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Review Article

Internet of Things: Its Dimensions in Library World

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A B S T R A C T

In the age of information, libraries are playing a very essential role in providing information in the shortest period of time. Although the use of ILMS (Integrated Library Management System) has been widely adopted across the world, so many challenges exist in the understanding of accurate calculations of user behaviour and inventory management. The Internet of Things (IOT) can play a major role in advancing libraries for the sharing of valuable information all around the world. RFID (Radio Frequency Identification) is the primary step in implementing IOT in applications in libraries. This article gives in-depth information on the basics, framework, communication methods, and applications of technology in various modules of the library. The present and future IOT gadgets will be omnipresent, setting mindfulness and empowering encompassing knowledge. This article also covers the present status of examination on the Internet of Things by looking at the writing, distinguishing the latest things, basic technologies of IOT, models, and portraying difficulties that compromise IOT dissemination, introducing open examination questions, and future bearings.

Keywords: Internet of things (IOT), Radio Frequency Identification Technology (RFID), Electronic label, University Library, Books Management

Introduction

Till recent times most people in today's information world were knowing and used the internet either on their devices such as computers or on mobiles or similar products, irrespective of their operating system, size etc. Thanks to the cheaper availability of the new generation internet that now it is in the grasp of everybody's hand. Reduced prices of gadgets and internet technology made it possible that anybody to be connected simultaneously.

The finding of information is a no more difficult task to normal use of internet technology thus making a true real connected world. With IOT we are one step ahead of the present connected information world. The technology has transformed millions of connected devices into a smarter intelligent systems. As its name appears IOT emphasizes interconnected devices with minimal or no human interventions. Any object of any kind e.g. air-conditioning, Fridge, washing machines etc. can communicate with other objects with help of sensors and network connectivity.

By the use of IOT all-around communication is possible in a multidimensional way, it may be an object to object or object to human or vice versa. In a more developing way, any object even an animal can be connected to a device if sought. An IOT system puts the soul in the devices through a modern interconnected communication system and has completely changed the lives of humans. An environment

known as the Internet of Things (IOT) allows people, animals, and things to be uniquely identified and, as a result, send data over a network without requiring human-to-human or human-to-computer interaction. Microelectromechanical systems (MEMS), wireless technologies, and the Internet have all come together to form the Internet of Things. IOT, which defies expectations that it is not a good idea, shows that the internet will serve more purposes than just connecting people. With a little additional infrastructure and the help of e-component miniaturization, a new global network that will enable devices to communicate electronically on a global scale will emerge. Wireless networking, cloud computing, sensors, and processors make up the technologies and infrastructure involved. lately, In order to give their products intelligence and sensing capabilities to sense, learn from, and interact with their environment, companies are integrating these technologies into consumer electronics. This refers to all interconnected objects of all types of sensing devices, such as global position systems, RFID infrared sensors, scanners, and other possible devices embedded in them.. Once connected, new objects can talk and think to each other and with the help of a network, they can communicate with humans and thus humans can control them anytime, anywhere from any location. The term "Internet of things" was formally established at the Tunis world summit on the information society (WSIS), the international telecommunications union. "The Internet of things is the concept of connecting any device (so long it has an on/off switch) to the internet and other connected devices. The IOT is a giant network of connected things and people all of which collect and share data about the way they are used and the environment around them." (Jan Clark). Another definition defines IOT as "A dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols, where physical and virtual things have identities. Integration of WSN with IOT applications: A vision, architecture, and future challenges".[1] Bajaj have revealed the key barriers to implementing this technology in any field. The sensors and their features have been discussed in detail. The connectivity among devices and objects plays a key role while implementing IOT in a wireless environment.

