

IoT Home Automation

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Abstract: This document is a review on IoT (Internet of Things) applications in the field of Home Automation exploring the growth in recent times, its potential and the challenges it faces in widespread adoption. The internet of things (IOT) is a system of combined computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.[1] The new Smart home technology which also be termed as Home automation is the use of devices in the home that is connected via a network, mostly a home network (LAN) or the internet. It uses devices such as sensors and other appliances connected to the Internet of things (IoT) which can be remotely monitored also controlled or accessed and can provide services that respond to the perceived needs to the users.[2] We would be looking at its origins, how much the extent it has become necessary in our lives, its applications to solve humanitarian issues and IoT in INDIA.

Keywords: IoT, Wi-Fi, Android, Cloud, Network

I. Introduction:

IoT based Home Automation today consists of two major segments, the of the. Concept of Home Automation has been there for quite some time in the form of science fiction movies, but the first IoT based Home Automation concept can be most probably traced back to the Millennium House in 1998. The Millennium House was a British show-home opened in 1998 to demonstrate how running a home could be automated with computer-controlled heating, security, lights, doors and gardens [3]. This was possible because of the rapid growth of Internet and increase in availability and falling costs of Integrated Circuits, otherwise some components of the Home Automation had existed way back in 1960s-70s in military applications. 1998 to early 2000s was the time when IoT and Home Automation became known to the masses. As technology becomes more and more affordable, and with the majority of western populations having home internet and a smart phone, smart technologies are slowly integrating into our homes. Today, the focus is on convenience, security and energy efficiency through connectivity and interactivity. The availability of high speed internet and smartphone devices in early 2010s gave shape to the IoT Home

Automation as we know it today, Smart devices like mobiles, watches, TVs connected with sensors detecting light, temperature, etc connected remotely in the simplest forms. It can be segregated to work on three distinct levels. Firstly on sensor level collecting/detecting all types of data, secondly on network layer level which works to transmit the data to decision making system and transmit the decision data back to the device and finally the application layer responsible for making all types of decision based on data received, storage of data and control of the devices. It is estimated that there are more than 45 million households in USA using some form of IoT based Home Automation [4].



Fig 1: Aspects of IoT Home Automation

II. Constituents of Technology

It might can prove a hard task if we would like to find out our way through the IoT technological maze given the diversity and sheer numerosness of the technology solutions that surround it. However, for matters of simplicity, we have break down the IoT technology stack into four basic technology layers which is involved in making the Internet of Things work. These are the following:

A. Device Hardware:

Devices are the objects which actually constitute the 'things' within the Internet of Things. Acting as an interface between the real and the digital worlds, they may take different sizes, shapes and levels of technological complexity depending on the task they are required to perform within the specific IoT deployment. Whether pinhead sized microphones or heavy construction machines, practically every material object (even the animate ones, like animals

or humans) can be turned into a connected device by the addition of necessary instrumentation (by adding sensors or actuators along with the appropriate software) to measure and collect the necessary data. Obviously, sensors, actuators or any other telemetry gear can also constitute standalone smart devices by themselves. The only limitation to be encountered here is the actual IoT which uses case and its hardware requirements (size, ease of deployment and management, reliability, useful lifetime, cost-effectiveness) [8].

B. Software:

This is what actually makes the connected devices 'smart'. Software is responsible for implementing the communication with the Cloud, collecting data, integrating devices as well as performing real-time data analysis within the IoT network. What is more, it is device software that also caters for application level capabilities for users to visualize data and interact with the IoT system.

C. Communications:

Having the device hardware and software in place, there should be an another layer which will provide the smart objects which contains both ways and means of exchanging information with the rest of the IoT world. While it is true that communications mechanisms are very strongly tied to device hardware as well as software, it is vital to consider them as a separate layer. Communication layer which includes both physical connectivity solutions (cellular, satellite, LAN) and specific protocols used in varying IoT environments (ZigBee, Thread, Z-Wave, MQTT, LwM2M [9]). The technology chosen will determine not only the ways in which data is sent to/received from the Cloud, but also how the devices are managed and how they communicate with third party devices. For the purpose of the present article, we will go into the details of some of the present-day communications solutions later in the text.

D. Platform:

An IoT platform is the place where all of these data are gathered, managed, processed, analysed and presented in a user-friendly way. Thus, what makes such a solution especially valuable is not merely its data collection and IoT device management capabilities, but rather its ability to analyse and find useful insights from the portions of data provided by the devices via the communications layer. Again, there are quite number of IoT platforms on the market, with choice depending on the requirements of the specific IoT project and such factors are architecture and IoT technology stack, reliability, customization properties, protocols used, hardware agnosticism, security and cost-effectiveness. It is also worth mentioning that platforms can be either

installed on-premise or cloud-based [5].

