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Smart n Secure Home Using IOT

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ABSTRACT

As the rise of internet increases day by day in this digital era, automation of the physical appliances has become necessary and the network of these appliances and their interconnectivity to exchange data is known as IOT (Internet of Things). The collaboration of IOT with the home automation enables the end user to interact with the physical devices connected to the internet flawlessly from any corner of the world. The alliance of home automation and IoT will increase security as it is the most concerning issue in current time, comfort of end-user predominantly physically challenged end user and remote control of home functions. Smart n Secure Home based on IOT involves automation and regulation of lightings, AC's, heating devices and other physical devices. It also incorporates features such as Motion Sensor based lighting which will increase energy efficiency; Security by detection of an intruder, gas leakage and automation of door locking system via RFID card. The most attractive feature that is checking for soil and moisture accordingly control and automate the water flow, which will increase the peace of mind of an end user. Internet (IOT) is the medium through which control of those features and receiving updates is obtained via an online dashboard and an android application thus introducing Gerontechnology in our project.

Keywords: IOT, Internet of Things, RFID card, Motion Sensor, Security, Home automation, online dashboard, Android application, Gerontechnology.

I. INTRODUCTION

Home automation also named as domotics [1] can be defined as automating or controlling the physical devices such as lightings, AC is, heating system, in other words, appliances and receiving the analog signals from the Sensors, which increases the security and reads the environment through various factors. The collective result is called as Smart Home or Smart House. In-Home automation Sensors are connected to the microcontroller such as Atmel ATmega169, Motorola MC68HC11, PIC24 microcontroller, Intel MCS-296, etc. which receives the analog and converts Analog signal into Digital signal. These signals are received for Remote Monitoring and controlled via Bluetooth, Wi-Fi (based on IEEE Standards), or Internet which is called as Internet Of Things (IoT).Bluetooth uses the technology of UHF radio waves with a frequency of 2.4 to 2.485 GHz while as Wi-Fi uses the technology of wireless communication based on radio waves with 5 different frequency range of 2.4 GHz, 3.6 GHz, 4.9 GHz, 5 GHz, and 5.9 GHz bands [2]. This concludes that wireless communication has longer ranges than Bluetooth technology. In approximation, Wi-Fi has a range of 32 meters or 105 feet depending on the antenna used, while Bluetooth has a range of 100 meters or 328 feet.

The term IOT was coined by Kevin Ashton in a presentation to Proctor & Gamble in 1999[3]. IOT is the network of physical objects such as automobiles, lightings, sensors, etc of the world each of which subsists of IP address in order to interchange information between different devices depending on the type of connection. The interchanged information consists of remote monitoring and controlling. "Things," in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, cameras streaming live feeds of wild animals in coastal waters,[4] automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring,[5] or field operation devices that assist fire-fighters in search and rescue operations.[6] Legal scholars suggest regarding "things" as an "inextricable mixture of hardware, software, data and service"[7].

In conclusion, Home Automation or Smart Home based on IoT is the technique of Remote Monitoring and controlling physical devices such as lighting, Fan, sensors, Heating devices, etc. by assigning each device with a unique IP address using online dashboards and mobile applications.

II. PRIOR WORK

Home Automation is an old concept which was implemented in 1975, under the idea of reducing manpower. Home automation subsist of microcontrollers or microprocessors like Arduino or Raspberry pi, sensors on the basis of which the physical appliances are controlled and security is increased which decreases the burden of an individual with satisfaction and tranquillity. Legion of work has been done on home automation since its introduction that also incorporates Gerontechnology which combines Gerontology and technology making the lives of senior citizen easier [8]. The control in home automation is obtained through a wired interfacing consisting of LAN, WAN or wireless interfacing consisting of Bluetooth, Wireless technology. But in recent years of development, IoT was introduced in home automation enabling the users to control and monitor their homes from anywhere. Because of the invention of new sensors which introduces innovative technologies, the automation possibilities and aspects have increased. Take an example of water storage units in homes which can be filled without any interference of an individual by sensing the water level of the storage units or automatic switching of devices. In recent years voice controlled systems were developed hence enabling users to activate or deactivate physical devices through voice commands. Cameras were introduced, which not only captured and stored the video for the security purpose but a live feed can be obtained on a Smartphone or any other internet enabled devices like Tablets, Laptops etc. The home automation has reduced power consumption, increasing energy efficiency which is the major issue in today's world thus solving a dominant problem.

