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Review Article

The Internet of Things (IoT): Features, Application Grounds, Technologies and Protocols

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Abstract
The word "IoT" has undergone significant evolution due to the confluence of several technologies, such as commodity sensors, embedded systems, and machine learning. IOT is a network of networked, interconnected devices that have been given unique identifiers (UIDS) to facilitate data transfer and device control. It lessened the need for direct human engagement when using a technology. IOT is an advanced automation and analytics system that uses big data, artificial intelligence, networking, sensing, and sensing technologies to supply entire systems for a good or service. When used in any system or industry, these systems enable increased performance, control, and transparency.

Keywords: Internet of Things, Technological and Protocols, Advantages, Features, Application Grounds, Security Systems.

I. INTRODUCTION
The idea of the Internet of Things (IOT) is that every device has an IP address, which anyone may use to identify that item on the internet. Unique identifiers (UIDs) and network data transmission capabilities are offered to mechanical and digital machines, eliminating the need for human-to-human or human-to-computer interaction. It was essentially founded as the "Internet of Computers." Studies have predicted that the number of "things" or gadgets connected to the Internet will increase dramatically. The "Internet of Things" (IoT) is the name of the resulting network. The recent developments in technology that permit the use of wireless controlling environments like Bluetooth and Wi-Fi have enabled different devices to have the capability of connecting with each other. Using a WiFi shield to act as a micro-web server for the Arduino eliminates the need for wired connections between the Arduino board and computer, which reduces cost and enables it to work as a standalone device. The Wi-Fi shield needs a connection to the internet from a wireless router or wireless hotspot, and this would act as the gateway for the Arduino to communicate with the internet. With this in mind, an internet-based home automation system for remote control and observing the status of home appliances is designed. Due to the advancement of wireless technology, several different types of connections have been introduced, such as GSM, WIFI, and BT. Each of the connections has its own unique specifications and applications. Among the four popular wireless connections that are often implemented in HAS projects, WiFi is being chosen for its suitable capability. The capabilities of WiFi are more than enough to be implemented in the design. Also, most current laptops, notebooks, and smartphones come with built-in WiFi adapters. It will indirectly reduce the cost of this system. The concept of “home automation” has been in existence for several years. “Smart Home” and “Intelligent Home” are terms that have been used to introduce the concept of networking appliances within the house. Home automation systems (HASs) include centralized control and distance status monitoring of lighting, security systems, and other appliances and systems within a house. HASs enables energy efficiency, improves security systems, and certainly increases the comfort and ease of users. In the present emerging market, HASs is gaining popularity and has attracted the interests of many users. Hass comes with its own challenges. Mainly, in the present day, end users, especially the elderly and disabled, even though they have huge benefits, aren’t seen to accept the system due to the complexity and cost factors.

II. RELATED WORKS

Satyendra et al. (2020) developed a smart energy-efficient home automation system using IOT. It uses IOT to convert home appliances into smart and intelligent devices with the help of design control. An energy-efficient system is designed that accesses the smart home remotely using IOT connectivity. The proposed system mainly requires Node MCU as the microcontroller unit, IFTTT to interpret voice commands, Adafruit, a library that supports MQTT, to act as an MQTT broker, and Arduino IDE to code the microcontroller. This multimodal system uses Google Assistant along with a web-based application to control the smart home. The smart home is implemented with a main controller unit that is connected to a 24-hour Wi-Fi network. To ensure that the Wi-Fi connection does not turn off, the main controller is programmed to establish an automatic connection with the available network and connected to the auto-power backup.

Tui-Yi et al. (2019) proposed an energy management algorithm for a home sensor network for a home automation system. Their work proposes an optimization of home power consumption based on PLC (Power Line Communication) for easy access to home energy consumption. This also proposes a Zigbee and PLC-based renewable energy gateway to monitor the energy generation of renewable energies. The ACS and DDEM algorithms are proposed for the design of an intelligent distribution of power management systems to ensure the ongoing power supply of home networks. To provide efficient power management, the power supply models of the home sensor network are classified into four groups: main supply only, main supply and backup battery, rechargeable battery power, and non-rechargeable battery power. Devices with particular features are assigned to these groups. It targets establishing a real-time processing scheme to address variable sensor network topologies.