III. Scope of Home Automation

Fig 2: Typical Smart Home Layout

A. Security:

The foremost and major use of IoT Home Automation is in safety and security of the house. This involves motion sensor detectors which upon detecting any motion activates a camera (usually able to shoot videos even in low light conditions) and sends an alert to the owner along with the video footage to the smart phone device over internet. The user then can take action if the cameras show any danger. This service can be extended to automatically alert police security agencies if the owner is not present in the house itself. This is the most widespread form of IoT based home automation in use by the public. Multiple vendors with competitive prices are now enabling the adoption of the same technology rapidly across the globe. This service in USA nowadays is often extended by providing automatic locking systems too for child protection [10].



B. HVAC(Heating, Ventilation and Air Conditioning)

HVAC based on IoT is another widely proliferated technology in the field of Home Automation. In addition to the automation and remote operations it enables improved efficiency and energy savings too. This is based on multiple sets of modules distributed in each room consisting of temperature sensor, humidity sensor and air quality monitors embedded in single modules. These sensor clusters continuously monitor the data collected and is connected over Wi-Fi to control systems which control the heating and air flow inside the buildings. All this controlled by any smart device being used by the user remotely over the internet. This system cuts down the energy consumption quite significantly [11].

C. Smart Lighting:

IoT based smart lighting is widely being accepted in industries to get green energy savings compliances.

This is based on the concept that all lighting systems are connected to a control system which monitors the data received from sensors and automatically controls the lighting. At the heart of this system is an occupancy sensor which detects if people are present and if so, then how many. This enables the control system to keep that space well lit. While alarm sensor and daylight sensors ensure that minimum amount of lighting is used during daytime and when the occupants are sleeping. The lighting can be remotely controlled to even control the intensity of light. For example, the user can remotely dim or switch off the lights if children are asleep in their rooms [12].

D. Hazard alert:

This is one crucial component now starting to appear in homes. This includes a set of sensors which detect smoke, gas leak or Carbon Mono-Oxide presence indoors. On detection of any of the above, an alert is sent to the home owner on his smart mobile over internet and to fire department simultaneously. This system has the potential to save the lives of people and reduce the number of affected people from domestic accidents very significantly.

E. Home Automation for elderly and disabled:

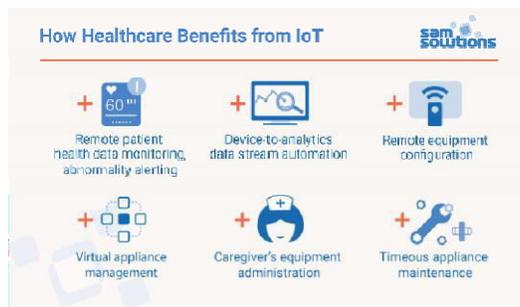


Fig 3: IoT in healthcare

Elderly, disabled and people with severe medical problems living a significant portions of their lives alone in their homes are the most vulnerable. A lot of deaths occur each year because the elderly or disabled in the home are alone with no way of calling for help. This can be solved by Home Automation. Video cameras, motion detector sensors and a wearable vital signs monitoring system can monitor the people when they are alone in the home and in case the sensors detect anything unusual, they can send an alert to the their relatives and medical agencies simultaneously.

F. Pet and Child Monitor system:

Another implementation of the home automation is the safety, monitoring and access control for pets and children remotely. Sensors includes motion sensors connected with video cameras. System can be extended to remotely give treats to pets.

G. Infotainment:

This system is fast catching up among the youngsters now a days. Voice Controlled devices like Amazon Alexa or Google Home is now used widely. AI can not only recognise the speech of the owner but also reply by completing the instructed task. Basically an assistant which can play music, videos, movies and even lighting just on voice instructions is an impressive feat.

Advantages

1. As this is an IoT based system, the requirement of cables and wires is removed during the process of installation. This makes the process fast, easy and cheaper.
2. As the system is based on Io Tans smart devices, this means that the whole system is easily scalable in future depending upon the requirements of the user.
3. As the whole system works on Wi-Fi, smart phones and compact sensors, it has advantage of being used and controlled from anywhere and anytime and the whole layout does not affect the beauty of the place.
4. Maximizing the home security. When we incorporate security and surveillance features in our smart home network, our home security can skyrocket. There are tons of options here – out of which only a few dozen of which are currently being explored. For example, home automation systems can connect motion detectors, surveillance cameras, automated door locks, and other tangible security measures throughout our home so we can activate them from one mobile device before heading to bed. We can also choose to receive security alerts on our various devices depending on the time of day an alert goes off, and monitor activities in real-time whether we are in the house or halfway around the globe [6].

