Software Development Intern at Unbox Robotics
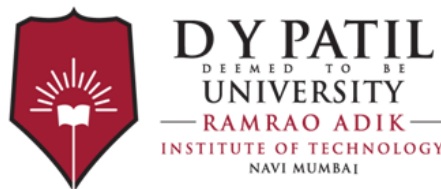
Submitted in the partial fulfillment of the requirements

for the degree of B.Tech in Computer Engineering

by

Chaskar Saish Santoshkumar 21CE1490
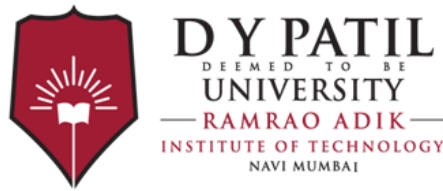
Supervisor

Mrs. Poonam Gadge

Department of Computer Engineering

Ramrao Adik Institute of Technology

Sector 7, Nerul, Navi Mumbai

(Under the ambit of D. Y. Patil Deemed to be University)

April 2025

Ramrao Adik Institute of Technology

(Under the ambit of D. Y. Patil Deemed to be University)

Dr. D. Y. Patil Vidyanagar, Sector 7, Nerul, Navi Mumbai 400 706

CERTIFICATE

This is to certify that, the Internship report entitled

Software Development Intern at Unbox Robotics

is a bonafide work done by

Chaskar Saish Santoshkumar 21CE1490

and is submitted in the partial fulfillment of the requirement for the degree of

B.Tech in Computer Engineering

to the

D. Y. Patil Deemed to be University

Industry Mentor	Supervisor	Project Co-ordinator
(Mr. Ujjval Pamnani)	**(Mrs. Poonam Gadge)**	**(Mr. Tushar Ghorpade)**

Head of Department	Principal
(Dr. Amarsinh V. Vidhate)	**(Dr. Mukesh D. Patil)**

Internship Report Approval

       This is to certify that the Internship entitled *" Software Development Intern "* is a bonafide work done by *Chaskar Saish Santoshkumar 21CE1490* under the supervision of *Mrs. Poonam Gadge*. This internship is approved in the partial fulfillment of the requirement for the degree of *B.Tech in Computer Engineering*

Internal Examiner :

    1. . . . .

    2. . . . .

External Examiners :

    1. . . . .

    2. . . . .

Date : . . ./. . ./. . . . . .

Place : . . . .

DECLARATION

I declare that this written submission represents my ideas and does not invovle plagiarism. I have adequately cited and referenced the original sources wherever others' ideas or words have been included. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action against me by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Chaskar Saish Santoshkumar 21CE1490

Abstract

This report details my six-month internship as a Software Development Intern (Fullstack) at Unbox Robotics, a leading automation machinery manufacturing technology company. The primary focus was developing a PCB Testing Tool to automate the testing process of Printed Circuit Boards (PCBs) for various robotic systems. The tool utilized React (Vite.js) for the frontend, FastAPI for the backend, and WebSocket communication to interface with C++ middleware for serial communication with PCBs. Additionally, I contributed to implementing UART communication in C++ for sensor integration. The internship enhanced my skills in fullstack development, embedded systems, and automation, significantly reducing manual testing time and improving efficiency.

Contents

List of Figures

Chapter 1

Introduction

PCB Testing Tool: Developing an Browser based PCB Testing Tool which connects with PCB middle-ware interactions to automate the testing process of the PCB of different versions and models.

Implementing UART in C++ : This Project aims to demonstrate the feasibility of implementing UART communication in intel Atom Processor. The primary motivation for this project is to integrate a new PDS sensor into robots. UART has been chosen as the communication channel because the Atom has unused UART pins, and this approach helps minimize the use of USB ports, of which only three are available on the Atom.

1.1 Overview

Unbox Robotics specializes in robotics-based fulfillment and distribution technology for e-commerce, retail, and logistics enterprises. Their mission is to empower customers with efficient order fulfillment using advanced robotic systems, aiming to be a global leader in logistics automation.

