

Autonomous System for Hotel Industry using Robotics

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Abstract—In Internet of Things network, a number of smart devices which are embedded with sensor technology integrate real data information and help in data exchange and it is helpful in robotic assistance. This integrated information can be used for number of tasks like sending alerts/e-mails, data mining, machine controlling by intelligent decisions etc. to give safe and secure environment in IOT architecture based applications. Number of professionals, entrepreneurs has accepted the three layer architecture of IOT but for smart applications like robot designing in hotels, this chapter presents four layered and five layered architecture of IOT. This paper defines the current knowledge regarding implications of robotics within the smart hotel which will provide the assistance system that interacts with number of guests and provide services to them.

Index Terms— Internet of Things, Robotics, Smart devices, Sensors, Smart Hotel, Safety and Security.

I. INTRODUCTION

A simple real-life example- Ram, between his road trip notices some problem with the check engine light, however, he doesn't know the intensity of the problem. The good part is that the sensor that triggers the check engine light monitors the pressure in the inner brake line. This sensor is one among many sensors present within the automobile that perpetually communicate with one another. A part known as the diagnostic bus gathers the information from these sensors then passes it to the entryway within the automobile. The entryway collects and kinds the information from totally different sensors. Before this association to happen, the car's entryway and platform should register with one other and make sure a secure communication [1]. The platform keeps on perpetually gathering and storing information from many cars worldwide, building a record in a database. The manufacturer has other rules and logic to the platform. The platform triggers an alert in his automobile, once sensing the brake fluid has borne below the counseled level. The manufacturer then sends him a meeting for servicing of his automobile, and the car's downside is corrected. This is all possible due to IOT. The web of Things (IOT) is a network of things used in everyday's life which are connected together through the Internet. This idea was proposed in 1999, its aura has been in continuous development and expansion. IOT's concept was first come from RFID (Radio Frequency Identification) fields. It is considered to be the information network constructed by the radio frequency identification technology and communication technology. The main function of an IOT system is to check the world around itself, to enable and aid, or to automate a response to changes in

the system's environment. The primary purpose of an IOT system is to improve the life's quality by providing the best response to an environmental change by giving responsive services which are specific to the needs of the end-users. The research presented in this paper is towards the designing of assistance system in hotels where the robots will work automatically to execute number of things like to guide guests for their room and for other special points in the hotel, to deliver items to guest's rooms.

A. IOT Components

There are four fundamental components of IOT system as shown in figure 1.1, which tells us how IOT works [2].

Sensors/Devices

First, sensors or devices ease in aggregation very minute knowledge from the encompassing environment. A device will have multiple sensors that may bundle along to try to do more than simply sense things. As an example, phone could be a device that has multiple sensors like GPS, accelerometer, and camera however our phone doesn't merely sense things. The most rudimentary step can forever stay to choose and collect knowledge from the encompassing environment be it a standalone sensor or multiple devices.

Connectivity

In this part, shipping is done from collected knowledge to a cloud infrastructure with the help of the sensors by using various mediums of communications like WAN, Wi-Fi, mobile or satellite networks, Bluetooth etc.

Data Processing

In data processing, role of software starts i.e. the knowledge which is collected, it will go to the cloud and then processing is performed. For example, to check the temperature, device reading for AC or heaters.

User Interface

Now, final step is the availability of information for end users either by alarm triggering on phones or by e-mail notification. The user generally might need an interface that actively checks their IOT system. As an example, the user incorporates a camera put in his home. He desires to use video recording and all the feeds with the assistance of a web server.

