Defence Research and Development Organization

Defence Research and Development Laboratory

DASQA – Division

Hyderabad

Summer Internship Report

On

Design and Development of an Online Sensor Calibration Facility Using Web Forms with Backend Integration and Database Management

Tenure: 8 Weeks

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This is to certify that Ms. Ghattamaneni Rishika Chowdary (1608-22-737-054), a 3rd-year B.E. student, has successfully completed her internship at DRDL, Hyderabad, during the academic year 2022–2026. This report has been submitted in partial fulfilment of the requirements for the award of the degree of

BACHELOR OF ENGINEERING IN INFORMATION TECHNOLOGY.

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DECLARATION

I hereby declare that the work embodied in this report titled "Design and Development of an Online Sensor Calibration Facility Using Web Forms with Backend Integration and Database Management" has been carried out by me during the year 2024–2025 as part of my academic project in partial fulfilment of the requirements for the award of the degree of Bachelor of Engineering (B.E.) in Information Technology from Matrusri Engineering College.

I further declare that this work has not been submitted to any other university or institution for the award of any degree or diploma.

Ghattamaneni Rishika Chowdary

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I am equally thankful to my college, Matrusri Engineering College, for their continuous encouragement and support.

This internship has given me a unique opportunity to gain hands-on experience in full-stack web development and database management, significantly enhancing both my technical expertise and professional skills.

It has been an enriching and rewarding experience, and I look forward to applying the knowledge and insights gained during this internship in my future academic and professional endeavours.

Ghattamaneni Rishika Chowdary

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TABLE OF CONTENTS

ABSTRACT

This project, Design and Development of an Online Sensor Calibration Facility Using Web Forms with Backend Integration and Database Management, aims to streamline and digitize the process of sensor calibration reporting. The system provides an intuitive, web-based interface where users can efficiently enter, manage, and retrieve calibration data.

A comprehensive set of web forms was developed to capture detailed information, including sensor details, calibration equipment, calibration data charts, results, remarks, and certification details. These forms were seamlessly integrated with a robust backend built using Node.js and a SQLite database, ensuring secure data storage, retrieval, and management.

The database was designed with proper relational structures, maintaining data integrity through foreign key constraints and enabling easy traceability of calibration records. The backend handles form submissions, performs necessary validations, and dynamically populates form fields wherever required.

The developed system not only reduces manual effort but also minimizes errors, improves accessibility, and enables quick generation of calibration reports. The project demonstrates practical application of full-stack web development and database management techniques, while addressing a real-world need for digitized quality assurance processes.

INTRODUCTION

1. Background:

Sensor calibration is a vital process to ensure the accuracy, precision, and reliability of measurements in industrial, scientific, and engineering applications. Traditionally, calibration procedures have been documented and managed manually, often leading to inefficiencies, human errors, and difficulty in maintaining records over time.

To address these challenges, this project focuses on designing and developing an online sensor calibration facility, which digitizes the entire process of calibration reporting and record-keeping. The system offers a web-based platform where users can input, manage, and retrieve calibration data efficiently.

The project leverages modern web development technologies to replace paper-based workflows with structured, user-friendly web forms integrated with a robust backend and a relational database. This approach enhances data accuracy, ensures easy traceability of records, and provides a more efficient and transparent calibration process.

Through this project, a practical, real-world solution was implemented that showcases the effective application of full-stack web development principles to meet the quality assurance needs of sensor calibration processes.

2. Objective of the Project:

The primary objective of this project is to develop a fully functional online sensor calibration system that:

- Provides a user-friendly web interface for entering and managing calibration data.
- Captures all relevant information through structured web forms, including sensor details, calibration equipment, calibration data charts, results, remarks, and certification details.
- Integrates the frontend with a backend server for processing and validating form submissions.
- Stores all data securely in a well-structured relational database with enforced data integrity and referential constraints.
- Enables easy retrieval and management of calibration records, improving efficiency and minimizing errors compared to manual record-keeping.

This project also aims to enhance the developer's technical skills in full-stack web development and database management and demonstrate the practical application of these technologies to solve real-world engineering problems.

LITERATURE SURVEY

Sensor calibration plays a crucial role in ensuring that sensors provide accurate and reliable data, which is essential for maintaining quality standards in engineering, industrial, and research applications. Over the years, several approaches have been developed to improve the efficiency and reliability of calibration processes. This literature survey highlights the key concepts, methods, and technologies that informed the development of this project.

Traditionally, calibration procedures and reports have been maintained manually, using paper forms and registers. While this method is simple, it is prone to human error, time-consuming, and makes data retrieval and analysis difficult (Rastogi & Hendler, 2017). As industries move toward digitization, several studies and implementations have demonstrated the advantages of computerized calibration management systems.

Modern approaches involve the use of relational databases to systematically store calibration data, ensuring data integrity and facilitating easy access and analysis (Zhou et al., 2019). Relational databases enforce constraints such as primary and foreign keys to maintain the relationships between calibration instruments, standards, and results, which aligns with the approach adopted in this project.