During my internship from January 15, 2025, to July 15, 2025, till now I have worked on two key projects: developing a PCB Testing Tool and implementing UART communication in C++ for sensor integration. The PCB Testing Tool aimed to automate testing processes for various PCB models, while the UART project focused on enabling efficient sensor data communication on an Intel Atom processor.

1.2   Roles and Responsibilities

As a Software Development Intern (Full Stack) at Unbox Robotics, I was actively involved in the end-to-end development of an internal test tool for the Production Team as well as working on software products of Unbox.

My key responsibilities included:

- Design user flows, information architecture, and follow core design principles to build intuitive and user-centric software solutions.

- Define system designs and technical specifications in alignment with functional requirements.

- Design scalable and modular software architecture through active collaboration with stakeholders.

- Develop robust software tools and internal applications to support the production and operations teams.

- Conduct end-to-end verification, testing, and deployment of developed solutions to ensure stability and performance.

- Understand and implement communication protocols such as UART on embedded systems and integrate them with higher-level applications.

- Configure reliable communication between processing units and external peripherals to support data exchange and control operations.

- Write and test scripts for serial communication across systems and peripherals.

- Debug and resolve software issues to maintain system integrity and efficiency.

- Document technical findings and propose improvements for better performance, maintainability, and scalability.

Chapter 2

Analysis of Existing Solutions

The existing PCB Testing Tool, built in C++, tested boards like AgvCb, ods, and AgvCob using defined test cases. It utilized shared memory for inter-process communication (IPC) and featured a desktop UI for setup and test environment logging, with CSV report generation. However, it lacked scalability, modern UI interactions, and efficient automation for diverse PCB versions.

For UART communication, traditional solutions included microcontroller-based systems (e.g., Arduino, ESP32) and Linux-based frameworks like PySerial and termios. These were limited by hardware constraints or inefficient data handling for high-frequency sensor data (824 bytes at 24 Hz).

Chapter 3

Proposed System

3.1 Problem Statement

PCB Testing Tool: The existing tool required manual intervention, taking 1-2 hours per test cycle, and lacked a scalable architecture for new PCB versions. The goal was to develop an automated, user-friendly tool with a modern UI, reducing testing time and improving scalability.

UART Implementation: Integrate a PDS sensor into robots using UART to minimize USB port usage, ensuring reliable data transfer (824 bytes every 43 ms) with minimal CPU utilization of less than (3%).

3.2 Project Methodology/Techniques

Literature Review: Studied FastAPI, React, WebSocket protocols, PostgreSQL, and UART principles.

Experimental Approach: Conducted Proof of Concepts (POCs) to select the technology stack (FastAPI, React, PostgreSQL) and validate WebSocket communication for PCB testing.

Software Development:

Frontend: React (Vite.js) for interactive UI.

Backend: FastAPI for API development and WebSocket integration.

Database: PostgreSQL for test data storage.

Middleware: C++ for serial communication with PCBs, interfaced via WebSockets.

Hardware Configuration: Configured UART on Intel Atom Up Squared 2 for sensor communication.

3.3 Design and Architecture

PCB Testing Tool:

Frontend: React (Vite.js) provided a dynamic dashboard for test setup and result visualization.

Backend: FastAPI handled API endpoints for test automation and WebSocket communication.

Middleware: C++ managed serial communication with PCBs, relaying data to FastAPI via WebSockets.

