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# Optimizing Book Stocktaking Process: Integration of Mobile Robot QRCode Commands with SLiMS

Mohammad Harry Khomas Saputra[1], Pipit Anggraeni[2], Wahyu Adhie Candra[3]
[1] *Teknologi Rekayasa Informatika Industri, Teknik Otomasi Manufaktur dan Mekatronika, Politeknik Manufaktur Bandung, Bandung, Indonesia*
[2,3] *Teknologi Rekayasa Otomasi, Teknik Otomasi Manufaktur dan Mekatronika, Politeknik Manufaktur Bandung, Bandung, Indonesia*
[1]harry@ae.polman-bandung.ac.id, [2]pipit_anggraeni@polman-bandung.ac.id, [3]wahyu@ae.polman-bandung.ac.id

### Abstract

*This study presents a novel approach to enhance efficiency and precision in library management through the utilization of QR code technology. Integration of a mobile robot equipped with a QR code reader into the stocktake process, interfaced with the SliMS framework via an accessible API, lays the groundwork for an automated book inventory management system. This groundbreaking system enables the generation of dynamic QR code commands, facilitating seamless adjustments to bookshelf layouts. The autonomous and accurate movement of the mobile robot significantly reduces the time required for recording, allowing library staff to allocate more time to value-added tasks. The implementation of this method entailed configuring the mobile robot to navigate library aisles, scan QR codes on book spines, and transmit inventory data to the SliMS system in real time. Research findings indicate a notable decrease in inventory processing time, accompanied by an improvement in accuracy resulting from the eradication of manual data entry errors. Specifically, the calculated efficiency gain of approximately 66.81% highlights the substantial benefits of integrating the mobile robot scan QR code process compared to manual methods. In conclusion, the deployment of this automated book inventory management system, driven by QR code technology, marks a positive shift in library management practices, enhancing the efficiency of the book inventory process and overall operational effectiveness.*

*Keywords: library management; QR code; mobile robot; Stock Take Process; API; SLiMS*

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## 1. Introduction

Libraries, as institutions of education and literacy, face challenges in the manual book inventory process[1], [2]. The book inventory process involves humans recording and checking book data in the database, but this manual method often takes a considerable amount of time and is inefficient due to human resource limitations and the risk of human errors. The utilization of QRCode labels and scanners in the book stocktaking process enhances efficiency and accuracy in book inventory management.[3], [4], [5].

Technological digitization is the key to improving efficiency and accuracy in library management.[6], [7]. However, with the continuous advancement of technology, new challenges emerge, including in the process of book identification and recording. Significant changes have been brought about by digitization in library management through the introduction of sophisticated library management software. Information technology-based library management systems enable libraries to manage book inventory more efficiently and accurately.[8], [9].

An intriguing innovative solution to address these issues is the use of a Mobile Robot capable of precisely following predetermined paths. Mobile Robots can be implemented in the book inventory process by leveraging QRCode technology[10], [11]. QRCodes affixed to each book serve as unique identification markers [12]. When the Mobile Robot is equipped with QRCode scanning technology, the process of

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identifying and recording book data can be automated and efficient. Thus, human involvement in the book inventory process is reduced, and their role is only necessary during the setup or initial configuration of the Mobile Robot[13].

The use of Mobile Robots equipped with QRCode technology can optimize the book inventory process and enhance the operational efficiency of the library [13]. These robots can move independently and accurately to recognize QRCodes[14] On each book, automatically retrieving data such as title, author, and inventory number. This process not only saves time but also reduces the risk of errors in data recording.

The use of QRCodes in book inventory management has proven effective in improving efficiency and accuracy. QRCode s are two-dimensional matrix codes with larger data storage capacity compared to traditional barcodes. The use of QRCode in education has shown significant benefits in various fields, including library management.[15], [16].

To address issues in the manual book inventory process, the development of an Automated QRCode - Book Inventory Management System on a Mobile Robot becomes an intriguing solution. In this system, QRCodes are applied to each book as unique identification markers, enabling the Mobile Robot to recognize books automatically. In addition to book identification, QRCodes are used to execute commands on the mobile robot, allowing it to be more dynamic and adaptable when there are changes in the library bookshelf layout. Integrating the mobile robot's QRCode reader with the SliMS (Senayan Library Management System) application is crucial to simplify and make the book inventory process more effective. Through the development of this system, it is expected that book inventory management can be conducted quickly and accurately. With the implementation of QRCode technology and a Mobile Robot in library book inventory management with wireless communication[17], [18], [19], it is hoped that libraries can provide more effective and efficient services to visitors, thereby enhancing the quality and accessibility of education and literacy in the community.

