OPTIMIZATION OF AGV ROUTES IN A SMART WAREHOUSE

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In this article we have set out to develop a small-scale AGV, where we have designed a virtual model and a wiring diagram of its sensors and components. So far, we have succeeded in making a prototype that can be controlled by remote control and is to be developed to be autonomous. We will explore the technical details and challenges involved in building an efficient and functional low-level AGV. Objectives include evaluating the advantages and disadvantages of forklift AGVs over other types of AGVs and identifying ways to optimize routing and storage using forklift AGVs. The methods used include literature search and study to develop a small-scale forklift AGV system that can be integrated into a warehouse.

1. Introduction

Optimizing AGV routing in a smart warehouse uses IoT technology and artificial intelligence algorithms to collect and analyze data about AGV movement and status, as well as storage inventory. The goal is to reduce delivery time, minimize operating costs and increase warehouse performance by using AGVs efficiently. Optimal planning and scheduling of AGV movements is carried out in real time to avoid congestion and wasted traffic time and to ensure efficient use of resources and warehouse space. Figure 1 shows three types of AGVs used in warehousing and logistics: forklift AGVs, platform AGVs and trailer AGVs.

a) AGV Forklift b) AGV with platform c) AGV with trailer

Fig. 1. Types of AGVs

2. The current stage

Forklift AGVs are increasingly popular in warehousing and logistics due to increased productivity and space optimization. With the ability to move autonomously and handle goods, they are an efficient alternative to traditional forklift trucks. Despite advances in optimizing AGV routes through genetic algorithms or neural networks, challenges such as congestion and safety in the warehouse still exist. Current developments involve using IoT technology and improving AGVs to meet the needs of smart warehouses [1].

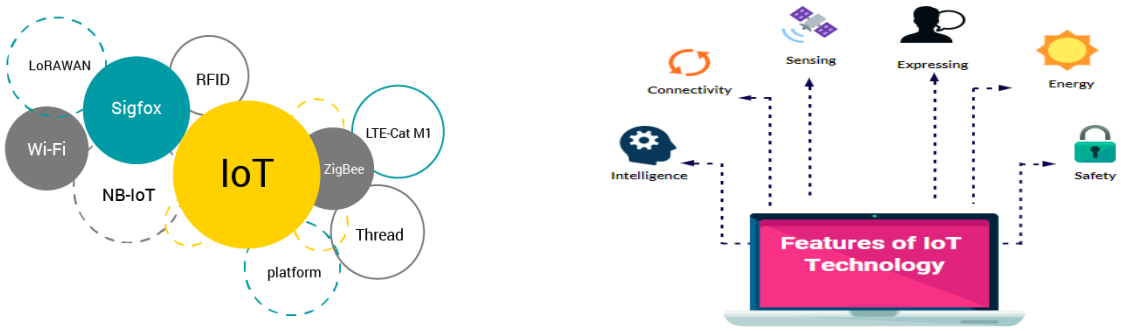

Fig. 2. Internet of Things Technology

The AGV forklift is an innovative solution for storing and handling goods, bringing efficiency and autonomy to any company. Integrated into a smart warehouse, it can transport and handle goods, load, and unload trucks, optimizing space and resources. With IoT technology and real-time data analytics, the forklift AGV improves warehouse performance and reduces human error, helping to streamline operations.

Fig. 3. Example of AGV Forklift

Fig. 4. Example of sensors used in an AGV structure

Currently there are solutions for optimizing AGV routing in smart warehouses, but they are only applied in large and complex warehouses [5]. Future solutions focus on IoT and artificial intelligence and are based on advanced data collection and analysis. Therefore, current technologies for such as 5G networks used to coordinate AGVs will play a crucial role in warehousing and handling of goods.

A major advantage of using forklift AGVs is that they can transport and handle large loads, unlike platform AGVs and trailer AGVs. Its ability to lift and transport pallets of goods makes it ideal for automated warehouse operations.

3. Steps in the development of the AGV

The forklift AGV designed for small-scale production was developed with the aim of being used for research and understanding how this type of automated guided vehicle works.

The stages in the development of this system were as follows:

- Component design and procurement

The designed AGV (figure 5) is driven by four DC motors, which provide the necessary propulsion for travel, and the drive of the lifting system is operated by a stepper motor (figure 6).