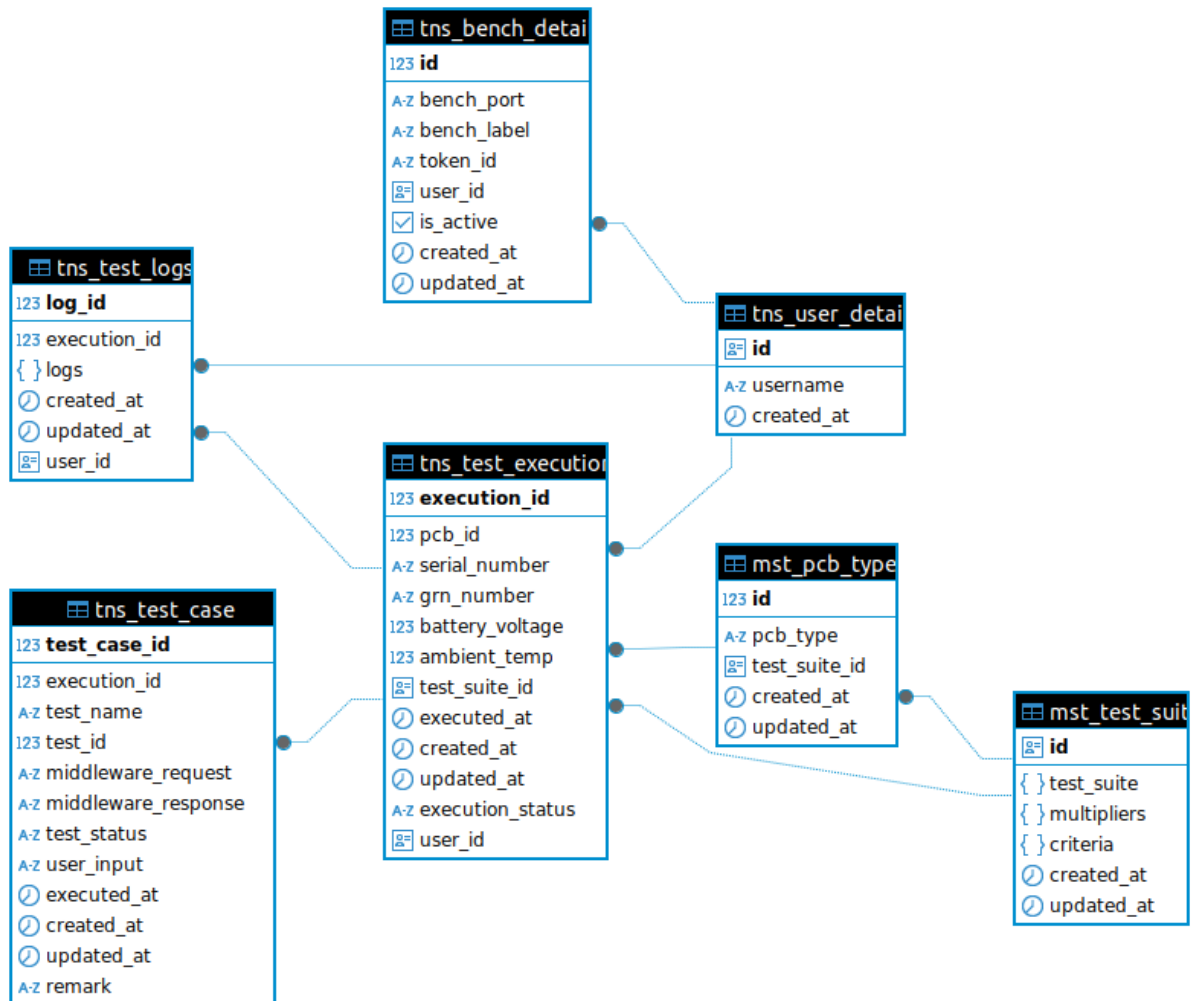**Database:** PostgreSQL stored test logs and reports.