## 2. Research Methods

The research methodology comprises several key stages to develop and assess an automated book inventory system based on QRCode technology implemented on a mobile robot. The initial phase involves identifying the issues in the library book inventory process and establishing research objectives focused on developing an automated book inventory system using QRCode on a mobile robot.

Following the identification of needs and research goals, a comprehensive literature review is conducted, specifically focusing on the technology of QRCode and mobile robots in the context of book inventory management.

The next phase involves the design of the automated book inventory system based on QRCode and the formulation of QRCode command mechanisms to control the mobile robot according to specified instructions.

The subsequent step is the development of software, including the creation of an Application Programming Interface (API) to seamlessly integrate the mobile robot's QRCode reader with the SliMS (Senayan Library Management System) during the book stocktaking process [20].

After the development, the system undergoes testing and evaluation in a library environment to identify its success and performance. Data is collected during this phase, and an assessment is conducted to evaluate the efficiency and accuracy of the system.

Following the testing and evaluation, the research methodology includes the analysis of the gathered data. Conclusions are drawn based on the results of the analysis to evaluate the performance of the book inventory system.

The research concludes with the formulation of overall findings and recommendations. Conclusions are drawn from the study, and recommendations are provided for further development and implementation in the library setting.

Finally, the research journey is documented comprehensively in a research report, encompassing all steps and outcomes of the study. This methodology aims to contribute to the advancement of automated book inventory systems in libraries, utilizing QRCode technology and mobile robots for enhanced efficiency and accuracy.

## 3. Results and Discussions

The system design created in this research is illustrated in Figure 1.

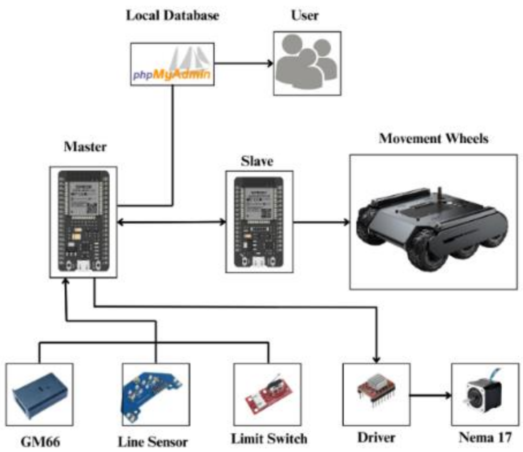


Figure 1 System Design Architecture

The architecture of the robot system in Figure 1 illustrates the interconnection of the ESP32 microcontroller with the Local Database that can be controlled by the user. The QR Code scanner GM66 is connected to the Limit Switch to regulate the movement boundaries of the robot and the scanned QR Code object, sending signals to the robot actuator for the next steps. The Line Follower sensor sends black line data to the ESP32, allowing the robot to follow its path.

The ESP32 is programmed and connected to the driver to control the movement of the Nema 17 Stepper after the GM66 successfully scans the QR Code. All these components are interconnected, forming a predefined mechanism and program for the UGV02 robot to operate as desired. This system uses ESP32 as the main brain responsible for processing QR Codes during barcode scanning. The resulting QR Code follows a specific structure, namely 00-000-000000000. This structure consists of three segments, with the first segment (00) serving as the identification number of the command to be executed by the ESP32.

When the ESP32 processes the QR Code, the first segment is read to determine the type of command to be executed. The second segment (000) functions as a parameter value, determining the number of rotations of the lifter motor to be executed. The third segment (000000000) acts as authentication or verification of the received command. For example, a value of "01" in the first segment may indicate a command to position the lifter in the starting position, followed by the robot motor moving forward, the QR Code scanner reading the code on the book, and storing the data in the database, as shown in Figure 2.

