numerous smart items to be connected, controlled, and managed through the wireless medium [6-7]. This system includes sensors that collect real-time values of a situation and help the user undertake decisions while executing them without any human labor.

According to Allied Business Intelligence (ABI) data [8], about 1.5 million automatic household appliances were installed in the United States of America (USA) in 2015, with a 45.2 percent annual growth rate. Again, one of the surveys done by CISCO shows that nearly 50 billion gadgets will be connected to the internet by 2020 [9-10]. These numbers show a picture of how advancement in technology has motivated us to implement more smart devices in our daily lives over the years. However, researchers are still innovating new ways and devices to maintain low costs while giving better performance than previous iterations. P. G.Gawade et al. implemented a smart home automation system using an Arduino as a microcontroller [11]. Their device can successfully identify gas leaks which will show on their LCD screen. Again, Y. Jeevani et al. implemented a system that uses the sensor value to ensure the home's security and uses relay modules to execute the user's command [12]. They have also used an Arduino-based microcontroller board to coordinate every data and an Ethernet module to communicate with the user.

In this paper, we implemented a smart home and security device that used a combination of NodeMCU and an Arduino Nano to control relay modules to execute relay commands. The integrated Wi-Fi module gives the device the ability to connect with the Wi-Fi system. This helps the user monitor sensor data and pass commands from the Goggle voice assistant by using voice commands or by typing. The device also alerts the user ifit detects any anomaly in sensor value by pushing notifications or messages according to the user preference.

II. METHODOLOGY

The system is divided into several subparts, each having different functionality while working harmonically to execute commands. The system includes Sensing units, a Smart switchboard, and a distressed unit. The following subsections cover the entire process of data transmission as well as hardware description.

A. Smart Switchboard

The smart switchboard integrates the analog switch input and the server input at the same time. The onboard IR sensor detects the touch of the user and registers as a command, respectively. The user can also input commands through their smartphones by using voice commands via Google Assistant or by manually inputting to the server page. The NodeMCU module manages this operation as it contains a build-In Wi-Fi module. The switchboard takes input from the server and updates the current state of eachswitch at a constant interval. This helps the user to monitor the appliance's condition continuously. Here Fig. 1. represents the Working process of the Smart switchboard.

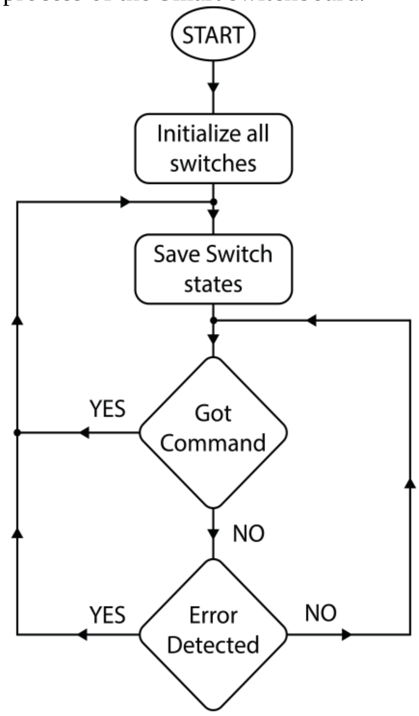

Fig. 1. Working process of the Smart Switch Board.

B. Sensing Units

The sensing unit contains a combination of several sensors which collect data from the surroundings and report to the central unit. Here the sensing unit includes an IR sensor that detects a sudden spike in Inferred value to detect fire. A gas sensor detects a range of flammable gases like methane and propane, indicating any leakage in the room. A PIR sensor to detect any sort of movement at any specific period. A humidity and temperature sensor that collects environmental data to report to the user. These data are collected and then analyzed for any hazardous situation. If the units sense any anomaly, it instantly reports to the main module. Otherwise, ambient data is sent to the main module to update on the server. The communication between the Sensing unit and the main module is established HC-05 module. Fig. 2. represents all the sensors included in the sensing unit, and Fig. 3. illustrates the unit's workflow.

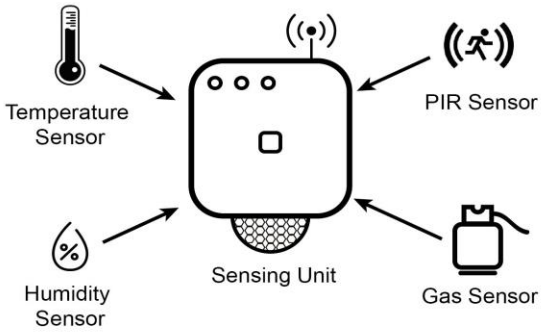

Fig. 2. Block diagram of the sensing unit.

