

Internet of Things: A Route to Smart Libraries

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Abstract

Internet of things (IoT) is the ubiquitous technology in the present scenario. The possibility of connecting various objects in the library with human–human, thing–human, thing–thing without human interference is possible through these embedded technologies. The artificial intelligence of this kind helps mankind in various aspects in daily life. This paper discusses the concept of IoT applicable to library housekeeping activities. Radio-frequency identification (RFID), wireless sensor network (WSN), WiFi, mobile applications, wearable body sensors paved the way for new trends in the library services. The future is of IoT libraries instead of digital libraries.

Keywords: *Internet of things (IoT), radio-frequency identification (RFID), Cloud computing, smart libraries, digital libraries*

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INTRODUCTION

A tremendous change in the libraries can be found with application of Internet of Things (IoT) in libraries. Infrastructure facilities, resources and shape of the physical libraries will get changed. Physical form of services mixed with new technological trends is definitely helpful to the libraries in rendering valuable services to the users. IoT facilitate the users to communicate with the resources and resources with the users are possible in the library. Physical libraries definitely gain maximum benefits with the changing technology. Users can use their devices and access the data at their own or remotely connect to libraries and read the content. This is the time for the library staffs to upgrade their skills to fulfill the users' needs and to satisfy themselves in serving the users.

HISTORICAL BACKGROUND OF IoT

Around 16 years back, the concept of IoT was known as Embedded Internet or Pervasive computing. The term 'Internet of Things' was coined by Kevin Ashton who used to work in the Procter & Gamble during the year 1999. Ashton was curious in inventing new technology to apply in his work environment,

which paved the way in linking radio-frequency identification (RFID) to the "IoT" as a very important tool [1].

Since year 1990, the usage of internet gained momentum in enterprise and consumer markets with limited use because of stumpy performance of network interconnect. In the year 2000 onwards, internet connectivity became a part of enterprise and industrial products development to provide or to retrieve information on related areas. However, to bring more accuracy human interaction became necessary in dealing with these technologies. The real role of IoT has just started to overcome this hurdle in getting things as per human needs without human interaction. At present the world has deployed 5 billion "smart" connected things; by the year 2020 it may be raised to 50 billion connected devices—we will witness trillion-node network in our life time [2].

DEFINITION OF IoT

According to Kevin Ashton "Today's information technology is so dependent on data originated by people that our computers know more about ideas than things. So far computers used to store data it is time for them

to know about things—using data they gathered without any help from us—we would be able to track and count everything, and greatly decrease waste, failure and expenditure. We would know when things need to replace, repair or recall, and whether they were clean or long-ago their best. We need to empower computers gathering information at their own, so they can see the world in a glorious state. RFID and sensor technology enable computers to view and understand the world—without any human interaction” [3].

According to Gartner, the concept of IoT means “The network of things which contain embedded technology for conversation and interact with their internal states or the external environment” [4]. According to various business houses, IoT is the future of connecting computers to things. CISCO defines it as “IoT is simply the point in time when more things or objects were connected to the Internet than people” [5]. Accenture takes the definition one step ahead by keeping the vast market opportunity of IoT in mind and rephrases it as “Industrial IoT” with the definition “Universe of intelligent industrial products, processes and services that communicate with each other and with people

over a global network” [6]. When we talk about the IoT, we most often mean the Internet of Everything, which Cisco defines as follows: “The Internet of Everything (IoE) brings together people, process, data, and things to make networked connections more relevant and valuable than ever before—turning information into actions that create new capabilities, richer experiences, and unprecedented economic opportunity for businesses, individuals, and countries” [7].

STRUCTURE OF IoT

Different organizations defined different structures as per their requirements for IoT-based products. The basic structure of IoT platform has sensing, communication and application layers. The sensing layer has sensors, RFID, wireless sensor network (WSN), Reader, IP Camera, MEMS etc. in it. The function of this layer is sensing, identification, collection and capturing of information. Network layer is the heart of IoT performing seamless data transmission networking. It consists of IoT data center, IoT control center, 3G/4G networks, WiFi, WIMAX, Zigbee networks and so on. Application layer handles the delivery to the users at large where many applications run [8].

