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Enhanced Smart Home Automation System based on Internet of Things

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***Abstract*—The Internet of Things (IoT) connects users with interconnection of things to facilitate the life. IoT is now shifted towards 'Thing to Thing'. Smart home concept brings comfort and convenience in our lives with the aid of IoT. Major issues in current smart home scenario are automation and security. Problem in security arises due to network of devices in the home with internet. Focus is sifted towards providing confidentiality, authenticity, and integrity of data sensed and exchanged by smart home objects. Computation overhead is also a concern for smart home solutions. Comfort and user requirements as per scenario or situation are basic need for automation. Automation with learning human behavior is also a major concern with smart home concept. Paper represents IoT based smart home automation approach which is secure and also reduces computation overhead.**

Keywords—Smart Home, IOT, Automation System, IOT Security, Learning

I. INTRODUCTION

Kevin Ashton [1] coined Internet of Things (IoT) in 1998. The IoT "allows people and things to be connected Anytime, Anyplace, with Anything and Anyone, ideally using any network and any service" [2]. 50 to 100 billion devices will be connected to the Internet by 2020 in different means [3]. This requires automatic management and adaptation of these devices. Now a day's devices are equipped with various sensors as per application requirements. Sensors are communicating with each other using various topologies in IoT [4]. Data travels locally or remotely from or in by each sensor node. As per application and requirements, sensor nodes may be of same type or different type. For a smart home, it is essential to combine sensor network with internet and intelligent real life objects. Integration of these sensors, smart objects, devices and network is IoT.

Existing smart home solutions uses various encryption techniques for providing security like AES, ECDH, hybrid etc. Some solutions uses intermediate gateway for connecting various sensor devices. Survey concludes that these systems increases overhead of computation. Proposed system has develop a model to reduce this computation overhead. Proposed model has also provided a method for automation with sensor based learning. System uses temperature sensor for development but other sensors can also be used as per requirement. These smart home devices with sensors can configure themselves autonomously and can operate without human intervention [5].

II. IOT ARCHITECTURE

Figure 1 shows the architecture of IoT [5].

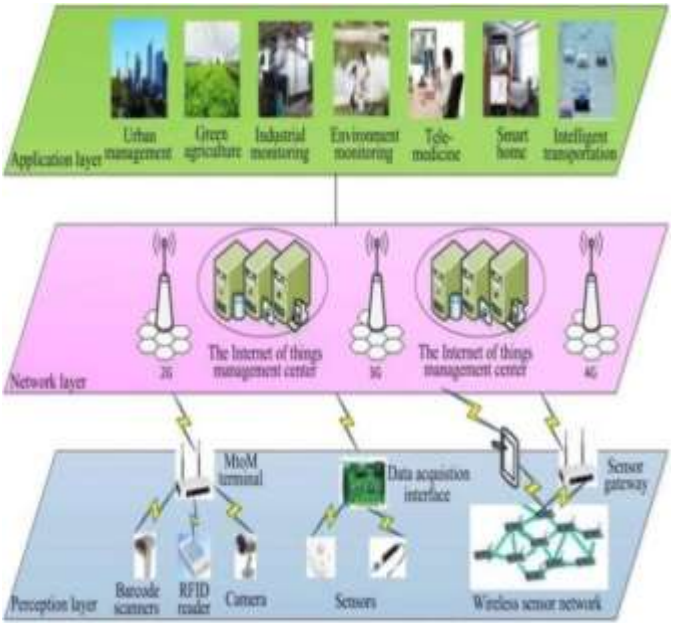

Fig. 1. Architecture of IOT[5]

Industrial applications and different scenarios requires different IoT platforms and devices [7]. Normally IoT architecture and has the following features [8]: 1) Hardware and software interface that includes various protocols and devices 2) user requirement fulfillment with operative IoT applications and 3) extensible and scalable.

Naser et al [6] provides a three level IoT architecture that is extensible. It contains sensing layer, network layer, and application layer. This layered architecture model is shown in Fig. 2.