Figure 3.1: Database Architecture

Architecture: MVC pattern for backend, ensuring modularity and scalability.
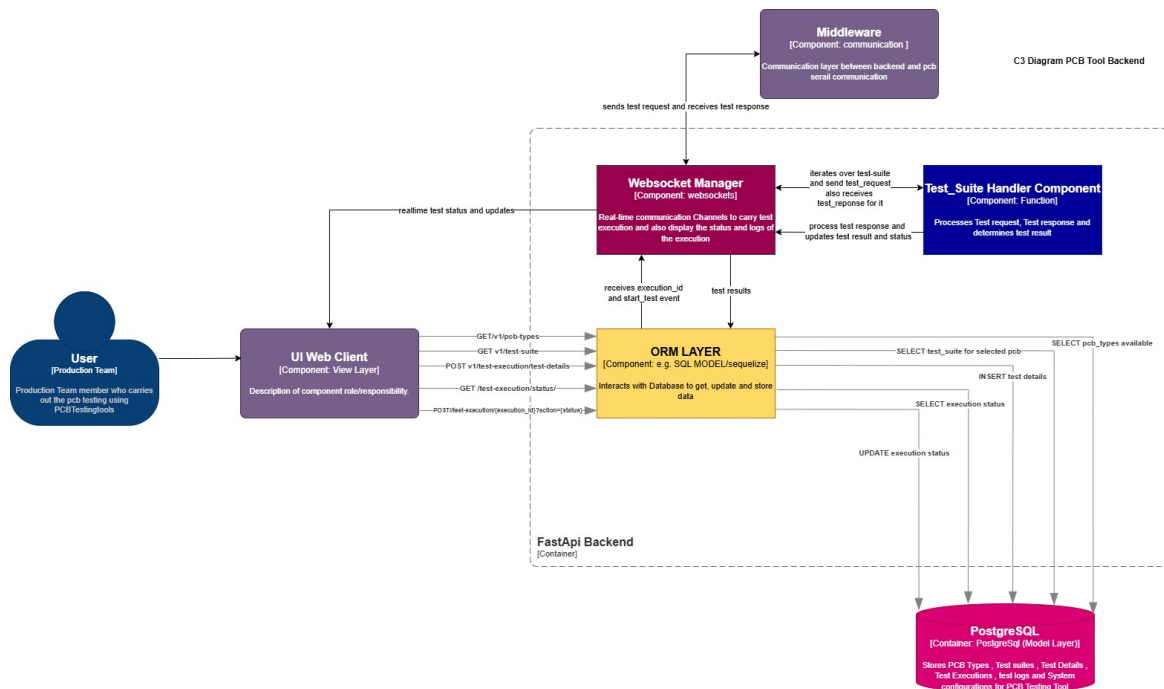

Figure 3.2: C3 Diagram PCB Testing Tool

UART Implementation: Configured serial ports with specific baud rates, parity, and stop bits. Developed C++ scripts for data reading and error handling, integrated with CSV logging.

3.4 Skills Development

Software Development: Mastered fullstack development with React, FastAPI, and PostgreSQL; implemented WebSocket communication.

Embedded Systems: Gained expertise in UART configuration, C++ middleware, and PCB testing automation.

Testing and Automation: Developed automated test workflows and report generation systems.

Collaboration: Enhanced stakeholder communication and technical documentation skills.

Chapter 4

Results and Discussion

4.1 Implementation Details

PCB Testing Tool:

Developed a responsive UI with React (Vite.js) for test configuration and result display. Built FastAPI backend with APIs for test execution and WebSocket endpoints for real-time middleware communication. Integrated C++ middleware for serial PCB interaction, ensuring seamless data flow. Implemented PostgreSQL schemas for storing test logs and generating CSV reports.
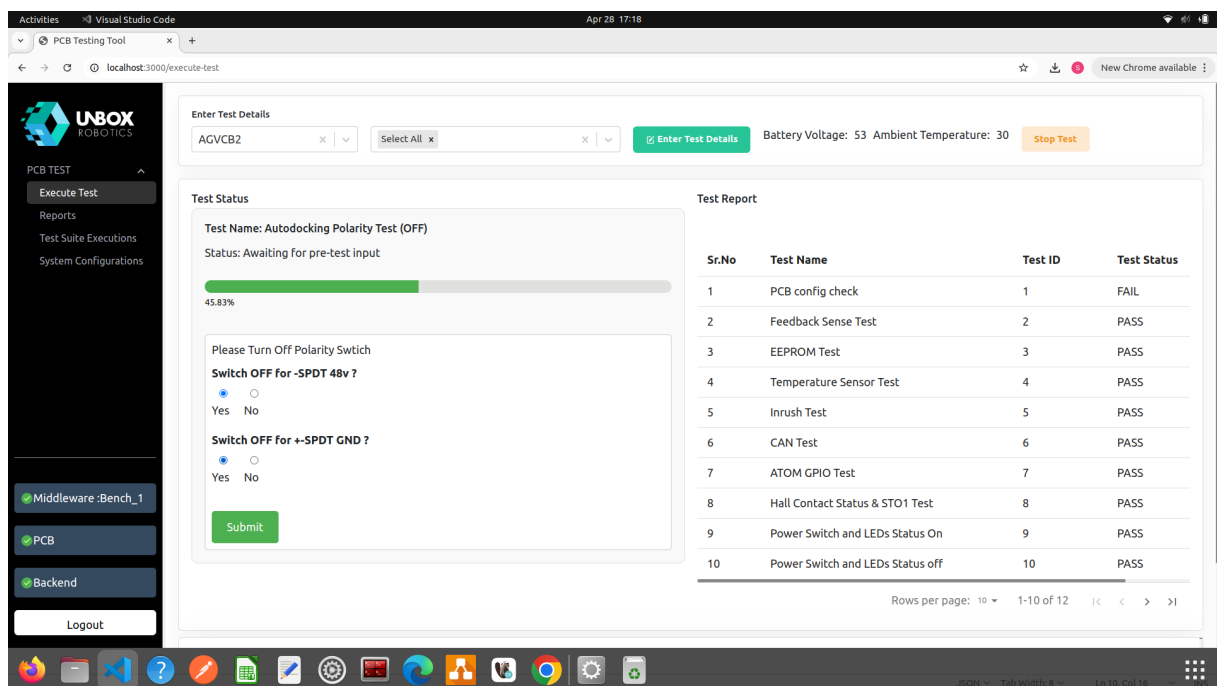