"Internet of things: The beginning of a new era for libraries"[2] Bansal has described several key areas of library administration services where IOT has emerged as a one-step-ahead solution in patron services despite some technical glitches. In a fantastic analysis.[3] Xie explored in his study "An IOT-based risk warning system for smart libraries" how safety standards of the construction industry can be applied in the risk management of libraries. The system makes library managers competent that how they can implement safety standards of the construction industry for monitoring equipment, personnel and materials in a real-time framework. The newest advancement might be to sort out all present barriers in the near term. Sheeja & Susan explored[4] that standardization of services is a great dispute in the adaptation of IOT in libraries. They also found many challenges at the application level including safety. Safety has been a major challenge for libraries and related activities. The same concerns have been raised in the paper "Libraries in the Internet of Things (IOT) era" Systems, methods and algorithms are making IOT systems pervasive and RFID is playing a key role in the delivery of services in an IOT environment.[5] In the article "The internet of things: Mobile technology and location services in libraries' ' Hahn had done a case study at the University of Illinois. The study went deep inside to explore the outcomes of the two technologies' blending. The Bluetooth low-energy beacons along with mobile technology are perhaps the best-integrated technology in implementing IOT at the initial level. In this case, study Beacons are playing a major role in providing real-time location access and resource suggestions. This paper explored methods that can integrate IOT technologies as an academic library in the real world. An excellent example of IOT implementation is that in an integrated academic library system, a location-based recommendation suggests E-Resource (E-Book, e- JL) with the coherence of books available with stacks.[6]

Beyani and others have dreamt of a global research process through IOT. The paper has investigated IOT uses in libraries at Global pretext. The well-connected IOT system comprising data acquisition, database systems, and cloud computing will transform the idea of a global library into reality. IOT can tie distributed libraries and information centers into Global Research entities[7]

Before IOT linking with multiple physical, and virtual attributes and things were almost impossible.[8] "The IOT has brought a plethora of changes in library services and it is the next big change after the internet".[9]

Main characteristics of an IOT system

Three major components form the basis for the architecture of IOT:

- **Hardware:** It is composed of various sensing nodes, an embedded communication system and different interfacing circuitry.
- **Middleware:** It involves the storage of data, analysis and handling of various resources.
- **Presentation layer:** It involves proficient visualization tools which are attuned to diverse platforms for diverse applications and present the data to end-user in a comprehensible form.

Features of IOT Systems

Unique Identity

An IP address or a URL (uniform resource locator) makes an IOT device unique in a connected system. Through a properly set-up mechanism, an IOT device can communicate with each other and with its users in a given context of the environment. A user can put in a query, check remotely or monitor the status, and control an IOT system.[10]

Self- adopting

In a self-sustaining, robust IOT system, self-adoption is one of the essential characteristics. In a dynamic environment, the system should be self-calibrated in a new context. For example, if any IOT system is being used in a library for surveillance, the camera should adopt the way of operating based on the requirement. Cameras should be switched between normal and infrared according to local requirements. Similarly, if any motion is detected, the camera should transfer from a lower to a higher resolution.

Self- Configuring

When an IOT system is configured well, it automatically fetches the latest software update for a large number of devices installed across many areas with minimal intervention.

Integration with Network

A properly calibrated and configured IOT system exchanges data with other devices and networks. It automatically explored the available network and other devices. For example, a surveillance system can describe its surveillance capability to other devices for exchanging data. Specific integration ability makes a true IOT device smarter in a given network.

IOT Framework

Based on serving different commercial objectives, several types of frameworks are available that meet the diversified needs of clients. A framework works between sensors, actuators, and cloud servers to enable secure communication using defined protocols. ka Although various commercial as well as open-source frameworks are available these days, libraries have always been inclined towards open-source platforms due to economical constraints and greater interoperability.

Great scalability and flexibility are key reasons behind adopting open-source platforms, yet it is the choice of customers eventually.

Frameworks can be chosen according to specific requirements, but the following attributes make them ideal:

- Scalability
- Reliability
- Customization
- Protocols
- Cloud technology
- Hardware support

The robust interoperability connection is an embedded feature of an open-source framework. Even though various open-source and commercial frameworks are in use these days, the following five open-source frameworks are widely used by users today.

- Thingspeak
- Devicehive
- Mainflux
- Thinger: IO
- Zatta

Basic Thing speak IOT Framework

A typical IOT system works on certain predefined protocols (figure 1).

