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# Automated Smart Home Using Internet of Things (IoT): A Survey

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**Abstract**– Our aim is to conduct a general survey of smart home appliances controlled with wireless technologies (IoT). Today in the headway of Automation innovation, everyone needs comfort and ease with the use of technology. IoT is the integration of electronics software with physical devices. Like many other potential applications, it can be implemented in Home automation which offers various features i.e., efficient energy consumption, safety, and protection.

**Index Terms**– Smart Home, IoT, Cloud Computing and Home Appliances

## I. INTRODUCTION

IoT stands for Internet of Things that is basically a modern technology based on interconnecting humans with electronic devices and cloud computing that has the ability of transferring data to the server to take some action after processing. It makes a simple home into a smart home by automating different appliances to control from anywhere.

### A) IoT Architecture

IoT follows an architecture which consists of four components: Sensors or Actuators, IoT Connectivity Gateway, Cloud Server, User Interface.

**Sensors and Actuators:** Sensors are the devices which are used to convert any physical data into an electrical signal. And Actuators convert electrical energy into mechanical energy. There are variety of sensors having different abilities to detect the problems at mild stages. A sensor basically identifies the changes occurring in its environment and responds to them. Sensors get input from environment in various forms such as temperature, speed, sound, humidity, light, motion, and pressure. IoT sensors are beneficial in enhancing efficiency, minimizing cost, and increasing security measures.

**IoT connectivity Gateway:** The input received is to be forwarded to the cloud server using a medium so that actions can be done. A variety of methods are used for IoT connectivity with cloud server which include satellite connectivity, cellular data, Wi-Fi, low range Bluetooth or low-power WAN. All the above-mentioned methods are source of providing data to the server.

**Cloud Server:** At this stage, uploaded input is processed, and decisions are taken. This could as simple as checking that the temperature is maintained to the fixed acceptable range or

it could also be a bit complexed like using motion detecting cameras to identify any motion or object such as intruder in video.

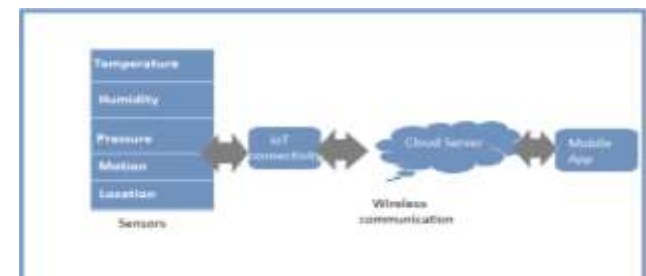


Fig. 1: Overview of IoT Component

**User Interface:** The information is then available and useful for further processing by the end-user. User is intimated in many ways that may be an alert generated through email to the user, a simple text message, or some notifications to timely inform the user about system's state. For example, an alert via text is generated to indicate the temperature increase in the coolant room. System can perform some actions automatically by the predefined set of rules just like instead of waiting for you to adjust the temperature it can maintain a fixed range. Similarly, the IoT system will immediately inform the concerned authorities in case of emergency i.e., police to take an action.

### B) Feature of Smart Home

The applications of home automation are being explored in the previous years and stills further work is going on. As a result, current market has introduced many incredible products related to this field.

It a sensitive task to make your home smart having unique feature associated with building, energy system, security, electronic appliances, and smart furniture.

- Building:** This category is concerned with the interior and exterior of your building which is referred as home. It includes air purifying, automated window glasses, smart doors etc.
- Energy System:** In this category, focus is on efficient energy consumption like heat and weather resistant walls, windows, and roofs. Deploying solar panels to provide

enough power supply to fulfil the entire needs of electricity.

- c. *Security*: This category covers the security related issues of your building to be automated like to ensure the authorized entry to your home smart locks are used.
- d. *Electronic Appliances*: This category holds the necessities of your home related to electronic appliances which include smart TVs for entertainment, intelligently working cleaning agents, smart refrigerators, smart baking ovens and many more.
- e. *Smart Furniture*: This work is not popular yet, it is an evolving field because slowly its gaining interest of people. Smart beds, smart mirrors which act like skin specialists and smart washrooms which maintain water temperature.

## II. RELATED WORK

The remotely control and management of your home appliances from anywhere in this big wide world is the actual charisma of the Home Automation system. IoT based smart automated home can efficiently help in saving cost and energy. Automating lights, air conditioners, geezers and others electronic devices refers to automating your home. Smart trail room in malls, smart clothes changing and may ideas be already proposed which are also helpful in further growth in this field. The recent survey of our country has suggested only 11.5% of people are aware of what IoT actually is, from which majority lies between 36 to 55 age group that shows there are high chances of opportunity for common acceptance of IoT based devices. With a few improvements, this field has a bright future such as, lower the prices as it become many affordable to consumers and adaptation increased at large number.