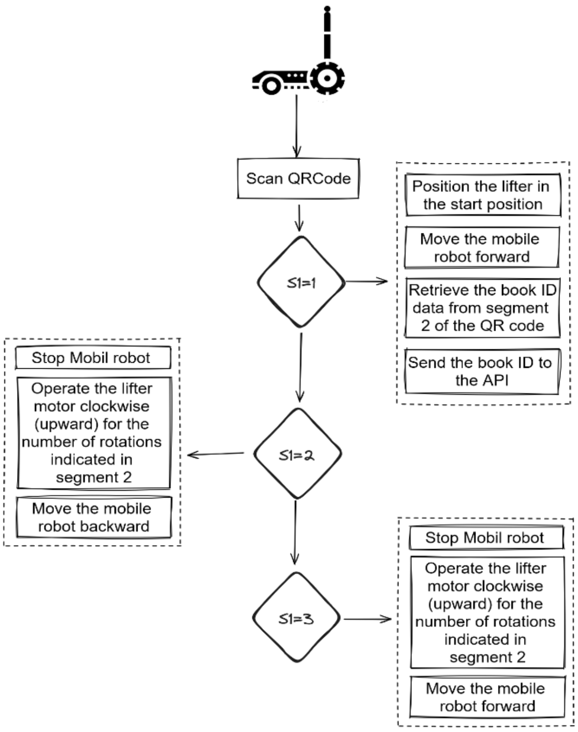


Figure 2. Flowchart for mobile robot QR code

Figure 2 illustrates the process flow of the mobile robot QR code system. If the first segment has a value of 02, the ESP32 will execute a command to stop the motor on the mobile robot, move the lifter motor clockwise according to the value in the second segment, and move the mobile robot backwards. If the first segment is valued at 03, the ESP32 will execute a command to stop the motor on the mobile robot, move the lifter motor clockwise according to the value in the second segment, and move the mobile robot forward.

### 3.1 *Mechanical Design*

Figure 3. Mechanical Design

Figure 3 shows the structure of the lifter equipped with V-slot supports along with the QR scanner GM66, Nema 17 with a belt stretch tensioner, also balanced with right-left V-slots to counterbalance the weight of the robot, preventing severe instability during robot movement.

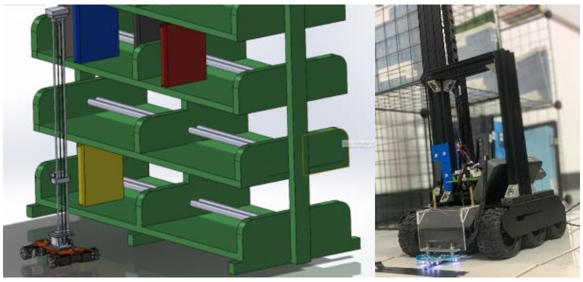

Figure 4. Mobile robot mechanism

Figure 4 represents the robot's mechanics in the library, where Nema 17 moves the belt stretch simultaneously with GM66 going up and down to scan the QR Code attached to each book on the shelf. The height of the V-slot remains below 2 meters to maintain the robot's balance during movement. The height of the V-slot could potentially be increased after the robot is truly stable at a height below 2 meters, allowing GM66 to scan more books.

### 3.2 *Communication System*

The communication system between components and networks in Figure 5 is initiated through ESP32 (Master) and ESP32 (Slave), where each of their pins is connected to components such as Limit Switch, Line Sensor, Motor 4 Wheels, and A4988 Motor Driver equipped with Nema 17 (Lifter). TX and RX pins on ESP32 are used in serial communication between ESP (Master & Slave) and GM66. The data signals obtained from each working component are inseparable from the role of the microcontroller that is already connected to the internet and supported by WiFi Access Point, IP

Server, and XAMPP devices along with the MySQL database.