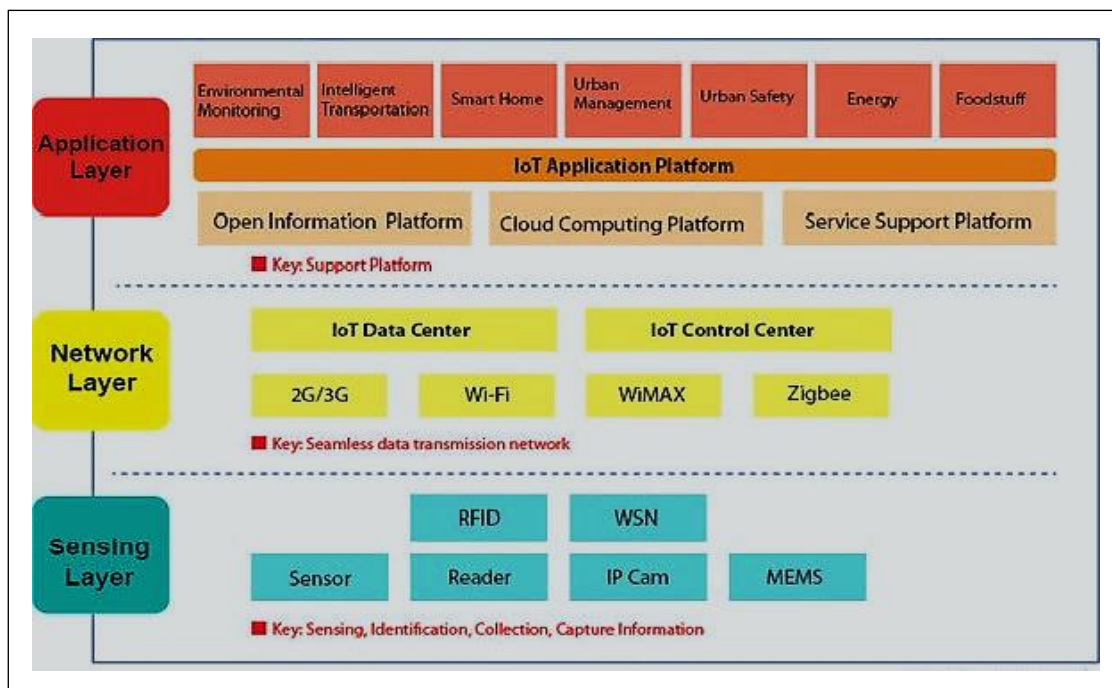


Fig. 1: Structure of IoT [9].

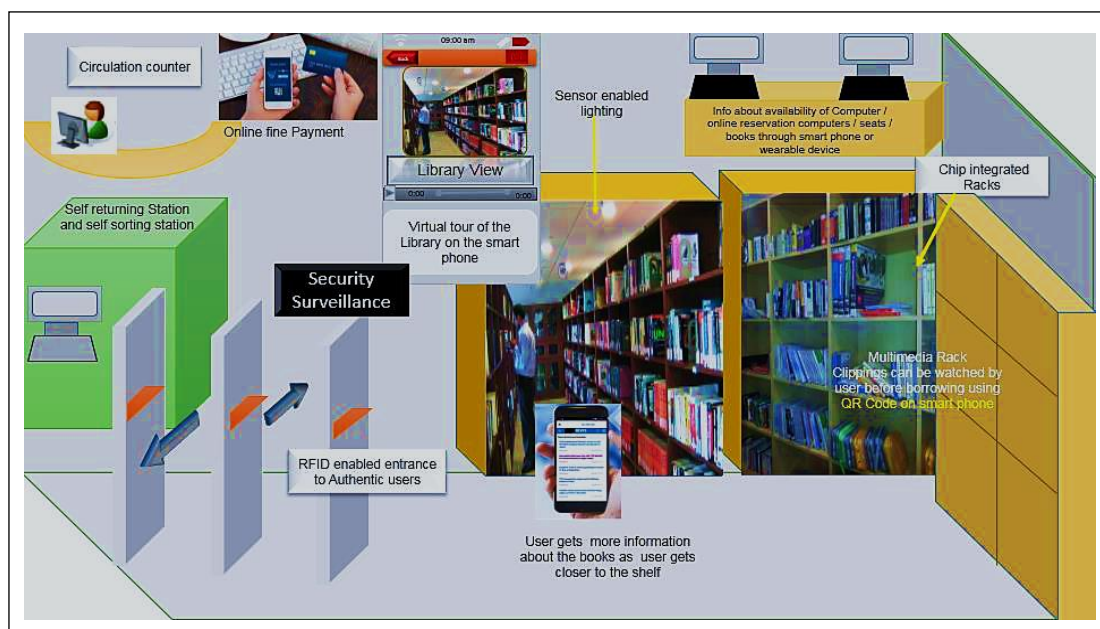


Fig. 2: Applicability of IoT in Libraries.

