

REPORT ON

FIFTEEN WEEKS OF INTERNSHIP

Carried out at

EXPERIMIND LABS PRIVATE LIMITED

Submitted to

NMAM INSTITUTE OF TECHNOLOGY, NITTE
(An Autonomous Institution affiliated to VTU, Belagavi)

In partial fulfillment of the requirements for the award of the

Degree of Bachelor of Engineering
in
Electronics and Communication Engineering

by
SWAPNIL SHARMA
USN 4NM21EC161

Under the guidance of

Dr. K. S. SHIVAPRAKASHA

PROFESSOR



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(An Autonomous Institution affiliated to Visvesvaraya Technological University, Belagavi)

Nitte – 574 110, Karnataka, India



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CERTIFICATE

*This is to certify that the “Internship report” submitted by Mr. Swapnil Sharma bearing USN 4NM21EC161 of VIII semester B.E., a bonafide student of NMAM Institute of Technology, Nitte, has undergone fifteen weeks of internship at Experimind Labs Private Limited from December 2024 to March 2025 fulfilling the partial requirements for the award of Bachelor of Engineering in **Electronics and Communication Engineering** at NMAM Institute of Technology, Nitte.*

Name and Signature of Mentor

Signature of HOD

Certificate of Completion

This is to certify that

Mr. Swapnil Sharma (4NM21EC161, NMAM Institute Of Technology, NITTE) has successfully completed 17 week internship with Experimind Labs Private Limited as a Product Developer from 2 December 2024 to 31 March 2025.

During this period, he was actively involved in the development of real-world solutions across domains such as application development, Internet of Things (IoT), and full-stack web technologies. He worked on multiple technically intensive assignments, contributing to both mobile and web platforms, and demonstrated strong skills in system architecture, real-time communication, and data handling.

He also showcased the ability to work independently and collaboratively in a dynamic, innovation-driven environment.

His contributions and dedication during the internship were exemplary and have significantly contributed to the goals and objectives of Experimind Labs.

We extend our sincere appreciation and wish him all the best in his future endeavors.



Best Regards,
Akshay Mashelkar,
Founder,CEO
Experimind Labs Pvt. Ltd.



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ACKNOWLEDGEMENT

I would like to express my sincere gratitude to Experimind Labs, Nitte, for granting me the opportunity to pursue my internship at their organization. It has been a transformative learning experience where I was exposed to a range of modern technologies and real-world problem-solving in application and IoT development.

I am especially thankful to Mr. Akshay Mashelkar, Director, and Mr. Adarsh Devadiga, CTO of Experimind Labs, for their vision-driven leadership and for creating an environment that fosters innovation, learning, and hands-on experimentation. Their encouragement and technical insights were invaluable to my growth during this internship.

I extend my heartfelt thanks to Dr. K. S. Shivaprakasha, my internship guide at NMAM Institute of Technology, for his consistent mentorship, timely feedback, and academic guidance that helped me structure and refine my work throughout the internship.

I also wish to thank the faculty and staff of the Department of Electronics and Communication Engineering, NMAMIT, for facilitating this internship and providing the academic foundation upon which I built my contributions.

Finally, I am grateful to my peers, friends, and family for their unwavering support, motivation, and belief in my capabilities throughout the course of this journey.

Swapnil Sharma (4NM21EC161)

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ABSTRACT

Experimind Labs, based in Nitte, is an educational research-focused startup that innovates at the intersection of pedagogy and technology. The organization specializes in curriculum development, educational tool design, and interactive digital systems to improve learning outcomes. Its competitive advantage lies in leveraging modern software development practices and IoT technologies to create scalable, impactful solutions in the education sector.

The objective of this internship was to gain industry-level experience in full-stack development, mobile app development, IoT integrations, and cloud infrastructure. During the course of the training, I contributed to six significant projects, including a usage reporting system for AI robots, a portable tinkering lab platform, a TCP-based ESP32 robot control interface, and an IoT-based adaptive water management system. The company encouraged innovative practices such as modular design, real-time communication via MQTT, cross-platform development using React Native, and robust backend integration using Fastify and Firebase. Suggestions provided during the internship included optimizations for hardware response latency and structuring Firestore collections for multi-device scalability.