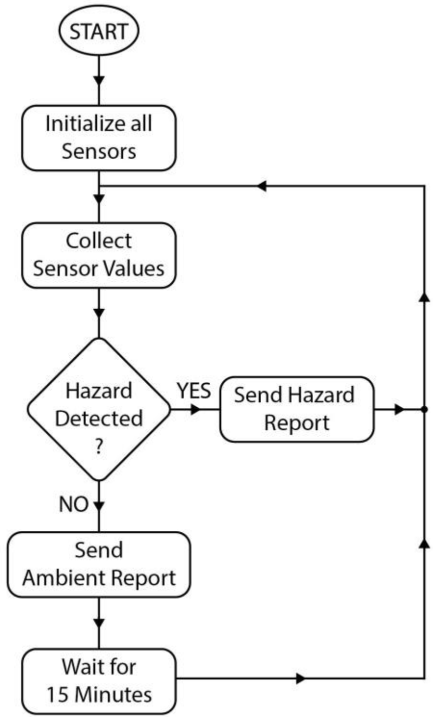

Fig. 3. Working process of the Sensing unit.

C. Main module

The module collects data from the sensing unit coordinates with the server. The board also contains an onboard NodeMCU that enables the unit to upload ambient data to the server. Both the Smart switchboard and the Main module use the Adafruit IO interface and IFTTT interface for data storage and establish communication between Google assistant and Smartphone accordingly. After receiving data from the sensing units, if the module gets any Hazardous Report, it immediately contacts appropriate authorities with necessary information. The device notifies the user via message, or a voice call according to the user's preference. The device also has the option to notify local authorities about the inconvenience to avoid fatality. Here, Fig. 4. represents a block diagram of the Main module working process.

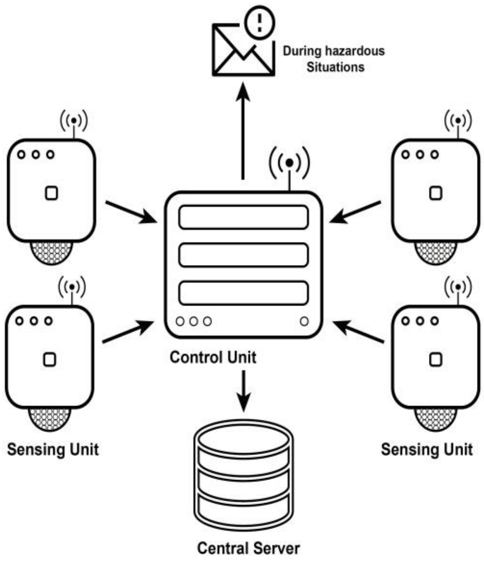

Fig. 4. Block diagram of the Main Module.

III. SYSTEM DESCRIPTION

Now, we shall be giving a small description of the hardware and the user interface of our system as follows,

D. Hardware Description:

The hardware portion of the system can be divided into three parts. The first is the smart switchboard that can be attached to the wall. Each switchboard contains five (5) IR sensors for replicating the functionalities of traditional toggle switches. The board also has two variable switches that can turn on/off the fans while controlling the speed simultaneously by the duration of the touch input is given to the device. The second part of our system consists of an aluminum encloser that houses all the sensors and their interconnected circuits. This unit contains onboard HC-05 modules so that they can communicate with the main module and share ambient as well as hazardous reports. The last part is again an aluminum encloser that houses circuits that contains a NodeMCU for internet connectivity as well as a GSM module for pushing notification in time of distress.Here, Fig. 5. (a) and (b) represents the front and internal circuitry view of the Smart switch board. Then, in Fig. 6.we can see the sensing unit with all of the sensors indicated with notations.

try

(a) (b)

Fig. 6. Sensing Unit

E. User Interface

The user interface allows the user to communicate with the system. To establish seeming less communication between the user and our end device we have taken the help of the Adafruit IO interface to build and customize our system's home page. As per Fig. 7. we can see that the interface has five toggle switches and two fan switches. When the user gives manual input or voice command via personal assistants in Smartphones like Goggle assistant, the switches automatically update. This then is conveyed to the end device for the execution. The user also has the access to toggle switches and also adjust the speed of the fans manually from the homepage. The page also shows the ambient temperature and the humidity percentage of the room at any given time. The temperature and humidity value updates every 15 minutes to conserve power usage.

