ENPM808X: Software Development for Robotics
Midterm Project Proposal

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Overview

Acme Robotics is poised to launch a groundbreaking robotics-based product that promises to redefine the dynamics of robot-human interactions in shared spaces. However, the current trajectory of development poses challenges to the timely realization of this vision. A pivotal component that demands immediate attention is the perception module. Our proposal outlines the design and development of a Human Obstacle Detection and Tracking module, with an ambitious goal of integrating MiDaS for enhanced human detection and depth estimation in future iterations.

Component Description

The module under consideration pertains to Perception, specifically the Human Obstacle Detection and Tracking system. Using a monocular camera, this module will identify humans within the robot's operational vicinity and monitor their movements in real-time. While the primary focus is on human detection and tracking, an ambitious goal is to incorporate MiDaS in future iterations to enhance human detection capabilities and provide depth distance estimation, offering a more holistic understanding of the environment.

Design and Development Process

To ensure the highest standards of software engineering, we will employ methodologies like Test-Driven Development (TDD) and the Agile Iterative Process (AIP). The design intricacies will be captured using UML diagrams, detailing class structures, dependencies, and component interactions.

Technologies and Libraries

- Programming Language: C++14
- Build System: CMake
- Unit Testing: Google Test framework
- Static Analysis: cppcheck
- Coding Standard: Google C++ Styleguide with cpplint validation
- Documentation: Doxygen

External Libraries

- OpenCV for image processing and human detection
- Kalman Filter for tracking

All chosen libraries are open-source, ensuring compatibility and freedom from legal constraints.

Algorithms and Techniques

- Background subtraction and human contour detection for initial human identification
- Kalman Filter for consistent tracking of detected humans

Risks and Mitigations

- False positives/negatives in detection: Mitigation involves employing a blend of detection techniques and iterative learning.
- Handling occlusions: While not a primary requirement, crowded settings might pose challenges. Continuous model training and updates can help alleviate this.
- Integration of MiDaS in future iterations: As an ambitious goal, the integration of MiDaS might pose challenges in terms of compatibility and real-time processing. Research and preliminary testing will be essential before full integration.

Final Deliverables

- A comprehensive Human Obstacle Detection and Tracking module, complete with documentation and tests
- UML diagrams elucidating the design
- GitHub repository housing the code, tests, and a CI setup
- Developer-centric documentation in the README and through Doxygen annotations
- A demonstrable module showcasing effective performance in real-world conditions

Team Coordination

Embracing pair programming will be pivotal to maintain code quality and facilitate knowledge dissemination within the team. Regular sprint evaluations and retrospectives will be integral to align with Acme's expectations and delivery timelines.

Through a meticulous design approach and by harnessing established open-source libraries, this proposal seeks to accelerate the development trajectory.