Tushar Churasia and Prashant Kumar Jain. (2019) developed a model to reduce the computation overhead in existing smart home solutions that uses various encryption technologies like AES, ECHD, hybrid, etc. These solutions use an intermediate gateway for connecting various sensor devices. The proposed model provides a method for automation with sensor-based learning. The system uses a 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 operate without human intervention. This work minimizes encryption and decryption and focuses on authentication and automation of smart home devices with learning. The system bypasses the local gateway mentioned in the existing system to provide better security for smart home devices and sensor data and save computation overhead. The real-time broker cloud is directly connected to Smart Home and manages all incoming and outgoing requests between users and devices. The main purpose of using the real-time broker cloud is to save time on cryptographic operations.

Suraj et al. (2020) designed a visual machine intelligence system for home automation. The proposed method of sensing the state of appliances results in a novel home automation system. The accessibility of the suite of devices in the home over a remote network is facilitated by the IP-addressing methods in the IOT. This project uses two boards, viz., the Raspberry Pi and the Intel Galileo Gen 2. The communication between the user devices, the Raspberry Pi, and the Intel Galileo boards happens over a wireless network. The UDP protocol is deployed to facilitate the wireless communication of the nodes present in the home automation network. A Pi Cam and a USB Logitech camera attached to the rotating shaft of two different servo motors capture snapshots that are passed as inputs to the machine learning-based models trained using dlib-C++ to detect the state of the operation of the appliances. The proposed method uses visual modality to automate the appliances, as privacy concerns may emerge while using the images from some specific places. As a counter to this issue, an SPDT switch is added to the Raspberry Pi, which, when turned off, ensures that even if the images are taken from the webcams, they are just passed as inputs to the machine learning models and are not displayed on the website when the users access the website on the server address obtained from the Raspberry Pi.

Paul et al. (2021) developed a voice-controlled home automation system using natural language processing and the Internet of Things. A fully functional voice-based home automation system that uses the Internet of Things, artificial intelligence, and natural language processing (NLP) to provide a cost-effective, efficient way to work together with home appliances using various technologies such as GSM, NFC, etc. was designed. It implements a seamless integration of all the appliances into a central console, i.e., the mobile device. The prototype uses an Arduino MK1000, known as the Genuino MK1000. The NLP in this project gives the user the freedom to interact with the home appliances with his or her own voice and normal language rather than complicated computer commands. The appliances are connected to the mobile device through an Arduino board that establishes the concept of the Internet of Things. The Arduino boards are interfaced with the appliances and programmed in such a way that they respond to mobile inputs.

III. FEATURES OF INTERNET OF THINGS

1. Intelligence:

IOT is intelligent because it combines hardware, software, and algorithms with compute. IOT's ambient intelligence improves its capabilities, enabling objects to respond intelligently to a given circumstance and assist in completing specified activities. Despite the widespread usage of smart technologies, the term "intelligent" in the context of the Internet of Things refers solely to a method of communication between devices; graphical user interfaces and standard input techniques are used to do this.

2. Connectivity:
By connecting commonplace devices, connectivity enhances the capabilities of the Internet of Things. The importance of these objects' connectedness lies in the fact that even basic interactions among them foster the IOT network's collective intelligence. It makes networks compatible and accessible. The networking of smart objects and apps can open up new markets for the Internet of Things with this connectivity.

3. Dynamic Nature:
The gathering of environmental data is the Internet of Things' main function. The dynamic changes that occur around the gadgets help to achieve this. These devices' states fluctuate dynamically, for instance, when they are connected or not, sleeping or waking up, and in different contexts with respect to temperature, location, and speed. The quantity of devices varies dynamically with the person, place, and time in addition to the device's status.