Table I: Related papers with description

Title	Author	Description
Learning IoT: An Intelligent Self Learning System for Home Automation Using IoT	Vishwajeet Hari Bhide, Dr. Sanjeev Wagh [1]	Remote controlled operation and its potential for home automated systems has been described in this paper. It also discussed the problems while implementing those operations, possible solutions using different network technologies and highlighted the ways to optimize the use of automated systems.
Design of Wireless Home automation and security system using PIC Microcontroller	V. Sathya Narayanan1, Gayathri [2]	In this paper the system proposed provides the hardware as well as software architecture, the implementation process is also given. The rapid advancement in the field is electronics has set new ways of development.
A Smart Home Automation Technique with Raspberry Pi using IoT	Vamsikrishna Patchava, Hari Babu Kandala, P Ravi Babu [3]	This paper presents automated designed system for Smart Home with Raspberry Pi technology using IoT. The web application is designed by integrating

		CCTV cameras and sensors which detect motion.
Home automation using IoT and a chatbot using natural language processing	Cyrial Joe Baby, Faizan Ayyub Khan [4]	In this paper, the authors proposed a web-based application that will enable users to control fans, lights, and other electrical appliances over the Internet.

In various recent literatures, the main idea is to combine different technologies together to produce a best outcome possible. As, Christos Stergiou et al. [5] proposed the concept of combining two technologies which are cloud computing and IoT. He showed the improvement in the functionality of IoT with the use of cloud computing. Majid Al-Kowari [6] paid attention on embedding IoT for analyzing data about different home appliances of smart home remotely and to execute commands for them. Trisha Datta et al. [7] presented the library for preserving the privacy to embed traffic management for appliances sharing common resources. Jian Mao et al. [8] improved the quality of ecosystem in a smart home by making advancement in processes for machine learning. Faisal Saeed et al. [9] suggested that sensors detect fire and provide runtime solution with high accuracy and efficiency. IoT [10] is really the secret that makes this whole system work. NY Waterway make the impossible into a reality by taking control of its marine and passengers in a way with the use of wireless networks. So, it revolutionized its applications providing security, energy management, fleet handling, digital signing off, open Wi-Fi, online ticketing and many more [11]. We can improve quality of service up-times, emergency response coordination, incident management and reduce costs of operation in all areas by using IoT devices for operating infrastructure and monitoring [12].

## III. PROPOSED METHODOLOGY

There are lot of methods to control home appliances which are IoT compatible/ converted to IoT, communicated using the cloud server, through Wi-Fi using mobile apps for user interface like smartphone and touch screen-to automate your home. Home automation using wireless technology is an initiative like internet of things developed to remotely control the devise at your home from anywhere in the world using cloud server. It can also be controlled via speech recognition (Amazon Alexa, Google Home, Google Nest and many more) and artificial Intelligence. Artificial Intelligence provides us to configure smart devices in an energy efficient way to optimize it at maximum efficiency by keeping the operations cost at minimal level. It also helps us to collect the data from number of devices to keep track of multiple trends like room temperature, humidity level, energy consumption, operational hours of any devices and working behavior. In home automation there will be multiple devices connected over the IoT like Air Conditioners, washing machine, refrigerator, televisions, home theater systems, lighting, sockets and many more. It can be programmed to perform multiple tasking like just by a single command it can change the room ambiance lighting and play your favorite movie over the home theater.

### A) IoT Transmission Protocol

In network communication, there are some set of rules as per standard adopted by the different communication protocols like TCP/IP or OSI. In their comparison, the IoT architecture has no fixed standard set. To understand the network communication protocol of IoT, here Message Queuing Telemetry Transport (MQTT) protocol is discussed for exchanging data between user and server. It is a very lightweight protocol for sending small messages like alerts generated by system. It has three main components which are Publish, Broker and Subscriber. It provides faster data transfer as compared with TCP/IP protocol. WebSocket based on JavaScript interface, Advanced Message Queuing Protocol (AMQP), Constrained Application Protocol (CoAP), and Node are also used as data transferring protocols. MQTT focuses mainly on data. It is designed using the Publish/Subscribe pattern. It transfers small amount of data of size two bytes with a compact binary header. It provides three levels of quality service. This protocol supports 1 to zero, 1 to 1 and 1 to n data distribution.

