Smart Drowsiness Detection System

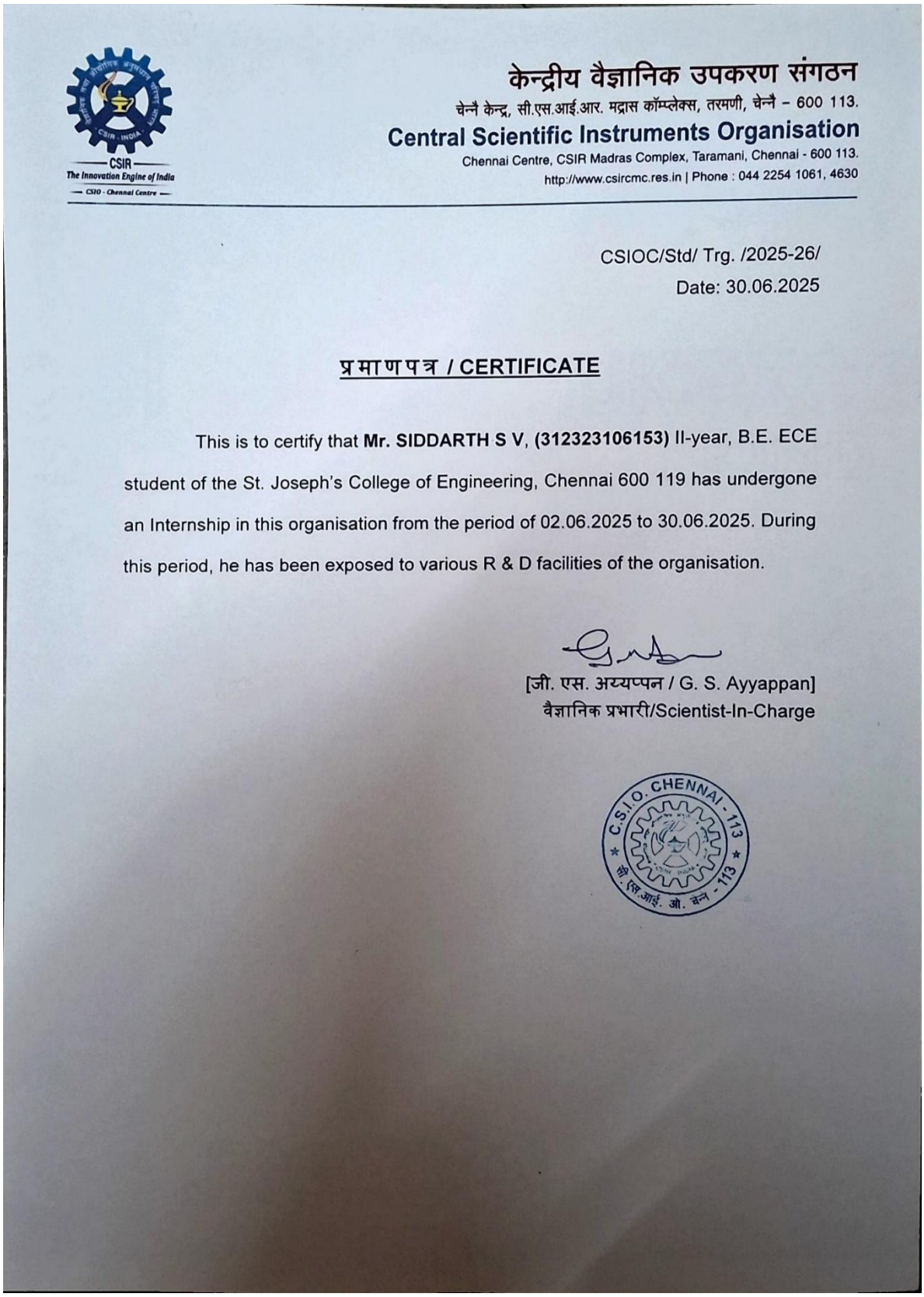
Submitted by

Siddarth S V
&
Lokesh R

JUNE 2025

TABLE OF CONTENTS

Internship Certificate



केन्द्रीय वैज्ञानिक उपकरण संगठन
चेन्नै केन्द्र, सी.एस.आई.आर. मद्रास कॉम्प्लेक्स, तरमणी, चेन्नै - 600 113.
Central Scientific Instruments Organisation
Chennai Centre, CSIR Madras Complex, Taramani, Chennai - 600 113.
http://www.csircmc.res.in | Phone : 044 2254 1061, 4630

CSIR
The Innovation Engine of India
CSIO - Chennai Centre

CSIOC/Std/ Trg. /2025-26/
Date: 30.06.2025

प्रमाणपत्र / CERTIFICATE

This is to certify that **Mr. SIDDARTH S V, (312323106153)** II-year, B.E. ECE student of the St. Joseph's College of Engineering, Chennai 600 119 has undergone an Internship in this organisation from the period of 02.06.2025 to 30.06.2025. During this period, he has been exposed to various R & D facilities of the organisation.

