SUTRON: IoT-based Industrial/Home Security and Automation System to Compete the Smarter World

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ABSTRACT

One of the important earnings of an individual is home. Home security has been a major issue as burglary/theft/crime rates are increasing drastically day-by-day. Everybody wants to take proper measure to insure protection of home and prevent intrusion. These crimes can cause catastrophic consequences, both financially and emotionally. In addition, there was need to automate currently present home security system with the help of new technological advancement. Internet of things (IoT) is one of the major advancement in technology as nonliving things can be controlled through Internet. This could lead to advancement of analytical and computational power. The proposed system emphasises on home security with the power of IoT. The proposed system would continuously monitor through various sensors and alert user when any problem is noticed. The system would retrieve data from various sensors and store those data on cloud server. Data analysis and interpretation would be carried by application on the central server and would be notified to the user on mobile device or on the proposed system.

Keywords: Data analytics, Home security, Internet of things, Security alarm, Sensors

1. INTRODUCTION

Uses of Internet of things (IoT) provide a low-cost solutions for automated home security systems. Here, different types of daily use electronic items are connected through Internet and send massages to home owner against of a predefined event. The event may be for any misconduct related to security issues, any power and cost saving uses of items. Raspberry Pi works with different sensors [passive infrared (PIR), smoke, temperature, humidity, gas] to detect or identify intruder or unauthorised access to homes and commercial spaces; it will also notify to the user about the illegal activity. The common parameters or characteristics of home security system are 24-h monitoring the intruders, ease of use, reliability, efficient, fast and precise notification system[1]. The requirements of secure smart homes, or home automation, began to increase in popularity in the early 2000s. As per the development of IoT-based automated home security, the Smart homes suddenly became a more affordable option. Domestic technologies, home networking and other gadgets began to appear on store shelves. Today's smart homes are more about security, living greener and energy saving by preventing unnecessary energy consumption based on IoT devices. The alerting or notification mechanism about intruders (whether we're home or not) make these systems more usable. At present, the remote mobile control, automated lights, automated thermostat adjustment, scheduling appliances, mobile/email/text notifications and remote video surveillance are popular requirements in home automation[2]. We have found different papers related to security system. Different security systems are used for different purposes. Nichal[3] implemented real-time video monitoring system and acquired data. The PIR, temperature, humidity sensors are used. It requires first automation and configuration from user side to get massages and notification. This smart supervisor system using IoT was based on embedded Linux OS (Operating System)

with ARM11 architecture[3]. Al-Sakran implemented Real-Time Intelligent Traffic Monitoring System using IoT: The system uses RFID (Radio Frequency Identification), wireless sensors like laser sensor, infrared sensor and ad-hoc networking. It enables the drivers to choose optimal paths to reach the destination. The moving vehicles can be monitored, controlled and administrated by the system. Traffic jam can be reduced to a great extent, and traffic safety is guaranteed[4]. Sowmiya has developed to connect any door with Internet and also implemented a surveillance system based on PIR sensor and camera[5]. Bharadwaj produced an IoT-based Waste Management system for smart city plans. The paper also depicts the importance of waste management for a smart city. An IoT-based waste management for Bengaluru city is taken as an example for explanation[6]. Sensors used in these types of IoT application generate large amount of data in a large speed and different variety. Due to large volume, high velocity and different variety of data, the data analysis is considered under big data analytics problem[7]. In[8], the open source solutions available to handle the storage, management and analysis of this large-scale dataset is discussed.

2. RELATED WORK

As per the popularity of IoT-based home automated security system, many researchers proposed, implemented and published their research work in this subject area. Following are some selected research papers in the area of IoT-based automated home security systems.

Chuimurkar presented smart monitoring system for smoke detector to detect the fire using Raspberry Pi, PIR sensor and mobile device. The systems will be capable for sending notification after capturing the image to user mail via Wi-Fi. The background subtraction algorithm is used for motion detection and smoke detection algorithm[9].

Tavagad produced a detailed survey on various surveillance systems; the importance of video surveillance and benefits of many security systems are also discussed[10].

Minoli reviews some of the technical opportunities offered and the technical challenges faced by the IoT in the smart building arena. Commercial space has substantial requirements in terms of comfort, usability, security and energy management. A related and cost-effective user-level IoT application is the support of IoT-enabled smart buildings. IoT-based systems can support these requirements in an organic manner. Papers also highlighted the issues and challenges to build a robust IoT-based automated security system for smart buildings[11].

Mehta presents a Raspberry Pi-based real-time monitoring system. The motion is detected and checked for face identification with the comparison with stored data on local storage. The background subtraction algorithm is used for face detection. Authors concluded that the system is able to identify faces, and user can be able to monitor remotely[12].

Park provides a security system that combines the functions of smart phone and home network system. Whenever a trespasser try to access a restricted area of an automated secure home, this system can be used to report to the police or home security service provider immediately when a trespass occurs[13].