METAMORPHOSIS OF DIGITAL LIBRARY INTO A SMART LIBRARY SYSTEM

When change is inevitable library professionals never run away from the change, the manuscript narrates that how IoT can be applicable in the library house-keeping activities. Any program which is user centric will definitely get prominence; IoT is not an exception to this. Let us discuss how a regular library experience can be enhanced with IoT-enabled technologies [10]. Normally a user might be using the library through physical or digital. User enrollment in the libraries is generally created based on their personal details and preferences mentioned in their profile, in addition to this users' previous browsing or borrowing history. The library can have a comprehensive information to provide services to its users by creating a library app. When these library services and activities are combined with IoT there is a boost up in the user services (Figure 1).

When the users visit the library, they get a welcome message from the library on their app. Users can click on their personal page designated in the app to check for the updates on their areas of interest. Once the users enter the library, they can go near the shelves and the sensors on the shelf will redirect them to the right shelf. Another sensor/signal

recognizes their presence and shares relevant information such as the most popular book or event from library, or the event scheduled for that day or going on in another area of the library at the same time. Once users decide the book they are borrowing, they can go to a self-checkout counter and get the material checked out. As they leave the library, another signal will recognize and thank them for using the facility (Figure 2). Users can make a list of their favorite books at home using the feature to locate items, and then come to library and once they are in, they will be guided using a map and directions to the available items on the shelf. Hence, they will be automatically alerted if the books have been checked out already or even if it were mis-shelved, they would be able to find them without any help from the staff [11].

SIGNIFICANT TOOLS FOR IoT Cloud Computing

Cloud computing is nothing but the collection of computing software and services that can be accessed through the Internet instead of accessing directly from desktop or internal server. Cloud computing is independent of location network connectivity. The very specialty of Cloud computing is its accessibility to multiple users through Internet. Cloud computing is completely different from traditional computing.

Magic Mirror

As the technology is getting advanced, mirrors have more and more applications. Magic mirror consisting of camera and Wi-Fi enabled sensors, provides interaction between people and computers. This technology is useful to apply for different kind of information, such as location recognition, review of the contents, similar like material [12]. Also the information of the users' review is stored in the database [13].

Pressure Pad Sensor

Pressure pad sensor consisting of a thin sheet sensor pad facilitated with Wi-Fi technology is connected to dispensation unit, which records and controls the system. Regular movement of the user in particular passageway is to be recorded so that the collection of books of recorded section can be increased to provide sufficient information. Pressure pad sensor can also be linked to electrical energy system to minimize electrical energy loss in the library.

Wireless Sensor Network

Current technological advances in low power integrated circuits and wireless communications have made proficient availability, at low cost, low power tiny devices for use in remote sensing applications.

The blend of these factors have improved the practicality of utilizing a sensor network consisting of a large number of intelligent sensors, enabling the collection, processing, analysis and dissemination of valuable information, gathered in a variety of environments.

Radio Frequency Identification

In the RFID systems, we use tags, which contain transponders that emit signals readable by specialized RFID readers. These RFID tags store some sort of identification code as memory. A reader retrieves information about the identification code from a database, and acts accordingly. Writable memory of RFID tags which can store information for transfer to various RFID readers are placed in different locations. Tracking of tagged item's movement is possible by making that information available to each reader.

APPLICATION OF IoT IN LIBRARIES

The Book Transactions Analysis

Mobile alert is possible as and when the users access the racks. User will get a message about the most issued and demanded books list on his mobile. This also helps library staff in procuring more copies to be placed.

Navigation by GPS

Mobile apps using RFID, Near Field Communication and ZigBee will help users to locate books inside the library.

Checking of Availability

The availability of a book can be checked with Bluetooth technologies or Learning Management Systems.

Maintenance of Infrastructure

Sensors can help in controlling the usage of the lights, fans and air conditioners can be on and off based on the usage.

QR Code

The QR code helps the user by giving a brief introduction about the book he is going to borrow; this can be done through his smart phone using internet facility.

Book Reservation Status

The implementation of this facility depends on RFID tags attached to the books. The reservation status of the book can be known as and when book will be returned to the library by sending mailer alert to the user who is waiting for the document.

Library Fines

Online fine payments or debit machine facility can be enabled.

Gate Register through Biometrics

Users who are entering into the library have to gone through the biometric identification otherwise the entry may be restricted without proper authentication.

