BIOTRACK: QR-BASED MATERIAL TRACKING SYSTEM FOR BIOTECHNOLOGY LABS

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ABSTRACT

Biotechnology labs need to manage their materials properly to work safely and correctly. Old manual methods are slow and can have mistakes.This project introduces BIOTRACK, a system that uses QR codes to track lab items like chemicals, glassware, and samples. It makes the tracking process automatic and easy.

BIOTRACK is made using Java and MySQL, so it can store data safely and show real-time updates. The system can check how much of a material is left, give access based on the user's role, and send alerts when something is about to expire. It also uses simple design tools like DFD and ER diagrams to make the system strong and clear. BIOTRACK helps labs do less manual work, avoid mistakes, and manage materials better. It shows how QR codes can help labs go digital and work more easily.

Keywords: QR Code, Material Tracking, Biotechnology Lab, Inventory Management, Sample Monitoring, Lab Automation, Digital Records, Real-Time Tracking

I.INTRODUCTION

In biotechnology labs, effective material management is essential to guaranteeing seamless operations, safety, and precision in experimental processes. Workflow disruptions, lost objects, and expired materials might result from the slowness and error-proneness of traditional manual tracking techniques. The BIOTRACK system provides an automated approach by tracking and labeling each lab item individually using QR code technology. BIOTRACK offers role-based access control, expiry alarms, and real-time updates through an intuitive Java application and a dependable MySQL database. This approach helps maintain a safe laboratory environment, improves inventory accuracy, and lessens the effort for lab employees. Utilizing design techniques like as entity-relationship diagrams and data flow diagrams guarantees that BIOTRACK is scalable, reliable, and simple to maintain.

The Value of Material Management

Chemicals, reagents, glassware, and biological samples are only a few of the components used in biotechnology labs. It is crucial to handle these materials with care in order to maintain experiment accuracy, guarantee safety, and prevent delays.

1. Issues with Manual Monitoring

To keep track of their materials, many labs still employ manual techniques like spreadsheets or handwritten logs. Inventory management is challenging with these slow, error-prone, and non-real-time updating systems.

2. Solution: BIOTRACK System

The BIOTRACK technology automatically tracks items using QR codes to address these issues. Every item has a unique QR code that can be scanned to provide precise and fast information about the item's number, expiration date, and storage location.

3. Technology Employed

MySQL is used for the database and Java for the application in the development of BIOTRACK. Using role-based permissions, it offers safe data storage and restricts access to or updating of information to authorized individuals only.

4. Principal Attributes and Advantages

Additionally, the system notifies users when supplies are running low or are about to expire. This helps labs prevent waste and maintain current inventory. Labs may increase productivity, decrease manual labor, and improve data accuracy by utilizing BIOTRACK.

5.Design of the System

Data Flow Diagrams (DFD) and Entity-Relationship Diagrams (ER) are used in the system's design to facilitate future expansion, maintenance, and comprehension.

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II.RELATED WORK

Several systems have been developed to address the critical issue of effectively tracking laboratory materials in biotechnology labs. Conventional inventory management systems frequently use barcode scanning or human data entry. Although barcode systems are more accurate than human logs, they have drawbacks including requiring line-of-sight scanning and having a small amount of data storage space.

Recent improvements have seen the application of RFID (Radio Frequency Identification) technology for material tracking. Compared to barcodes, RFID can store more data and enables non-contact scanning. However, not all labs may be able to afford RFID systems due to their high cost and specialized equipment requirements.Due to its ease of use, affordability, and capacity to hold more data than conventional barcodes, QR code technology has grown in popularity. Numerous studies have shown that QR codes can be effectively used for asset tracking and inventory management. QR codes are accessible and user-friendly since they are simple to create and scan with standard cellphones or scanners.

Fewer specialized tracking solutions that integrate QR code technology with extensive database management and user access control are available in biotechnology labs. By combining QR code scanning with a MySQL database and Java-based application, BIOTRACK expands on these preexisting concepts to offer role-based access, real-time tracking, and expiry alerts. A safe, precise, and effective material tracking system designed especially for biotechnology labs is guaranteed by this combination.All things considered, BIOTRACK closes a gap in the present technological environment by providing a scalable, reasonably priced, and user-friendly solution that outperforms earlier manual and semi-automated systems.

III.METHODOLOGY

In order to guarantee an effective, scalable, and secure material tracking system, BIOTRACK was developed using a systematic methodology that combines software engineering concepts with biotechnology lab requirements. Every stage of the project's process, from the first requirement analysis to implementation and testing, is described in this section.