III. PROPOSED SYSTEM

The objective of our proposed system is Remote control of physical devices, which include lighting devices, heating devices, water sprinkler, gas valve and other devices of high voltage; Remote Monitoring of humidity and temperature, Soil moisture and Security such as detection of an intruder or gas leakage and smoke detection through Online Dashboard and an android application. Arduino is an open-source electronics that can be programmed. There are different Arduino boards but the one in our proposed system is Arduino Mega. Arduino Mega is a microcontroller board based on ATmega2560 [9], which are connected to 4 sensors:

1) *PIR Motion Sensor.*
2) *Gas and Smoke Sensor.*
3) *Humidity and Temperature Sensor.*
4) *Soil Moisture Sensor*

The data received and transmitted by an Android application and Online Dashboard, used for the monitoring and remote controlling the devices, which include:

1) *Monitoring of home temperature and humidity based Humidity and Temperature Sensor data.*
2) *Motion detection of an intruder based on PIR Motion sensor.*
3) *Switching on and off lighting device.*
4) *Controlling water sprinklers based on Soil moisture sensor data.*

5) *Switching on and off gas valve based on Smoke/Gas Detector sensor data.*
6) *Controlling other electrical appliance with high voltage.*

IV. HARDWARE MODEL

The Circuit Diagram explains the connection and flow of signals between different components much clearly:

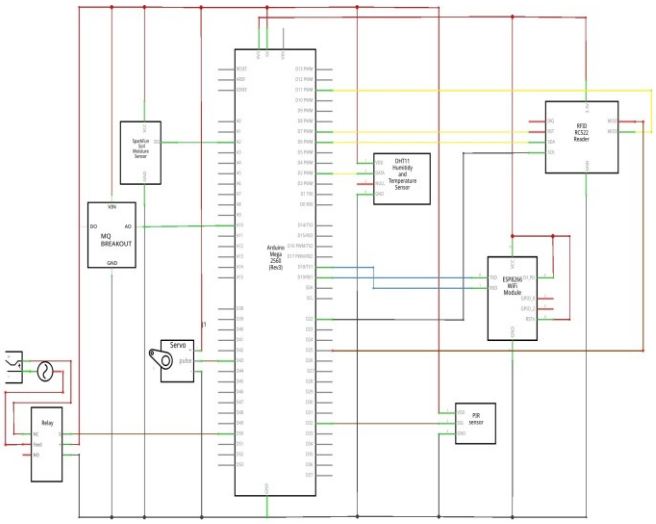

Figure 1. Circuit Diagram of Smart n Secure Home Based On IoT

The Hardware components, their working, explanation and collaboration with each other concerning to the formation of proposed system are covered in the following division:

A. Arduino Mega

Arduino Mega is a microcontroller based on Atmega2560 consisting of 54 digital input/ output, 16 analog inputs, 4 UARTs, 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button[6]. Arduino is programmed by connecting to a computer through USB connection and using Arduino IDE for programming Arduino which uses C/C++ programming language. In our system design, some of the pins in 16 analog inputs are used to connect to the sensors. According to the programming applied to the Arduino, the microcontroller will convert the signals from sensors and Remote controls the physical devices via ESP8266 which enables IOT feature in the Arduino. The digital pin of Arduino mega connected to relay module and servo motors.

B. Relay Module

A relay is an electrically regulated switch which is used to control high voltage appliances. The Relay module that we are using has a power consumption of 5v which provides a benefit of connecting to the voltage pin of Arduino board, thus eliminating the need for an external power source. Relay Module has 3 connections:

1) *COM*: common pin
2) *NO (Normally Open):* there is no contact between the common pin and the normally open pin. So, when you trigger the relay, it connects to the COM pin and supply is provided to a load
3) *NC (Normally Closed):* there is contact between the common pin and the normally closed pin. There is always a connection between the COM and NC pins, even when the relay is turned off. When you trigger the relay, the circuit is opened and there is no supply provided to a load.[10]

The relay module receives its programme signals from the Digital pin of Arduino.

