Intelligent Automated Guided Vehicle Using Machine Vision

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Abstract - Automated Guided Vehicles (AGVs) play a vital role in modern industries for efficient material handling and internal logistics. Conventional AGV systems rely on fixed infrastructure such as embedded wires, magnetic tapes, or predefined tracks, which limits flexibility and increases installation cost. This paper presents the design and implementation of an Intelligent Automated Guided Vehicle (IAGV) using machine vision and image-based visual serving. The proposed system utilizes image processing techniques to recognize directional signs and navigate autonomously in a dynamic shop-floor environment. The mechanical structure is designed using a three-wheel tadpole configuration to enhance maneuverability and reduce rolling resistance. Structural analysis using finite element analysis (FEA) validates the load-carrying capacity of the vehicle. Experimental results demonstrate that the proposed IAGV provides improved flexibility, safety, and adaptability compared to conventional AGV systems, making it suitable for modern industrial environments.

Key Words: Automated Guided Vehicle (AGV), Machine Vision, Image Processing, Visual Servoing, Intelligent Systems.

1. INTRODUCTION

Automated Guided Vehicles (AGVs) have emerged as indispensable components in modern industrial automation, logistics, and smart material handling systems. Traditionally, AGVs follow fixed guidance mechanisms such as magnetic tape, wires, or predefined markers, which limits their adaptability and responsiveness in dynamic environments. With the rapid advancement of robotics and artificial intelligence, there is an increasing demand for AGVs that can operate autonomously with minimal human intervention while handling the complexities of real-world scenarios.

Machine vision, a field that combines image acquisition with computational processing and intelligent analysis, has become a key enabling technology for enhancing robotic perception and decision-making. By integrating machine vision into AGVs, autonomous vehicles can perceive their surroundings more effectively, recognize objects, and make real-time navigational decisions. This integration transforms conventional AGVs into intelligent platforms capable of navigating unstructured environments, detecting obstacles, and adapting to changes in layout or operational context. In recent years, significant progress has been made in computer vision algorithms, particularly deep learning-based techniques, which have revolutionized object detection, scene understanding, and spatial reasoning. These advancements present an opportunity to develop intelligent Automated Guided Vehicles (I-AGVs) that leverage visual data to achieve robust performance in tasks such as path planning, localization, and obstacle avoidance. Unlike traditional AGVs that depend on external infrastructure or rigid path definitions, vision-enabled AGVs can dynamically interpret their environment and autonomously adjust their behavior.

2. Body of Paper

Generally, the AGV's are having four wheels but in this research, the concept of three wheelers has been applied, as four-wheelers are having more rolling resistance when comparison with three-wheeler. Steering response is 33% more responsive than a four-wheeler with respect to yaw axis. Tadpole configuration has more stability compared to a delta configuration. Unparalleled performance is offered by the three-wheeler compared to four-wheeler at an affordable cost. So, a tadpole type AGV had been designed and analyzed for the load carrying capacity in the FEA software

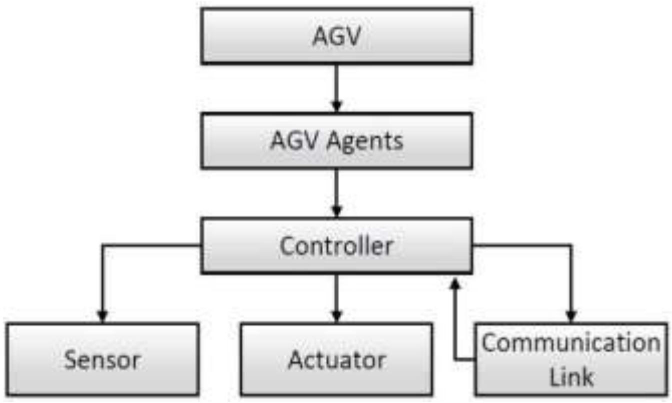

Fig 1: Block Diagram

2.1 Hardware Description

1. AGV

The **AGV** block represents the complete automated guided vehicle system. It is a mobile platform designed to transport materials autonomously within industrial environments such as factories, warehouses, and logistics centers. The AGV integrates mechanical structure, electronics, sensors, actuators, and control algorithms to perform navigation and material handling tasks without human intervention.

