LiDAR–IMU Perception for Real-Time Dynamic Obstacle Detection in Complex Urban Environments

Ismail Eren Kucukali
Technical University of Catalonia, BArcelona, Spain

Dr. Laia Pages
Technical University of Catalonia, BArcelona, Spain

Miguel Ferrando-Batalle
Professor, Technical University of Catalonia, BArcelona, Spain

Luis Jofre-Roca
Professor, Technical University of Catalonia, BArcelona, Spain

Abstract:

Urban environments present extreme challenges for autonomous navigation due to dense crowds, unpredictable motion patterns, and lack of structure. This paper introduces a lightweight, LiDAR–IMU–based perception system for real-time dynamic obstacle detection and tracking, developed for the autonomous urban robot ONA developed by UPC and CARNET. Unlike prior approaches that rely on cameras or operate in structured road settings, our system targets fully unstructured city centers using only LiDAR and IMU sensors. The pipeline integrates 360° LiDAR fusion, ground segmentation, adaptive clustering, and ego-motion–aware Kalman tracking with angular correction and multi-frame motion reasoning. Real-world deployments in complex urban areas demonstrate robust operation at 10–15 Hz and over 80% static filtering accuracy, while dynamic tracking accuracy improves up to 50% through ego-compensated filtering. The proposed system advances scalable and deployable perception for autonomous service robots in real public spaces.