[जी. एस. अय्यप्पन / G. S. Ayyappan]
वैज्ञानिक प्रभारी/Scientist-In-Charge

C.S.I.O. CHENNAI - 113
सी.एस.आई.ओ. चेन्न - 113

ACKNOWLEDGEMENT

The contentment and elation that accompany the successful completion of any work would be incomplete without mentioning the people who made it possible. Words are inadequate in offering our sincere thanks and gratitude to our respected **Chairman Dr. B. Babu Manoharan, M.A., M.B.A., Ph.D.** for his outstanding leadership, unwavering dedication, and invaluable contributions to our organization. His vision, guidance, and commitment have been instrumental in shaping our success and driving us towards excellence.

I express our sincere gratitude to our beloved **Managing Director Mr. B. Shashi Sekar, M.Sc., (Intl. Business)** and **Executive Director Mrs. B. Jessie Priya, M. Com., (Commerce)** for their support and encouragement.

I also thank our beloved **Principal Dr. Vaddi Seshagiri Rao, M.E, MBA, Ph.D.,** for having encouraged us to do our under graduation in Electronics and Communication Engineering in this esteemed institution.

I also express our sincere thanks and most heartfelt sense of gratitude to our eminent **Head of the Department, Dr. S. Rajesh Kannan, M.E., Ph.D.,** for having always extended his helping hand.

I thank all staff members of our department, our family members and friends who have been the greatest source of support to us.

ABSTRACT

Road safety continues to be a critical concern worldwide, with drowsiness being a silent but dangerous contributor to traffic accidents. Drivers experiencing fatigue often fail to notice their own declining alertness—resulting in slower reaction times, lapses in concentration, and in severe cases, micro sleep episodes behind the wheel. These subtle symptoms, if undetected, can quickly escalate into life-threatening situations.

Our project addresses this issue by designing a **real-time driver drowsiness detection system** using embedded hardware and a deep learning model. The system captures images of the driver using a camera module and analyses their eye state locally. When signs of prolonged eye closure are detected, the system triggers a **vibration alert** to awaken the driver and reduce the risk of an accident.

The **motivation** behind this project stems from the lack of affordable and practical drowsiness detection systems in most commercial and personal vehicles. While some high-end cars include such features, they are out of reach for many. We aimed to build a **cost-effective, customizable, and non-intrusive solution** that operates fully on-device—**ensuring fast response times and preserving user privacy**.

This project reflects our commitment to applying embedded systems and AI for public safety, especially in scenarios where lives depend on timely intervention. It also shows how **open-source tools and edge computing** can be combined to create impactful, real-world solutions.

CONTRIBUTION TOWARDS ACHIEVING SUSTAINABLE DEVELOPMENT GOALS

The **Smart Driver Drowsiness Detection System** directly and indirectly supports several United Nations Sustainable Development Goals (SDGs), enhancing road safety, promoting innovative and affordable technologies, and reducing health disparities by making life-saving driver assistance accessible to all. By preventing accidents caused by driver fatigue, the system contributes to healthier communities and more sustainable transportation networks.

1. **SDG 3: Good Health and Well-being**

   This application actively monitors drivers for signs of drowsiness and alerting them before they fall asleep, the system helps prevent road accidents, reducing injuries and fatalities. This supports the target of halving the number of global deaths from road traffic accidents.

2. **SDG 9: Industry, Innovation, and Infrastructure**

   The innovative use of affordable embedded hardware and AI-based image processing promotes sustainable industrialization and fosters innovation in the automotive safety sector, especially in low-cost markets where advanced safety features are rare.

3. **SDG 11: Sustainable Cities and Communities**

   By enhancing road safety, the system contributes to making transport systems safer and more sustainable, helping build cities where people can travel without fear of drowsy drivers causing accidents.

4. **SDG 12: Responsible Consumption and Production**

   The project emphasizes efficiency by using minimal resources and off-the-shelf components, demonstrating responsible production practices for scalable and eco-friendly safety solutions.