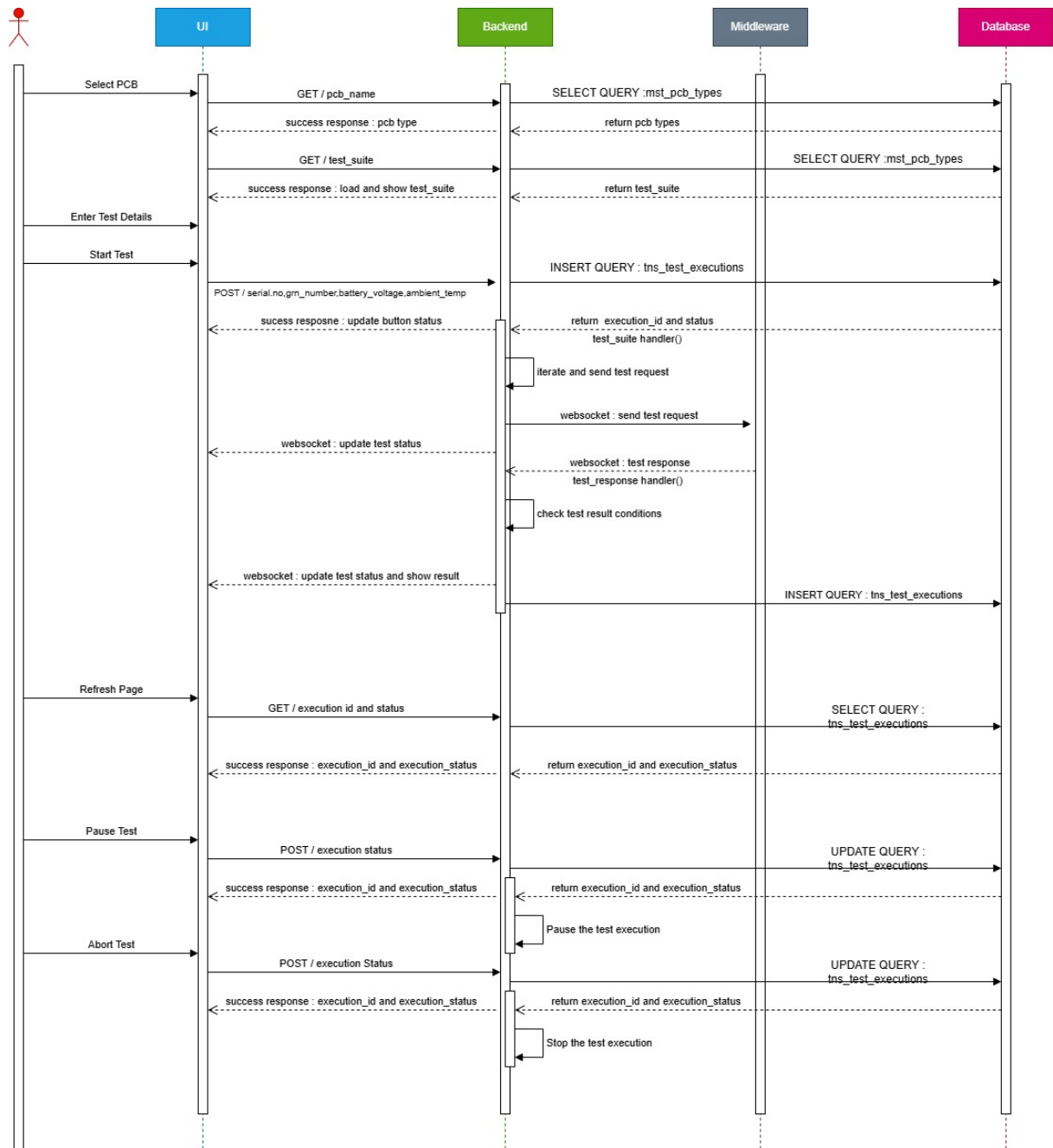Figure 4.1: Dashboard PCB Testing Tool

Figure 4.2: Sequence Flow Diagram of PCB Testing Tool

UART Implementation:

Configured UART on Intel Atom Up Squared 2 to read 824 bytes every 43 ms. Developed C++ scripts for data processing, error handling, and CSV logging. Optimized data reading to prevent packet loss and ensure synchronization.

4.2 Testing Strategies

Unit Testing: Validated FastAPI endpoints and React components.

Integration Testing: Ensured seamless WebSocket communication between frontend, back-end, and middleware.

Hardware Testing: Executed PCB test scripts to validate outputs.

Performance Testing: Optimized test execution to reduce cycle time.

UART Implementation:

Tested various baud rates and configurations to ensure reliable data transfer. Used tools like minicom to debug connectivity issues. Analyzed CSV logs to identify packet drops or mis-matches.

4.3 Result Analysis

PCB Testing Tool:

Reduced manual testing time from 2-3 hours to 5 minutes. Achieved consistent UI design with existing Unbox Robotics products. Developed an initial MVP with frontend, backend, and database integration. Project remains in the development phase, with ongoing enhancements.

UART Implementation:

Achieved an average packet time difference of 42.82 ms, meeting the 43 ms requirement. Maintained CPU utilization below 1.5%, well under the 3% target. Identified and mitigated abnormalities (e.g., heartbeat packet drops) through error handling.
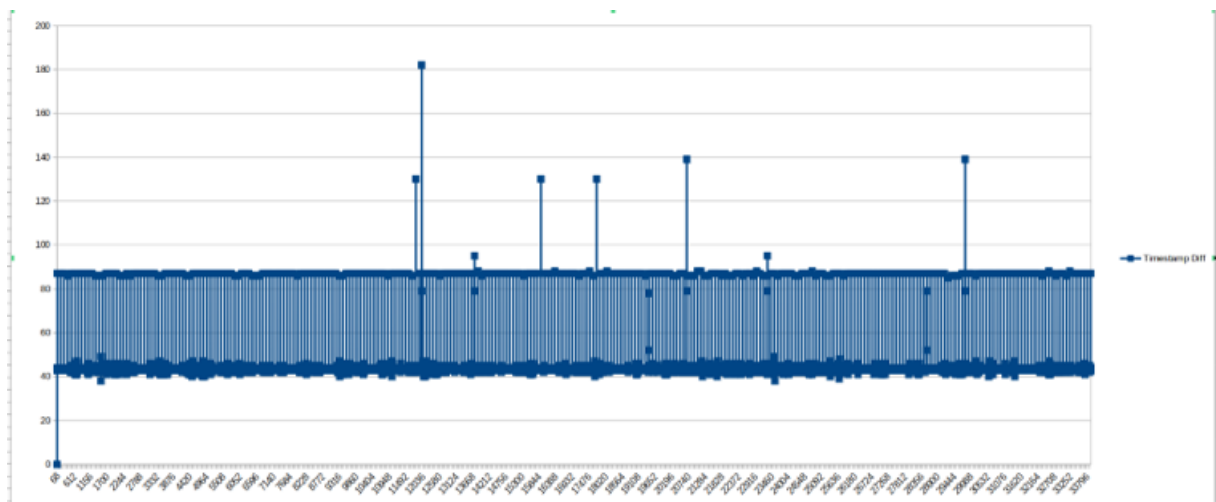
Figure 4.3: Output Data

Chapter 5

Summary of Work

During my internship at Unbox Robotics, I successfully contributed to developing a PCB Testing Tool, leveraging React (Vite.js), FastAPI, WebSocket communication, and C++ middleware to automate PCB testing, reducing testing time by over 90%. I also implemented UART communication in C++ for sensor integration, achieving reliable data transfer with minimal CPU usage. These projects enhanced my technical expertise in fullstack development, embedded systems, and automation, while fostering collaboration and documentation skills. The internship provided valuable industry experience, aligning with Unbox Robotics' mission to deliver efficient robotic solutions.

Appendices

Appendix A

Company Details

Unbox Robotics is a leading automation machinery manufacturing technology company, specializing in robotics-based fulfillment and distribution technology for small to large e-commerce, retail and logistics enterprises. Unbox Robotics' cutting edge technology solutions accelerates the parcel sortition and order fulfillment to facilitate efficient express logistics operations delivering seamless and customer experience.

Mission : -

Our mission is to empower our customers to deliver the most efficient order fulfillment experience using future-ready robotic systems

Vision : -

We envision to be the world's go to robotics technology & software company with efficient & revolutionary logistics automation solutions which deliver impact and enrich lives of our customers, partners and end consumers

Appendix B

Industry Mentor Details

Field	Details
Name	Unbox Robotics Private Limited
CIN No.	U72900PN2019PTC232507
Industry	Automation Machinery Manufacturing
Name of Mentor	Mr.Ujjval Pamnani
Designation	Associate Director (Software)
Email ID	ujjval.pamnani@unboxrobotics.com
Internship Duration	15 January 2025 to 15 July 2025 (6 months)

Appendix C

Attendance Report

Department of Computer Engineering
BE Internship - Monthly Progress Report
Even Semester 2024-2025

Title :

Internship No.	Roll No. & Name of Student :

Name of the Guide:

Month	Interaction No.	Date	Attendance	Progress/Suggestion
January	1			
	2			
February	1			
	2			
March	1			
	2			
April	1			
	2			
	1			
	2			
	1			
	2			

Name and Signature of Guide

Appendix D

Internship Completion Certificate

Appendix E

Plagiarism Report

54% Overall Similarity

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A Flag is not necessarily an indicator of a problem. However, we'd recommend you focus your attention there for further review.

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Acknowledgments

I thank the many people who have done lots of nice things for me.

Date: _____