Table II: Comparison of MQTT and HTTP protocol

MQTT	HTTP
Transfer data in Binary form	ASCII/Text
It is a lightweight protocol	Complex
Asynchronous	Synchronous
Publish/Subscribe	Request/Response

### B) Architectural layers

There are 5 level of IoT Architecture [13].

1. Business Layer
2. Application Layer
3. Perception Layer
4. Transport Layer
5. Processing Layer

Table III: Comparison of TCP/IP, OSI and IoT Layers

TCP/IP Layers	OSI Layers	IoT Layers
Application	Application	Application
	Presentation	Business
	Session	Perception
Transport	Transport	Transport
Network	Network	Processing
Data Link	Data link	
Physical	Physical	

**Business Layer:** This layer is not widely used by home appliances to ensure safety and data privacy. Any devices which are working in a large-scale environment, business layer is used there. For example, to provide online monitoring or controlling a large network of devices at the backend. This layer monitors the working of system as per design including general operations and health monitoring of devices.

**Application Layer:** Application layer is playing a major role to provide an end user to interact with the appliances to manage and customize it as per requirement. Entire IoT system can be managed by the application. This is being a front face of the complete architecture.

**Perception Layer:** This layer senses the data from the environment using several sensors which temperature could be, current, voltage logs, humidity level, lux level and many more data required by the appliances depending upon their functionality to take feedback from the surroundings.

**Transport Layer:** The information received from the perception layer is collected here and transported that data for processing to the microcontrollers. The medium can be WIFI, 4G, LAN or Bluetooth depending upon the network design and feasibility of the system. It is a gateway between sensors and processors.

**Processing Layer:** It processes the data as per the user's requirement received from transport or application layer, analyses, store, computation over the cloud or server depending upon infrastructure and respond accordingly.

### C) Microcontroller

IoT is providing us a gateway of communication between sensors, actuators, storing the data over the cloud but there is a device responsible of executing all the task as per design methodology. This task is performed by microcontrollers. Microcontrollers are the integrated Circuit designed to perform task as per end user requirement. It provides us the feasibility to interface with sensors (Both analogue & digital), Actuators and other communication devices through serial communication. There general-purpose input/ Output (GPIO) consists of Digital ports, analogue ports, serial communication ports and Pulse width Modulation ports. Microcontrollers provide us the feasibility to be installed in any device because of its compact design and wide range of availability depending on number of interface and memory. It consists of microprocessor, Clock, EPROM all embedded in a single IC.



Fig. 2 [15]

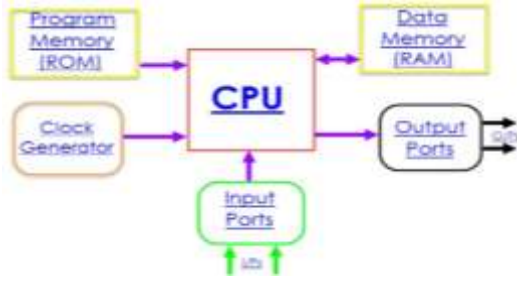


Fig. 3 [16]

There is wide application of microcontrollers currently widely adopted by millions of electronic devices program to perform task efficiently.

D) ESP 8266

Microcontrollers can easily be interface with Wi-Fi module over a serial communication to develop IOT architecture. As this architecture was widely adopted by number of companies, engineers come up with a solution of developing an IC integrated with microcontroller and WIFI known as ESP8266.

ESP8266 provide embedded WIFI solution to meet market demand. It is highly effective, Energy Efficient, and compact in size so that it can easily be integrated in any device. It can work as a standalone hardware (Master) or as a secondary device (Slave) like integrated with other microcontrollers so that equipment can continue to work as per their user requirement and ESP8266 provide us the feasibility to interface with cloud storage and boost up that hardware to work with high efficiency based on feedback received from number of sensors and data store over the cloud.

ESP8266 consist of integrates antenna, Signal amplifier, Filters, and power modules. The compact design of this IC Minimizes the PCB size and requires minimal external circuitries.

E) Pin Layout

ESP 8266 is 4.95 x 4.95-millimeter IC consist of 32 pins. Each pin has a specific task which are consist of GPIO, communication ports, power ports, status signals and antenna.