CHAPTER 1
INTRODUCTION

1.1 OVERVIEW OF THE ORGANIZATION

- CSIR-CSIO (Central Scientific Instruments Organization) was started in 1959 in Chandigarh, India. It was set up under the Council of Scientific & Industrial Research (CSIR) to design and develop scientific instruments for India's growing industries and research needs.
- 'CSIR-CSIO is a national laboratory focusing on research, development, and training in the field of scientific and industrial instruments. It works on electronics, optics, medical devices, and sensors.
- The main policy of CSIR-CSIO is to promote innovation and self-reliance in instrument technology, support industries with advanced tools, and train people in modern instrumentation techniques.
- CSIR-CSIO's main competitors are other scientific R&D labs and private companies developing instruments, like DRDO labs, ISRO's instrumentation teams, and private firms like Agilent or Bosch in specialized areas.

1.2 ORGANIZATIONAL STRUCTURE

- **Director** – Heads the entire organization, makes key decisions, and oversees all activities.
- **Chief Scientists / Principal Scientists** – Lead different research divisions like Electronics, Optics, Biomedical Instruments, and Mechanical Systems.
- **Scientists & Engineers** – Carry out R&D projects, develop new instruments, and support innovation.

- **Technical Officers & Technicians** – Assist scientists in experiments, testing, maintenance, and production of instruments.
- **Administrative Staff** – Handle HR, finance, procurement, and other office work to keep the organization running smoothly.
- **Support Staff** – Manage day-to-day services like security, housekeeping, and logistics.

1.3 OBJECTIVES

- Develop advanced scientific and industrial instruments to support India's technology growth and reduce dependence on imports.
- Promote research and innovation in electronics, optics, sensors, and medical devices.
- Transfer technology to industries so new instruments can be produced commercially and benefit society.
- Provide training and skill development in modern instrumentation techniques for students, engineers, and industry professionals.
- Support national missions in defense, healthcare, environment, and industrial automation through specialized instruments.

CHAPTER 2
SUMMARY OF WORK DONE

2.1. INTRODUCTION

During my internship at CSIR-Central Scientific Instruments Organization (CSIR-CSIO), I had the opportunity to explore the world of advanced scientific instrumentation and electronics firsthand. This internship helped me connect theoretical knowledge from my engineering studies to practical applications in the field of research and development. Throughout the program, i attended multiple technical sessions, learned about various scientific instruments, communication protocols, and control systems, and worked on a practical project focused on driver safety technology.

The internship experience also improved my communication and problem-solving skills, as I interacted with experienced scientists and engineers who guided me through the intricacies of instrumentation and electronics design. The structured approach of the training allowed me to gain both theoretical insights and practical exposure, making it a transformative learning experience.

2.2 TRAINING & CLASSES ATTENDED

2.2.1 basic electronics

I attended training sessions on basic electronics, which covered the working principles and real-life applications of fundamental components like resistors, capacitors, inductors, diodes, and transistors. The sessions included practical demonstrations of how these components behave in different circuits. We also

learned how to read circuit diagrams, calculate component values, and use multimeters and oscilloscopes to measure voltage, current, and resistance. These basics formed the foundation for understanding more complex systems later in the internship.

2.2.2 communication systems

In the communication systems classes, i learned about different methods of transmitting and receiving information electronically. We studied analog and digital modulation techniques, signal encoding, and error correction methods. A significant focus was given to communication protocols like UART (universal asynchronous receiver-transmitter) and USART (universal synchronous/asynchronous receiver-transmitter), which are widely used in embedded systems. We also learned about Modbus, an industrial protocol, and observed how these protocols enable reliable data exchange in instruments and control systems.

2.2.3 control systems

The control systems training covered the fundamentals of feedback systems, open-loop and closed-loop control, stability analysis, and tuning of controllers like PID (proportional-integral-derivative). Practical examples of control systems were demonstrated using laboratory setups involving dc motors and sensors. We discussed how control systems are critical in robotics, automation, and instrumentation for maintaining precision and stability.

2.2.4 operational amplifiers (op-amps)

We explored the theory and applications of operational amplifiers, including configurations like inverting, non-inverting, summing amplifiers, and differential

amplifiers. The sessions included hands-on exercises using breadboards to build op-amp circuits for signal amplification, filtering, and mathematical operations. This knowledge is essential for signal conditioning in instrumentation systems.

2.2.5 PCB designing

I attended sessions on printed circuit board (PCB) designing, where I learned the basics of creating schematics, routing tracks, and placing components efficiently. The trainers explained the importance of design rules, grounding techniques, and minimizing noise in PCB layouts. We also got to see how PCBs are fabricated in professional setups and how different layers are used for power, ground, and signal routing.