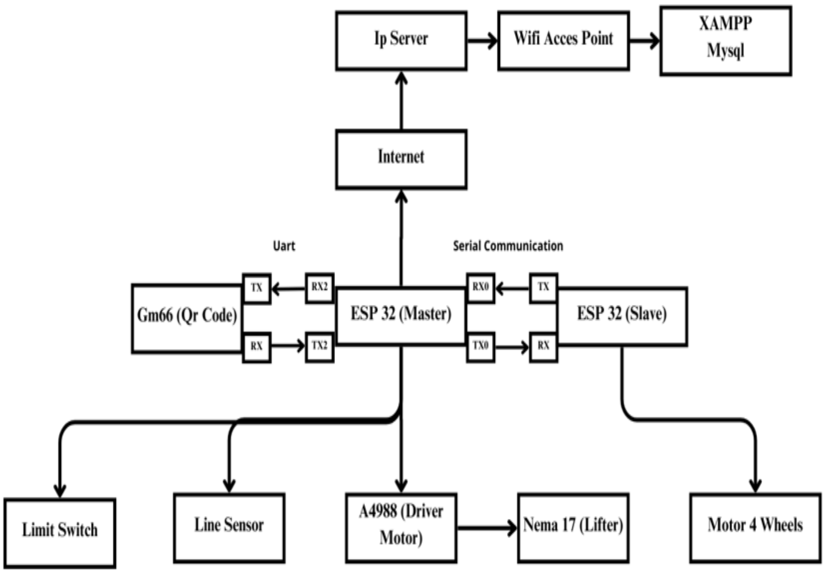


Figure 5. Communication System

### 3.3 Electrical Circuit Diagram

Figure 6 illustrates the electrical schematic, where the battery serves as the main power source for the UGV02 robot to perform actions. This system utilizes a filter operating at a voltage of 12V. The LM2596 Step Down DC-DC converter module, which uses the LM2596 chip, is employed to reduce the input voltage from 12V to 5V. Subsequently, the input voltage is directed to the ESP32 microcontroller as an initiation to connect to other components, enabling the acquisition of data signals for controlling the robot's movements. There is an exception for the 4 Wheels Motor, where each motor on the robot's four wheels requires a full input voltage of 12V.

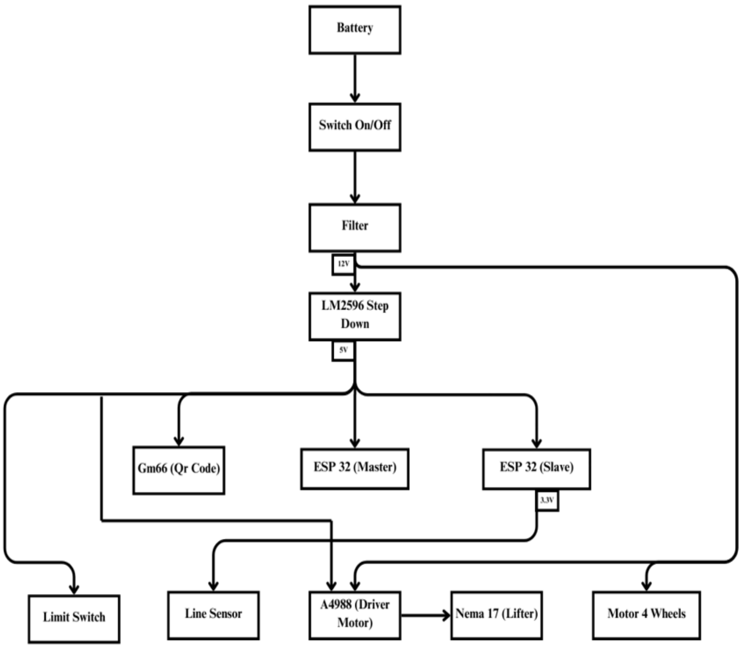


Figure 6. Electrical Circuit Diagram

### 3.4 Software Block Diagram


Figure 7. Software Block Diagram

There are several components in the software that will be created to ensure that the book inventory system operates as planned. The block diagram of the software system is illustrated in Figure 7. MySQL serves as the primary data storage software. The Arduino program will execute commands based on the QRCode scanned by the scanner. Subsequently, the acquired data will be stored in the MySQL database through the prepared Web API.

Figure 8 illustrates the flowchart of the process of making a GET request to the SLIMS API to update book item data during stocktaking on a mobile robot.