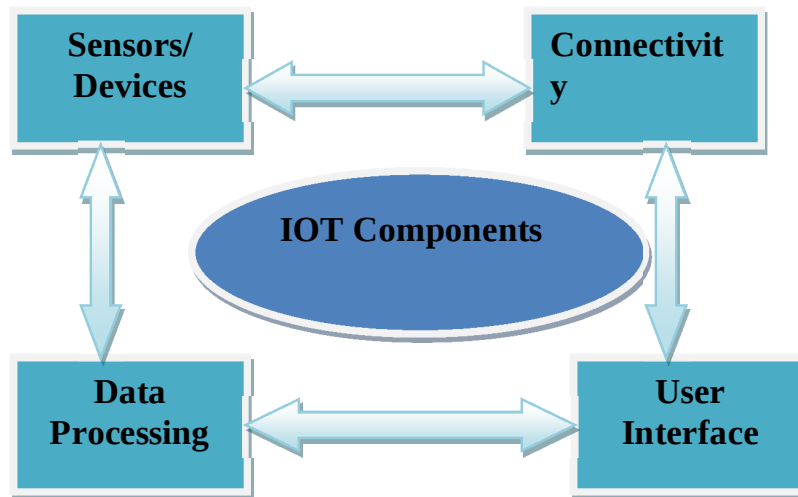


Fig 1.1 Components of IOT

B. Different IOT Scenarios

Imagine a situation when:

- You are on your way while getting back from work and you use an application on your cell phone to change on the lights, the AC in your house, and tune the Television to your number one.
- What would very make a fridge "smart" would be on the off chance that it might check labels and alert home proprietors once their food is near arrive at their ending date, For instance, or then again perhaps it might talk with the web schedule and manufacture orders consistently in a way that things will be delivered surely.

This innovation has a ton of uses in different fields. The following are some possible zones where web of Things (IOT) can be used to solve every day issues.

Smart Cities- IOT is regularly monitoring the vibrations of landmarks, bridges, and buildings just in the event that the structure material is undermined or overburden. Noise contamination can be controlled around clinics and universities. It tends to be used to oversee traffic especially all through traffic jams, top hours, mishaps, and rains. Another sensible application is making the authorities aware of empty the garbage cans once loaded with waste [3].

- House automation- IOT is often accustomed remotely management and program the appliances in your home. It is often helpful in identifying and keeping away from robberies.
- Industrial automation- By exploitation this innovation, we can robotize creating measures distantly. It can even prove supportive in improving the production measures. We can able to manage the inventory and the supply chain. It can also be checked that if there is any discharge of harmful gases to evade injury to labourer's wellbeing and furthermore the surroundings.
- Smart environment- In this, we are able to check the emissions from factories and vehicles to attenuate pollution. It is possible to additionally keep tabs on the standard of water being equipped for drinking. We are able to send warnings of earthquakes and tsunamis by sleuthing tremors. We are able to keep the water level of rivers and dams beneath police investigation to be ready just in the event of floods. The discovery of forest fire is moreover can be done with this innovation.

II. LITERATURE REVIEW

Omar Said and Mehedi Masud introduced a paper named as "Towards Internet of Things: Survey and Future Vision", this paper [1] presents the historical backdrop of IOT, various models of IOT, where he referenced about the advantages and parts of a smart building and introduced a Quantitative estimation of a building intelligence. In paper [2], Internet of Things: Architectures, Protocols and Applications, an overview of condition of art methods, conventions and applications is presented. This paper presents an application to have any kind of effect in human life, especially for elder and disabled people. In this, a wide clarification of sensors is given as they are the main segment of smart things. For making any smart application, various sensors are characterized in detail. In paper [3], a spite of positives about IOT, number of negative things has been examined w.r.t malicious users. This paper describes the disadvantages of security in IoT. Utilizations of IoT are wide in reach and use of the IoT characterized with the assistance of various functions and functions are treated as layers. Three-layer architecture of IOT (Internet of Things) is defined in paper [4]. As per the genuine demand of lodging chain industry for improving visitors living environment, the paper likewise discusses about the plan of IOT application scheme. The plan may successfully meet the administration necessities of lodging chain industry. There are number of disadvantages in the Three-layer architecture of IOT (Internet of Things) as mentioned in [5]. In this, the real interest of hotel chain industry for improving visitor's living climate is defined; the paper additionally examines the plan of IOT application scheme with utilising the IOT gateway as a bridge. The plan may adequately meet the administration pre-requisites of hotel chain industry. In a research [6], the creator has explored the utilization of web of things. Two principal factors on which this paper has focused are: security and protection. Because of these components, IOT is received widely. This paper presents a review of structure of layered architectures of web of Things with their attacks about security. With this, a survey of systems that gives answers for these issues is given with their limitations. This paper proposed another protected layered architecture of IOT to defeat these issues. This paper [7] gives a point to point architecture of IoT as layers. The paper covers layers beginning from business to perception layer. Both hardware and software assume a significant function in the IoT, so the paper covers details of the hardware just as software along the difficulties of web of Things.