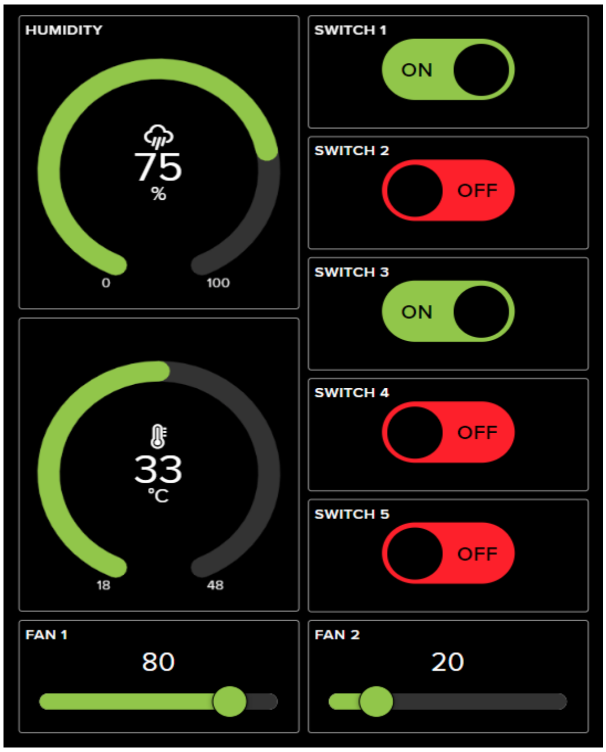

Fig. 7. User Interface

IV. EXPERIMENTAL RESULTS

To ensure the performance of our system, a large amount of data was collected over a long period. These data include the response of the system, accuracy, and dependability. They are as follows,

F. Tempreture sensor accurycy

The performance of the temperature sensor used for our system was determined by comparing the data with the weather forecast for an extensive period. Here we have taken the average weather forecast results for the month of October in Dhaka district. Here all temperature values were recorded on the Celsius scale. The results show that the sensor gave values with an almost constant error rate of less or equal to 1. Therefore, we can conclude that the temperature results that we acquired from the device were quite accurate.

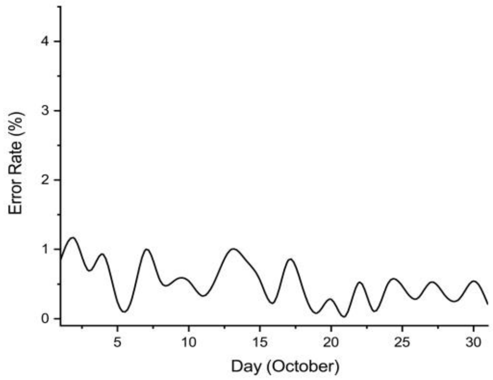

Fig. 8. Temperature error rate for the month of October

G. Humidity sensor accurycy

The data for humidity sensor was also compared the way as the temperature sensor. The same way we have taken the average humidity value for Dhaka district for the month of October. After that we compered the values gathered from the Humidity sensor. From the comparison we find that the error rate of our device is between (1.5-6) percentage. The higher value of error rate is due to the fact that at times the value for the weather forecast is measured in situations where no other circuitries are involved. But for our case the device was in doors which can greatly affect the performance of the device. In spite of the ill situations the device has successfully showed a quite good result.

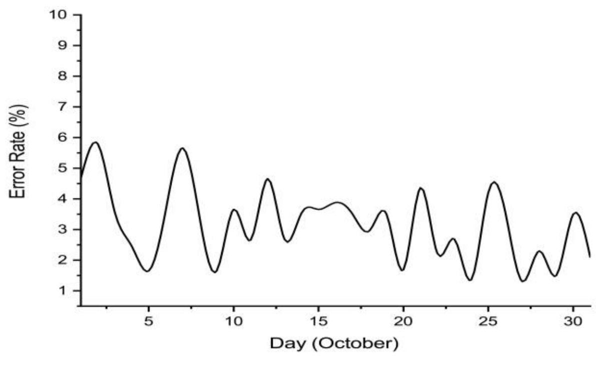

Fig. 9. Humidity error rate for the month of October

H. Response Time of the System

Significant effort is given towards minimizing the reaction time for the device's seamless operation. A balance between minimum delay time while keeping the system from being overloaded was given higher priority. The System Response Timing is described in Table I

Parameters	**Response Time**
Web database to end devices	3.0s
Physical Click to end device	0.1s
Voice command to end device	1.5s
Manual input in homepage to end device	1s

Table 1. System Response Timing

I. Overall performance

TABLE II represents the overall operating and efficiency parameters of our Smart Home automation system. All data was acquired for this study at room temperature and in real-life scenarios.

Parameters	**Response Time**
Temperature measurementaccuracy	99%
Hummidity measurement accuracy	94%
PIR sensor accuracy	99%
Smoke detaction	98%
Fire detection	10%
Voice Command detaction	100%
Touch detection	100%

Table 2. Overall Performance

V. CONCLUTION

Everyone is choosing automation in today's era of digitalization. Smart Home Automation is a breakthrough in living standards that makes a home more convenient, comfortable, and cost-effective. When gadgets are connected to the internet, they may be monitored and controlled from anywhere on the globe. Smart home automation systems may be controlled from any location. The goal of this study was to develop a system that digitalized human life while being efficient and ensuring security. We discussed different aspects and showed the cumulative results of our research. However, Furthermore, while there are several benefits to Home Automation, there are certain security concerns that must be addressed. Machine learning and Artificial Intelligence approaches might be used in the future to improve the efficiency and reliability of these systems.

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