

# Smart Library: An IoT Approach

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**Abstract:** -- The revolution created by Internet of Things due to the widespread use of smart phones with internet access has started [1][10]. Like other services in the industry, IoT can help in the advancement of the services provided by libraries [2]. In this paper, an effective implementation for Internet of Things used for managing the library by means of low cost NFC tags and readers is reported. The description about the integrated network architecture and the interconnecting mechanisms for the transmission of data via internet is being presented.

**Keywords:**-Internet of things (IoT), Radio Frequency Identification (RFID), Near Frequency Communication (NFC)

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## I. INTRODUCTION

Internet of things is the next revolution where any physical object can be globally discovered and queried throughout the internet. It conceptualizes to bring different technologies and research areas in to these physical objects, that helps these objects communicates across the world [14][10]. Internet of Things help in interconnection of objects, the things that will help to do this is:

- ♣ Connect both living and non-living things to network
- ♣ Use sensors and automatic identification technologies for data collection
- ♣ Change the items that was connected to the internet

In 2008 the number of devices exceeded the number of people, and is approximated to reach 50 billion in 2020. A wide-ranging Internet of Things (IoT) ecosystem is emerging to support the process of connecting real-world objects like buildings, roads, household appliances, and human bodies to the Internet via sensors and microprocessor chips that record and transmit data such as sound waves, temperature, movement, and other variables [4]. The prevailing network connection, smart connectivity, context aware computations and the existing network resources helps in making Internet of Things a reality [10]. Automatic Identification technologies play the main role in identifying physical objects by giving them virtual identity [15]. Non-professional end-users will be able to make additions to products, according to their septic needs with the help of the emerging trends of user

programming. Many devices can be controlled mechanically using low cost hardware and open source soft ware's. In the coming era end-users will be able to shape products according to their needs [15]. Everything from GPS tracking of children, cargo, and endangered animals to monitoring a pregnant woman's unborn child for health concerns will be possible. Real-time data are collected by smart devices from user for serving better and forecasting their needs. In business, it will let us know which item is in most demand and where the stocks have to be rolled. In health care, smart devices have the potential to monitor the patient and send alert messages to hospital if any medical emergencies takes place [18].

IoT in Education is a two-faceted term. Many see IoT as a course or a part of a curriculum so as to show students how future life in the 21st century will look. Others see it as a technique to enhance education and make academic life easier [4]. Some of the scenarios where we can use IoT in education are lab, hall, classrooms and library. The techniques proposed by researchers [4][5][12] for classrooms and lab has its pros and cons. Using RFID tags for attendance can cause huge risk to privacy. RFID tags that can help in tracking students was implemented in North side Independent School district of San Antonio, Texas. This was strongly opposed by parents and students [19].

IoT has a huge potential for libraries even if it is at its inception. Libraries will be able to add more services and end eavour rich library experience to the patrons. Librarians are already accustomed with RFID in libraries, where while interacting with machines and tags, the library management system can get updated. In

the case of IoT the only difference is the thing or object which interacts with the internet. Libraries possess books, journals, Cds/DVD and the most persistent problems is the misplacement of objects and their usage can be solved using IoT[1].

## II. RELATED WORK

Even though IoT is at the stage of its inception in libraries, researches have been done on how we can implement IoT in libraries. According to researchers, looking at the number of physical assets books, music, movies, equipment, and staff in a library, IoT is extremely beneficial to libraries in terms of saving staff time and improving user service [18]. IoT could use user data to make tailored recommendations, all by collecting real-time data. Connecting the library services to IoT system can help to redefine services outside the library building [17]. The new management mode by the IoT devices in libraries can help in the intercommunication between user, library and resources [13]. A new framework known as SELIDA proposed by Kyriakos Stefanidis and Giannis Tsakonas [2], integrated typical library services such as checking in or out items at different libraries with different Integrated Library Systems without requiring substantial changes, code-wise, in their structural parts. To do so they used the Object Naming Service mechanism, that allows us to retrieve and process information from the Electronic Product Code of an item and its associated services through the use of distributed mapping servers. Researchers [1][3] identified some of the potential library areas where IoT can be implemented effectively and efficiently. They include accessing the library and its resources, library management, education of new users about the library, locating resources, issuing and returning resources, appliance management and recommendation services. [8] Proposed an RFID system where the books are issued and returned by swiping students ID tag and RFID tag attached to book. The transactions and usage can be monitored using the mobile application. A similar system designed [7] sends message via SMS while swiping the card, and on clicking the link provided the website of library can be accessed [9] implemented a smart library which provides the luxury of fetching a book from its place with the assistance of an IoT based interconnected system using a Wi-Fi based Local Positioning System (LPS) and Near Field Communication (NFC) tags. The proposed paper illustrates a smart library for regular monitoring and