Research Gaps: From the related literatures reviewed so far, the following gaps have been identified with respect to using embedded IoT in mitigating fraud in the hospitality industry:

- Embedded IoT technology has not been applied in enforcing integrity of stored data in hotel DBMS in order to reduce fraud in room bookings. Appropriate software engineering principles and patterns have not been adequately applied in developing fraud reduction/elimination system for hotel room reservations using embedded systems and IoT technology. The real-time properties of entities constituting of the hotel DBMS have not been adequately considered as factor for checkmating and enforcing data integrity and consistency

Research Objectives: To evaluate the procedures involved in hotel room bookings and reservations and determine possible causes of fraud in hotel management.

To model the system by adopting object-oriented system analysis and design techniques. To develop an embedded IoT system that enforces access control in hotel door locking systems. To develop a web application and a secured database for checkmating the integrity and confidentiality of data relating to hotel room allocations and associated funds. To build a prototype system by integrating the embedded IoT system and with the web application and secured DBMS.

III. LAYERED ARCHITECTURE OF IOT W.R.T ATTACKS

There are number of architectures which have been proposed by analysts. As per a few analysts, IOT architecture has three layers; however a few specialists upload the four-layer architecture. They imagine that, because of upgrade in web of Things, the design of three layers cannot fulfill the requirements of usages [4]. Because of a challenge of IOT as for security and protection, the engineering of five layers has similarity been proposed.

A. Three Layered Architecture

This includes three layers named as: perception, network and application layer as shown in Figure 3.1.

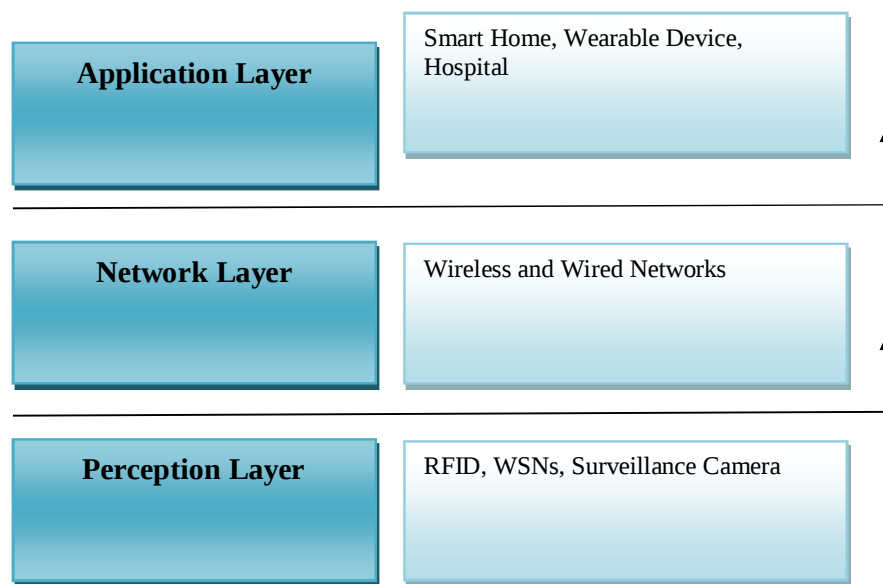


Fig 3.1 IOT Architecture (Three layered)

Perception Layer

The other name for this layer is sensor layer and it will work according to person's eyes, ears and nose. There are categories of sensors used for information collection according to the need of users. The collected information from the sensors can be about zone, changes noticeable all around, atmosphere, movement, vibration and so forth. Most of the dangers are related to the sensors. Ordinary security dangers of this layer are:

- **Eavesdropping**
- **Node Capture**
- **Fake Node and Malicious**
- **Replay Attack**
- **Timing Attack**

Network Layer

This layer is also named as transmission layer. It is actually an extension between the perception layer and application layer. Its role is to send the data which is gathered from sensors embedded objects by using two ways: i.e. remote or wire based. Different security threats and issues to network layers are:

- **Denial of Service (DoS) Attack:** It is an attack to shield genuine clients from getting to gadgets or other organizational assets.
- **Main-in-The-Middle (MiTM) Attack**

- **Storage Attack:** The information of clients is taken care of on storage gadgets or the cloud.
- **Exploit Attack**

Application Layer

The role of this layer is to describe the applications that utilize the IOT innovation in number of fields like: smart homes, smart cities, smart health, animal tracking, etc. It has the obligation to bring to the types of sorts of help to the applications.

Essential security dangers and issues of application layer are:

- **Cross Site Scripting**
- **Malicious Code Attack**
- **The capacity of managing Mass Data**

A. Four Layered Architecture

Previous to this, most fundamental architecture was three-layer design in which all the prerequisites of IOT were not fulfilled. This is the reason for the introduction of four layered design. It works in the same way as three layered architecture with additional one layer: a support layer [5]. Below Figure 3.2 presents the design for this 4 layered architecture with its recommended security system.

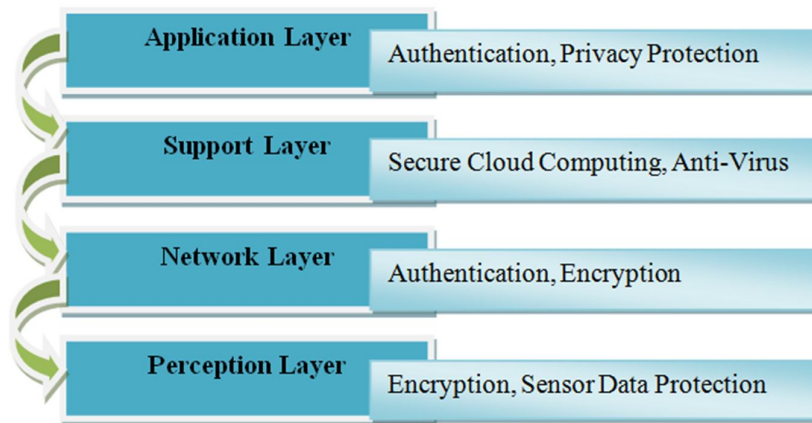


Fig 3.2 IOT Architecture (4 layered) with security mechanisms

Support Layer

The introduction of fourth layer is due to the security in plan of IOT. In light of sending information clearly to the network layer, the odds of getting threats increase. The support layer is providing two functions: valid customer's certification and risk protection. Other duty of this layer is to send data to the network layer. Regular threats and issues of this layer are:

- **DoS Attack:** This attack is mainly identified with respect to the network layer. In this, to make network traffic drenched, an attacker sends a ton of information. This is the reason for huge utilization of system assets depletes the IoT and makes the client not prepared for getting into the framework.
- **Malicious Insider Attack:** This attack occurs from inside an web of things environment for getting the individual data of users. This function is performed by an approved user in order to get the other user's data. This is actually a totally different and complicated attack which requires number of mechanisms to prevent the threat.

B. Five Layer Architecture

The significant part for web of things advancement is four-layer architecture. There were some issues with respect to security mechanism and storage system in four-layer architecture. So, due to the factors, Researchers proposed five-layer architecture in a way to make the web of things secure. It is actually having three layers like past frameworks with additionally two more layers: processing and business layer [6]. The functions of processing and business layers with their security attacks are described under:

Processing Layer

The other name for this layer is middleware layer. The function of this layer is to collect the data which is sent from a transport layer and then this collected data is processed. The major duty is to eliminate additional data

that has no significance and then extracts the useful data. Be that as it may, it additionally eliminates the issue of large information in web of things. In enormous information, a lot of data is received which can influence execution of IOT. There are various attacks that can influence the processing layer and disturb the performance of IOT. Normal attacks are:

- **Exhaustion**
- **Malwares**

Business Layer

It alludes to a planned behavior of an application and acts like an administrator of a complete system. From this layer, it is to be decided that how the data is created, its storage system and how it will be modified. Basic issues with respect to security of business layer are:

- **Business Logic Attack:** It takes advantage of a defect in a programming. It controls and deals with the exchange of data between a client and a supporting information base of an application.
- **Zero-Day Attack**

In Figure 3.3, a hierarchy is shown which relates all proposed layered architecture of Internet of Things (IOT).