C. ESP8266-WiFi Module

ESP8266 is a microchip (SOC) which is used to connect the Arduino Mega with internet thus enabling IOT. This System-on-chip (SOC) is responsible for assigning the devices connected to Arduino with a unique IP address which makes it possible to control them remotely via the internet. It supports full TCP/IP stack. The RX and TX pins of ESP8266 are connected to the TX and RX pins of Arduino respectively and the power consumption of ESP8266 is 3.3v.

D. Servo Motor

Servos have integrated gears and a shaft that can be precisely controlled. Standard servos allow the shaft to be positioned at various angles, usually between 0 and 180 degrees. Continuous rotation servos allow

the rotation of the shaft to be set to various speeds [11]. The Servo is controlled by connecting to the digital pin of Arduino. In system model, the Servo is meant for switching the Gas valve and sprinklers on and off based on the readings provided by Gas/Smoke sensors and Soil moisture sensor, respectively.

E. RFID

RFID stands for Radio Frequency Identification. In this scenario, the RFID is used for automated door lock mechanism. An RFID system consists of two main components, a transponder or a tag which is located on the object that we want to be identified, and a transceiver or a reader. The RFID reader consists of a radio frequency module, a control unit and an antenna coil which generates the high-frequency electromagnetic field. On the other hand, the tag is usually a passive component, which consists of just an antenna and an electronic microchip, so when it gets near the electromagnetic field of the transceiver, due to induction, a voltage is generated in its antenna coil and this voltage serves as power for the microchip. Now as the tag is powered it can extract the transmitted message from the reader, and for sending a message back to the reader, it uses a technique called load manipulation. Switching on and off a load at the antenna of the tag will affect the power consumption of the reader's antenna which can be measured as voltage drop. This change in the voltage will be captured as ones and zeros and that is the way the data is transferred from the tag to the reader [12]. The RFID module is connected to the digital pins of the Arduino, which detects the correct tag based on transferred data and unlocks the electromagnetic lock.

F. Sensors

Various Sensors included in this project with a brief description are:

1) PIR Motion Sensor

PIR stands for Pyroelectric Infrared Sensor and its functioning depends upon the levels of infrared radiation it detects. In this project, PIR Motion Sensor when switched on for engaging detects the presence of any intruder and notifies the end user as elucidated earlier through the internet. PIR uses Fresnel lens concerning the change of range and sensing pattern of the sensor. Thus, augmenting the security.

2) Smoke/Gas Detection Sensor (MQ-2)

This Sensor in addition to smoke espies gas such as LPG, Butane, Methane, and Alcohol. Its voltage consumption is 5v and is linked to the analog pin of Arduino in order to receive the signal and operate according to the programmed Arduino in such a way that the end user is warned if there is the presence of gas or smoke so that gas valve is shut off.

3) Temperature and Humidity Sensor (DHT11)

It is also known as Hygrometer and senses both temperature level as well as humidity level in the surrounding air. DHT11 temperature range is from 0 to 50 degrees Celsius with +-2 degrees accuracy. Also, the DHT22 sensor has better humidity measuring range, from 0 to 100% with 2-5% accuracy, while the DHT11 humidity range is from 20 to 80% with 5% accuracy [13]. One of the benefits of this sensor is that it has a digital output as a result of which it ought to be connected with the digital pin of the Arduino. Hence, the end user can examine the current temperature and humidity from anywhere as a result of internet connectivity.

4) Soil Moisture Sensor

This sensor detects the content of water in the soil and an end user can examine the moisture present in the soil accordingly the automated sprinklers is switched on and off. In addition to continuous examining of soil moisture through the online dashboard and Android application, the end user can receive an alert informing the moisture reduction of soil, which is set up to a certain threshold. Soil Moisture Sensor is connected to the analog pin of the Arduino and its power consumption is 5v. It works on resistance or amount of flow of current, as it

consists of 2 conductive probes, which allow the current to pass through the soil because of which a resistance value is acquired to measure the moisture value. It culminates, high resistance means less moisture value and low resistance results in high moisture value.

V. SOFTWARE MODEL

Software model subsists of end-user product which is the software, its development, and elements used in its development. The end user product is the software that is used for Remote Monitoring and Remote Control of sensors and devices or physical appliances, respectively.

