DESIGN AND DEVELOPMENT OF INTELLIGENT PARKING SYSTEM USING THE PC BASED AGV PARKING ROBOT

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Introduction:

1. With the rapid increase in urbanization and vehicle ownership, efficient parking management has become a major challenge in modern cities. Traditional parking systems rely heavily on human intervention, leading to inefficiencies, increased waiting time, and improper space utilization. Automated parking systems are emerging as a solution to address these issues by reducing human effort and optimizing parking operations.
2. This project focuses on developing a Smart Parking System using an Automated Guided Vehicle (AGV) that can autonomously detect, navigate, and park vehicles into available slots. The system integrates computer vision techniques using OpenCV for real-time parking slot detection and decision-making.
3. The current stage of the project demonstrates a partially functional prototype where the AGV is capable of basic movement and identifying parking slots using image processing techniques. The system aims to evolve into a fully autonomous valet parking solution capable of handling real-world scenarios efficiently.

Objectives:

To design a lightweight and structurally efficient AGV body
To implement an automated slot detection system.

Methodology:

The project is divided into hardware and software implementation stages.
The hardware system consists of a Raspberry Pi 4 as the central controller, DC motors for movement, motor drivers for control, and an ultrasonic sensor for obstacle detection. The AGV structure is designed using lightweight materials with a stable chassis.
On the software side, OpenCV is used for image processing and line detection, while YOLO is implemented for object detection such as vehicles and obstacles. A camera mounted on the AGV captures real-time video, which is processed to detect parking slots and guide navigation.

The system follows a structured workflow where sensor data is continuously acquired and processed. Based on detection results, control signals are generated and sent to the motor driver to control movement.
At the current stage, the AGV can perform line following, detect obstacles, and identify parking slots using OpenCV. Testing is carried out in a controlled indoor environment to validate system performance.
Future improvements include integrating advanced path planning algorithms, improving detection accuracy, and implementing full autonomous parking functionality

Result and Conclusion:

In conclusion, the project has successfully demonstrated the basic functionality of an AGV-based smart parking system. The prototype is capable of detecting lines, identifying parking slots using OpenCV, and performing controlled movement.
The YOLO-based detection model has shown accurate object detection performance during testing. The ultrasonic sensor provides reliable obstacle detection, enhancing system safety. Although the system is currently in a partially completed stage, it establishes a strong foundation for developing a fully autonomous parking robot. Some limitations such as performance under varying lighting conditions and lack of advanced path planning are identified.

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Future Scope:

The future scope of this project includes:

1. Enhance the AGV system to achieve full autonomy and real-world implementation.
2. Implement advanced navigation techniques such as SLAM (Simultaneous Localization and Mapping) for accurate mapping and localization.
3. Improve the perception system by integrating LiDAR or depth cameras for better environmental understanding.
4. Optimize machine learning models to improve detection accuracy under varying lighting and environmental conditions.
5. Integrate IoT platforms for remote monitoring and control of the parking system.
6. Develop a mobile application interface for user interaction and parking service requests.
7. Expand the system to support multi-AGV coordination for large-scale parking facilities.
8. Incorporate mechanical enhancements such as vehicle lifting mechanisms for full valet parking functionality.
9. Explore commercialization opportunities for deployment in smart city infrastructure.