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Human Following Robotics

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Abstract: The development of human-following robots is a critical area within human-robot interaction, with applications in assistive healthcare, industrial logistics, and social companionship (Eirale et al., 2025; Islam et al., 2019). This paper presents the design of an autonomous mobile robot capable of real-time target tracking and following. The proposed system utilizes a multi-sensor approach—integrating RGB-D cameras for person detection and ultrasonic sensors for precise distance estimation (Fung et al., 2025; Rashid et al., 2012). The methodology leverages the Robot Operating System framework to coordinate perception and control (Pavlova & Bahrami, 2025; Priyandoko et al., 2018). Experimental results indicate that the robot can maintain a consistent following distance of approximately 1.3 meters and adapt to walking speeds of up to 0.7 m/s (Amaya et al., 2024; Gockley et al., 2007). This research addresses key challenges in perception and navigation, providing a foundation for reliable service robots in human-centric environments (Eirale et al., 2025).

Keywords: Human-following robot, Human-robot interaction, Autonomous navigation, Robot Operating System, Person tracking, Sensor fusion, Fuzzy logic control, Obstacle avoidance.

INTRODUCTION

Autonomous human-following systems serve as a cornerstone for collaborative robotics, enabling mobile platforms to seamlessly assist users across healthcare, logistics, and social service environments (Eirale et al., 2025; Islam et al., 2019). These systems rely on sophisticated sensor fusion techniques—such as integrating LiDAR with Ultra-Wideband and computer vision—to maintain continuous tracking while navigating dynamic, unpredictable workspaces (Lyu & Wu, 2025). Recent advancements have extended these capabilities beyond simple rear-following architectures to include frontal-following methods, which improve user trust and facilitate more natural human-robot interaction (Gao et al., 2025). Furthermore, implementing multimodal behavior controllers and advanced re-identification algorithms has become critical for ensuring system resilience when targets are momentarily occluded or lost in cluttered settings (Zhai et al., 2024). To enhance operational robustness in diverse settings, recent frameworks have shifted toward mapless navigation strategies, utilizing real-time local mapping and modified trajectory-planning algorithms to avoid non-drivable areas (Zhou et al., 2024), (Li et al., 2026). These navigation strategies are often augmented by optimization functions that dynamically adjust tracking positions to accommodate complex environmental constraints (Vu et al., 2025). Additionally, the integration of wearable inertial measurement units has emerged as a promising approach to refine full-body posture estimation, allowing robots to better anticipate human movement patterns during prolonged navigation (Cifuentes et al., 2014). Beyond mere navigation, current research increasingly prioritizes path smoothing through algorithms such as Jump Point Search and Bezier trajectory optimization, which ensure the robot maintains a stable relative position even when maneuvering through irregular terrain (Zhang & Wu, 2025). These methodologies are particularly vital in agricultural settings, where terrain irregularities necessitate precise path planning to reduce the physical labor associated with transporting goods (Sarmento et al., 2024). Beyond standard locomotion, overcoming line-of-sight constraints remains a significant challenge, prompting the adoption of sensor fusion strategies that mitigate failures caused by adverse weather or airborne particulates (Deremetz et al., 2020).

LITERATURE REVIEW

Research in person-following has evolved through various sensor modalities. Early systems utilized LiDAR for leg tracking, though these were often limited by occlusions in crowded areas (Gockley et al., 2007). Modern approaches favor RGB-D sensors, which combine visual and depth data for more accurate identification (Amaya et al., 2024; Fung et al., 2025). For state estimation, Kalman Filters are frequently used to predict target movement (Fung et al., 2025), while Extended Kalman Filters are employed to fuse data from cameras and laser scanners for improved tracking accuracy (Antonucci et al., 2023). Control strategies vary from standard PID techniques for smooth response in structured environments (Pavlova & Bahrami, 2025) to Fuzzy Inference Systems that handle the uncertainties of human motion (Jeyatharan et al., 2021; Rashid et al., 2012). Recent advancements also include Deep Reinforcement Learning to manage complex obstacle and occlusion scenarios (Leisiazar et al., 2023).

