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The Role of the Internet of Things (IoT) in Library Applications

– Patel Rahulkumar Somabhai

Abstract:

The Internet of Things (IoT), fueled by advancements in internet connectivity and mobile communication networks, is poised to usher in a transformative period for the information industry. As a global technological breakthrough, IoT is predicted to play a pivotal role in stimulating economic progress and reshaping societal norms. This paper delves into the IoT concept, tracing its historical evolution, exploring a range of applications, and examining the contribution of RFID technology and related devices. It highlights the benefits of IoT, its continuous developments, and explores the promising potential of IoT in revolutionizing libraries in the future.

Keywords: Internet of Things (IoT), RFID Technology, Tags

1.0 Introduction

The Internet of Things (IoT), also known as the Internet of Objects, refers to the interconnected network of physical devices embedded with sensors, chips, and communication technologies. These devices—such as radio frequency identification (RFID) tags, infrared sensors, global positioning systems (GPS), and laser scanners—enable objects to "think," "sense," and "communicate" with each other. By integrating with the existing infrastructure of the Internet and mobile networks, IoT allows seamless interaction between devices and humans, enabling real-time monitoring, control, and automation. This connectivity enhances efficiency, convenience, and intelligence in various applications, bringing the vision of a "Smart Planet" closer to reality. IoT is essentially a self-configuring wireless network of sensors designed to interconnect all things. The concept traces its origins to the former Auto-ID Center, founded in 1999 at the Massachusetts Institute of Technology (MIT). Initially, IoT was defined simply as a system that connects objects to the Internet via RFID and other sensing technologies to enable intelligent identification and management. The significance of IoT was formally recognized in 2005 at the World Summit on the Information Society (WSIS) in Tunis,

where the International Telecommunication Union (ITU) officially introduced the concept of the "Internet of Things."

2.0 History of IoT

The concept of the Internet of Things (IoT) was introduced by Kevin Ashton in the early 2000s. While working on a project for Procter & Gamble to optimize supply chain management, Ashton proposed linking RFID technology to the Internet, laying the foundation for what would later be known as IoT. In 2000, LG made a major move by announcing plans to develop the first Internet-connected refrigerator, marking an early example of consumer devices becoming part of the IoT ecosystem. The International Telecommunication Union (ITU) recognized the growing importance of IoT in 2005, formally mentioning it in one of its reports. In 2008, the formation of the IPSO Alliance further advanced IoT by promoting the use of Internet Protocol (IP) for connecting devices in areas such as energy, healthcare, consumer products, and industry. A significant breakthrough came in 2012 with the launch of IPv6 (Internet Protocol version 6). This new protocol expanded the number of available IP addresses, allowing every device on Earth—down to individual atoms—to be assigned a unique identifier, facilitating a vast increase in IoT connectivity. The rapid expansion of IoT can be attributed to several key factors: the adoption of IPv6, support from major companies like Cisco, IBM, GE, and Amazon, and the decreasing costs of connectivity. General Electric (GE) estimates that the "Industrial Internet" could add between \$10 trillion and \$15 trillion to global GDP over the next two decades. IoT's future growth is promising. Cisco's Internet Business Solutions Group (IBSG) forecasted that 25 billion devices would be connected by 2015, and 50 billion by 2020. Additionally, a report from BI Intelligence predicted that by 2019, IoT would become the largest device market globally.

3.0 Application of Internet of Things (IOT)

Currently, approximately 100 organizations across more than 10 countries, including Singapore, Australia, India, the Netherlands, and Malaysia, are utilizing RFID technology within their library automation systems.

4.0 How RFID Works

RFID (Radio Frequency Identification) is a technology that falls under the broader category of Automatic Identification and Data Capture (AIDC). AIDC systems are designed to automatically identify objects, gather data, and input this information into computer systems

with minimal human involvement. RFID uses radio waves for this process, and it operates through three primary components: an RFID tag (or smart label), an RFID reader, and an antenna.

The RFID tag consists of an integrated circuit and an antenna, which allows it to communicate with the RFID reader (also called an interrogator). The reader captures the radio signals sent by the tag and converts them into usable data. This data is then sent to a host computer system via a communication interface, where it is stored in a database for later analysis. RFID tags vary in shape and size and are classified into two types: passive and active. Passive tags are smaller, more cost-effective, and rely on the RFID reader's signal to power them for data transmission. Active tags, on the other hand, contain their own power source, such as a battery, allowing them to transmit data continuously.