4. Enormous Scale:
Compared to the number of devices already connected to the Internet, there will be a significant increase in the number of devices that need to be managed and communicate with one another. It becomes more important to handle the data produced by these devices and understand it for use in applications. The large scope of IOT is confirmed by Gartner (2015) in their anticipated research, which states that 6.4 billion connected items will be in operation worldwide in 2016, up 30% from 2015, and that 5.5 million new things will get linked every day. According to the research, there will be 20.8 billion linked devices by 2020.

5. Sensing:
Without sensors that can measure or detect changes in their surroundings and produce data that can be used to report on their status or even interact with the environment, the Internet of Things would not be conceivable. The ability to develop capabilities that represent a true understanding of the physical world and the people in it is made possible by sensing technology. Although the sensing data is just an analog input from the outside world, it can nonetheless provide us a deep insight of our intricate reality.

IV. ADVANTAGES OF IOT

1. Communication:
IOT encourages communication between devices, also famously known as machine-to-machine (M2M) communication. Because of this, the physical devices are able to stay connected, and hence total transparency is available with lesser inefficiencies and greater quality.

2. Automation and Control:
Due to physical objects getting connected and controlled digitally and centrally with wireless infrastructure, there is a large amount of automation and control in the workings. Without human intervention, the machines are able to communicate with each other, leading to faster and more timely output.

3. Information:
It is obvious that having more information helps make better decisions. Whether it is mundane decisions like needing to know what to buy at the grocery store or if your company has enough widgets and supplies, knowledge is power, and more knowledge is better.

4. Monitor
The second most obvious advantage of IOT is monitoring. Knowing the exact quantity of supplies or the air quality in your home can further provide more information that could not have previously been collected easily. For instance, knowing that you are low on milk or printer ink could save you another trip to the store in the near future. Furthermore, monitoring the expiration of products can and will improve safety.

5. Time
As hinted in the previous examples, the amount of time saved because of IOT could be quite large. And in today's modern life, we all could use more time.

V. DISADVANTAGES OF IOT

1. Compatibility
Currently, there is no international standard of compatibility for the tagging and monitoring equipment. I believe this disadvantage is the easiest to overcome. The manufacturing companies of this equipment just need to agree to a standard, such as Bluetooth, USB, etc. This is nothing new or innovative.

2. Complexity
As with all complex systems, there are more opportunities for failure. With the Internet of Things, failures could skyrocket. For instance, let's say that both you and your spouse each get a message saying that your milk has expired,

and both of you stop at a store on your way home, and you both purchase milk. As a result, you and your spouse have purchased twice the amount that you both need. Or maybe a bug in the software ends up automatically ordering a new ink cartridge for your printer each and every hour for a few days, or at least after each power failure, when you only need a single replacement.

3. Privacy/Security

With all of this IOT data being transmitted, the risk of losing privacy increases. For instance, how well encrypted will the data be kept and transmitted? Do you want your neighbors or employers to know what medications you are taking or your financial situation.

4. Safety

Imagine if a notorious hacker changed your prescription. Or if a store automatically ships you an equivalent product that you are allergic to, a flavor that you do not like, or a product that is already expired. As a result, safety is ultimately in the hands of the consumer, who must verify any and all automation. As all household appliances, industrial machinery, public sector services like water supply and transport, and many other devices are all connected to the Internet, a lot of information is available on it. This information is prone to attack by hackers. It would be very disastrous if private and confidential information was accessed by unauthorized intruders.

5. Lesser Employment of Menial Staff

The unskilled workers and helpers may end up losing their jobs as a result of the automation of daily activities. This can lead to unemployment issues in society. This is a problem with the advent of any technology and can be overcome with education. With daily activities getting automated, naturally, there will be fewer requirements for human resources, primarily workers and less educated staff. This may create an unemployment issue in society.

VI. APPLICATION GROUNDS OF IOT

1. Wearables

Wearable technologies are a hallmark of IOT applications and are one of the earliest industries to have deployed IOT in its services. Fit Bits, heart rate monitors, smartwatches, and glucose monitoring devices reflect the successful applications of IOT.

2. Smart homes

This area of application is concerned with this particular project, so a detailed application is discussed further. Jarvis, an AI home automation employed by Mark Zuckerberg, is a remarkable example in this field of application.