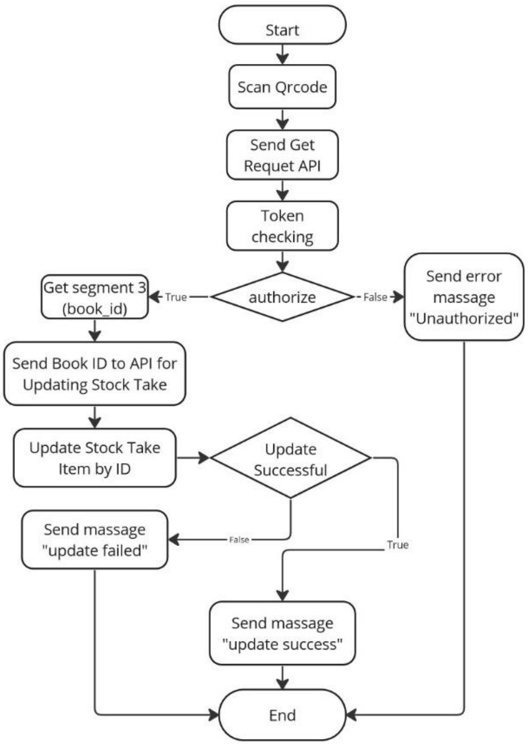


Figure 8 Flowchart GET request to the SLIMS API

Start; Scan QRCode; Send get Request API to endpoint http://localhost/slims9/index.php?p=api/stocktake/updateStockTakeItemById/{book_id}; Token Checking; If the token is true, Retrieve segment 3 data from the QR code as the book_id

If the book id exists in the stock_take_item table, update the status to 'e', checked_by to 'mobilerobot', last_update to $currentTime. If the update is successful, send a message indicating the update was successful.

### 3.5 *Software requirements*

In developing a mobile robot with a QR code for the book stocktake process, a web-based approach is utilized with an API to integrate the mobile robot with the SLiMS system. The software used is indicated in Table 1.

Table 1. Software requirements

| No. | Components Name |
|---|---|
| 1. | Arduino 1.8.18 |
| 2. | Apache 2.4.52 |
| 3. | XAMPP 3.3.0 |
| 4 | PHP 8.1/2 |
| 5 | My SQL 5.1.1 |
| 6 | SliMs 9.5 |

Arduino 1.8.18 is utilized for controlling the hardware components of the mobile robot, including sensors and motors. Apache 2.4.52 serves as the web server, enabling the hosting of a web-based interface for monitoring and controlling the stocktake process, while XAMPP 3.3.0 provides an integrated development environment comprising Apache, MySQL 5.1.1, PHP 8.1/2, and Perl for local development and testing. PHP 8.1/2 scripts handle data processing, interact with the MySQL database to store and retrieve inventory information, and generate dynamic content for the user interface. MySQL 5.1.1 stores and manages inventory data, including book IDs and quantities, facilitating efficient stocktake operations.

### 3.6 *Hardware requirements*

This design requires several hardware and software components that meet the minimum standards for development. The minimum hardware and software specifications used are outlined in Table 2.

Table 2. Hardware Requirements

| No. | Components Name |
|---|---|
| 1. | ESP32 ESP-32S DOIT WIFI BLUETOOTH IOT DUAL CORE TYPE-C 38 PIN |
| 2. | Barcode Scanner GM66 |
| 3. | L298N L298 DUAL H BRIDGE STEPPER MOTOR DRIVER MODULE |
| 4 | Printer Epson LabelWork |

In the implementation of the Mobile Robot with QR Code, the ESP32 ESP-32S DOIT serves as the central control unit, overseeing the stepper motor for robot navigation, communicating through WiFi/Bluetooth for data exchange with the server, and processing information from the QR Code. The GM66 Barcode Scanner assists in identifying each book by reading the QR Code, while the L298N L298 Dual H Bridge Stepper Motor Driver Module controls the stepper motor to move the robot precisely. The Epson LabelWork Printer is utilized to print QR Code labels affixed to each book, ensuring automatic accessibility to inventory data. This hardware integration enhances efficiency and accuracy in library inventory management by minimizing human involvement.

### 3.7 *Robot Stabilization*

Referring to the designed structure, the stabilization of the robot's movement becomes a crucial aspect to be discussed as a parameter for the success of the implemented design.

Table 3 .Robot Stabilization Test

| Wheel Stability (%) | Robot Stability (m/s) | Robot Stability (%) |
|---|---|---|
| Left (± 86) | ± 0,034 | ± 84,5 |
| Right (± 83) | ± 0,034 | ± 84,5 |

Based on the obtained data, Table 3 shows that the percentage of stability for the left wheel is greater than the right wheel because the lifter's position is inclined towards the right side, causing the right wheel to bear a heavier load than the left wheel. The robot's speed is adjusted so that the average speed during the QR Code ID scanning process is only approximately ± 0.034 m/s. This is to achieve good stability for a smooth QR Code ID scanning process.

