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Enhanced Person-following Wheelchair with Light-weight Re-identification and Gating

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INTRODUCTION

Safe mobility is critical for individuals with severe motor impairments, yet reliable person-following remains challenging for assistive wheelchairs. Conventional trackers fail under occlusion, distractors, or close-range navigation, leading to unsafe identity (ID) switches and false follows [1-2]. While advanced multiple object tracking (MOT) frameworks improve robustness, they are too computationally demanding for embedded platforms. To address this gap, we propose a lightweight system where a YOLOv11 detector (a modern real-time object detection algorithm) finds the target object, the motpy tracker (a lightweight multiple-object tracking library in Python) maintains the target's identity across frames. This baseline tracker is enhanced with reidentification and geometry gating to make it robust against occlusions and distractors while making it suitable for edge devices. The hybrid cost function extends established MOT practices [3] that fuse motion and appearance cues, but is adapted specifically for real-time, close-range wheelchair navigation to improve safety and reliability.

MATERIALS AND METHODS

A ZED Mini stereo camera provided RGB and depth input for 3D target localization. The motpy tracker used Kalman prediction (a classical algorithm for estimating motion over time) and Hungarian matching, extended with (i) OSNet (Omni-Scale Network), a lightweight convolutional neural network for person re-identification and cosine similarity, and (ii) geometry gating to reject mismatched depth/bearing.

The fused target pose was integrated into Nav2 (the standard ROS 2 navigation framework) using object-follow behaviour with Theta* global planning and regulated pure pursuit control. Controlled trials enabled comparison between the baseline and improved tracker across ID switches, false follows, and latency.

RESULTS AND DISCUSSION

The Motpy baseline produced three ID switches and four false follows over ten trials. The improved tracker achieved zero ID switches and zero false follows, maintaining 100% target retention accuracy despite occlusion and distractors. Latency increased from 34.4 ms (~29 FPS) to 172.9 ms (~5.8 FPS), but remained acceptable for slow-moving object-following wheelchair navigation. Thus, the extension (with Re-ID and Gating) significantly improved tracking safety and reliability with tolerable computational cost.

Fig. 1 Object-following wheelchair with proposed tracking approach

CONCLUSIONS

This study presented a lightweight tracker that eliminated identity switches and false follows while operating within real-time bounds. Though slower than the baseline, it has a lighter architecture than DeepSORT and is more practical for embedded deployment. Future work would involve embedded GPU deployment and clinical trials with pediatrics users. The framework prioritizes safety and robustness, offering a feasible solution for assistive wheelchair person-following in dynamic environments.

REFERENCES

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Table 1: Comparison between baseline and improved tracker

	Number of Switches	Number of false follows	Latency
Motpy baseline	3	4	34.4 ms
Motpy + Re-ID +Gating	0	0	172.9 ms