Two L298N drivers were used to drive the DC motors (figure 7). These allow control of the direction and rotational speed of the motors, thus ensuring precise movement of the AGV.

The MPP driver (figure 7) was used to drive the specific motor of the lifting system. The stepper motor drivers convert the impulse signals from the controller into motor motion to achieve precise positioning.

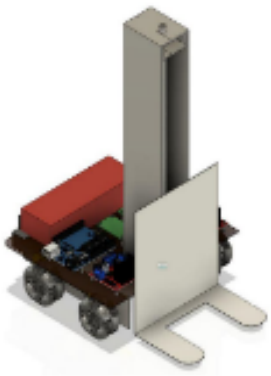

Fig. 5. AGV - virtual model

Fig. 6. Motors used for drive

Fig. 7 Motor drivers

- Processing and assembly of components.

The creation of the AGV system was an extremely important step and involved the processing of the infrastructure components and their assembly (figure 8).

Materials used to make the chassis:

- Polycarbonate plate
- Aluminum profile
- Lead screw
- Fasteners

Fig. 8. Different phases in the processing and assembly of the designed system

After assembling the mechanical components, the connections between the actuation components and the drivers, respectively the Arduino board and the connections between the sensors and the Arduino board were made. The detailed schematic showing all the components is shown in figure 8.

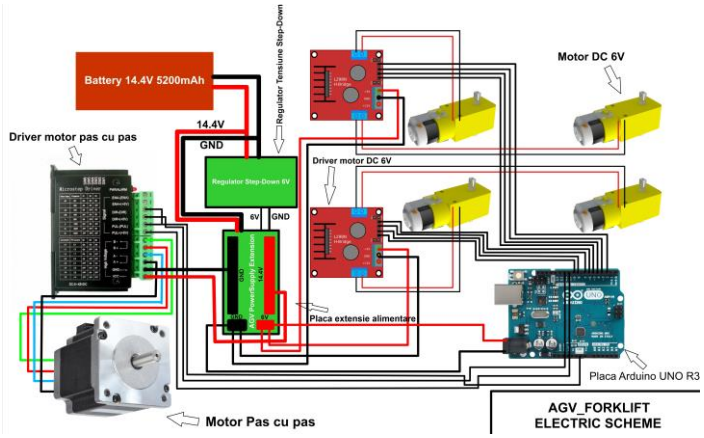

Fig. 8 Wiring diagram of actuator and control components

The AGV is powered by 4 omnidirectional Mecanum wheels, which allow movement in plane, in any direction. This is achieved by means of rollers mounted on the circumference of the wheel that facilitate movement in any direction and at any angle [3].

Figure 9 highlights the directions in which the omnidirectional wheels can move in relation to how they are operated.

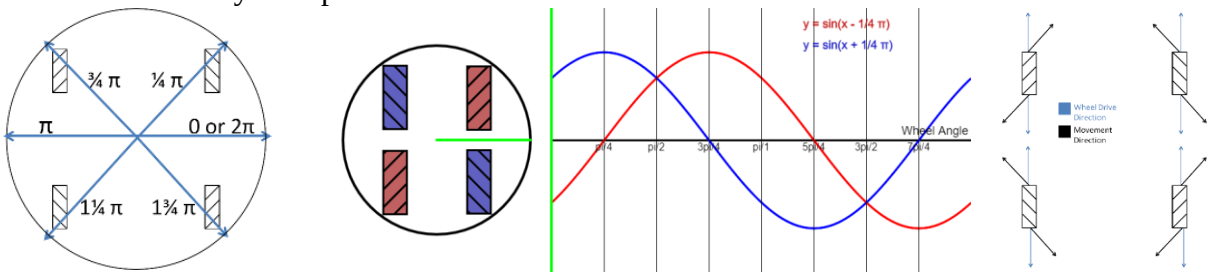

Fig. 9. Omnidirectional wheels movement

4. Conclusions

The design and development of a forklift AGV for the autonomous transport of goods in a smart warehouse, made on a small scale, was presented.

All the steps taken to design, procure, process, assemble, and program the automated guided vehicle, were briefly highlighted.

5. Bibliography

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