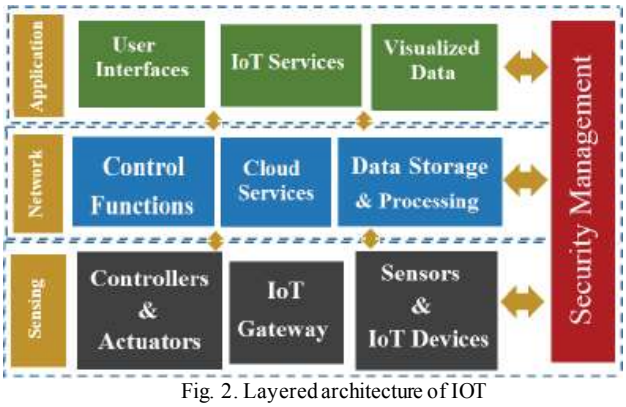

Fig. 2. Layered architecture of IOT

IoT gateway is an intermediate to connect various sensors, IoT devices, controller and actuators. Controller modules, common interface modules, and communication modules are main parts of gateway modules. It allows communication among IoT enabled devices. Network layer consist of controlling functions, data storage and processing, and cloud services. User interfaces, IoT services, and the data visualizations are main functions of application layer. The user interfaces is a medium for communication between system and user. It uses various open APIs to facilitate the development of IoT applications.

III. SMART HOMES METHODOLOGIES

Smart home automation is now a very important characteristic of IoT application. It reduces human efforts and increases comfort and convenience. Wireless technologies play an important role in automation system. Web of Things (WoT), Industrial Internet of Things (IIoT), Internet of Everything (IoE) defines IoT as "devices that are connecting to the internet, integrating greater compute capabilities, and using data analytics to extract valuable information" [9].

In building automation system (BAS) buildings can be equipped with IoT enabled device [6]. Older homes can be made smart with minimum investments. Nowadays most smart homes are equipped with technologies like LTE, 4G, 5G, or Wi-Fi [10]. The concept of a smart home is illustrated in Fig. below.

Fig. 3. Smart homes elements

Methodologies for making smart homes are categorized as below:

A. Bluetooth Based

Smartphone, Arduino board and Bluetooth technology based automation systems are secured and of low cost [11]. Main components of such system consist of the Arduino BT board and a cell phone. Bluetooth technology is used to communicate between Arduino BT board and cell. The Arduino BT board has a range of 10 to 100 meters, 3 Mbps data rate and 2.4 GHz bandwidth. Relay is used to connect devices with the board. It can be utilized by only authorized user. It can be used for easily converting existing home to smart home. Limited range and control are its limitations..

B. Voice Recognition Based

S Sen et al [12] has developed a system which consists of Arduino UNO and smartphone. Bluetooth has been used for communication between the smartphone and the Arduino UNO. Android OS based application has used for automation. Android based voice commands converts the user voice command into text, then it transmit that message to Bluetooth module HC-05 which is connected with Arduino UNO. This system reduces effort to manage smart home. You can add or delete new devices in the system. Its work efficiency is less due to existence of noise in the environment.

C. Zigbee Based

ZigBee based wireless home automation system [13]has been developed with three main modules: microphone module, central controller and appliance controller. Microsoft speech API is used as a voice recognition application, wireless network is established using RF ZigBee modules due to their low power and cost efficiency. Voice commands were tested and system have 79.8% recognition rate. Accuracy has been also effected by noise.