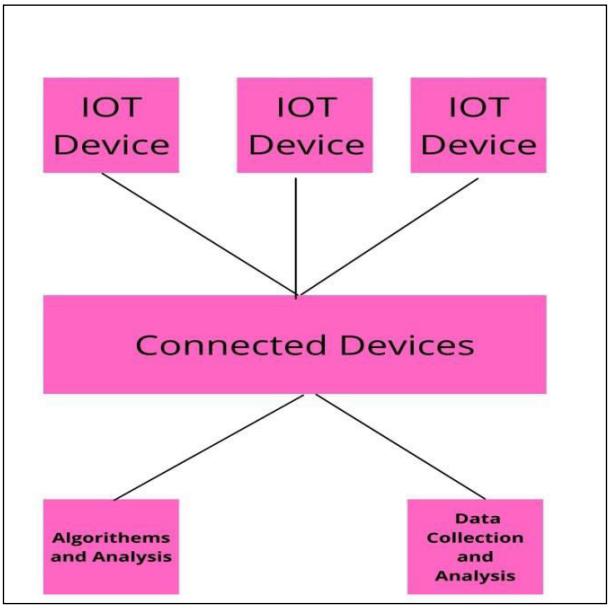

Figure-1 Internet of Things: Protocols

Link Layer

The physical transport of data via various channels is guaranteed by the link layer. For instance, copper wire, coaxial cable, or radio waves. The associated hardware device's coding and transmission of data packets to the potential host are controlled by the link layer. Some popular link protocols are here Table 1.

Table 1.Table outlines popular link layer protocols and their corresponding methods, including 802.11 (WIFI) and 802.3 (ETHERNET)

Protocol	Method
802.11	WIFI
802.3	ETHERNET

Network and Internet Layer

From the source network to the destination network, the network layer is key. It ensures host addresses and traffic routing. Utilise strategies for hierarchical IP addresses to access various networks. The common and most popular layers are.

IPV4

In recent years, Internet Protocol version 4 has become the most widely used protocol. It connects to 232-bit or 4294967296 addresses using a 32-bit address. This protocol ran out in 2011 because of the rising demand for IOT connections, and IPV6 finally took its place. Although the IPV4 set of protocols functions wonderfully with packet networks, it cannot ensure packet delivery.

IPV6

This system is the next generation of IPV4 protocols. It supports 2128 or 3.4*1038 addresses and employs a 128-bit algorithm.

LOWPAN

The LOWPAN technology was chosen by devices with weak processing power, notably in the 2.4 GHz frequency band. It supports 250 kb/sec of data transmission.

Transport Layer

All issues with message segmentation, flow control, error control,and other network layer issues have been resolved by the transport layer protocol. An end-to-end message transport facility is offered by this layer of the protocol, which operates independently from the underlying network.

This protocol's two primary features are:

1. Sending unacknowledged messages (TCP)
2. Messages that Acknowledge (UDP)

Application Layer

Data in the bottom layer (for example, the transport layer) is sent over the network using this layer. The transport layer encrypts and encapsulates an application layer protocol. The application layer includes the port number. For instance, port 22 is for SSH and port 80 is for HTTP. HTTP (Hypertext Transfer Protocol), COAP (Constrained Application Protocols), XMPP (Extensible Messaging and Presence Protocol), and DDS (Data Distribution Source) are the most commonly used application layer protocols.[11]

Internet of Things: Communication Models

Request-Response Model

This type of communication operates on its own. When a server hears a client request, it retrieves the information, gets ready, and responds appropriately. Usually, it is a stateless communication model.

Push-Pull Model

The model places a lot of emphasis on message queuing; for many queued messages, consumers retrieve data from queues. The requirements of the consumer are not always known by the data's creator. The numerous messages in the queue serve as a buffer and are quite helpful. However, there may be a rate differential while transmitting from both sides (producer and consumer).

Publish-Subscribe Model

Selective message dissemination is the foundation of this communication approach. Typically, the producer of the data creates the data and gives it to the broker (a middle device). To meet such demands, a broker determines what information is required.

Exclusive Pair

A committed duplex way of communication works bi-directionally between server and client. The hierarchy is that it supplies information until requests are generated, and both client and server interchange the information exclusively with each other. The server exclusively works independently with all open connections.

