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Designing a Smart Home Automation System Using Internet of Things and Mobile Application

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Abstract – The Internet of Things (IoT) refers to the system, which is a network of interconnected machines, devices and objects that have the ability to transfer data. The Smart Home automation is an example that uses the IoT technology. The IoT Smart Home automation provides the ability for its users to monitor and control devices, irrespective of time or location. These devices can be lighting, home appliances, computers, and sensors. In this paper the smart home system with mobile application designed experimentally. The system is specifically designed for the comfort of the citizens with an objective of achieving user adapted controls and efficiency. The proposed system controls and monitors several home functions via wireless networks (Wi-Fi). With the use of the designed application, the user can control and monitor the home across anywhere from the globe using the Wi-Fi alone.

Index Terms – Internet of Things, Smart Home, Wi-Fi, MyDevice.

1. INTRODUCTION

The Internet of Things (IoT) is a rapidly evolving concept. It revolutionizes and changes the way devices interact with the physical world. The devices can range from smart phones, lamps, doors, elevators, wearable devices, multi-media equipment, security systems, sensors, actuators to the internet where the devices are intelligently linked together. This enables a new form of communication. As per a Gartner's survey, it is estimated that the amount of connected devices will be between 26 and 64 billion by 2020.

The IoT is an extensive network of linking "objects", that in relation to things-things, people-people, and people-things [1]. The IoT can be an innovative concept for smart homes system. This system is developed to allow comfort, security, intelligence and quality of life improvement. It plays a significant role in smart homes [8, 21].

In this paper, a smart home controlled based on Wi-Fi through mobile application is detailed, that enables the user to control the home using internet irrespective of the location he resides in.

1.1. Smart Home Automation Techniques

There are several functions at houses such as opening/closing of doors and windows, turn-on and turn-off of the electrical devices like lights, air conditioner, refrigerator and so on, that is generally handled manually. This poses the user to be present at the location and operate with the switch or with the remote, which is not convenient. In addition, guarding houses, emergency alerts and control the things around could be an issue. These problems can be resolved by the IoT system that can be deployed as smart homes and through the remote wireless technology. This research application will offer powerful features for monitoring and control of home appliances. When designing a smart home system, a number of factors should be considered. The following main functions are required for smart home system applications [3, 2]:

1.1.1. Alert

The smart home system is capable of detecting and sending warnings to the user. The alert information may include level of gasses/smokes, humidity, temperature etc. alert could be sent to the user over cell phone, as a SMS message, or through email, Wi-Fi as text message.

1.1.2. Monitor

A smart home system is able to monitor its surroundings with the help of different sensors and cameras. Monitoring refers to keeping track of every movement or activity in the home which involves any action or decision that needs to be made. For example, monitoring level of gas/smoke/fire and sending alert to user to take a decision if the level of gas /smoke/fire is above the permitted or pre-decided threshold [15].

1.1.3. Control

The IoT allows user to control and monitor all linked objects in a home regardless of time and location [9]. The user can control various activities with this function such as air conditioners, lights and appliances can be switched on / off and open / close doors and windows locally or remotely from any location by using an easy-to-use mobile application [18].

1.1.4. Intelligence

Home intelligence (HI) refers to intelligent, home-based behavior. Intelligence automatically determines how different events occur depends on the artificial intelligence (AI) mechanism built in the smart home environment. HI is not just giving a brain to intelligent home but is an important feature for the home security [7, 19, 20].

In this paper we will design system experimentally, integrate the designed system with mobile application for smart home and use wireless sensors network to monitor the house.