D. IOT Based

Rajeev Piyare [14] has develop an IoT enabled automation system. It consist of micro web server, controlling devices, smartphone and a software application. Home environment, home gateway and remote environment are main components of the system. Fig. 4 illustrates the architecture of this system

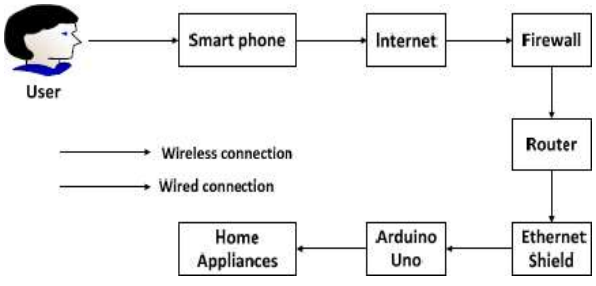

Fig. 4. IOT based smart homes

Wi-Fi, 3G or 4G supported android application has been developed for controlling the environment. Home gateway provides translation service between internet router and

Arduino ethernet server. Various sensors such as current, humanity and temperature sensors are used.

Arvandy and Yoanes Bandung [15] developed a secure IoT smart home system. It has challenges such as battery life, computational power, and storage. Researchers have proposed a security mechanism for the sensing layer using hybrid cryptosystem. Proposed system is vulnerable to MITM attack, Proposed IoT platform is shown below:

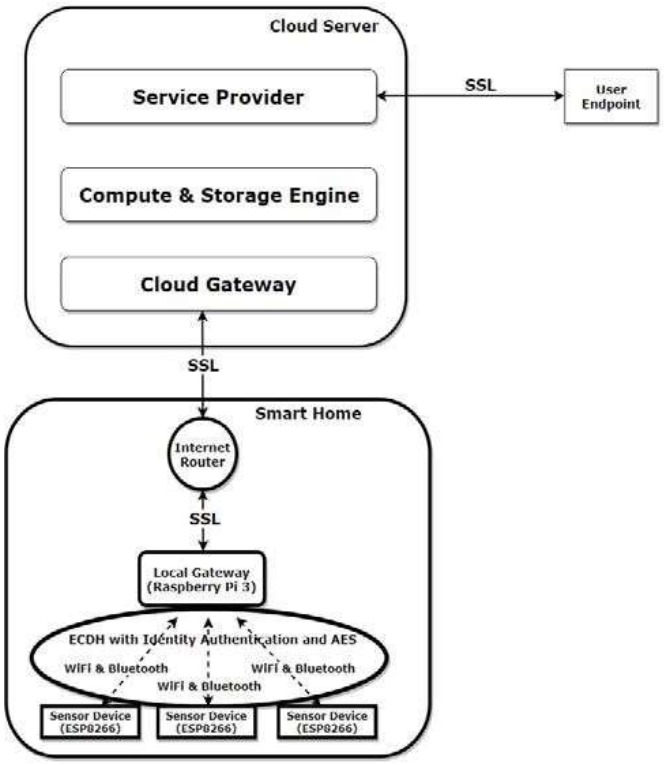

Fig. 5. IOT based smart homes [15]

IV Proposed Work

In existing system[15], sensing layer security mechanism has been proposed by using hybrid cryptosystem. Their cryptosystem reduces the computational power that required for securing the data. Key size and storage requirements are major concern with existing solutions. There are various limitations with cryptosystem like use of hardware for encryption, slow processing, increasing costs etc. In place of encryption authentication may be a solution for secure system. It also manages integrity. An example of such an application is the room inside the house for some needs, importance of editing value of temperature is low rather than by authenticated person.

In the proposed work we will minimize the encryption and decryption burden and we will focus on authentication and automation of smart home devices with learning. Figure below represents proposed smart home automation solution. In the proposed system we bypass local gateway mentioned in existing system to provide better security for smart home devices and sensor data and save computation overhead.