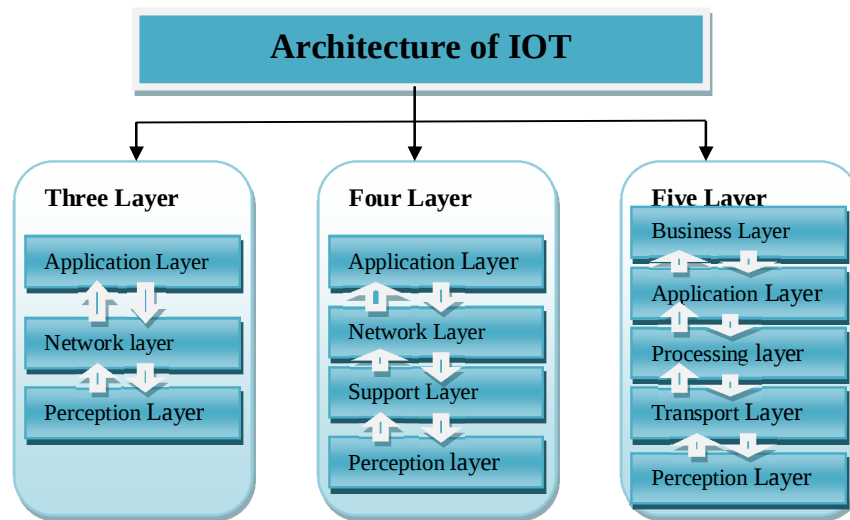


Fig 3.3 The layered architectures of IOT (three, four and five layers)

This figure 3.4 shows the architecture that how robots are integrated in hotel industry and how they are connected to a central server using WiFi. The process will be like: firstly the users will request ant type of service like a newspaper, any snacks, bottle etc. from the terminal in the room and second option is to interact directly with the robot. Next step is of server which will receive the request and decide itself that which robot can be send to fulfill this request.

IV. IOT IN HOTEL INDUSTRY

It is an association of number of computerized gadgets and machines which are interrelated with the help of web for improved progressed expenses and guest experience. There are number of cases in hotel industry like: An IOT engaged lodging in Goa named as Le Meridian, which diminishes usage of energy and it passes on awesome guest experience. These things are refined by Schneider Eco structure which is interoperable and it passes on updated an incentive around security, proficiency and accessibility for the clients. Second is JW Marriott Inn which made IOT space for the customers by worked together with Legrand and Samsung and this room can do number of modified exercises like a guest can demand that the virtual helper will give update at 7.00 am for yoga or he/she can demand for starting shower at a particular time with voice request or by using application [7].