Through this experience, I gained practical exposure to architectural thinking, API lifecycle management, and handling real-time data in mobile and embedded systems. I improved my skills in debugging asynchronous systems, optimizing UI responsiveness, and designing systems that are both scalable and maintainable. The internship helped me better understand the professional expectations of working in a fast-paced tech environment and reaffirmed the importance of ethical software practices. It significantly contributed to my technical growth and future employability, aligning well with the academic objectives and professional standards expected from industrial training.

INTRODUCTION TO THE COMPANY

Experimind Labs Pvt. Ltd. is a Karnataka-based EdTech startup founded in 2023 with its headquarters located in Sirsi.

The company operates at the intersection of **STEM education, embedded systems, IoT, and robotics**, and is committed to redefining traditional learning experiences through practical, hands-on engagement. As an early-stage startup with a lean team of 2–10 employees, Experimind Labs offers a highly collaborative and innovation-driven work culture.

The core focus of Experimind Labs lies in **developing educational tools and embedded systems solutions** aimed at making learning more accessible, interactive, and experimentation-oriented. Their flagship products include **portable STEM learning kits, robotics-based educational solutions**, and **custom IoT platforms** designed for schools and research-driven institutions. These products are supported with curated tutorial content and real-time learning dashboards, allowing educators to effectively integrate technology into the classroom.

With a mission to bridge the gap between theory and practice, the organization positions itself with a strong **competitive advantage** in the education technology space by offering **custom-built embedded hardware**, scalable software platforms, and personalized support for learners and educators. Their core competency lies in combining **hardware prototyping, embedded firmware development, and full-stack application engineering** under one roof.

The company's small team size enables agile product development, rapid iteration, and deep intern involvement in real-world problem-solving. With a growing presence and

partnerships with schools, the company is continuously expanding its ecosystem of educational innovation, making it a unique platform for aspiring engineers to learn and contribute meaningfully.

DETAILS OF TRAINING UNDERGONE

During my internship at **Experimind Labs Pvt. Ltd.**, I received extensive exposure to both software and hardware domains, working primarily in application development, embedded systems integration, and real-time data communication. The training was structured around contributing to multiple live projects, each demanding a unique combination of theoretical knowledge, practical implementation, and technical problem-solving. The work environment promoted ownership, agility, and end-to-end system design.

Departmental Objectives & Exposure Gained

Although Experimind Labs is a startup with a flat structure, my work aligned with the following key functional areas:

- **Mobile Application Development:**

Objective: Build scalable, responsive mobile apps with real-time data integrations.

Exposure: Worked with React Native, Redux, and Firebase for building cross-platform apps.

Skills: UI/UX design, push notification integration, offline-first strategies using AsyncStorage, and performance optimization.

- **Web Development & Cloud Integration:**

Objective: Deliver administrative dashboards and public interfaces for managing IoT systems.

Exposure: Built interfaces using Next.js and TailwindCSS, integrated with Firestore and Fastify backends.

Skills: REST API integration, authentication, deployment on Vercel.

- **Embedded Systems and IoT:**

Objective: Design and interface ESP32-based hardware modules with cloud platforms.

Exposure: Implemented motor control, flow sensor data handling, and MQTT communication using C++ and MicroPython.

Skills: Real-time data transmission, interrupt handling, secure MQTT (TLS), and remote command execution.

Projects Undertaken and Technical Contributions

I worked on the following six key projects during my internship, contributing across planning, development, and deployment phases:

1. Siksha Usage Report App

The **Siksha Usage Report App** was developed to solve the problem of unorganized recording, management, and review of AI-driven conversations from educational robots deployed in classrooms. Without such a system, debugging and usage analytics were difficult for developers and educators.

The app aimed to provide a React Native-based mobile interface capable of storing robot interaction logs per device, allowing users to trace specific robot sessions efficiently. Firebase Firestore was utilized with a robot-wise collection structure to enable organized data storage. To ensure reliability under poor network conditions, the app used an offline-first architecture with AsyncStorage to queue logs locally, which were later synced to Firestore with proper timestamps and context tags.

The snapshots are presented in Figures 1 and 2.