management of library. In this technique each rack in the shelf is XED with NFC readers. When a person takes the book out of the book shelf the status of the book in the database is updated as taken. When the book is taken out and placed back in the book rack, the status of the book is updated. This helps in finding the specific location of the book. The proposed technique also consists of the following:

- ♣ Registration of the new user through mobile or laptop
- ♣ Locating the position of the book: As the books are shuffled, finding the book using the automated library management system is useless because the position displayed in the system may not be the correct location. While in the smart library we get the exact location of the book.
- ♣ Issuing and returning the book using mobile or laptop: The user has to go to the librarian for issue and return. In this system issue and return is done automatically through the mobile phone.
- ♣ Providing abstract: It is a time consuming task to select a single book out of many. Providing oral abstract for the books taken out of the book rack is the perfect solution

## III. EXPERIMENTAL SETUP

### A. Components Required

With the help of Zig Bee communication standard, raspberry pi and some network architectural design strategies help in connecting library devices to internet. The end devices collect the data and forward the data to raspberry board using Zig Bee network. The key elements integrated with the library system consist of:

- ♣ Raspberry pi B+
- ♣ ZigBee module
- ♣ NFC reader and Tags
- ♣ Arduino Board
- ♣ RS232TTL converter

1) **Raspberry pi B+:** Raspberry pi is a compact and cheap education oriented computer board. This credit card sized helps in interfacing with devices. Its processor is a 32 bit, 700 MHz system on a chip, which is built on the ARM11 architecture [6].

2) **Zig Bee Module:** Zig Bee Module is a low-power, low cost, wireless mesh networking standard. The low

cost allows the technology to be widely released in wireless control and monitoring applications, the low power-usage allows long life with smaller batteries, and the mesh networking provides larger ranges and high reliability.

**3) NFC Reader (PN532 RFID/NFC Shield):** The PN532 is the most popular NFC chip, and is what is embedded in pretty much every phone or device that does NFC. It can pretty much do it all, such as read and write to tags and cards, communicate with phones (say for payment processing), and act like a NFC tag.

**4) Arduino:** It provides a low cost, easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. An Arduino board historically consists of an Atmel 8-, 16- or 32-bit AVR microcontroller with complementary components that facilitate programming and incorporation into other circuits. An important aspect of the Arduino is its standard connectors, which let users connect the CPU board to a variety of interchangeable add-on modules termed shields. Some shields communicate with the Arduino board directly over various pins.

**5) RS232TTL converter:** RS-232 to TTL converters makes easy connections between your TTL equipment and RS-232 ports. All TTL converter models convert two channels in each direction from TTL to RS-232 or RS-422

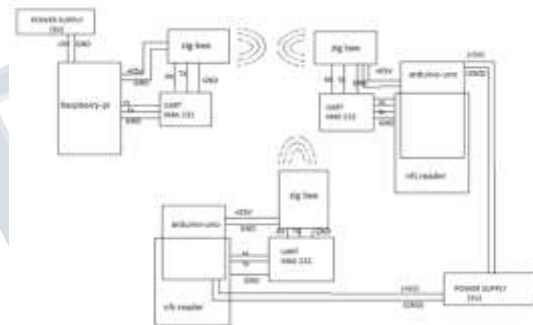
**B. System Design**

The ZigBee, RS232 to TTL converter along with Arduino and NFC reader forms a single shelf unit. The figure 1. Contains two shelf unit connected to a power supply of 5v. The Raspberry pi, Zig Bee, and RS232TTL converter act as the other unit. The Zig Bee accepts the signals from other two shelf unit and sends the data to Raspberry pi. Here raspberry pi act as the central server

**1) Registration of users:** The user accessing the site for the RST time provides his details in the websites signup page. The data from these pages such as name, branch, student id is saved in the database. The librarian checks the details and approves the user. The approved user is added to the table of list of users. Figure.2 shows the home page.