A. Benefits of IOT Solutions for Hotels

Number of focal points is there if IOT is applied in lodging industry-

- *front work zone executives*
- *housekeeping*

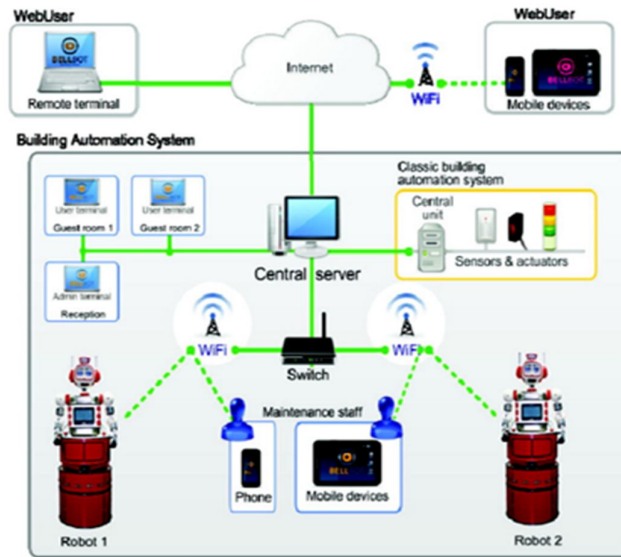


Fig 3.4 Connections in architecture

- More number of positive studies and composed customer commitment; in this way more pay generation.
- Lesser interferences at work on the ground that there is less unpredicted extraordinarily appointed uphold calls. Likewise, planned support is more affordable, does not eat a great deal of time and is definitely not hard to anticipate.

B. Benefits of IOT in Hotel Industry concerning Visitors

The basic goal of lodging industry is extreme Guest experience which can take your hotel to heights [8]. They do not look for long enlistment lines or hold on to get the room of choice. There are number of preferences for the guests when IOT is applied in hotels:

- Customized offers/food as indicated by guest's cooking decisions.
- Room settings customized by the guest's liking.
- Turn on the guest's number one TV channels or music.
- Remember the standard request for breakfast for the guest.
- Ideal water temperature at whatever focuses the guest needs to shower.

C. Where IOT can be utilized in Hotel

- Guestroom automation for room service upgrades- It offers guests accurately what they have come for to hotel, a wonderful and customized stay. They favor an absolutely extraordinary experience that has everything tuned as they would like. IoT gives you an incredible opportunity to improve the room organization from different viewpoints. Guests would love on the off chance that hotel recollect their loving and preferences. Their food and room choices, their main coffee, practices that they like to appreciate, etc.
- Smart hotel upkeep- The hospitality industry spends a ton on maintenance. Consider a situation where sensors can distinguish the difficulty zones in the hotel and fix them naturally or if nothing else prompt or advise the hotel before the guest does. Since, assuming that the guest faces a broken machine, it sure will impact his experience and hotel's reputation. There are models where guests complain of faulty lights or spilling water in the lodging. Sensors can be acquainted to recognize spilling taps or defective lights which can trigger exercises to one or the other fix [9].
- Cross property combination- It will be very extraordinary if properties of a chain share visitor's details and inclinations associating IOT frameworks. Preferably, the visitor information ought to be brought together in hotel network scenarios.
- In-room highlights-Rooms are the appeal of a property. IoT can change the visitor experience in the room. Keyless entryways that open consequently when the visitor shows up is one thing that is in pattern now days. Some different instances of in-room highlights are: Set temperature in the indoor

- regulator according to the visitor's inclinations, showing his number one channel on TV, proper lighting in the room could be not many experiences conceivable with IoT [10].
- Amazon Alexa, a voice-based communication assistant is the ideal case of IoT used in the hospitality industry.
 - **Smart answers for building and coordination's**- IoT can likewise help improving and keeping up the structure and give smart coordination's. Foreseeing what the visitor is searching for and giving an experience better than expected will assist an individual with making an edge in visitor satisfaction.

V. CONCLUSION

The arising thought of Internet of Things (IoT) is rapidly discovering its way all through the advanced life, meaning to upgrade the life quality by interfacing number of smart devices advances and applications. By and large, the IoT would take into account the automation of all the things around us. This paper introduced a diagram about different layered designs of IoT with security attacks. In this paper, a system is introduced that could be utilized by hotels to execute the idea of robots in smart hotels. This system permits the hotels to offer complex administrations to their visitors while regarding the visitor's security. It introduced two instances of how advanced administrations could be offered through the joining of smart specialists and IoT devices. The main service helps the visitor to give access to different visitors in the hotel to his/her room depending upon their associations with the visitor and the visitor's timetable. The subsequent service empowers the visitor to be awakened progressively utilizing music and light rather than the annoying buzz of a morning timer. This exploration is likewise a case of how the incorporating among AI and IoT advancements could provide clients with a superior quality of service, consequently expanding the clients' satisfaction and expanding the pace of bringing customers back.

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