Fig. 1 Home Screen

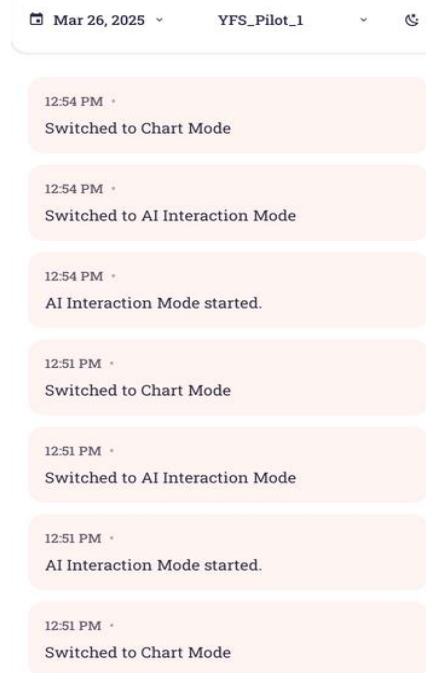


Fig. 2 Logs Screen

2. Portable Tinkering Lab App

The Portable Tinkering Lab (PTL) App addressed the need for a structured, offline-first platform for STEM learners, especially in environments with limited internet access. The objective was to deliver electronics tutorials, embedded tool support, and local progress tracking.

The app utilized Firebase Auth, Firestore, and Storage for media and user session handling. Offline capabilities were made possible through `react-native-fs` and `react-native-video` for caching video content. Local search was powered by Fuse.js, enhanced with debounce optimization to ensure fast and smooth user experience.

The app successfully enabled students in rural areas to learn electronics without requiring constant internet access. Engagement was significantly improved, especially when used alongside PTL hardware kits. Technical highlights include TensorFlow Lite integration for offline model inference and UI theming with NativeWind. Future plans could add quizzes with auto-evaluation powered by on-device ML and enable teacher dashboards for session tracking.

Snapshot of the homescreen is presented in Figure 3.

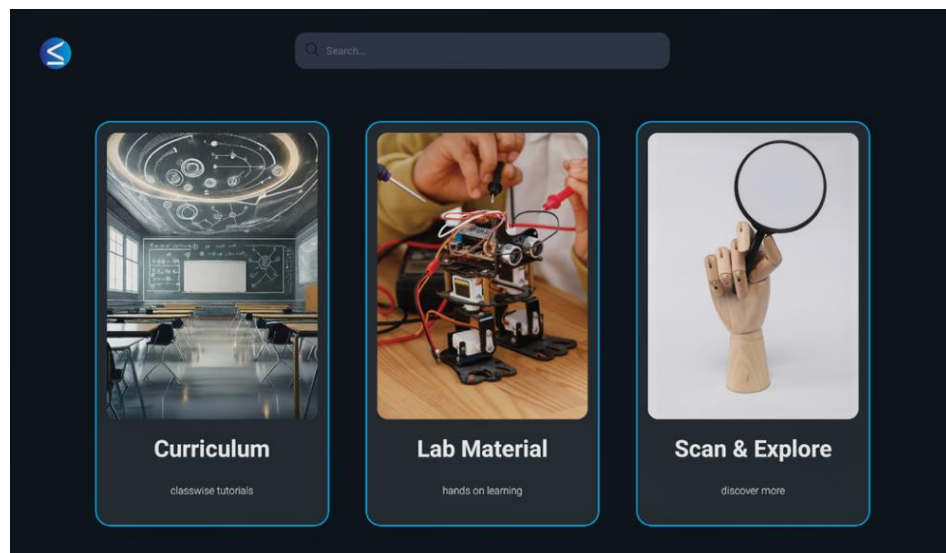


Fig. 3 Homescreen

3. ESP32 Remote Control Robot App

The **ESP32 Remote Control Robot App** was created to address latency issues found in BLE or cloud-based robot control, which negatively affected real-time responsiveness during testing.

To overcome this, a direct communication approach was adopted using TCP sockets

between the ESP32 (running MicroPython) and a React Native app. A custom command packet format and a handshake mechanism were implemented to ensure reliable connections. Additionally, a reconnect strategy was built to handle dropped connections, making the system robust.

This setup allowed for sub-100ms command execution times and smooth robot control within a local network, even in the absence of internet access. The use of raw TCP over WiFi in a React Native context was an innovative move, paired with thorough socket lifecycle management. Suggested improvements include integrating live video streaming from ESP32-CAM and enabling route history tracking and path automation. Figure 4 presents a snapshot of the remote control app.