A. Cloud Connection

The cloud-based network connection enables storage, maintenance, security, hassle-free accessibility of the data. Its data is organized automatically, thus reducing the burden because of the cloud-computing feature. The data in our system model that is uploaded to the cloud and downloaded from the cloud are as follows:

1) *Sensor Data:* The four sensors that are used in our project yields data processed by Arduino that is uploaded to the cloud through a gateway by using ESP8266 which connects the Arduino to the internet.These 4 sensors are:
   - PIR Motion Sensor.
   - Smoke/Gas Detection Sensor.
   - Temperature and Humidity Sensor.
   - Soil Moisture Sensor

   The data collected from those Sensors uploaded to the cloud is downloaded by the android application, which is also connected to the cloud.

2) *Android Application Data:* The android application is connected to the cloud and it uploads the data which remotely controls devices connected to the Arduino Mega. Those devices are:
   - Servo Motors.
   - Physical Appliances working on high voltage.
   - Sprinklers.

   The data is downloaded from the cloud through internet which is provided bY ESP8266, instantly.

B. Android Application

Android Application is developed by employing Android Studio IDE. The application should be connected to the same cloud as the hardware is connected to. The application has an extension of .apk and has a bunch of buttons and visuals. The buttons are meant for Remote Controlling the physical devices while as visuals are meant for Remote Monitoring of data sensed by the 4 sensors present in the system model.

Android Application, when launched will consist a login screen in order to provide security. This process will avoid any other person to operate our automated home system and legitimate users will be registered. Subsequently, four visual remote monitors are present which keeps on synchronizing in real time. One will monitor Temperature and humidity, second will monitor amount of Gas/Smoke in the surrounding environment and alert the user if there is presence of gas/smoke above the threshold, third will monitor soil moisture of garden accordingly end user will be notified if there is compulsion to water the garden and the last but not least, if there is any movement detection.

The bunch of buttons present in application, will act as switch for high voltage (220v) devices (such as lighting, Ac's, heating devices, etc), servo motors for the sake of gas connections when an alert is received, sprinklers when moisture of garden is below a specific level and an extensive button to turn PIR motion sensor on and off.

C. Online Dashboard

There should be an additional Remote control and monitoring service other than an Android application. For that purpose, an Online Dashboard will be present in our system, which has same

functions as that of Android Application, but the difference is that of the platform. The Online Dashboard will work on any Browser (such as Chrome, Internet Explorer, etc) based on PHP which is a scripting language. The Online dashboard will use HTTPS, which stands for Hyper Text Transfer Protocol with Secure Socket Layer enabling the encryption and decryption of data while transference of data to and fro, respectively[14].

VI. CONCLUSION

This paper demonstrates the collaboration of IOT with home automation, which provides the facility of obtaining the real-time data regarding Humidity and Temperature, Soil moisture, Gas/smoke, movement detection accordingly appliances are controlled remotely. An Android application and an online dashboard attain this ability, which are secured by providing access control. The access control is provided by user login, which is implemented at the start of the opening of the Android application and online dashboard. An administrator of the system does the registering of the legitimate user. Our system consists of cloud-connected to the Android application, online dashboard, and the hardware via ESP8266 or ESP-01(Consists of 1 MiB of built-in flash, allowing for single-chip devices capable of connecting to Wi-Fi [15]) for the management, security, storage and real-time availability of data availability of data. The User Interface of application is user-friendly which provides an abstraction of the complexity of the system.

The augmentation of the system is provided by RFID door lock system which enables door unlocking by tags which improve safety mechanism. There is also the inclusion of smart garden in smart n secure home by the introduction of soil moisture sensor which measures the moisture and informs the user so that the sprinklers are made to work. This is known as Smart Garden. Our system defends from fire thanks to the Gas/smoke sensor which measures the concentration of gas/smoke in our surrounding and cautions the user so that specific measures are taken such as closing off the gas connection. The overall system introduces Gerontechnology helping aged people via user-friendly interface of our android application and automation of devices. Conferences are held each year for the implementation of Gerontechnology considering the health and maneuverability, which upsurges the independence of aged individuals. Thus, elderly people can control and monitor home without moving around maintaining their health.

VII. FUTURE SCOPE

The Home Automation based on IOT can be annexed in future by introducing extra sensors concerning greater security and automation. Addition of HD camera will increase security and which will provide 24-hour surveillance from anywhere. Water level sensor module and vibration sensor module can be combined to the system which provides water level measurement and seismic alerts, respectively. Also, voice control can be added resulting in management of physical devices using specific voice commands. In this fashion, there are vast areas where home automation based on IOT can be extended.

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