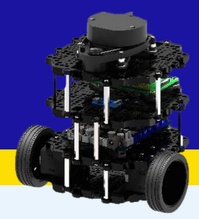
Trajectory Tracking Control of Mobile Robot

Aakash Singh || Harshul Nanda || Madugula Jayaram

Under supervision of - Prof. Harendra Pal Singh

Cluster Innovation Centre, University of Delhi



ABSTRACT

The study focuses on creating a sophisticated autonomous system that can effectively avoid obstacles and navigate from one point to another using a combination of control strategies. The proposed system utilizes a Proportional Integral Derivative (PID) controller to manage collision avoidance and predict obstacle velocities through a LiDAR-based mobile robot. The research includes extensive experiments conducted in simulated and real-world environments using Gazebo World, evaluating the robot's performance in scenarios with both static and dynamic obstacles, analyzing navigation paths, and testing various collision avoidance protocols. The findings indicate that the PID-based approach effectively prevents collisions and enhances navigation by adapting to the environment dynamically. By comparing PID and machine learning techniques, the aim is to contribute to the progress of robotic navigation systems.

TASKS PERFORMED

- **Tele-operation :**Implemented remote and physical control.
- **SLAM:** Analyzed and implemented SLAM in virtual and physical environments
- **Navigation :**Implemented and Optimized navigation parameters
- **Circle and Ellipse Generation :**Programmed TurtleBot3 for circular and elliptical paths
- **PID Control :** Studied and implemented PID control principles (Kulbir Alhuwalia)
- **PID Control with Trajectory Plotting :** Visualized and tested robot trajectories , Implemented real-time trajectory plotting
- **Point A to Point B Navigation :**Programmed navigation between waypoints using linear and parabolic paths
- **Obstacle Detection with PID Control:** Utilized LiDAR for obstacle detection , Integrated obstacle avoidance with PID control

RESULTS

The Figure 3, 4 , 5, 6 represents the different plots of the graph between x and y positions while changing the kp_distance , ki distance ,kd distance ,kp_angle ,ki angle kd_angle in the PID.

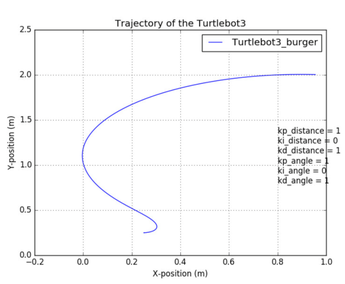


Fig 3

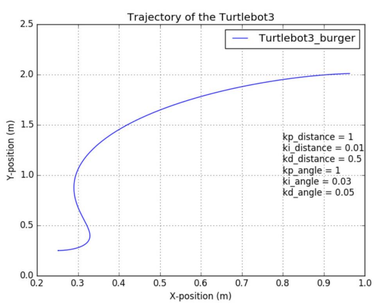


Fig 4

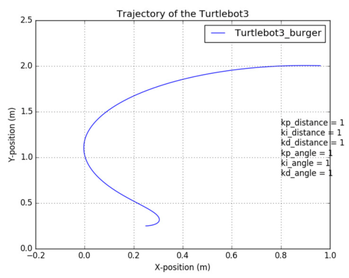


Fig 5

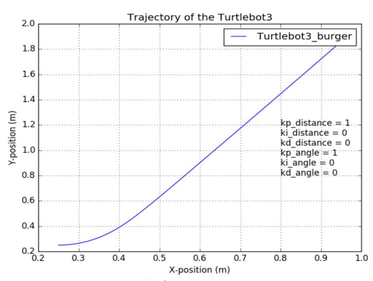


Fig 6

METHODOLOGY

We have tested and experimented with many code logics, and we have finalized the logic used for Obstacle Detection Integration with PID control. Among these, there are two code logics: one with high accuracy and another with less accuracy for obstacle detection integration with PID.
Here is the code logic:

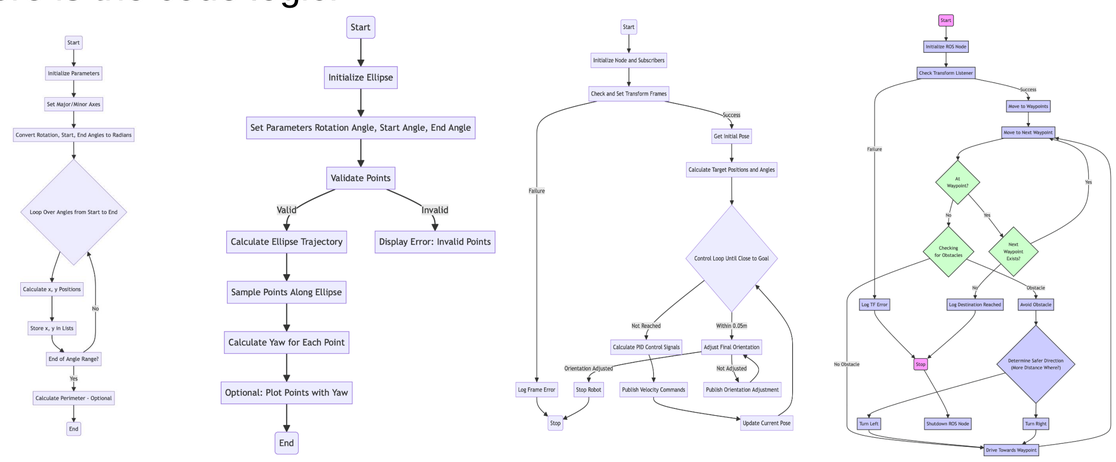


Fig 1: Logic for Obstacle Detection Integration with using PID (Less accurate)

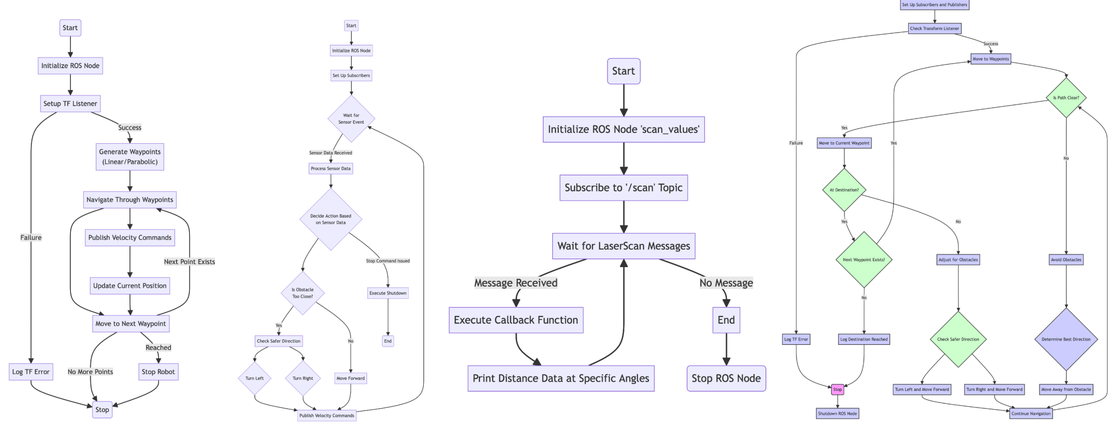


Fig 2: Logic for Obstacle Detection Integration with using PID (More accurate)

FUTURE WORK

1. Implementing Machine learning algorithm with PID controller in real life.
2. Dynamic Obstacle detection and optimizing trajectory using machine learning and deep learning algorithm
3. Integrating Open-manipulator arm with the Turtle Bot to provide mobility to the arm and Implementing on Drones.

REFERENCES

Scan the QR code to get all the references.

CONCLUSION

This project successfully integrated advanced robotic control techniques using TurtleBot3. Through tele-operation, SLAM, and autonomous navigation, the robot maneuvered effectively in simulated and real environments. PID control and dynamic trajectory plotting ensured precise movement and adaptive waypoint navigation, while LiDAR-based obstacle detection enhanced safety. This synergy of technologies lays a strong foundation for future advancements in autonomous systems and equips us to tackle sophisticated challenges in robotics.