# HUMAN DETECTOR AND TRACKER

ENPM808X MidTerm Project Proposal

## INTRODUCTION

Perception, Planning, and Controls are the three main components of any autonomous robotics system. Together, these parts enable the robot to see its surroundings, make judgments based on those perceptions, and carry out those decisions to accomplish the objective. In order to incorporate real-time environmental data into the planning algorithm, perception is essential. This project is focused on perception. In particular, it detects and tracks human obstacles in the frame of a monocular camera of a robot.

## PROBLEM STATEMENT

For a mobile robot moving in a confined space or outdoors, detecting any obstacle such as humans and objects is a critical component. The project's primary objective is to develop a perception software module for the delivery robot. This module will enable the robot to identify the presence of humans and continuously monitor their movements, allowing it to avoid collisions and choose efficient paths in dynamic environments. The primary function of the delivery robot is to transport goods from one location to another, regardless of whether it operates within a confined indoor setting or in an outdoor environment. Human detection is the process of identifying the presence of humans within a given area or image where detection is performed by computer algorithms that analyze the visual data to locate and identify regions or objects by extracting features that represent human figures. Human tracking is the continuous monitoring and recording of the movement and position of one or more humans between frames in a video or in real time video feed by assigning an id to each human. Detecting and tracking humans to prevent collisions stands as the central task for the delivery robot to ensure smooth and safe navigation.

## METHODOLOGY

The project's algorithm proceeds as follows:  Firstly, the human detection is performed by using the YOLO V5 pre-trained model trained on COCO dataset. YOLO is a pre-trained object detection system that can be used to detect objects in an image.COCO dataset has many classes. But this project will focus on humans mainly. The bounding box for each human detected is then tracked using a tracker algorithm developed. The project plans to follow the method of object tracking algorithms like SORT (Simple Online and Realtime Tracking) and CSRT (Channel and Spatial Reliability Tracker). Through the use of the Kalman filter, SORT effortlessly blends object detection with data association and prediction. The Discriminative Correlation Filters (DCF)-based tracking algorithm CSRT, in contrast, prioritizes the processing of visual features and spatial data for object tracking. The main idea behind CSRT is to use a discriminative correlation filter to estimate an object's position in the current frame by analyzing both spatial and visual cues. Both tracking methods will be carefully analyzed, and the model that produces the most precise predictions and results will be chosen for execution. Once Humans are tracked and the position is derived, this position is transformed into robot coordinate frame/ World coordinate frame and thereby passed to the navigation module which generates an optimal path.

## SOFTWARE DEVELOPMENT PROCESS

The project aims to follow the software engineering practice Agile Iterative Process which involves breaking down the project into tasks and organizing them into 3-week iterations. Throughout each week of development, there is a consistent focus on UML design and high-level project design. The team conducts regular sprint meetings and employs a collaborative approach to work utilizing tools such as Version Control Git, including the practice of pair programming.

# SOFTWARE TECHNOLOGIES

Programming Languages: C++
Development Tools: CMake, Git, Cppcheck, Cpplint, Makefiles, VSCode
Testing tools: Valgrind, Google Test Suite
Documentation: Doxygen
Continuous Integration and Code Coverage: GitHub CI, CodeCov

# EXTERNAL DEPENDENCIES

Models: YoloV5 (Detection)
Math & Computer Vision Libraries: OpenCV, Eigen, Tracking

# POTENTIAL RISKS

1. **Real-Time Processing Delays:** The risk of real-time processing delays with YOLOv5 due to limited robot hardware can be mitigated by optimizing the model's size, using quantization, and choosing appropriate hardware components for real-time performance.
2. **Accurate Tracking:** The accurate tracking of humans and id tagging fails mostly in case of occlusion and multiple detections. This problem is planned to be mitigated by development of an accurate tracking algorithm.

# DELIVERABLES

1. Human obstacle detector and tracker application
2. Unit tests using Google Test framework
3. UML diagrams
4. Description of proposed algorithm, potential risks, technology used and dependencies
5. Code coverage with CodeCov
6. Developer-level documentation

# TEAM MEMBERS AND ORGANIZATION

| Driver | Navigator | Design Keeper |
|---|---|---|
| Neha Nitin Madhekar(UID:119374436) | Vinay Krishna Bukka(UID: 118176680) | Rashmi Kapu(UID: 119461754) |

We have adopted the Test Driven Development (TDD) methodology. In the initial phase (Phase 0), Rashmi will assume the role of the designer, Neha will act as the driver, and Vinay will take on the role of the navigator. As we proceed with subsequent tasks, these roles will be rotated among team members.

# REFERENCES


1. Software Engineering Current Practice by Vaclav Rajlich
2. M. A. Bin Zuraimi and F. H. Kamaru Zaman, "Vehicle Detection and Tracking using YOLO and DeepSORT," 2021 IEEE 11th IEEE Symposium on Computer Applications & Industrial Electronics (ISCAIE), Penang, Malaysia, 2021, pp. 23-29, doi: 10.1109/ISCAIE51753.2021.9431784.
3. Object Detection using OpenCV and Python
   "https://learnopencv.com/object-tracking-and-reidentification-with-fairmot/"