Dhillon proposed a lightweight biometric-based remote user authentication and key agreement scheme for secure access to IoT services. It also proposed a lightweight protocol based on Hash and XOR operation for data analysis to make robust secure system. The formal verification is performed using AVISPA tool, which confirms its security in the presence of a possible intruder[14].

3. PROPOSED SYSTEM

The following mentioned data are based on study/research of existing automation/security system. The purpose of the study was to find out what functionalities are provided by existing system and what they are lacking at.

(a) Security alarms: The most basic feature of every home security system is an alarm which notifies user if any unwanted activity is detected. For example if any door or windows is opened after normal day hours, the system would ring inbuilt speakers to notify about the activity. System would be having various sensors to detect unwanted activities. It would also be provided with panic button if user identifies any threat. This type of alarm would alert intruder that their presence is known. (b) Door chime: This feature notifies to the user about the activities occurring near chime attached doors which would be helpful to monitor the entrance door activity remotely. This feature is one of the good measures to detect intruder from door/window where chime is attached. (c) Home automation: Well-placed lighting helps to deter criminal activity. Installing security lights can allow bystanders to see what is going on, which can aid in identifying a criminal. They are necessary in dark areas where cameras are installed. (d) Security cameras: Security cameras are considered as one of the best and effective feature of a security system. These cameras are useful to store proof of any unidentified activity. Our proposed system would not only effectively store visual images/videos, but it would also analyse activities with help of image processing and artificial intelligence. Visual images/videos would be stored on cloud server and would also be displayed to user's mobile devices. User can also control security camera from their mobile devices with active Internet connection. The proposed system would have motion activated image/video recording system which would effectively store visuals. This technique would be helpful for users to solve crimes that are reported long after they take place (Figure 1).

(a) Three way connectivity: System would be connected to Internet through Wi-Fi, GPRS (General Packet Radio Service) and ETHERNET shown in Figure 1. They would be switched to alternative technology if any one of above fails. In addition to Internet, it would also send SMS(Short Message Service)on registered mobile devices.
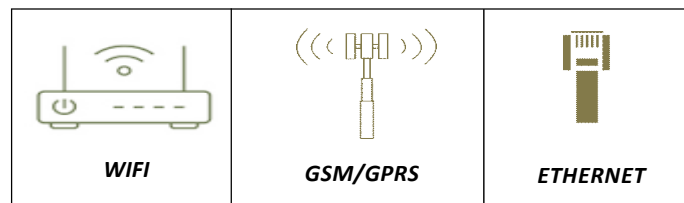
Figure 1: Three way connectivity

(b) Extra security sensors: Various sensors such as PIR, ultrasonic sensors, gas sensors, fingerprint sensors, RFID, light sensor, mic, temperature/humidity, water flow sensor, hall current sensor and so on would be helpful to automate security system. Adding extra sensors not only offers another level of security but also adds to safety by offering some protection against vandalism and fire.

(c) Monitoring system: System would allow users to monitor data remotely using their mobile phones or from web app which would be developed as a part of proposed system. Data for the system would be stored on board memory of device as well as on central cloud server.
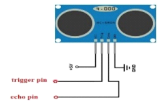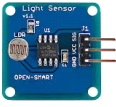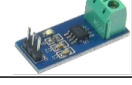
4. DIFFERENT SENSORS FOR SYSTEM DEVELOPMENT

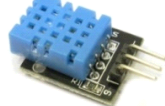Sensors are major part of security/automation system. They provide crucial data depending upon change in environment. Table 1, describes few of the sensors mechanisms, major use and specifications which may be used to make a home security/automation system.

5. PROPOSED SYSTEM ARCHITECTURE

A complete security/automation system comprises of different components used for different purpose. Although these components can be categorised based on some similar functionality/use of the component. Below-mentioned list diversely classifies different categories of the component layer wise.

Table 1: Different sensors specifications

| S.No.	Sensor Name	Image of Sensor	Mechanism	Major Use
1	Ultrasonic sensors		Ultrasonic sound	Obstacle detection, distance measurement
2	PIR sensor (passive infrared sensors)		Passive infrared	Motion detection, living object detection
3	Gyroscope sensor		Vibration and gravitational force (MEMS)	Direction provision, movement of object/thing
4	Gas sensors (MQ)		Ionisation (reacting to different elements)	Detecting harmful gas, detecting air purity levels
5	Fingerprint sensors		Optical image /capacitance scanner	Security system, authentication
6	RFID RF IC card sensor module (MFRC-522, RC522,EM18)		Magnetic	Motion detection, living object detection
7	Laser sensor module 6mm		Laser technology	Motion detection, living object detection
8	Light sensor (photo resistor diode)		Photo resistor diode	Light density, light luminosity
9	Sound sensor (MIC)		MIC	Sound detection, human interaction
10	Temperature and humidity sensor (DHT22, DHT11, LM35)		Heat resistance	Temperature, heat measuring
11	Infrared IR distance measuring		Passive infrared	Distance measurement, living object detection
12	Water flow sensors		Water flow rotation	Calculation of water flow
13	Hall current sensors		Passive infrared	Current measurement

Layer 1: Sensors and external hardware: Sensor provide crucial data depending upon change in environment. These may be used by microcontroller to analyse the situation and react appropriately it.