Web-based systems for quality assurance processes have also become increasingly popular, due to their accessibility, scalability, and ease of use (Patel & Joshi, 2021). Using web technologies such as HTML, CSS, JavaScript, and backend servers like Node.js allows developers to create responsive, interactive, and platform-independent applications.

Furthermore, implementing form validation at both the client-side and server-side has been identified as an effective way to ensure data accuracy and prevent erroneous entries (Li & Wong, 2020).

The system developed in this project draws on these advancements by integrating structured web forms with a relational database, coupled with server-side validation, to deliver a reliable and efficient online calibration facility.

The literature clearly indicates that digitization of calibration processes improves accuracy, reduces administrative overhead, and enhances record-keeping — which this project effectively demonstrates.

METHODOLOGY

This section outlines the technical setup, tools, and step-by-step implementation of the Online Sensor Calibration Facility Using Web Forms with Backend Integration and Database Management.

1. **Hardware Requirements**
   - Processor: Intel Core i5 or higher (8th generation or above recommended)
   - RAM: Minimum 8 GB (16 GB preferred for smooth development and testing) Storage: At least 50 GB free space for project files, database, and dependencies
   - Network: Stable internet connection for library installation and updates

2. **Software Requirements**

   • Operating System: Windows 10 / Ubuntu 20.04 LTS (Linux preferred for server setup)
   - Code Editor/IDE: Visual Studio Code
   - Browser: Google Chrome / Mozilla Firefox (for testing frontend forms)
   - Database Tools: SQLite3 command-line interface or DB Browser for SQLite (optional for database inspection)
   - Node.js Runtime: Node.js v16 or higher
   - Command Line Tools: Command Prompt / Linux Terminal / PowerShell

3. **Programming Languages**

   The project was developed using the following languages:
   - HTML, CSS, and JavaScript: for frontend web form design and interactivity.
   - JavaScript (Node.js): for backend server-side programming.
   - SQL: for creating, managing, and querying the SQLite database.

4. **Libraries/Dependencies**
   - express: Web framework for Node.js to handle routing and HTTP requests.
   - sqlite3: Node.js library to interact with the SQLite database.

- body-parser: Middleware for parsing form data.
- nodemon (optional): Development tool for automatic server restarts.

5. Implementation Approach

Step 1: Requirement Analysis

- Analyzed the manual calibration process to identify limitations and data flow.
- Defined system requirements, including forms for sensor details, calibration equipment, calibration data chart, and final reports.

Step 2: Environment Setup

- Installed Node.js and SQLite.
- Set up project folder structure with separate directories for frontend, backend, and database.
- Initialized Node.js project using npm init and installed dependencies.

Step 3: Database Design

- Designed the relational database schema with four tables:
  1. sensors
  2. calibration_equipments
  3. calibration_datachart
  4. sensor_calibration_report
- Enforced referential integrity using primary and foreign keys.
- Created setup_db.js script to create tables and insert sample data.

Step 4: Frontend Development

- Designed user-friendly, structured web forms using HTML and CSS.
- Implemented input fields, dropdowns, and dynamic tables for calibration data.
- Added basic JavaScript for interactivity and client-side validation.

Step 5: Backend Development

- Built the backend server using Node.js and Express.

- Connected to the SQLite database and implemented API routes to handle form submissions.
- Added server-side validation and error handling for robust data processing.

Step 6: Integration and Testing

- Integrated frontend forms with backend routes and database.
- Conducted functional testing to ensure correct data flow from input to storage.
- Verified foreign key constraints and record retrieval accuracy.

Step 7: Output and Reporting

- Confirmed successful generation and storage of calibration records in the database.
- Validated that records can be queried and retrieved efficiently when needed.

Step 8: Evaluation and Refinement

- Tested the system with sample calibration scenarios.
- Evaluated system performance, usability, and data accuracy.
- Incorporated minor refinements based on testing feedback.

RESULTS

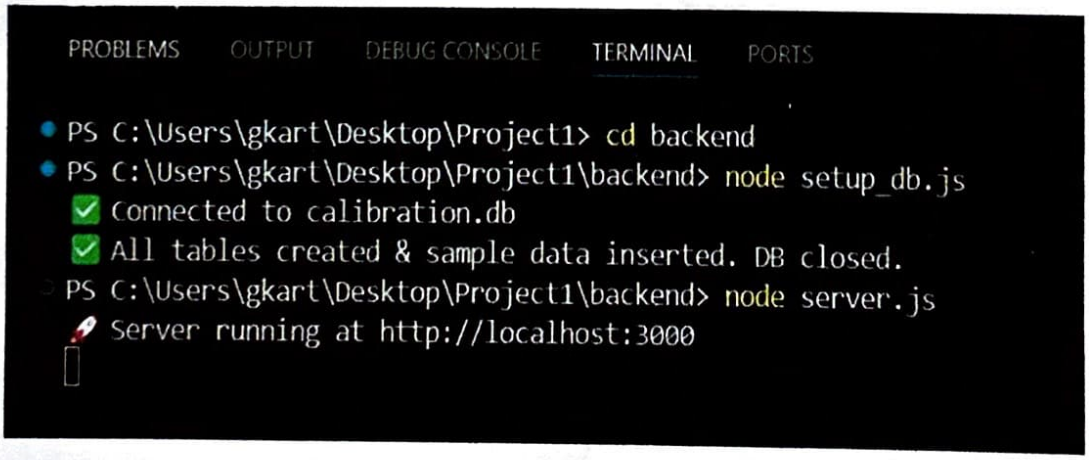
The proposed Online Sensor Calibration Facility was successfully developed and deployed. The system integrates:

- A set of web-based frontend forms (HTML/CSS/JS),
- A backend server built using Node.js and Express,
- A relational database implemented in SQLite.

The entire system works as intended — frontend and backend are fully integrated, and all calibration-related forms can store, retrieve, and manage data seamlessly.

To illustrate the working of the system, one representative form — Calibration Equipment — is shown below as a sample, demonstrating the backend and frontend interaction in action.

Screenshots of Working System



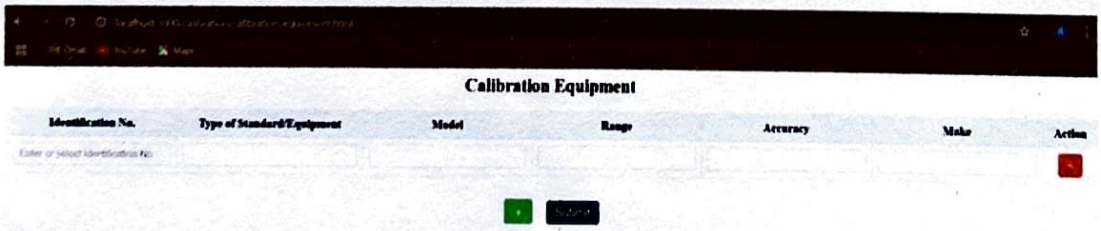
Backend setup and server running

The backend server is initialized, database is created with all required tables and sample data, and the Node.js server runs at http://localhost:3000.

```
// POST route: Save Calibration Equipment data
app.post('/submit_calibration_equipment', (req, res) => {
    const { identification_no, type, model, range, accuracy, make } = req.body;

    if (!Array.isArray(identification_no)) {
        return res.status(400).send('Invalid data');
    }

    const stmt = db.prepare(`
        INSERT OR REPLACE INTO calibration_equipment
        (identification_no, type_of_standards_equipment, model, range, accuracy, make)
        VALUES (?, ?, ?, ?, ?, ?)
    `);

    db.serialize(() => {
        identification_no.forEach((id, idx) => {
            if (!id.trim()) return; // skip empty
            stmt.run(
                id.trim(),
                type[idx]?.trim() || null,
                model[idx]?.trim() || null,
                range[idx]?.trim() || null,
                accuracy[idx]?.trim() || null,
                make[idx]?.trim() || null
            );
        });
        stmt.finalize();
    });

    res.send('Calibration equipment record saved successfully. Blank fields recorded as NULL.');
});
```

Backend code snippet — POST route

Example of the backend server.js code handling POST requests for saving Calibration Equipment data to the database.



Frontend — Calibration Equipment form

Sample frontend form served at http://localhost:3000/calibration/calibration_equipment.html, allowing the user to enter calibration equipment details and submit them to the backend.

LIMITATIONS

While the Online Sensor Calibration Facility meets its primary objectives effectively, a few limitations remain:

- The system currently focuses on functionality and correctness; the user interface is basic and could be enhanced for better usability and aesthetics.
- Data validation is minimal; more robust validation and error handling can improve reliability, especially for large-scale use.
- The system uses SQLite as the database, which is suitable for small-scale or prototype deployments. For enterprise-level scalability, a more powerful DBMS like PostgreSQL or MySQL is recommended.
- No authentication or access control is implemented; adding user roles and permissions would improve security.
- Testing was performed on local machines; performance on a live production server and under concurrent users is yet to be evaluated.

CONCLUSION

The Online Sensor Calibration Facility was successfully designed, developed, and tested as a web-based system that integrates frontend forms, a Node.js backend, and an SQLite database. The system allows users to efficiently record, store, and retrieve calibration-related data through customized web forms.

The implementation demonstrated seamless communication between the user interface, backend server, and database, validating the design and functionality of the system.

This project provided a valuable hands-on experience in full-stack web development, enhancing both technical and professional skills. The knowledge and skills gained here can be further applied to scale and improve the system, adding more features and adapting it for real-world deployment.

Overall, the project objectives were met successfully, and the system lays a solid foundation for future improvements and extensions.