3. Health care

IOT applications have turned reactive medical-based systems into proactive wellness-based systems. IOT focuses on creating systems rather than equipment. IOT creates a future of medicine and healthcare that exploits a highly integrated network of sophisticated medical devices. The integration of all elements provides more accuracy, more attention to detail, faster reactions to events, and constant improvement while reducing the typical overhead of medical research and organizations.

4. Agriculture

A greenhouse farming technique enhances the yield of crops by controlling environmental parameters. However, manual handling results in production loss, energy loss, and labor costs, making the process less effective. A greenhouse with embedded devices not only makes it easier to be monitored but also enables us to control the climate inside it. Sensors measure different parameters according to the plant requirements and send them to the cloud. It then processes the data and applies a control action.

5. Industrial Automation

For a higher return on investment, this field requires both fast developments and quality products. This vitality thus coined the term IIOT. This whole schematic is re-engineered for IOT applications. Following are the domains of IOT applications in industrial automation.

- Factory Digitalization
- Product flow Monitoring
- Inventory Management
- Safety and Security
- Quality Control
- Packaging optimization
- Logistics and Supply Chain Optimization
- Government and Safety

IOT applied to government and safety allows for improved law enforcement, defense, city planning, and economic management. The technology fills in the current gaps, corrects many current flaws, and expands the reach of these

efforts. For example, IOT can help city planners have a clearer view of the impact of their designs and governments have a better idea of the local economy.

VII. Technologies and Protocols

Several communication protocols and technologies cater to and meet the specific functional requirements of IOT systems.

1. Bluetooth

Bluetooth is a short-range IOT communication protocol and technology that is profound in many consumer product markets and computing. It is expected to be key for wearable products in particular, again connecting to the IOT, albeit probably via a smartphone in many cases. The new Bluetooth Low-Energy (BLE)—or Bluetooth Smart, as it is now branded—is a significant protocol for IOT applications. Importantly, while it offers a similar range to Bluetooth, it has been designed to offer significantly reduced power consumption.

2. Zigbee

ZigBee is similar to Bluetooth and is mostly used in industrial settings. It has some significant advantages in complex systems, offering low-power operation, high security, robustness, and high reliability, and is well positioned to take advantage of wireless control and sensor networks in IOT applications. The latest version of ZigBee is the recently launched 3.0, which is essentially the unification of the various ZigBee wireless standards into a single standard.

3. Z-Wave

Z-Wave is a low-power RF communications IOT technology that is primarily designed for home automation for products such as lamp controllers and sensors, among many other devices. A Z-wave uses a simpler protocol than some others, which can enable faster and simpler development, but the only maker of chips is Sigma Designs compared to multiple sources for other wireless technologies such as ZigBee and others.

4. Wi-Fi

Wi-Fi connectivity is one of the most popular IOT communication protocols and is often an obvious choice for many developers, especially given the availability of Wi-Fi within the home environment within LANs. There is a wide existing infrastructure as well as fast data transfer and the ability to handle large quantities of data. Currently, the most common Wi-Fi standard used in homes and many businesses is 802.11n, which offers a range of hundreds of megabits per second, which is fine for file transfers but may be too power-consuming for many IOT applications.

5. Cellular

Any IOT application that requires operation over longer distances can take advantage of GSM/3G/4G cellular communication capabilities. While cellular is clearly capable of sending large quantities of data, especially for 4G, the cost and power consumption will be too high for many applications. But it can be ideal for sensor-based low-bandwidth-data projects that will send very low amounts of data over the Internet.

6. NFC

NFC (Near Field Communication) is an IOT technology. It enables simple and safe communications between electronic devices, specifically smartphones, allowing consumers to perform transactions in which one does not have to be physically present. It helps the user access digital content and connect electronic devices. Essentially, it extends the capability of contactless card technology and enables devices to share information at a distance that is less than 4 cm.

Conclusion

Many recent papers about the internet of things have been reviewed for this research. Their benefits, drawbacks, features, technical protocols, and areas of use on the internet of things have all been observed.

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