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Detection of Wheelchair Orientation in Human-Robot Interactions

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ABSTRACT

BACKGROUND: Autonomous mobile robots are being introduced in human-populated environments with increasing frequency, notably in hospitals and long-term care facilities. Hence, ensuring safe and intuitive human robot interaction (HRI) is becoming a growing need, especially for pedestrians with mobility aids, such as wheelchairs.

OBJECTIVE: The dynamics of wheelchair users differ from those of foot pedestrians, so accurate characterization of a wheelchair's location and orientation for state estimation is crucial.

METHODS: The 2D laser scanner is a well-suited sensor for accurate distance measurements with fast computation speeds, but the sparsity of its data is often a hindrance to effective object detection. Despite so, 2D range data from laser scanners is found to be effective in the detection and orientation estimation of wheelchairs, even in cluttered environments.

RESULTS: The range data is pre-processed by segmenting out objects using density-based clustering. The two-step classification algorithm first identifies wheelchair candidates from segmented objects with the random forest classifier, then estimates the wheelchair's orientation as one of six classes with a neural network. The models achieve 98% true positive rate for detection and 86% for orientation classification.

CONCLUSIONS: The outcomes of this research can inform future works in building a real time wheelchair detection and state estimation for mobile robots.

KEYWORDS: mobile robots, pedestrian detection, human robot interaction.