Kiosks in the Library

It helps the users for browsing Online Public Access Catalogue (OPAC).

Sensors

Fire safety is very much essential in libraries. The library can be protected from fire accidents with the help of smoke or heat sensors. At the same time, there is a possibility of alerting the library staff when the books on the racks are misplaced by users.

Virtual Library Tour

To make the new users familiar with the library.

Mobile Alerts

Alerts like new arrivals, special collections, library archives, shelving assistance to the users is possible.

CAPABILITIES FOR A SMART LIBRARY PROFESSIONAL

To compete with IoT technologies and its applications the library professional should be well versed with the following skills:

Mobile Communications

The library professional should be skilled in using the hand-held devices, smart phones, tablets and so on. They should have knowledge in the main ingredients of IoT such as RFID and Cloud computing technologies for information sharing.

Information Analysis

With the proliferation of IoT-enabled devices, the amount of data generated will be very huge in quantity. The library professional should be able to analyse the content, and classify and catalogue it for easy retrieval.

Digitization

As IoT is the basis for digitization and automation, it is imperative to have the knowledge on digitization technologies.

CONCLUSION

The IoT has paved the way to identify and connect things, which can exchange information and make decisions by themselves. In IoT, the communication forms will be human-human, human-thing, thing-thing. If we treat books and other materials as things there will be much more scope to libraries to become smart libraries with the help of IoT technologies.

The concept of IoT has so much of scope for libraries. Proper planning is required in implementing and using these technologies, perhaps we can bring value addition to library resources and services. This particular concept of IoT is still in beginning stage. This is the time for librarians to be expertise to adopt and avail for implementation in libraries. Libraries accept change and it has been proved time and again in the history of library science. As we have accepted Internet and used its benefits for digital library; hence, IoT would be the next thing, which is going to bring smart libraries instead of digital libraries. The term "Digital library" may fade out in the near future and may be metamorphose to "Smart Libraries"

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REFERENCES

1. Lueth KL. Why the Internet of Things is called Internet of Things: Definition, history, disambiguation. IOT ANALYTICS [Internet]; 2014 Dec 14. Available from: <https://iot-analytics.com/internet-of-things-definition/>
2. Chase J. The Evolution of the Internet of Things. TEXAS INSTRUMENTS [Internet]; 2013 Sep. Available from: <http://www.ti.com/lit/ml/swrb028/swrb028.pdf>
3. The Internet of Me. Accenture [Internet]; 2015. Available from: <https://www.accenture.com/us-en/insightinternet-of-me>
4. Internet of Things, IT Glossary. Gartner [Internet]; 2015. Available from: www.gartner.com/itglossary/internet-of-things/
5. Ashton K. That 'Internet of Things' thing, in the real world things matter more than ideas. RFID Journal. 2009; 22: 1p.
6. Ivans D. The Internet of Things: How the Next Evolution of the Internet Is Changing Everything. Cisco Internet Business Solutions Group [Internet]; 2011 Apr. Available from: https://www.cisco.com/web/about/ac79/docs/innov/IoT_IBSG_0411FINAL.pdf
7. What is the Internet of Things? Internet of Things Definitions and Segments. i-

- SCOOP [Internet]; 2016. Available from: <http://www.i-scoop.eu/internet-of-things/what-is-the-internet-of-things-iot-definitions/>
8. Norton S. Internet of Things Market to Reach \$1.7 Trillion by 2020", IDC. *CIO Journal* [Internet]; 2015 Jun 2. Available from: <http://blogs.wsj.com/cio/2015/06/02/internet-of-things-market-to-reach-1-7-trillion-by-2020-idc/>
 9. <https://www.ctimes.com.tw/art/2014/12/11/1910233230/p1S.JPG>
 10. Press G. A Very Short History of the Internet of Things. *Forbes* [Internet]; 2014. Available from: <http://www.forbes.com/sites/gilpress/2014/06/18/a-very-short-history-of-the-internetof-things/>.
 11. Ali F. Teaching the Internet of Things Concepts. *Proceedings of the WESE'15: Workshop on Embedded and Cyber-Physical Systems Education*; 2015 Oct 4–9; Amsterdam, Netherlands. 10p.
 12. Kim M, Cheeyong K. Augmented reality fashion apparel simulation using a magic mirror. *Int J Smart Home*. 2015; 9(2): 169–78p.
 13. Kachare S, Vanga S, Gupta E, *et al*. Fashion accessories using virtual mirror. *Int J Soft Comput Eng*. 2015; 5(2): 11401–6p.

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