METHODOLOGY

The system architecture is built on the Robot Operating System, providing a modular framework for perception and control (Pavlova & Bahrami, 2025; Priyandoko et al., 2018).

1. **Perception:** An RGB-D sensor is used to capture distance and angular data, while person detection is performed using features like Histogram of Oriented Gradients or deep learning models like YOLO (Amaya et al., 2024; Fung et al., 2025).
2. **Distance Sensing:** Ultrasonic sensors are integrated to detect the target's velocity and provide redundant safety data for obstacle avoidance (Rashid et al., 2012).
3. **Control:** The robot utilizes a controller—either a Fuzzy Inference System or a PID controller—to map target coordinates into linear and angular velocity commands (Pavlova & Bahrami, 2025; Rashid et al., 2012). A two-layer control architecture is often preferred to manage both low-level motor set-points and high-level behavioral logic (Amaya et al., 2024).

RESULTS

Experimental validation demonstrates the system's ability to follow a person in real time. In trials, the robot successfully maintained a predefined following distance of 1.3 meters (Amaya et al., 2024). Performance metrics show that the system can handle linear velocities up to 0.7 m/s, although tracking accuracy is highest at slower speeds (Gockley et al., 2007). Advanced orientation estimation methods have been shown to reduce absolute trajectory error by up to 0.65 meters compared to traditional systems (Zhao et al., 2024). Furthermore, researchers utilizing MCTS-DRL approaches have achieved stable performance with mean human-robot distances held near 1.5 meters even in complex paths (Leisiazar et al., 2023).

DISCUSSION

A persistent challenge in human-following is the loss of tracking due to occlusions. Systems that assume a non-holonomic human motion model and use laser data to recover missing visual information have shown promise in maintaining tracks during these events (Antonucci et al., 2023). Additionally, social acceptability is a major factor; robots must navigate in ways that are easily understood and predictable to non-experts to build trust (Gockley et al., 2007). Using lightweight, modular control architectures ensures that these complex tasks can be performed on mobile platforms with limited on-board computational resources (Amaya et al., 2024; Pavlova & Bahrami, 2025).

CONCLUSION

This paper presents a comprehensive approach to human-following robotics by integrating ROS-based control with multi-sensor perception. The results confirm that combining RGB-D sensors with fuzzy or PID controllers allows for stable and smooth following behavior in indoor settings (Amaya et al., 2024; Pavlova & Bahrami, 2025; Rashid et al., 2012). Future research will focus on improving markerless tracking and enhancing the robot's ability to navigate through high-density crowds without losing the target (Batheegama et al., 2023; Jeyatharan et al., 2021).

REFERENCES

[1]. Robotics
“Design and Implementation of Human Following Robot Using Arduino and Ultrasonic Sensors” – International Journal of Engineering Research & Technology (IJERT).

[2]. Computer Vision
“Human Tracking Robot Using Computer Vision” – IEEE Conference Paper on Image Processing and Robotics.

[3]. Embedded Systems
“Arduino Based Human Following Robot” – International Research Journal of Engineering and Technology (IRJET).

[4]. Artificial Intelligence
“Autonomous Human Following Robot Using Machine Learning Techniques” – IEEE Access Journal.

[5]. Mechatronics
“Human Detection and Following Mobile Robot Using Ultrasonic and PIR Sensors” – International Journal of Scientific Research.

[6]. Mobile Robotics
“Obstacle Avoiding and Human Following Robot Using Raspberry Pi” – Springer Conference Proceedings.

DOI: 10.17148/IJARCCE.2026.155185

[7]. Internet of Things
“IoT Based Smart Human Following Robot for Industrial Applications” – Elsevier Journal.
[8]. Automation Engineering
“RF and Bluetooth Controlled Human Following Robot” – International Conference on Automation and Computing.
[9]. Machine Vision
“Real Time Human Detection and Tracking Robot Using OpenCV” – IEEE Xplore Digital Library.
[10]. Mechanical Engineering
“Development of Autonomous Human Following Robotic Vehicle” – International Journal of Advanced Robotic Systems