Internet of things: Prerequisite

Some essential prerequisites need to be adopted before applying for IOT applications. This is:

1. A system needs to be able to accommodate several user requirements at once. Broadly stated, scalability is one of the most important criteria, especially in a library where a huge number of materials and users may be active at some point. The system should be flexible, self-optimising, and adaptable, in addition to being scalable.
2. The IOT application frequently provides consumers with tailored services. Therefore, it must be intelligent, self-sufficient, and capable of making the chosen decisions.
3. A good IOT application should have little latency, as smart technology keeps latency rates to a minimum. The fourth law of library science, "save the time of the user," is fulfilled when a delay is decreased or lowered.
4. An IOT application in the context of a library gathers a lot of data about a user and utilises patterns in addition to associated information with an item; thus, there should be open and honest privacy rules in place when using this technology.

IOT Application in Libraries

Libraries across the world, and notably those in India, have gone a long way to address issues with information management. The proportion of automated libraries in India is still a riddle. A small number of automated libraries in India are developing self-service frameworks. Since an IOT

application can be accessed from any distant place, it may create dissemination and control. IOT can provide smart services to users, as well as a range of self-service modes like self-inventory, self-borrowing, automated inventory, etc. It is a much more important technology that contributes to the goal of libraries. The major areas of IOT application in libraries are:

1. **Smart Monitoring:** Monitoring collections and users is one of the libraries' most challenging duties. Another crucial problem for contemporary information scientists is the rational use of the collection with an objective. IOT can create, integrate, evaluate, and report on billions of events and alerts in addition to creating them. Monitoring a dynamic system and process is made simple by IOT.
2. **Real-Time Resource Location:** Although location access is already streamlined by library automation systems, it is based on the call number, so it will be rather difficult for readers to find their desired resource if a patron cannot understand cell number-based location identification. In this case, IOT may play a significant role by directing the patron to the precise place. An audio- or video-based shelf guide might make the task easier. IOT therefore nurtures and promotes the fourth law of the library, which is to "save the time of users".
3. **Preferred Literature:** The machine learning era, which often results from difficult algorithmic equations and user behaviour, performs quite well in the IOT context. IOT may provide suggestions that are specific to users based on their historical borrowing habits. The method proposes readers for works with shared features. The IOT makes recommendations for other relevant materials that may be of interest to the user.
4. **Resource Optimization:** IOT can provide real data on available resources and humans present in the library. IOT may be a true paradigm shift for libraries when it comes to efficient resource use. It may simultaneously pamper the facilitator and the client. Libraries may have to deal with situations when resources are partially or inadequately exploited. The most effective man-machine combo can function cleverly, according to genuine data reports. The facilitator has decision-making authority over the supply of human hands and the usage of electronic gadgets.
5. **Financial Task:** IOT may provide users with a variety of financial tasks. Users can pay membership dues, penalties, and fees for additional services like photocopying, plagiarism checking, or downloading legitimate papers. An effective IOT system can provide a distinctive system history for libraries. Additionally, it is simple to track the financial allotment for the collection that requires special attention.
6. **Resource Availability:** Overcrowded libraries frequently have trouble controlling crowds, especially at busy times. An effective IOT system can ensure that resources are available in the library. For instance, a reader may quickly determine if a computer system is empty at the time of his choosing or whether there is enough room in the building to accommodate additional users during a specific period.

By using a mobile app, libraries may provide their patrons with a virtual borrower's card that allows them access to the physical location and all of its services. The library app installed on the user's mobile device will display a map of the library, directing them to the location of the resource(s) when they access the library catalogue to locate the desired resource(s). Linking to a website like Amazon may also provide additional information on a resource, allowing the individual to research it all before borrowing it.

Conclusions

The library world has been greatly impacted by quick technological transformation. IOT technology may be used effectively to address the large transactional volume of services, quick customer service, rapidly changing user interests, real-time analysis, and global research that may be processed by utilising IOT services that are globally networked. The availability of inexpensive hardware and the development of newer technology are encouraging the widespread use of IOT in modern libraries. More than 20 billion devices were connected by the IOT as of 2020. However, security and privacy are philosophical roadblocks to keeping someone's secrets. Another issue with technology adoption is internet speed, whereas scalability is a crucial component of cost-effective technology adaptation, especially in developing countries like India.

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