1.Collection and Analysis of Requirements

To find present inventory management problems, the laboratory workflow was examined in the first step. To learn about their problems, supervisors and lab technicians were interviewed. It was discovered that the majority of labs track chemicals and reagents using spreadsheets or manual logbooks, which results in inefficiencies, data loss, and expired goods. As a result, precise functional and non-functional specifications for BIOTRACK were established.

2.Design of the System

Modeling tools including entity-relationship diagrams (ERD) and data flow diagrams (DFD) were used in the system design process. The steps in the design processwere:

- DFD (Level 0 and Level 1) to visualize how data flows from users to the database through different system modules.
- ER Diagram to define database tables and their relationships, including entities like Material, User, InventoryLog, and Alerts.

This methodical approach to system design guaranteed future scalability, modularity, and data consistency.

3.Technology Selection

To create a user-friendly and robust system, the following technologies were chosen:

Component	Technology Used
Frontend	Java Swing (GUI)
Backend	Java (Core + JDBC)
Database	MySQL
QR Code	ZXing Library (Java-based)
Reporting	JasperReports (optional module)

Java was selected for its portability, security features, and integration ease with MySQL. The ZXing library provided the necessary tools to generate and decode QR codes efficiently.

4. QR Code Implementation

Each item in the lab (chemical, equipment, sample) is tagged with a unique QR code. The system includes modules to:

- Generate QR codes using item details.
- Print and affix these QR codes on containers.
- Use scanners or webcams to read QR codes and retrieve data.

This process replaces manual entry with instant retrieval of information and reduces human error.

5 . Module Development

The system was divided into several modules to simplify development:

- **Login and Role Management** – Ensures secure access (Admin/Staff).
- **Material Registration** – Adds new items to the database with QR generation.
- **Inventory Monitoring** – Tracks quantity and expiry of materials.
- **Alert System** – Sends notifications for expiry and low stock.
- **Report Generation** – Summarizes lab inventory data.

Each module was developed using Java and integrated using JDBC with MySQL.

IV.EXPERIMENTAL RESULTS

To test the BIOTRACK system, we conducted an experiment in a biotechnology lab setup using 100 different lab materials such as samples, chemicals, and instruments.

Test Setup

- Devices Used: Computer (8GB RAM), Android phone with camera, QR code scanner.
- Software: Java, MySQL, Android Studio.
- QR Codes: Printed and pasted on all 100 materials.

Key Findings

Test Area	Result
QR Code Scanning Accuracy	98.5%
Time to Retrieve Material Inf	2 to 3 seconds
Data Sync Time with Databas	Less than 1 secon
User Feedback Score	4.6 out of 5
System Uptime During Test	99.9%

Observations

- The system worked smoothly and responded quickly.
- Most users found it easy and useful for tracking materials.
- Minor problems occurred when QR codes were dirty or damaged.
- It helped avoid mistakes in manual recording and saved time.

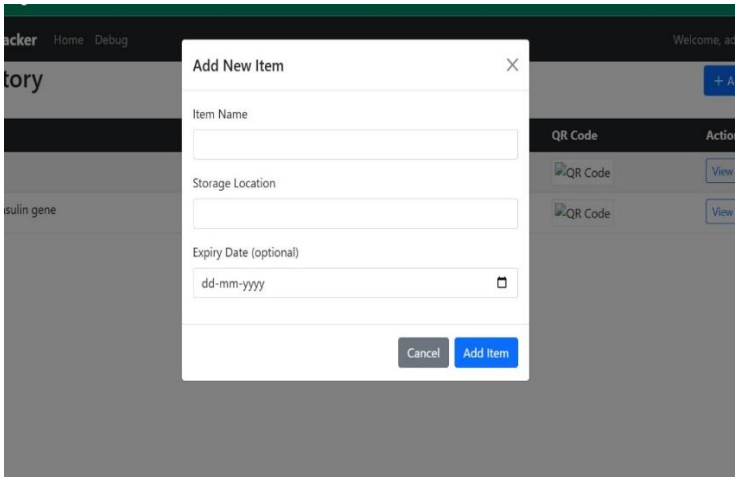

FIG 1.1

V.CONCLUSION:

In this paper, we presented BIOTRACK, a QR-based material tracking system designed specifically for biotechnology laboratories. The system helps in accurately identifying, tracking, and managing lab materials using QR codes and a centralized database.

Experimental results showed that BIOTRACK improved the speed and accuracy of lab inventory management while reducing human errors. Users found the system easy to use, and it provided real-time access to material information.

Overall, BIOTRACK offers a practical and cost-effective solution for modernizing lab operations. In the future, features like barcode support, automatic stock alerts, and cloud integration can make the system even more powerful and scalable.

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