REPORT ON PROJECT STAGE - I

# AI/ML Based Robotics - Implementation for Vision, Communication, and Advanced Mechanics

SUBMITTED TO SAVITRIBAI PHULE PUNE UNIVERSITY
FOR PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

**BACHELOR OF ENGINEERING**
In
Electronics and Telecommunication Engineering

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**OCTOBER 2024**

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# CERTIFICATE

This is to certify that the Project Stage - I Report entitled

**"AI/ML-Based Robotics - Implementation for Vision, Communication, and Advanced Mechanics"**

has been successfully completed by

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towards the partial fulfillment of the degree of **Bachelor of Engineering** in **Electronics and Telecommunication Engineering** as awarded by the **Savitribai Phule Pune University**, at **Pune Institute of Computer Technology** during the academic year 2024-25

**INTERNAL GUIDE**
( Prof. Girish S. Mundada)

**HOED**
( Dr. M. V. Munot )

# ACKNOWLEDGEMENT

We would like to express our heartfelt gratitude to Prof. Girish Shrikisan Mundada, our esteemed guide, for his unwavering support, expert advice, and continuous encouragement throughout the development of this project. His profound knowledge in the field of electronics and telecommunications, combined with his patient mentorship, has been invaluable in steering our project toward successful completion. His guidance was instrumental in helping us overcome challenges and refine our approach, ensuring that we achieved our objectives.

We also extend our sincere thanks to the Pune Institute of Computer Technology (PICT) for fostering an environment of innovation and learning. The resources and facilities provided by the institute enabled us to conduct thorough research and experimentation. We are particularly grateful to the faculty and staff of the Department of Electronics and Telecommunication for their constant support and encouragement.

Thanking You,

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# CONTENTS

# ABSTRACT

This project presents the design and implementation of an AI/ML-driven autonomous robotic system that integrates computer vision, intelligent communication, and adaptive mechanical control. The primary objective is to enable real-time navigation, decision-making, and interaction capabilities in dynamic and unstructured environments, thereby reducing reliance on manual control and enhancing operational efficiency.

The system architecture employs Convolutional Neural Networks (CNNs) for object detection and classification, along with Simultaneous Localization and Mapping (SLAM) for real-time environment mapping and localization. Natural Language Processing techniques are incorporated to facilitate voice-based human-robot interaction, while Reinforcement Learning (RL) is applied to optimize path planning and motion control. These AI models are interfaced with a robust hardware stack comprising LiDAR sensors, IMUs, STM32 microcontrollers, and power-regulated PCBs, orchestrated through the ROS2 middleware to ensure low-latency, modular, and scalable operation.

Extensive testing in indoor environments demonstrates high object recognition accuracy, improved localization precision, low-latency response to dynamic obstacles, and seamless human-robot communication. These outcomes validate the feasibility and efficiency of the proposed system for use in applications such as warehouse automation, smart surveillance, healthcare robotics, and collaborative industrial systems.

By merging the strengths of AI and embedded robotics, this project underscores the transformative potential of intelligent autonomous systems in shaping the future of human-centric and adaptive robotic solutions.

# Abbreviations and Acronyms

| | |
|---|---|
| AI | Artificial Intelligence |
| ML | Machine Learning |
| RL | Reinforcement Learning |
| CNN | Convolutional Neural Networks |
| ROS | Robot Operating System |
| SLAM | Simultaneous Localization and Mapping |
| RFID | Radio-Frequency IDentification |
| PID | Proportional, Integration, and Derivation |

# List of Symbols

| | |
|---|---|
| % | Percentage |
| $ | Dollar |

# List of Figures

# List of Tables