Challenges

Home automation suffers from platform fragmentation and lack of technical standards a situation where the variety of home automation devices, in terms of both hardware variations and differences in the software running on them, makes the task of developing applications that work consistently between different inconsistent technology ecosystems hard. Customers may hesitate to bet their IoT future on proprietary software or hardware devices that use proprietary protocols that may fade or become difficult to

customize and interconnect. The nature of home automation devices can also be a problem for security, data security and data privacy, since patches to bugs found in the core operating system often do not reach users of older and lower-price devices [13]. One set of researchers say that the failure of vendors to support older devices with patches and updates leaves more than 87% of active devices vulnerable. Concerns have been raised by tenants renting from landlords who decide to upgrade units with smart home technology. These concerns include weak wireless connections that render the door or appliance unusable or impractical; the security of door passcodes kept by the landlord; and the potential invasion of privacy that comes with connecting smart home technologies to home networks. Researchers have also conducted user studies to determine what the barriers are for consumers when integrating home automation devices or systems into their daily lifestyle. One of the main takeaways was regarding ease of use, as consumers tend to steer towards "plug and play" solutions over more complicated setups. One study found that there were large gaps in the mental- models generated by users regarding how the devices actually work. Specifically, the findings showed that there was a lot of misunderstanding related to where the data collected by smart devices was stored and how it was used. For example, in a smart light setup, one participant thought that her iPad communicated directly with the light, telling it to either turn off or on. In reality, the iPad sends a signal to the cloud system that the company uses (in this case, the Hue Bridge) which then signals directly to the device. Overall, this field is still evolving and the nature of each device is constantly changing. While technologists work to create more secure, streamlined, and standardized security protocols, consumers also need to learn more about how these devices work and what the implications of putting them in their homes can be. The growth of this field is currently limited not only by the technology but also by a user's ability to trust a device and integrate it successfully into his/her daily life [7].

VI. Home Automation in INDIA

From being a concept, the word smart has gradually evolved. Consumers now have access to intuitive technologies and virtual assistants which can remind them about daily chores, plan their day and operate their appliances. The real push for IoT based smart home automation in India happened when the Government of India formulated its Draft Policy on IoT in 2015. This set the state for growth of IoT based Home Automation in India. Today the market of Smart Home Automation in India is more than 6 Billion USD. A major segment of this is composed of door security system, voice controlled

infotainment systems and smart control switch systems. Godrej is a leader in IoT based door security system and it is almost a must in most new built homes in metros across India. Another system is the infotainment system. With the proliferation of 4G internet in India and with the availability of systems like Alexa , homes across India now have smart IoT based infotainment capability. Another niche in this technology is the smart switches. These have the capability of being pre programmed and remote operation. Smart switches to control water heaters, air purifiers and air conditioners are now widely used. Home Automation technologies beyond these few types are still not widespread in India due to various reasons which involve lack of fast internet connectivity in remote locations, very high acquisition costs and difficult user interface. But as the purchasing power of Indians grow it is expected that more and more types of IoT based home automation technologies will make way in Indian market. Its estimated that the Indian market for such devices will double in value in next 5 years [14].

Conclusion



Fig 4: Future Scope

Once a dream, iot home automation is slowly but steadily becoming a part of daily lives around the world. In fact, it is believed that the global market for smart home automation will reach \$40 billion by 2020. With the passage of time, more and more devices are sure to be added and with more smart features.

Here are some possible scenarios that we may see in future.

1. Lighting

These days, smart lighting is all the rage. They can be scheduled to turn on/off and also change their intensity. However, in future, it will be possible for this to be taken a step further. With IoT enabled across the home, the lights can respond to other actions taken by a person. For example they can turn off the lights completely if the sensor senses that you are watching a horror movie, which will give you the proper atmosphere.

2. Windows

Windows can become smarter as well. Imagine them automatically opening the shutters when the sunrises and close at sunset. We may even be able to program them to close automatically when it rains

3. Thermostat

The thermostat will be able to recognise if we are nearing our home. It will then check the room and external temperature and set the right one for us. It may even recognise when we are taking certain actions and adjust accordingly such as when we are showering or exercising.

4. Gardens

Even our gardens can become smarter in the future with IoT. We will be able to place IoT sensors in the garden. If these sensors detect dryness in the soil, they can trigger the irrigation system. Robotic lawnmowers can be automatically deployed if the grass exceeds a certain height.

5. Home routines

Smart alarms can play music when we wake up or even tell us the news. Voice assistants can even run entire routines where the lights, home appliances, thermostat, alarms and other devices are controlled. The shutters will open right before we wake up to help us get rid of that grogginess. Even before we wake up, the coffee maker will start getting our morning cup ready. The bathroom will get the water heated for our shower. Our stereo will start playing some morning tunes as we have our morning cup [15].

Of course, all of these are not going to happen overnight. There are a few barriers to widespread adoption of IoT-enabled smart homes, the primary of which is cost. Privacy is another major concern. Then there are the current technological limitations that create difficulties in a seamless connection between multiple IoT devices.

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