CYPRUS INTERNATIONAL UNIVERSITY

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

DIGITAL TECHNOLOGIES IN INDUSTRY

By

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OLUTOYE OPEYEMI

Date: February 6, 2025

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ABSTRACT

The research introduces CIU_Fox as an autonomous guided vehicle (AGV) that develops capabilities to transform factory and warehouse internal transportation operations. The designed AGV features autonomous navigation with a safe lifting capability using obstacle detection and collision avoidance systems for moving loads up to 200 kg. This system combines LIDAR with time-of-flight (ToF) sensors and barcode scanners to create a precise automated navigation system which monitors operations and handles loading duties. The mechanical structure incorporates an aluminum alloy frame together with a scissor-compartment mechanism and NEMA 23 stepper-motor powered differential steering. A Raspberry Pi 4 manages the system through ESP32 modules that run software programs built in Python and C++ within the ROS framework. The robot development followed four sequential stages that led to its physical assembly. Resources limitations required the project team to conduct final stage testing through the Gazebo simulation pipeline instead of building physical components. Coding for path planning alongside obstacle avoidance and load management functions while achieving complete integration of mechanical electronic software system components stands as major accomplishments. The commercial application scope of the AGV remains promising in multiple industrial sectors including manufacturing storage facilities and logistics operations because it shows potential to optimize operational efficiency while decreasing expenses and protecting worker safety. This work illustrates why interdisciplinary teams need to bring innovative solutions to modern industrial design using state-of-the-art technology applications. Research efforts will focus simultaneously on two fronts which include enhancing the AGV's operational excellence while evaluating opportunities to connect it with broader industrial system networks.

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Part I

INTRODUCTION

Chapter 1

introduction

Today's industries activity have merged with the robotic and automation world and day by day having the precise and betterquality product make the sense of using new technology. Between all types of robot, the AGV (automated guided vehicle) robot has the special place between others and improvement in technology helps this design to grow and become more helpful in various applications. The AGV robot is a programmable mobile robot integrated sensor device that can automatically perceive and move along the planned path [**?**] This system consists of various parts like guidance facilities, central control system, charge system and communication system [**?**].

The initial used and Invention AGV is not clear exactly and was mentioned in different articles and reference for many times but the earliest time of using this system in industries is mentioned in 1950s [**?**] (fig. 1.1) and even mentioned in some reference that the first AGV in the world was introduced in UK in 1953 for transporting which was modified from a towing tractor and can be guided by an overhead wire [**?**].

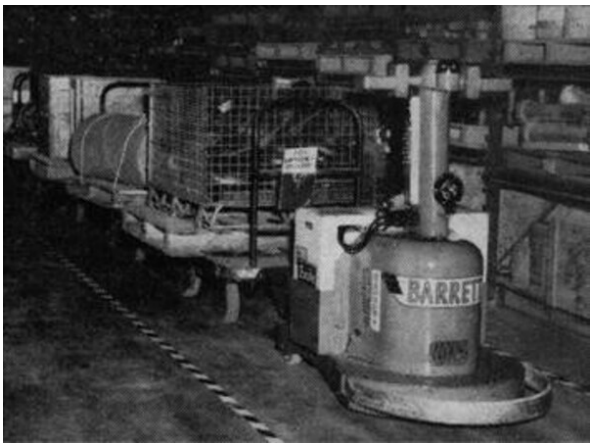

Figure 1.1: one of the Old AGV picture

AGVs are widely applied in various kinds of industries including manufacturing factories

and repositories for materialhandling. After decades of development, it has a wide application due to its high efficiency, flexibility, reliability, safety and system scalability in various task and missions. AGV operates all day long continuously that cannot be achieved by human workers. Therefore, the efficiency of material handling can be boosted by having the collaborating task with number of AGV . In this case, administrator can enable more AGVs as the system is extensible. AGV has capability of collision avoidance and emergency braking, and generally the running status is monitored by control system so that reliability and safety are ensured. Generally, a group of AGVs are monitored and scheduled by a central control system. AGVs, ground navigation system, charge system, safety system, communication system and console make up an AGV system. [**?**]. This report examines the design aspects and considerations for this type of robot, providing readers with key insights into the technologies commonly utilized in this field.

Chapter 2

Theory of AGV Design

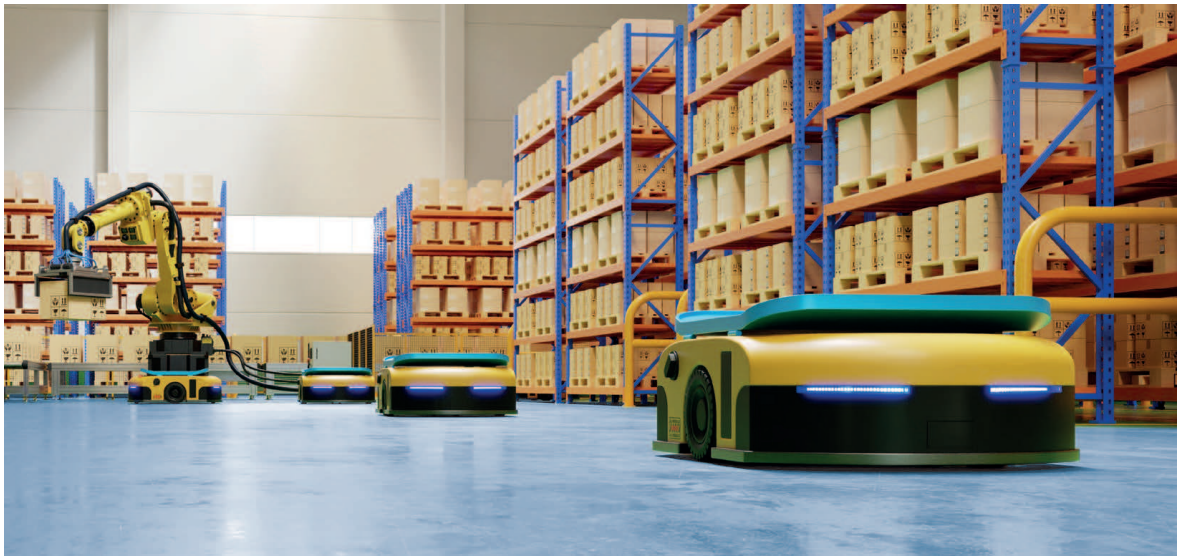

Figure 2.1: Smart AGV in Industry 4.0

AGVs are essential components in modern industrial automation systems, designed to improve efficiency, flexibility, and safety in material handling and logistics. This section discusses the fundamental theories and principles underlying AGV design, including navigation, control, and system integration.