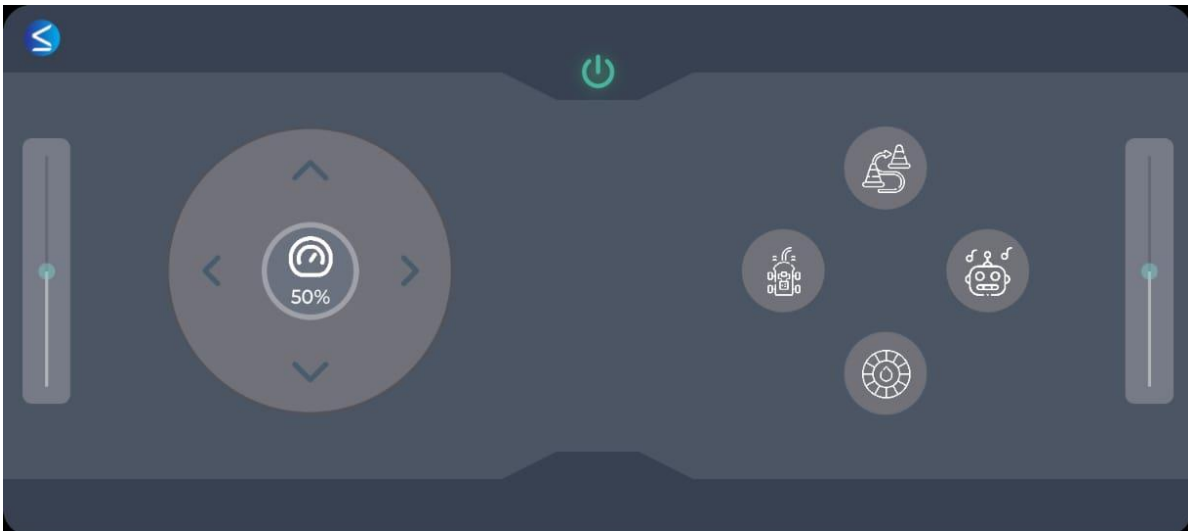


Fig. 4 Remote control app

4. Adaptive Water Management System (AWMS)

The **AWMS** was built to tackle water wastage and lack of monitoring in buildings, where there was no automated system for measuring flow or enforcing consumption limits.

This system leveraged ESP32 microcontrollers to read data from water flow sensors and published it over WiFi using MQTT via HiveMQ. A Fastify-based backend subscribed to MQTT topics, processed the data, and stored it in Firebase Firestore. Complementary interfaces were developed using React Native (mobile) and Next.js (web), providing real-time dashboards and valve control through MQTT commands.

The solution delivered a fully connected and functional multi-device water tracking system. Features like remote valve control and flow limit enforcement helped achieve operational goals. Noteworthy practices included non-blocking motor control logic on ESP32 and secure TLS-based MQTT communication. Future enhancements may include anomaly detection for unusual flow patterns using Firebase Functions and automated alert systems. The architecture of adaptive water management systems is presented in Figure 5.

