Proposal: Human-Aware Navigation in Crowded Indoor Spaces Using 2D LiDAR

In a dynamic indoor environment like restaurants or cafes, robots must move safely among human pedestrians while also maintaining an efficient path. The objective of this project is to implement a simulation of a mobile robot in Webots which performs human-aware navigation with 2D LiDAR sensor, in order to avoid pedestrians on its way when following a path towards its goal. The challenge is compelling because it represents real service robotics and requires the integration of perception, planning, and evaluation which are the core pillars of intelligent behaviour.

Our approach centres on three components:

1. **Static SLAM mapping**, using an existing ROS-compatible SLAM package to generate a reliable map of the environment;
2. **Human detection and tracking**, implemented via clustering of LiDAR point clouds to identify and follow moving obstacles; and
3. **Human-aware motion planning**, using the Dynamic Window Approach (DWA) to generate smooth, collision-free paths that respect personal space.

We will use Webots to simulate humans moving around using Webot objects and then tune the planner to avoid abrupt stops or unsafe proximity.

We will use existing SLAM and Planning frameworks, focusing our contribution on integration of dynamic obstacle detection with real time navigation. We will test our system across multiple crowd scenarios to compare performance with and without human-awareness. Important metrics will be collision rate, path smoothness and maintenance of safety distance

We speculate that if robots can take into account the behaviour of pedestrians, we can achieve less collision and using motion planning we can achieve smoother trajectories compared to naïve reactive planning. As a test of this, we will design controlled experiments in Webots, observing robot behaviour across different crowd densities and movement patterns. We will then visualized and analysed the results to support our conclusions.

Our team of four will divide responsibilities as follows:

- **Shiwang Zhou**: SLAM setup, evaluation design, and report writing
- **Geethanjali Muddahanumaiah**: LiDAR-based human detection and tracking
- **Pavel Irzhak**: Motion planning and DWA tuning
- **Waleed Tariq**: Webots simulation and Human Aware Prediction Module – Implement a Kalman-based human trajectory predictor and adaptive safety-radius logic that modifies the planner's behaviour in crowded conditions; responsible for simulation scenarios, integration testing and cross-team support.

This project offers a focused, achievable challenge that allows us to demonstrate intelligent robotic behaviour through perception, planning, and evaluation—all within a simulated environment.