2.3 Exposure to real-life applications

As part of the internship, I observed real-world examples of how the concepts we learned are used in the field:

- Saw how sensors and actuators are integrated into industrial control systems.
- Learned how communication protocols connect multiple devices in complex networks.
- Observed high-precision instruments for environmental monitoring and medical diagnostics.
- Understood how PCB design principles are applied in professional-grade equipment.
- We witnessed live demonstrations of instrument calibration and testing.

This exposure helped me understand the critical role of instruments in sectors like healthcare, defense, industry automation, and environmental monitoring.

2.4 Practical Project: Smart Driver Drowsiness Detection System

2.4.1 Project Overview

For my practical project, I worked on developing a **Smart Driver Drowsiness Detection System** aimed at preventing accidents caused by driver fatigue. The system uses a raspberry pi 4 connected to a USB webcam and/or CSI camera to capture real-time video of the driver's eyes, processes the images to detect eye closure, and triggers a vibration alert if prolonged eye closure indicates drowsiness.

2.4.2 Objective

The goal of the project was to design an affordable, easy-to-install system that could work in vehicles of all types, making advanced safety accessible to everyone, especially in regions where expensive driver-assistance systems are not available.

2.4.3 Hardware Used

- **Raspberry pi 4 (4gb ram):** acts as the main processing unit for image capture and analysis.
- **Webcam/CSI Camera:** for capturing live video of the driver's face and eyes.
- **Vibration Motor:** to alert the driver if drowsiness is detected.
- **5v Regulated Power Supply:** to power the raspberry pi and peripherals safely.

2.4.4 software & algorithms

- Used YOLOv8n (You Only Look Once v8 nano model) on the Raspberry Pi for accurate, real-time eye detection and classification.
- Trained or fine-tuned YOLOv8n to reliably distinguish between open and closed eyes from live video streams.
- Developed Python scripts integrating YOLOv8n's object detection outputs to monitor eye closure duration and determine signs of drowsiness.
- Implemented logic to trigger alerts when eyes stay closed beyond a threshold, ensuring fast and precise performance suitable for the Raspberry Pi's processing capabilities.
- Optimized frame size and detection frequency to maintain smooth, real-time operation with minimal latency.

2.4.5 Challenges Faced & Solutions

- **Lighting conditions**: variations in cabin lighting affected detection reliability; I implemented dynamic threshold adjustments and tested different lighting scenarios to improve accuracy.
- **Processing speed**: real-time image processing on the Raspberry Pi required frame resizing and reducing detection frequency for stable performance.
- **False Positives**: early tests triggered alerts unnecessarily; fine-tuning the detection window and adding logic for blink detection helped reduce false alarms.

2.4.6 Learnings

- Gained practical experience with Embedded Systems, using the Raspberry Pi for Real-Time Applications.
- Enhanced skills in image processing with OpenCV, learning how to handle live video streams and eye detection.
- Understood real-time system design challenges, including optimization for performance on limited hardware.
- Learned to debug integration issues between hardware (camera, motor) and software algorithms

CHAPTER 3
CONCLUSION

During my internship at CSIR-CSIO, I gained valuable theoretical knowledge and practical experience in electronics, communication systems, control systems, and PCB designing. The exposure to real-life applications of scientific instruments and interaction with experienced scientists helped me understand the importance of precision and innovation in instrumentation.

As part of the practical project, I developed a **Smart Driver Drowsiness Detection System** using Raspberry Pi 4 and YOLOv8n-based eye detection algorithms, combined with a vibration motor alert system. This project enhanced my technical skills in embedded systems, image processing, and real-time application development. I also learned to handle real-world challenges such as varying lighting conditions and resource optimization on embedded hardware.

Overall, the internship strengthened my problem-solving abilities, improved my communication skills, and gave me confidence to apply my engineering knowledge to meaningful projects. It was a transformative experience that has prepared me to contribute effectively to innovative solutions in the field of electronics and embedded systems, with a vision of developing technologies that can positively impact society.

REFERENCES

1. Driver Drowsiness Detection based on Monitoring of Eye Blink Rate
   P Baby Shamini; M. Vinodhini; B Keerthana; S Lakshna; K. R Meenatchi
   2022 4th International Conference on Smart Systems and Inventive Technology (ICSSIT)
   Year: 2022 | Conference Paper | Publisher: IEEE

2. Driver Drowsiness Detection System Using Image Processing
   Rishabh Kumar; Mayank Pratyush; Om Gupta; Utkarsh Tiwari; Shweta Chauhan
   2023 12th International Conference on System Modeling & Advancement in Research Trends (SMART)
   Year: 2023 | Conference Paper | Publisher: IEEE

APPENDIX – A

IMAGES WITH GEOTAG