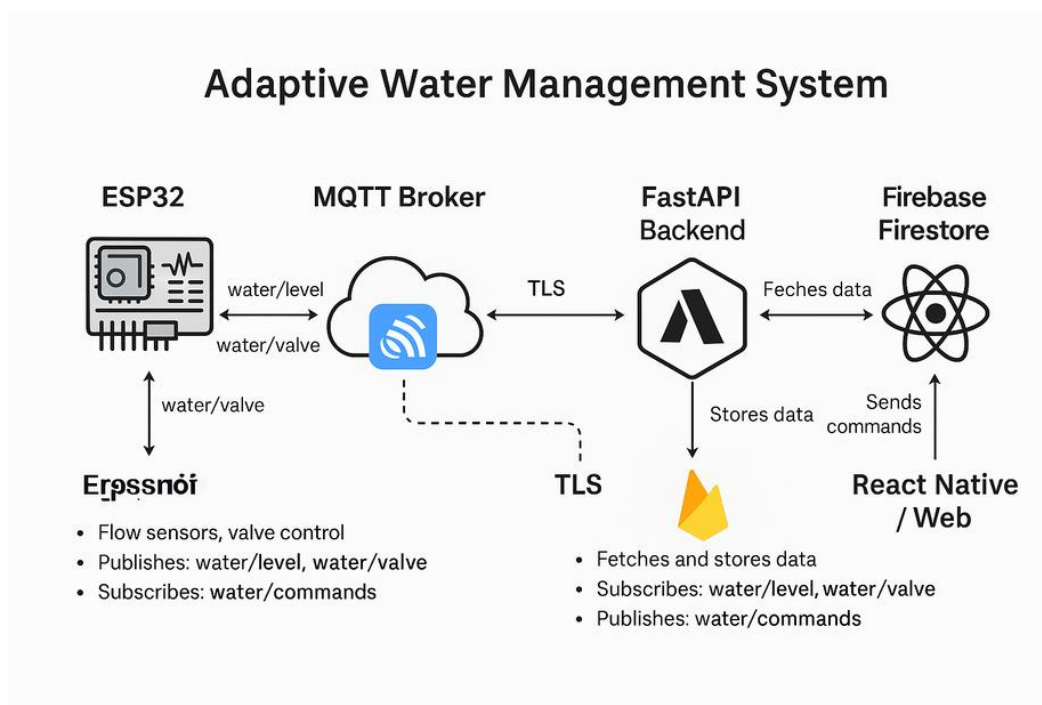


Fig. 5 AWMS architecture

5. Virtual Inventory

Developed to fix the shortcomings in traditional inventory systems that lacked real-time collaboration, accountability, and robust tracking of changes.

The platform, built using Next.js and Prisma ORM on a PostgreSQL database, enabled live updates through Pusher.js. It also included optimistic UI updates with rollback capabilities to manage race conditions and improve user experience. An audit log system tracked every item change with proper debounced writes to maintain integrity. Figure 6 shows the snapshot of the virtual inventory homescreen.