Smart labels are RFID tags that also include barcode technology. These labels are typically adhesive-backed, with an embedded RFID tag and often a printed barcode and other information. Unlike RFID tags, which require specialized equipment for programming, smart labels can be encoded and printed using standard desktop label printers.

5.0 RFID Technology Equipment

RFID technology has found innovative applications in library operations, such as digital library system interfaces, compatibility enhancements, and the extension of various applications. Significant progress has been made in the independent development of shelf labeling systems and document navigation, which have already been implemented in libraries. These advancements help address common challenges in library development and management, presenting a promising future for the widespread adoption of RFID technology in libraries. Beyond libraries, RFID technology is being integrated into real-time applications across various sectors. Examples include RFID tracking, the use of smart dust on battlefields, smart healthcare systems, smart irrigation systems for agriculture, and smart grids for efficient power consumption management. Additionally, RFID and other sensor technologies are being deployed in wildlife monitoring through multimedia sensor networks and in environmental applications, such as underground, underwater, and forest sensors, to mitigate natural disasters like tsunamis, earthquakes, forest fires, and floods.

6.0 Advantages of IoT in Library Management

Library management plays a crucial role in the application of IoT technology. While many libraries have adopted barcode recognition, computer networks, software systems, and

other modern technologies, challenges still remain for library staff. Issues such as self-service borrowing and returning of books, efficient inventory management, and organizing disordered books continue to be problematic, limiting the library's ability to enhance its management and service quality. These challenges can be effectively addressed through the implementation of IoT technology.

6.1 Self-service Borrowing and Returning of Books

With the self-service subsystem powered by RFID technology, users no longer need to manually scan each book's barcode. Instead, they can borrow or return multiple books at once, with the process being automated. This streamlines the borrowing and returning procedure, significantly improving operational efficiency. RFID self-service machines can operate 24/7 without requiring staff, greatly enhancing library services and book circulation.

6.2 Creation of a Reader Circle

RFID technology allows information about books, shelves, and borrowing records to be stored in electronic tags, integrating seamlessly with existing library systems. These tags are durable, dirt-resistant, and ensure the efficient borrowing and returning of books. Additionally, electronic tags can store extra data such as previous borrower information, book reviews, and suggestions for related books, helping readers make informed decisions. This feature can also facilitate the creation of a "Readers Circle" for more reference material and discussions.

6.3 Quick Book Search

RFID technology supports both mobile and fixed search options. For mobile searches, users can input information about multiple books into a handheld RFID terminal to locate related data. Fixed searches use RFID readers connected to a computer and wireless LAN to find books. With RFID's wireless location capabilities, books can be quickly located within the library, reducing instances where a book is found but cannot be retrieved due to misplacement.

6.4 Fast, Accurate, and Bulk Inventory Management

IoT and RFID technology enhance inventory processes, enabling long-distance, rapid, and accurate stock-taking of books. This technology improves inventory efficiency, reduces the physical labor involved, and features a graphical user interface for easier management. It

also includes functions like data downloading and pre-alarm notifications, showcasing the full potential of RFID for inventory control.

6.5 Preventing Book Theft

RFID technology helps detect book theft automatically through software integrated with RFID hardware. The system includes RFID circuits, sound and light alarms, and security door antennas. This setup allows for long-distance recognition (typically up to 2 meters), quick identification, and real-time alerts, all while minimizing false alarms.

6.6 Enhanced Library Card Functionality

RFID technology enables the activation of second-generation ID cards as library cards, allowing users to access library services anytime, without worrying about whether they carry their reader cards. This solution offers greater convenience, security, reliability, and easier management.

7.0 Development of IoT in India

The Internet of Things (IoT) holds significant strategic importance, and India has positioned itself as a global leader in ICT development. Whether in terms of policies, technologies, or the industrial ecosystem, India's IoT growth benefits from strong advantages and valuable opportunities for advancement.

In the past decade, the research and development of IoT networks in India has seen significant growth, especially after the government made the decision to promote emerging industries, including IoT, new energy, new materials, and information networks. With the current government's support, IoT is experiencing rapid development and is becoming a key driver for economic growth. This progress offers India an opportunity to catch up with developed nations, positioning the country to play a leading role in global economic development and attracting substantial investments.