2. RELATED WORK

Over the past few years, intelligent home systems and cloud computing have been popular. This is merely, because of the ease, scalability and functionality that they offer. Most smart home systems are controlled by smartphones and micro-controllers. Could computing provides scalable computing power, storage space and applications for developing, maintaining, running home services, and accessing home devices anywhere at any time. C Stergioua et al, combine cloud computing and IoT to show how the cloud computing technology enhances the functionality of IoT [16]. Md. Wasif Islam develops a voice-controlled home automation system that controlling all electronic devices of an apartment to be controlled by speech commands, provides fire and movement suspicious detection and also helps the owner personally. It also provides security using an automatic door controlled with fingerprint sensor [5]. Md. Salman Rifat & M. N. Fahad control and operate home appliances online in real-time in various modes from any remote location. It focuses on operating and controlling home appliances in the desired modes [6]. J Mao et al, developed machine learning algorithms in the smart home ecosystem that enhanced security [13]. M Al-Kuwari et al, focuses on embedded IoT to remotely execute commands of home applications in a smart home by using analyzed data [14]. F Saeed et al, proposes using sensors to sense and provide in real-time, fire detection with high accuracy [15]. M Elkhodr et al, propose an IoT-MP management platform with some important management functions, including those needed to monitor, control, and communicate things in smart home [17]. In our research we propose to design a smart home application which controls and operates home appliances remotely. It focuses on operating and controlling home appliances in the desired modes. In addition, it provides security using an automatic door controlled by smartphones.

3. PORPOSED MODELLING

As seen in Figure 1, the user uses an android-based device to monitor modes and appliances. Through our application, named Smart Home Application (SHA), the users command is sent via internet from the device; then Wi-Fi ESP8266 gets the instructions from the internet and transfers it to the Arduino mega 2560 controller board which executing the operations. Android Phone (SHA) acts as a client and data are transmitted via Wi-Fi network and then Arduino runs the appliances according to user desired command.

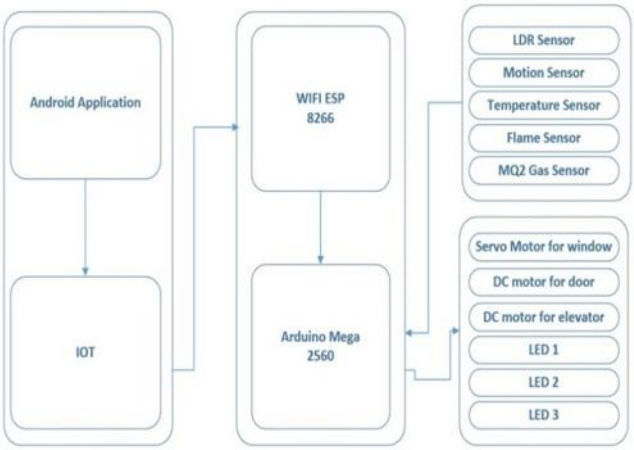

Figure 1 Proposed System Architecture

4. RESULTS AND DISCUSSIONS

This section discusses the designing of the experimental part and the application mobile, also their result as appear in the Figures below.

4.1. The Experimental Work

In this section we will describe the experimental works and evaluate the collected results. In this experimental as its shown in Figure 2, we use the following components; esp32, Arduino IDE, breadboard, transistors, sensors, lights, motors, buzzer and wires and each have special functions. All sensors, motors and lights are connected to the microcontroller via the wire. The wire is connected to the pin in the microcontroller and each sensor has a special pin. The sensors are connected by analog pin and the motors connected by digital pin. The microcontroller is connected via Wi-Fi to the broker and is controlled by mobile or computer via Message Queue Telemetry Transport (MQTT) Protocol.

The heat sensor (LM35), senses the temperature of the air through the microcontroller, and sends the value of the sensor reading to the temperature measurement unit “C°". The heat sensor is connected through ground wire and the analog wire is connected to the microcontroller, then gives the appropriate code via the Arduino platform, and the application is connected via channel "0". If the temperature is greater than (45°) will send a message to the mobile and give an alarm at the buzzer.

The flame sensor detects the fire or other sources of light that are within the wavelength range from 760 nm to 1100 nm. This is a sensing through the infrared signal. When the flame is detected, the unit will turn on the red light. The flame sensor which is connected via ground wire and analog wire is connected to the microcontroller, and then gives the appropriate code via the Arduino platform. The application is connected via Channel 1, which senses the sensitivity of flame,

if the value greater than 500 nm, it gives an alarm by the buzzer and gives notification to the mobile.