Layer 2: Microcontroller and microprocessor: Data provided by sensor are analysed and processed then appropriate actions are taken. Microcontroller also makes repository of the data by sending data to database.

Layer 3: Internet and cellular connectivity devices: These are set of devices which are used to transfer data from microcontroller to database. These devices are backbone of any IoT devices.

Layer 4: Cloud storage and database: Data processed by microcontroller would be stored to make better decisions in future. This is also helpful in displaying and interacting with end user as data would be stored in consistent manner.

Layer 5: Application layer: This would consist of final software, applications which would be interacting with user to execute some major tasks.
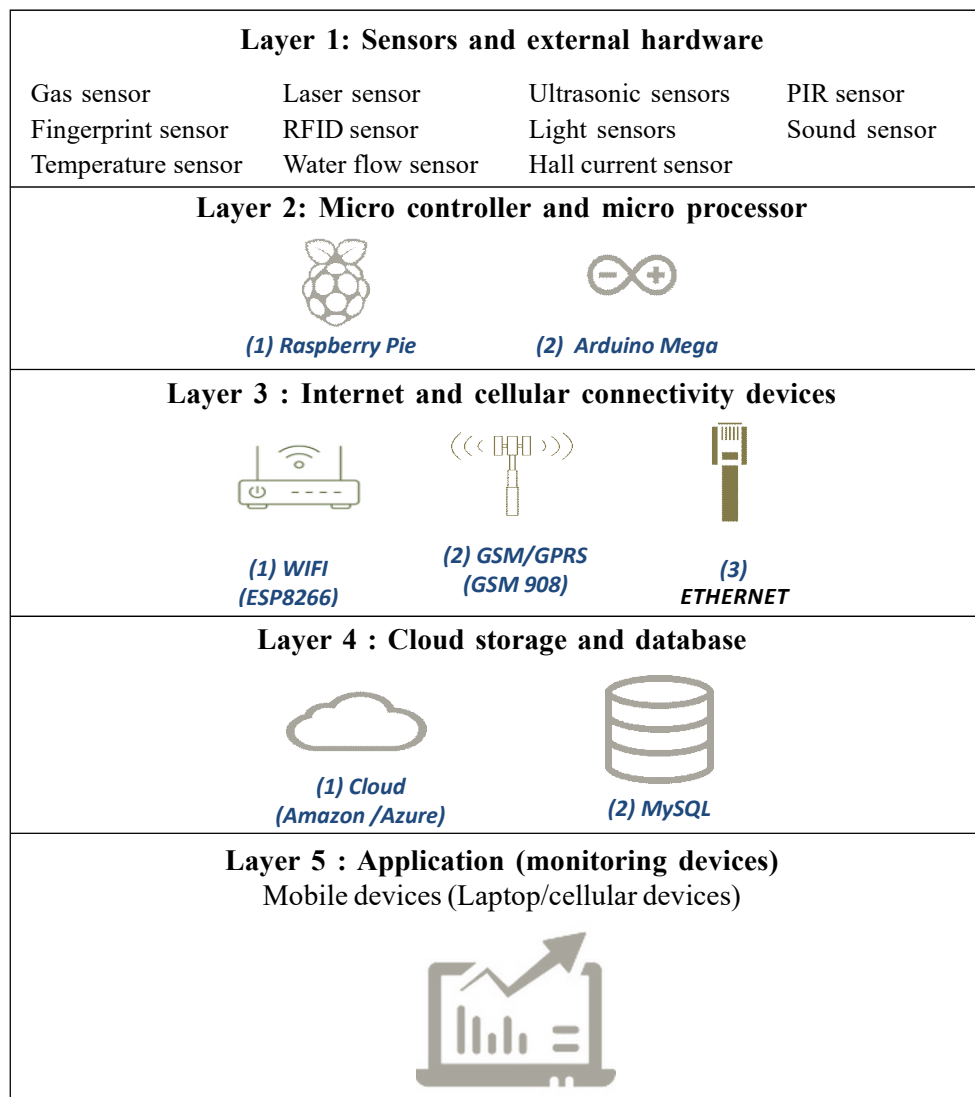
Figure 2: IoT home/industrial security and automation system model

Figure 2 graphically represents IoT home/industrial security and automation system model which describes the different usability layers of the proposed system.

6. CONCLUSION AND FUTURE WORK

Today, the rate of burglary/theft/crime rates is increasing drastically which becomes the main reason for requirement of robust and strong automated home security system. IoT provide a low-cost solution for robust and real-time system that will be helpful for user to prevent the home from unauthorised access. In this paper, an IoT-based home security system with the list of sensor requirement, their technicities and way of working is presented. The system architecture depicts the different components placed on different layers of proposed system. The system implementation, evaluation with different measure and data analysis to enhance the performance and usability of the system is proposing as the future extension.

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