### 3.8 Lifter Test

The V-Slot material lifter, equipped with the QR Code Scanner (GM66) and powered by Nema 17, can operate as intended. However, there is a condition where the connecting holes between Nema 17 and V-Slot do not align properly, causing the belt to stretch to adjust the position of these two components. As a result, gradual abrasion on the Nema 17 gear occurs when the GM66 is lowered from a certain height. However, this can be minimized by adjusting the wheel locking force on the GM66 retainer with the V-Slot. The testing includes the height of GM66 on the lifter for scanning the QR Code ID.

Table 4. Lifter Test

| Shelf | Book Position Height (cm) | GM66 Scanning QRCode (cm) |
|---|---|---|
| 1 | 2,5 | 23,5 |
| 2 | 37,5 | 54,5 |
| 3 | 72,5 | 90 |

Based on the data in Table 4, on the first shelf, the base height of the book from the floor surface is 2.5 cm. The datum position 0 of the GM66 Scanner is at a height of 23.5 cm parallel to the QRCode ID attached to the book, which is at a height of 23.5 cm from the base of the book. Next, the GM66 Scanner will move up to the next shelf by adding a height of 21 cm from the previous QR Code ID. Similarly, when the GM66 Scanner reaches shelf 3, it is raised by 35.5 cm from the QR Code ID of shelf 2.

### 3.9 Line Follower Sensor Test

The line follower sensor used has six photodiodes as line reading sensors. However, there are situations where the robot moves, but its movement is not 100% straight. This sensor can help guide the robot back to the intended path when the robot moves less than 100% straight.

Table 5. Line Follower Sensor Test

| Movement Speed | Tilt | Photodiode Sensor Stability Response |
|---|---|---|
| Slightly to the left | ± 10° | ± 95% |
| Slightly to the right | ± 10° | ± 95% |

### 3.10 API Endpoint Test

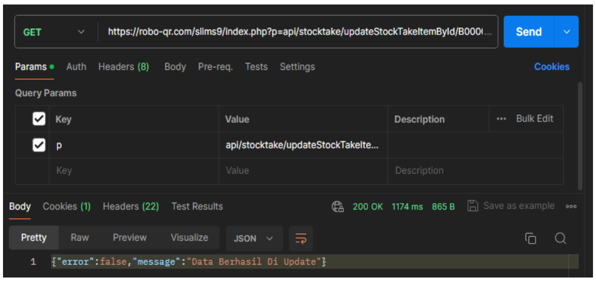


Figure 9. API Endpoint Test

Figure 9 shows the stock take process that will be called by the Arduino system. The Arduino system simply accesses the endpoint: https://robo-qr.com/slims9/index.php?p=api/stocktake/updateStockTakeItemById/ and sends the item ID or QR code ID via a GET request method. If the data is present in the stock_take_item table, the status will be updated to 'exists'.

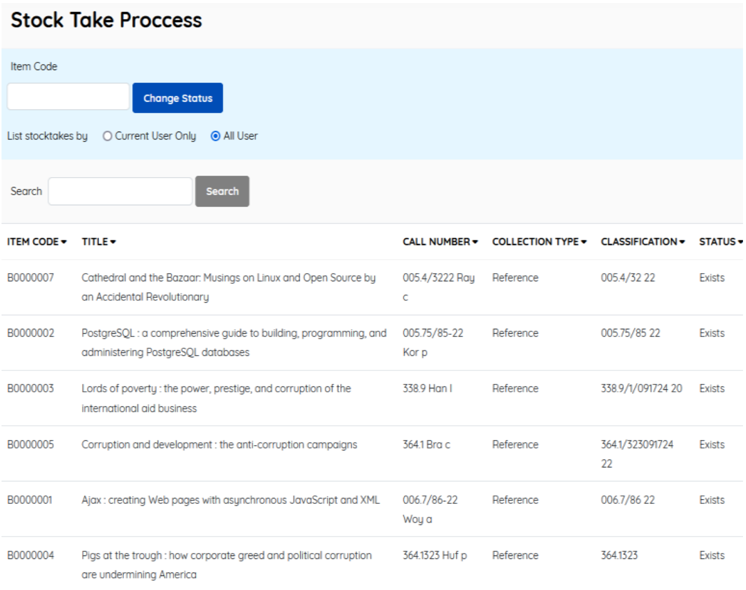


Figure 10. Stock Take Process – SliMS UI

Figure 10 shows the results of the stock take process that has been carried out through the stock take API processed by the QRCode mobile robot.