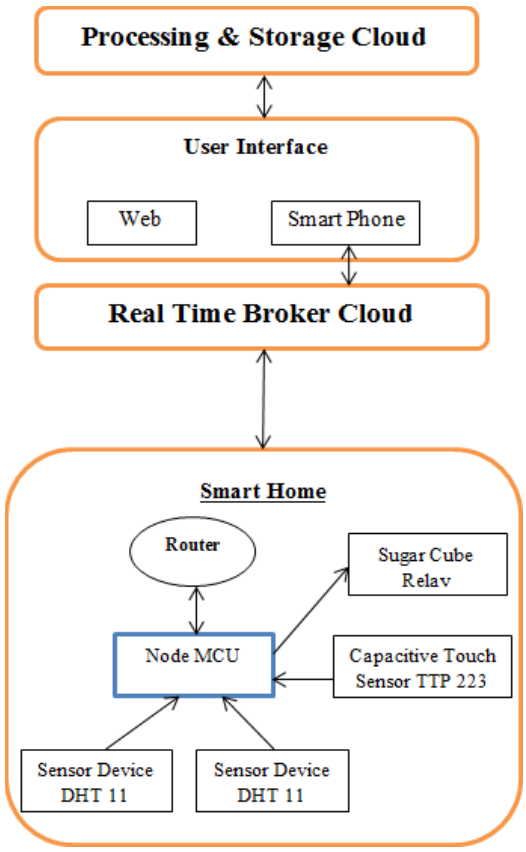

Fig. 6. Proposed IOT based smart home

In above figure real time broker cloud is directly connected with smart home and manages all incoming and outgoing request between users and devices. The main purpose to use real time broker cloud is save time of cryptographic operations. Processing and storage cloud is connected with user interface on web and smart phones which saves computational overhead. We have secured smart home system by applying google authentication system which manage login and location based security. On router proposed system will provide security using AES. DTH 11 sensors will sense humidity and temperature of the area which helps us to trigger related device with the help of relay. Proposed system also performs automatic triggering of devices using application of machine learning algorithm on usage data. Steps for authentication and learning in the system are as follows:

Step 1: Login/Sign up with Gmail Auth.

Step 2: Check Mobile GPS location, user preferences for devices, temperature settings and store it in cloud. (For future authentication and learning).

Step 3: User patterns are recorded into cloud.

Step 4: End Process.

After completion of above process user can manage his IoT devices.

Very next time when the owner wants to switch IoT devices from his smart phone, then the device list is available for owner without any authentication with learning approach, because of once the smart phone authenticate by gmail auth, the credential has been reused for every further logins.

But when the cloud receives unknown location or temperature settings which are not stored in its cloud, then machine will ask for thumb impression for authentication. This increases the home automation security from remote access.

V Result

Proposed system is more secure than existing one due to removal of local gateway as well as usage of third party security (google cloud security). Broker cloud helps to enhance the speed to manage processing between user and devices. It also reduces computation overhead of cryptographic operations between devices. Automation is equipped with location based triggering and machine learning. Machine learning algorithm like SVC learns from usage history to predict users need of devices.

Figure below represents a model of proposed work.

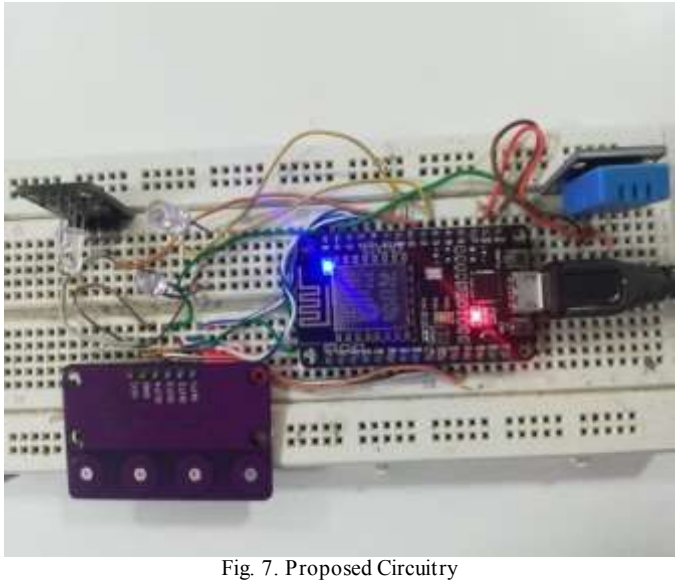

Fig. 7. Proposed Circuitry

Figure above represents hardware components used in development like Node MCU, touch switch, LED, relay, DTH 11 sensor etc. Use of touch buttons is shown below:

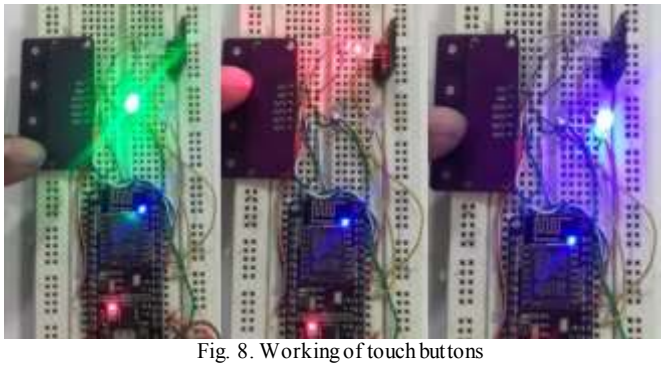

Fig. 8. Working of touch buttons

Switching to automation mode from manual is shown below:

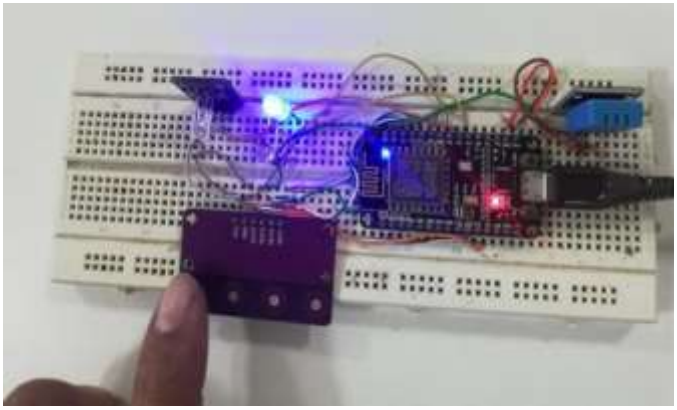

Fig. 9. Automatic mode

In automatic mode microcontroller will check temperature of environment gathered from temperature sensor. If temperature is greater than 26 degree centigrade than switching on blue LED represent automation status. Otherwise the device will switch off the blue LED.

Automation mode prediction accuracy of SVC is found higher than naïve Bayes in different test cases. Chart below represent prediction accuracy of the system.

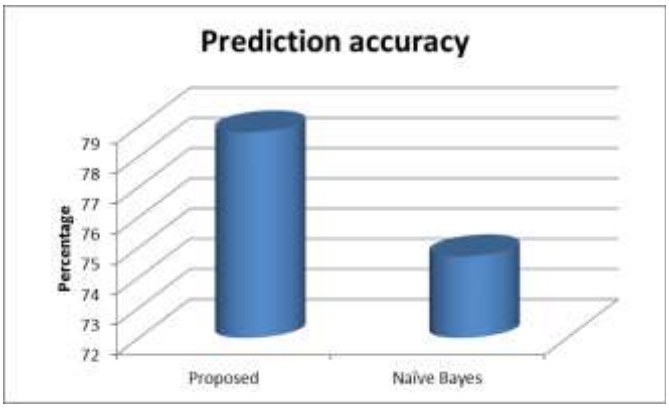

Fig. 10. Accuracy

VI Conclusion

Paper represents developments of smart home system with enhance security and comfort. Proposed system will enhance automation service and security. It reduces computation overhead. In future system will updated to provide more secure mechanism and enhanced smart home services. Proposed system has reduces the need of gateway by using cloud for intermediate data storage and processing so it reduces cost also. As compare to Bluetooth, voice, Zigbee based systems our system provides more secure and automated IoT enabled smart home.

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