**2) Locating the position of the book:** The shelf unit detects the NFC tag and the 4 Byte- hexadecimal value which is the unique ID of the NFC tag. This 4 byte hexadecimal value is sent from the NFC reader to the Arduino board. The ID along with the shelf no is sent from the Arduino board to

**Fig. 1. Circuit Diagram of Smart Library**



**Fig. 2. Home page**



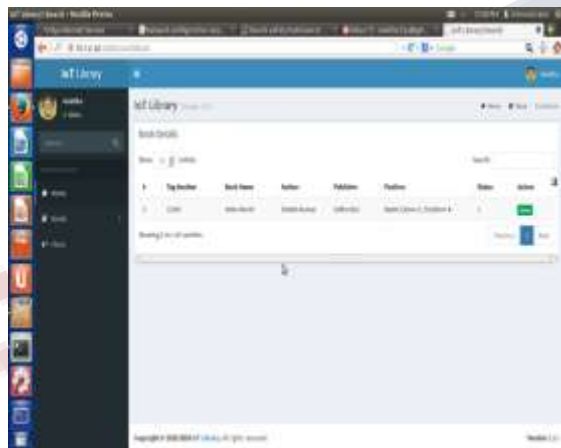
The raspberry pi. The information is updated in the library database and the shelf no is checked accordingly. When the user searches for the book, the book no is sent to the database and corresponding shelf no is returned.

**3) Issuing book and Returning book:** All the user has a separate prole and all the information regarding the transactions are maintained in the library server. After

searching for the book and locating the position, the user takes the book from the shelf. When the issue button is pressed, the book is issued and updated in the database. Figure.3 shows the issue page.

While returning the user takes the book and keeps it in the shelf as mentioned in the website. The shelf unit detects the NFC tag and the 4 Byte-hexadecimal values which is the unique ID of the NFC tag. This 4 byte hexadecimal value is sent from the NFC reader to the Arduino board. The ID along with the shelf no is sent from the Arduino board to the raspberry pi. The data arrived at the raspberry pi is split back to tag ID and shelf no and checked in the database. If it is the correct shelf, the user will be able to return the book else the user will not get the successfully returned pop up window.

Fig. 3. Issue page



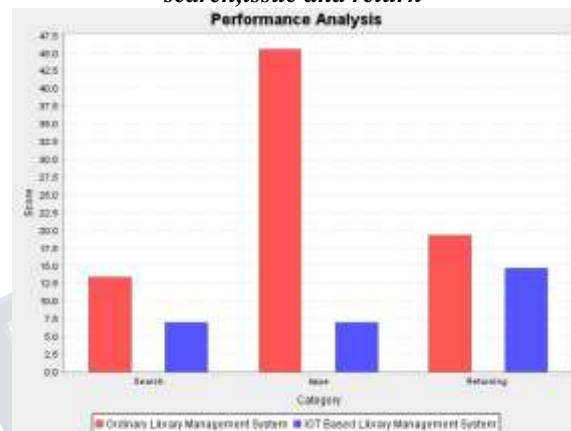
4) **Abstract of the Book:** To enter the book name, Author name, Abstract corresponding to the book id the librarian swipes the tag in one of the NFC reader unit. When the tag ID appears the book name author name and abstract is entered. The abstract is read out during book search using one of the plugins of responsivevoice.org.

#### IV. IMPLEMENTATION RESULTS

The implementation of NFC technology has daintily quickened the entire of process of issue, return and search. The traditional method of library management involved manual entry; which is arduous

and a time consuming process. The analysis was performed on few students and books. The books were arranged in two shelf, each shelf was attached with a shelf unit. Figure.4 shows the performance analysis of smart library.

Fig. 4. Performance analysis of smart library for search, issue and return



Based on the experiment, the response time taken to search, issue and return has improved to 47.9%, 84% and 18% respectively. These findings infer that the smart library with an IoT approach, when compared with the traditional library operation mode, can provide the library with more efficient utilization and operating efficiency in terms search, issue and return.

#### V. CONCLUSION

The phrase Internet of Things signals a vision where every animate and in-animate objects can communicate with the internet, exchanging information about themselves and surrounding [16]. Application of IoT has taken diverse sectors, and Library being one of them. The proposed system focuses on the information gap and time delay in a library management system and how it can be solved by implementing IoT in libraries. The future work might lead to locating the position of the book within the shelf as the proposed system will only let the user know which shelf. Effective security measures can be implemented to provide a safe transaction in libraries.

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