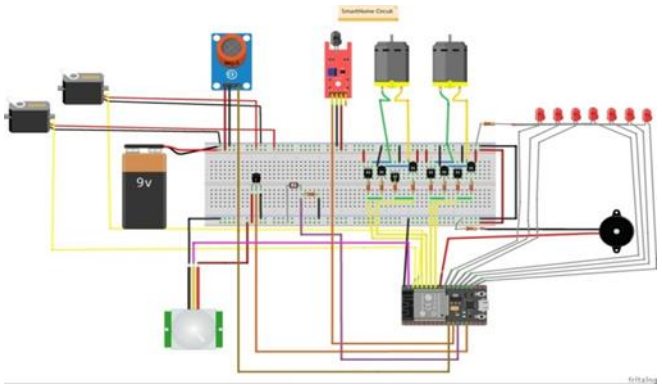

Figure 2 SHA Experimental Circuit

Gas sensor detects the flammable gases and smoke. The sensor resistance is varied according to the type of gas and sends a voltage value to the microcontroller which is proportional to the concentration of smoke / gas This implies that there are more installation. The gas is reduced as the concentration of the gas decreases and the output voltage decreases. The gas sensor switch is connected via ground wire and analog wire is connected to the microcontroller. We then give the appropriate code via the Arduino platform. The application is connected via Channel 2, which senses the sensitivity of gas if the value greater than 500 ppm, it gives an alarm by the buzzer and sends a notification to the mobile.

Motion sensor senses the infrared radiation when a warm body passes in front of the sensor such as human or animal, which leads to positive differential change. When the warm body leaves the sensor area, the sensor generates a negative differential change, this pulse of change is sent to the precise microcontroller. The Motion sensor connected via ground wire and analog wire is connected to the microcontroller, and then gives the appropriate code via the Arduino platform. The application is connected via Channel 3, which senses the sensitivity of Motion if the value greater than 500 C°, it gives an alarm by the buzzer and gives notification to the mobile.

A light sensor is a component that contains "LDR resistance" which changes with the intensity of light falling on it. The resistance contains the following: Daylight = 5kΩ, Night Light = 200 kΩ by this we can make a condition in the exact controller, if the sent value is = 5 kΩ, the microcontroller turns off the lights; if the sent value is more than 5kΩ the microcontroller turns on the lights. The light sensor connected via ground wire and analog wire which is connected to the microcontroller and then gives the appropriate code via the Arduino platform.

The DC motors start at a speed of (0-255 RPM), this motors used in closing and opening the elevators and windows by specific speed condition in the microcontroller. The DC motors connected via ground wire and digital wire is connected to the microcontroller and then gives the appropriate code via the Arduino platform.

Buzzer is a warning bell in case of gas leak, fire, feeling of foreign body or high degree of heat, and is linked to microcontroller. The buzzer is connected via ground wire and digital wire which is connected to the microcontroller, then gives the appropriate code via the Arduino platform which connect it with the appropriate sensors.

4.2. Application Design

MyDevices is an IoT technology company that offers IoT development services and enables developers to design, build prototypes and develop IoT applications quickly, to make the connected world simpler, MyDevices offers an attractive feature called Cayenne, a drag and drop IoT project builder [10]. Figure 3, displays the Web App Interface.

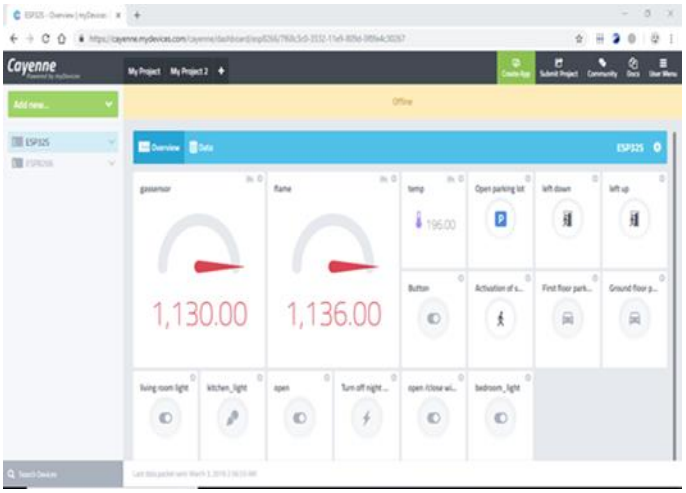

Figure 3 Web App Interface

Cayenne allows IoT applications to be rapidly and easily built and deployed in a wide variety of vertical structures for designers, developers, network operators and system integrators. Cayenne has the ability to integrate any device into the library with the MQTT API and a wide variety of IoT-enabled ready-to-use devices and connectivity options. All Cayenne devices have interoperability features, including rules engine, asset tracking, remote monitoring and control, and real-time and historical data visualization techniques. Figure 4, shown the ready-to-use devices and connectivity options for Mobile App Interface.