IoT is expected to generate trillions of dollars in economic value for India, with applications spanning across a wide range of industries, including logistics, transportation, agriculture, manufacturing, healthcare, security, smart homes, tourism, and defense. Over the next five years, IoT technologies will become widely adopted in areas such as smart grids, smart homes, digital cities, smart healthcare, and vehicle sensors, among others.

8.0 Future of IoT in Libraries

The future of IoT in libraries appears promising, given the advancements in this field. As IoT continues to evolve, it has the potential to revolutionize the way libraries operate and serve their patrons. Fully implemented, IoT could transform library buildings into "smart" spaces, where patrons can interact with various objects and access a wealth of information using connected devices.

Over time, IoT is expected to expand into even more areas within libraries. It could provide valuable insights, such as usage statistics of library resources, heat maps showing the most frequently visited areas, data on user satisfaction, and even track when users become frustrated with library resources and turn to alternatives like Google.

However, libraries must address several critical issues before fully adopting IoT. Privacy and security are major concerns, as patrons' data may be shared with third parties, potentially exposing it to hacking risks. Additionally, the cost of implementing IoT technologies, including financial investment, manpower, and time, must be carefully considered. Staff training is also crucial, and perhaps most importantly, libraries must be mindful of the potential decline in the use of physical spaces. By transparently communicating with patrons about data privacy and security, providing necessary training, and building the right infrastructure, libraries can successfully integrate IoT to enhance their services and improve the overall library experience for users.

9.0 Conclusion

The Internet of Things (IoT) holds immense potential for libraries, especially in today's fast-paced, urbanized world where time and efficiency are critical. RFID (Radio Frequency Identification), an emerging technology, is enhancing living standards and transforming how libraries manage their resources. Libraries, being central hubs of knowledge, are seeing increasing demand for books and publications. As the volume of library materials grows, effective management becomes a significant challenge. While some libraries have adopted RFID for automation, many still lack integrated alert systems.

IoT encompasses various technologies and research fields that extend the Internet's reach into the physical world. Technologies such as RFID, short-range wireless communication, real-time localization, and sensor networks are increasingly becoming common, paving the way for IoT applications in libraries. These advancements promise to improve library management, enhance user experiences, and streamline library operations in the near future.

Reference

1. Ashton, Kevin. "The Internet of Things." Kevin Ashton, 22 June 2009, <http://kevinjashton.com/2009/06/22/the-internetof-things/>. Accessed 11 Dec. 2017.
2. Donovan, Fred. "A Brief History of the Internet of Things." FierceMobileIT, 23 July 2014, <http://www.fiercemobileit.com/story/brief-history-internetthings/2014-07-23>. Accessed 11 Dec. 2017.
3. International Telecommunication Union. ITU Internet Reports 2005: Internet of Things. ITU, 2005, <http://www.itu.int/wsis/tunis/newsroom/stats/The-Internetof-Things-2005.pdf>. Accessed 11 Dec. 2017.
4. Wikipedia. "IPSO Alliance." Wikipedia: The Free Encyclopedia, http://en.wikipedia.org/wiki/IPSO_Alliance. Accessed 11 Dec. 2017.
5. Shen, Gang, and Xuejuan Huang. "Application of Internet of Things Technology in Library Management." ECWAC 2011, Guangzhou, China, April 16–17, 2011, Proceedings, Part II, edited by Xiaoxiang Liu, vol. 144, Springer, 2011, pp. 391–395.
6. Srinivasan, S., and R. Vanithamani. "An Internet of Things Approach to Library Management and Monitoring." IJREAT: International Journal of Research in Engineering & Advanced Technology, vol. 1, no. 2, 2013, pp. 21–30.
7. Bender, Henry. "Is the Future of Insurance in the Internet of Things?" PropertyCasualty360, 29 Apr. 2014, <http://www.propertycasualty360.com/2014/04/29/is-the-future-of-insurance-in-the-internet-ofthin>. Accessed 11 Dec. 2017.

Patel Rahulkumar Somabhai, Technical Assistant Librarian,

Gujarat Technological University – Institute of Technology & Research (GTU-ITR).

Email: rspatel2601@gmail.com