2. AGV Agents

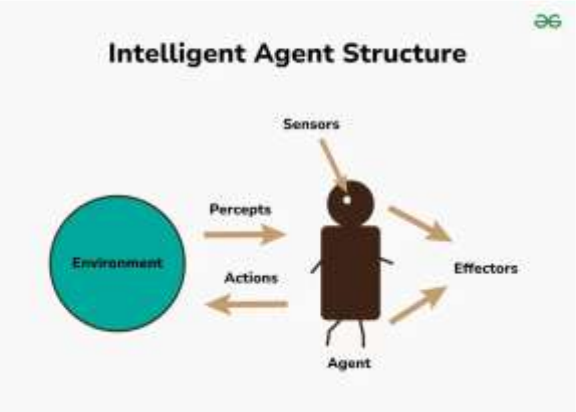

Fig 2: AGV Agents

The **AGV Agents** block refers to the intelligent modules or software agents responsible for decision-making and task execution. These agents handle functions such as:

- Path planning
- Obstacle avoidance
- Task scheduling
- Navigation strategy

The agent-based approach allows the AGV to respond dynamically to changes in the environment and improves system flexibility and scalability in multi-AGV systems.

3. Controller

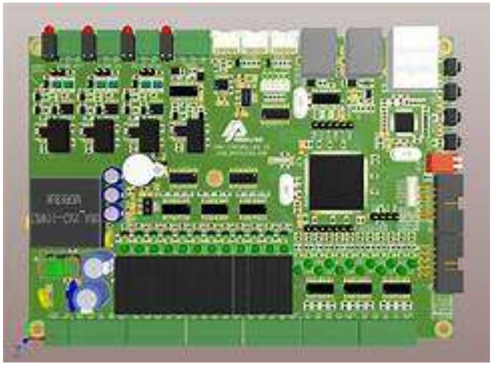

Fig 3: Controller

The **Controller** is the central processing unit of the AGV. It receives inputs from sensors and communication links and processes them using predefined control algorithms. Based on this information, the controller generates appropriate control signals for the actuators.

Key functions of the controller include:

- Motion control
- Speed and direction regulation
- Navigation control
- Safety monitoring
- Coordination with other AGVs

The controller ensures smooth, accurate, and safe operation of the AGV.

4. Sensor

Fig 4: Sensor

The **Sensor** block provides real-time information about the AGV's environment and internal state. Sensors continuously monitor conditions and send feedback to the controller.

Common sensors used in AGVs include:

- Proximity sensors
- Ultrasonic sensors
- Infrared sensors
- Encoders
- Line-following or magnetic sensors

Sensor feedback enables obstacle detection, position estimation, and closed-loop control.

5. Actuator

Fig 5: Actuator

The **Actuator** block represents the mechanical components responsible for physical movement. Actuators convert electrical control signals from the controller into mechanical action.

Typical actuators include:

- DC motors
- Servo motors
- Stepper motors

These actuators drive the wheels, steering mechanism, and load-handling systems of the AGV.

3. Software Architecture and Implementation.

The software framework for the Intelligent AGV is designed with a **modular architecture** to ensure real-time responsiveness and scalability. The system is built upon the **Robot Operating System (ROS)** (or a high-level Python/C++ environment), which facilitates asynchronous communication between the vision, navigation, and control modules.

The software system of the Automated Guided Vehicle (AGV) plays a critical role in enabling autonomous navigation, decision-making, and control. It acts as an interface between the hardware components (sensors, actuators, and communication modules) and the high-level operational objectives of the AGV. The software architecture is designed in a modular and hierarchical manner to ensure reliability, scalability, and real-time performance.

3. Result

Fig 6 : Result of Project

4. RESULT

The results indicate that AGVs help in faster material handling, better space utilization, and consistent workflow. They also reduce workplace accidents by following predefined paths and safety sensors. Although the initial installation cost is high, AGVs provide long-term benefits such as increased productivity, reduced operational costs, and improved reliability.

5. CONCLUSIONS

This project demonstrates that Automated Guided Vehicles provide an efficient, reliable, and safe solution for automated material handling. The implementation of AGVs reduces human intervention, improves operational accuracy, and enhances productivity. Despite higher initial costs, AGVs offer long-term benefits through reduced labor requirements, improved workflow consistency, and increased workplace safety. Therefore, AGVs are a key technology for modern industrial automation and smart manufacturing systems.

6. ACKNOWLEDGEMENT

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