### 3.11 Efficiency Comparison

In this section, we will explain the analysis of the comparison of time between the traditional manual stocktake process and the QR Code Scanning method with the Mobile Robot. The time recording in the manual process includes tasks such as retrieving and storing books on the bookshelves. The distance between the bookshelves and the recording table is 10 meters (closest distance).

Table 6. Comparison of Processing Time between Manual Process and QR Code Mobile Robot

| Book quantity | Time Process (seconds) Manual Process | QR Code Mobile Robot |
|---|---|---|
| 20 | 94 | 12 |
| 40 | 147 | 28 |
| 60 | 220 | 45 |
| 80 | 287 | 68 |
| 100 | 340 | 87 |

Calculation:

Average time for the manual process:

$$= \frac{94 + 147 + 220 + 287 + 340}{5} = \frac{1088}{5}$$

$$= 217.6 \text{ seconds}$$

Average time for QR Code Mobile Robot:

$$= \frac{12 + 28 + 45 + 68 + 87}{5} = \frac{240}{5} = 48 \text{ seconds}$$

Efficiency Percentage:

$$= (1 - \frac{48}{217.6}) \times 100\% = (1 - 0.2206) \times 100\%$$

$$= 0.7794 \times 100\% = 77.94\%$$

Through careful examination of the collected data, it is evident that there is a significant increase in efficiency achieved by leveraging modern technology in library inventory management. By comparing the time-consuming manual process with the simplified automation process facilitated by QR codes and mobile robots, an efficiency gain of approximately 77.94% is observed when implementing the mobile robot scan compared to the manual process.

## 4. Conclusions

The utilization of QR codes in the book inventory process at the library has demonstrated itself as a robust solution for enhancing the efficiency and precision of library management operations. Integrating the QR code reader of a mobile robot with the SliMS system during the Stock Take process can be seamlessly achieved through an accessible API, enabling the creation of an Automated Book Inventory Management System. This system heralds significant transformative changes in library management practices. The implementation of dynamically generated QR codes as commands offers considerable convenience to library administrators in adjusting the layout of bookshelves. Furthermore, the autonomous and precise movement of the mobile robot notably reduces recording time, thereby saving valuable staff hours and enabling them to focus on more value-added activities. Thus, the development of an Automated Book Inventory Management System, underpinned by QR codes and mobile robots, heralds positive transformations in library management. Through the adoption of this technology, the book inventory process in libraries becomes more streamlined, effective, and efficient, as evidenced by the observed efficiency gain of approximately 77.94% when compared to the manual process.

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## References

[1] A. Ozeer, Y. Sungkur, and S. D. Nagowah, “Turning a Traditional Library into a Smart Library,” in *2019 International Conference on Computational Intelligence and Knowledge Economy (ICCIKE)*, 2019, pp. 352–358. doi: 10.1109/ICCIKE47802.2019.9004242.

[2] J. K. Behera and S. P. Singh, “Problems and challenges of collection development of Indian libraries in Digital Era-An Assessment,” *Researchers World*, vol. 2, no. 1, p. 133, 2011.

[3] K. Stevens, “Taking Stock-the Process and Benefits of Performing a Regular Library Stocktake,” no. 6, 2011, [Online]. Available: http://www.librisdesign.

[4] M. Amrutkar, A. Palsokar, A. P. Raibagkar, and others, “QR code based stock management system,” *International Research Journal of Engineering and Technology (IRJET)*, vol. 4, no. 6, pp. 5606–5611, 2017.

[5] A. Singh, “Smart Library Management System using QR code,” 2019.

[6] I. A. Kliushnyk, T. O. Kolesnykova, and O. S. Shapoval, “UNIFIED DIGITAL INFRASTRUCTURE OF THE MODERN SCIENTIFIC LIBRARY ON THE BASIS OF WEB TECHNOLOGIES,” *Science and Transport Progress. Bulletin of Dnipropetrovsk National University of Railway Transport*, vol. 0, no. 1(79), pp. 64–80, Mar. 2019, doi: 10.15802/stp2019/160434.