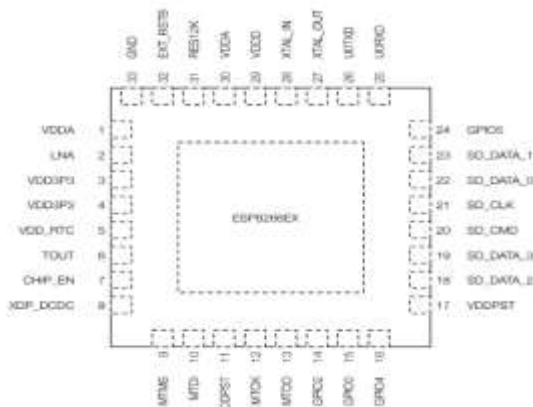


Fig. 4 [17]

There is total 17 GPIO, s which can be program to perform different functions with embedded 10 bit analogue to digital converter.

F) Functional Diagram

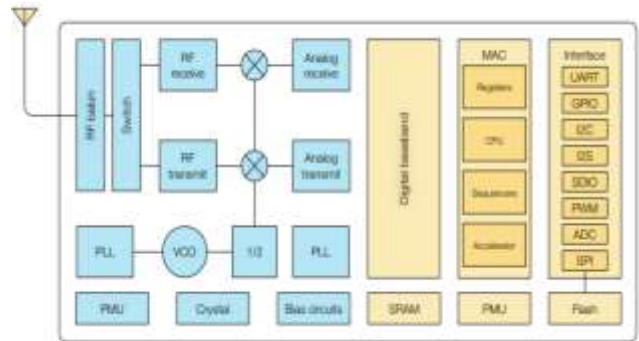


Fig. 5 [17]

ESP8266 consist of 32-bit CPU design to reach clock speed of 160 MHz at low power consumption. Internal Flash memory consist of 1 MB and can be extendable to 16 MB. High frequency clock is used to perform serial communication having a crystal frequency range of 24 MHz to 52 MHz

Its WIFI implement TCP/IP protocol and support 802.11b/g/n up to 72.2 Mbps of data rate, up to 20.5 dBm transmitting power. It applies low level protocol having 2 virtual Wi-Fi interface, BSS mode, SoftAp, Request to send, clear to send and acknowledgement.

G) Electrical Characteristic

IC operate at minimum voltage of 2.5 V to max 3.3V have a driving current of 170 mA measured at 3.0 volt at ambient temperature which make it a big success of widely adopting by an industry. Today this IC is widely used in millions of devices either smart Led bulbs or a luxury Sedan.

IV. VALIDATION

Home Automation provides the user with an automated system having an interface based on Internet of Things that means system can be accessed and controlled remotely. Home Automation refers to the control of home appliances by remote control and automated the modern houses through the internet. With the help of Wi-Fi modems user commands will be obtained over the internet. The Microcontroller used in this modem which can control and managed all the home appliances. IoT has changed every person life therefore everyone is talking about IoT which is second most thing in the technology's world. The number of users connected with the IoT based systems is numerously increased by the current year and it is still growing, because the new lines of service and business models are being introduced.

IoT is widely adopting by number of companies and there are lot of device readily available in market which are IoT configured by default. After number of technologies advancement, IoT proved itself to be an energy efficient and cost effective in terms of adopting and operations. Our Smartphones are by default automated and now we can integrate number of devices just by a single click.

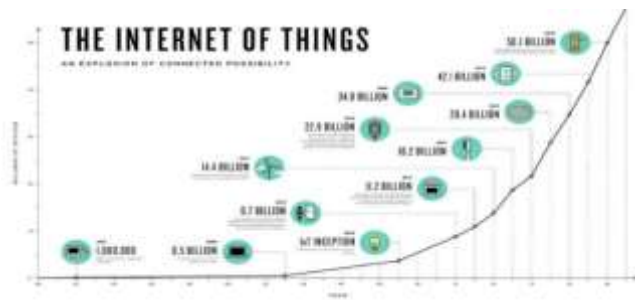


Fig. 6: Growth of IoT

In future, there will be rapid growth in devices having internet connectivity. In total, there will be immense increase in number of devices connected to the internet by the present time. The future of the way businesses interacts with the physical world will be based on IoT. It will contain huge potential and capabilities for streamlining and optimizing the business work leading to better profit margins and success. By some estimate, global IoT revenue will shoot to nearly \$ 7.1 trillion by 2020. Nearly \$ 6 trillion will be spent on IoT solution in next 5 years.

## V. CONCLUSION

The technology provides various benefits such as reduces energy consumption, minimizes error probability, ease of access and low cost and power, can reduce human effort, smarter processing and services, can be implemented at any device and automated, alert system is quick in case of an emergency, helps old age people to control simple interface.

Along with the above-mentioned advantages this technology also has some drawbacks as replacing humans is dangerous, it may take time in learning, preaches security concerns, vulnerable to attack, restricted range, high dependency on sensor devices which makes the system vulnerable if sensor fails.

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