In addition to technical services and support, myDevices also provides the tools SDKs and APIs for businesses that want Cayenne's innovative technologies for the development of personalized IoT products and applications. Cayenne ' myDevices ' is becoming the industry standard for the design and distribution of completed IoT solutions [12].

Figure 5, displays the operation of some devices such as flame and gas-sensor in the Mobile App Interface.

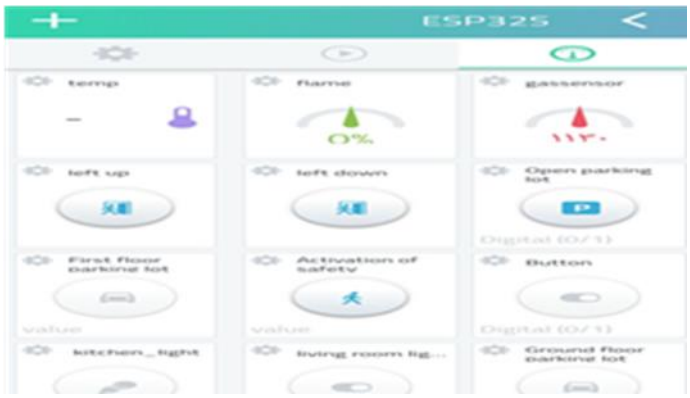

Figure 4 Mobile Appl interface

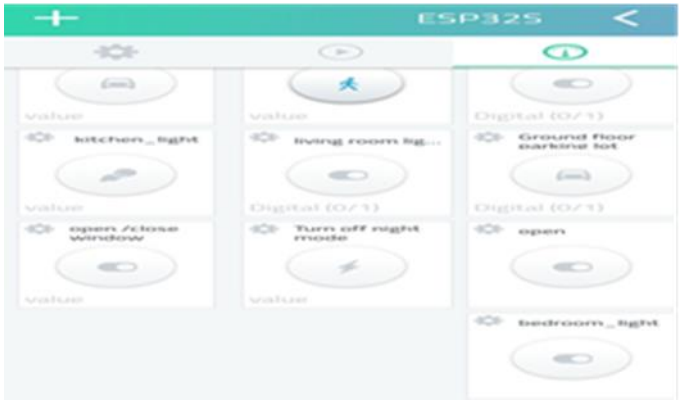

Figure 5 Mobile App Interface

In our work, we used the platform (myDevices) to show the values sent from sensors like heats, flame sensors, light and gas/smoke. As well as a set of buttons through which we control the lights and open and close the doors, windows and elevators within the experimental body of the house and every meter or button sends /receives values or signals through private channels for each one. As the connective medium is the Internet, it is imperative that the user should be connected to the Internet to be able to access the devices. The design of home is shown in Figure 6.

Figure 6 Smart Home Design

This part is very important for house automation project, because we need a place that we can apply the application on it. We add mechanical components to the house as needed for the project. Without this part no way to complete the house automation project in a real life.

5. CONCLUSION

IoT is an important system connecting people, devices, and things. Smart Home system presented in this paper consists of devices and sensors that connected to the internet via wireless network (Wi-Fi). The aim of this system is to play several functions of home automatically and intelligently to improve the quality of living as well as enable and enhance the security and safety. The Smart Home Application (SHA) in this research is a user friendly concept that meets the user requirements. Our system introduces the Internet of things in the electrical elements of the house by controlling the lighting, windows, doors and elevators, as well as adding sensors for heat, smokes and alarm in the event of fires. These features of home can controlled through the internet (Wi-Fi) anywhere in the world from any device which we can access the internet whether a mobile device, tablet, computer or laptop. The system consists of sensors, motors and lights, which are connected to the microcontroller. The microcontroller is connected via Wi-Fi to the broker and is controlled by mobile or computer via MQTT protocol. MyDevices platform used as the mobile application in this work. It can display the value sent by the sensors such as flame sensor, gas, light and temperature. As well as using a set of buttons which control the lights and open and close the doors, windows and from anywhere in the world via internet. So, the designed system with its application successfully works.

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