[7] S. Gul and S. Bano, “Smart libraries: an emerging and innovative technological habitat of 21st century,” *The Electronic Library*, vol. 37, no. 5, pp. 764–783, Jan. 2019, doi: 10.1108/EL-02-2019-0052.

[8] Hudron K. Kari, “Digital Transformation of Information and its Impact on Libraries,” *World Journal of Innovative Research*, no. 9, pp. 2454–8236, 2020, [Online]. Available: www.wjir.org

[9] T. H. Budianto, U. F. Vista, and G. B. Putra, “Design a library information system for a green library in Bangka Regency,” in *IOP Conference Series: Earth and nvironmental Science*, Institute of Physics, 2022. doi: 10.1088/1755-1315/1108/1/012045.

[10] A. Chanda, “Barcode Technology and its Application in Libraries,” 2019. [Online]. Available: https://digitalcommons.unl.edu/libphilprac/3619Electroniccop yavailableat:https://ssrn.com/abstract=3649957

[11] S. Novoselov, O. Sychova, and S. Tesliuk, “Development of the Method Local Navigation of Mobile Robot a Based on the Tags with QR Code and Wireless Sensor Network,” in *2019 IEEE XVth International Conference on the Perspective Technologies and Methods in MEMS Design (MEMSTECH)*, 2019, pp. 46–51. doi: 10.1109/MEMSTECH.2019.8817405.

[12] Z. Deineko, N. Kraievska, and V. Lyashenko, “QR Code as an Element of Educational Activity,” 2022, [Online]. Available: http://www.classtools.net/QR/;

[13] H. N. Alim, N. Tamami, and A. H. Alasiry, “Automated Library System Mobile Robot using A-Star Algorithms,” in

*2022 International Electronics Symposium (IES)*, 2022, pp. 355–360. doi: 10.1109/IES55876.2022.9888341.

[14] S. L. and S. T. and J. V. Megalingam Rajesh Kannan and Madhuri, "Robot Navigation Through QR and Text Detection," in *Computer Networks and Inventive Communication Technologies*, R. and R. Á. and B. G. N. Smys S. and Palanisamy, Ed., Singapore: Springer Nature Singapore, 2021, pp. 197–209.

[15] M. M. Din and A. F. Fazla, "Integration of Web-Based and Mobile Application with QR Code implementation for the library management system," *J Phys Conf Ser*, vol. 1860, no. 1, p. 12018, Mar. 2021, doi: 10.1088/1742-6596/1860/1/012018.

[16] G. Firmansyah and D. Hariyanto, "The use of QR code on educational domain: a research and development on teaching material," *Jurnal SPORTIF : Jurnal Penelitian Pembelajaran*, vol. 5, no. 2, p. 265, Nov. 2019, doi: 10.29407/js_unpgri.v5i2.13467.

[17] P. Anggraeni, M. Mrabet, M. Defoort, and M. Djemai, "Development of a wireless communication platform for multiple-mobile robots using ROS," in *2018 6th International Conference on Control Engineering & Information Technology (CEIT)*, 2018, pp. 1–6. doi: 10.1109/CEIT.2018.8751845.

[18] W. Candra, R. Merzouki, and M. Djemai, "Practical Validation of ORB2 SLAM Mapping on Indoor Logistic UAV Application," in *Proceedings of the 5th International Conference on Applied Science and Technology on Engineering Science - Volume 1: iCAST-ES*, SciTePress, 2022, pp. 976–981. doi: 10.5220/0011973800003575.

[19] S. Mulia, W. Candra, and M. Faisal, " Rancang Bangun Prototipe Automated Guided Vehicle Berbasis Mikrokontroler," *Jurnal TEDC*, vol. 17, no. 1, pp. 69–75, 2023, [Online]. Available: http://www.ejournal.poltektedc.ac.id/index.php/tedc/article/view/679

[20] B. Jeyapragash, T. Rajkumar, and A. Muthuraj, "SLIMS: An Open Source Library Management System," in *the Proceedings of the conference on 'Managerial competencies for Library Professionals: Trends and Opportunities'. Bishop Heber College, Trichy*, 2019.