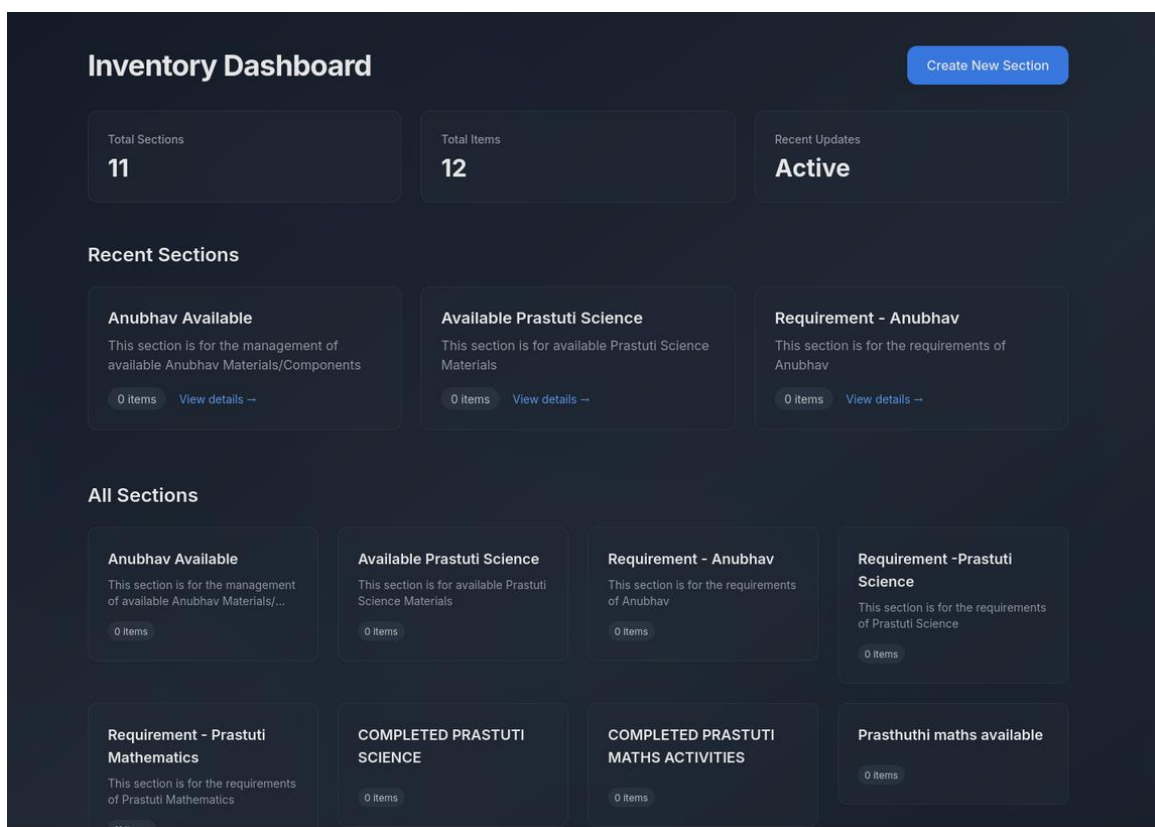


Fig. 6 Virtual inventory homescreen

This setup allowed team members to collaborate in real-time, reduced conflicts in data entry, and improved transparency across the board. Innovative aspects included granular stock update channels using Pusher and strong server-side validation with Zod schemas. Suggested future upgrades could involve UI-level change conflict hints and the introduction of warehouse zone mapping.

6. Employee Management System (EMS)

The **Employee Management System** was created to help small organizations handle HR activities such as attendance, leave tracking, performance evaluation, and report generation more efficiently.

It was developed using Next.js with Prisma ORM and PostgreSQL for backend storage. Secure access was managed using JWT-based authentication and RBAC (Role-Based Access Control). Features like attendance logging, leave request handling, performance metrics, and homework submissions were included. Dynamic reports were generated using pdfkit.

The result was a modular and comprehensive HR dashboard that simplified administration. Cron jobs were set up to generate scheduled reports, and email automation kept employees informed. Innovations included clean, role-based UI rendering using Radix UI and class variance utilities. Future enhancements could bring performance analytics dashboards and Slack/Telegram integration for instant employee notifications.

Figure 7 presents the snapshot of the admin dashboard.

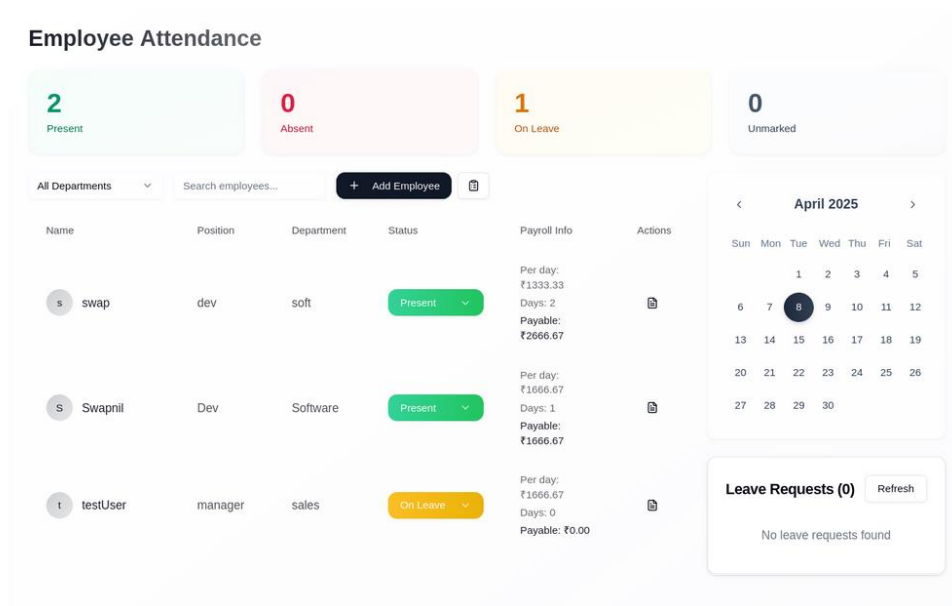


Fig. 7 Admin dashboard

CONCLUSION

This internship at **Experimind Labs** was a highly enriching experience that allowed me to apply my technical skills to real-world problems while exploring diverse domains such as IoT systems, scalable web platforms, and mobile app development. Working on projects like **StockSync**, **EMS**, and the **Adaptive Water Management System** helped me understand system design at scale, optimize for real-time performance, and implement clean, modular architectures.

I gained hands-on experience with technologies like **React Native**, **Next.js**, **Prisma**, **Firebase**, and **MQTT**, and learned how to approach challenges with a product-focused mindset. The fast-paced, startup environment taught me the importance of clean code, rapid iteration, and effective collaboration.

Overall, this internship sharpened my problem-solving abilities, deepened my technical understanding, and gave me the confidence to tackle larger, more complex projects in the future. I am grateful to Experimind Labs for this opportunity and look forward to building on this foundation in my career ahead.

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