

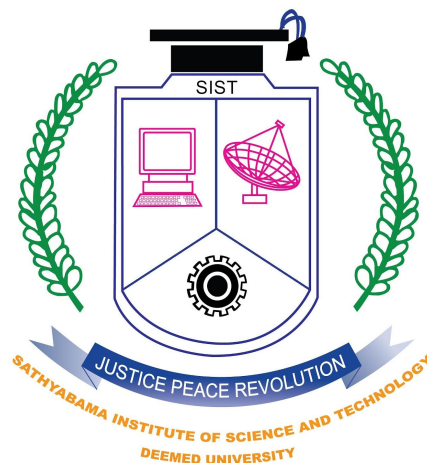
CHECK WEIGHING AUTOMATED GUIDED VEHICLE

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering in Mechatronics

by

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SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NACC | 12B Status by UGC | Approved by AICTE
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600119

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **DKRISHNA KAANTH. M (39090022)** and **MOHAMED RASHIK. M (39090024)** who carried out the Project Phase-2 entitled "**CHECK WEIGHING AUTOMATED GUIDED VEHICLE**" under our supervision from Jul to May 2023.

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DECLARATION

We **KRISHNA KAANTH. M (39090022)** and **MOHAMED RASHIK. M (39090022)** hereby declare that the Project Report entitled “**CHECK WEIGHING AUTOMATED GUIDED VEHICLE**” done by us under the guidance of **Dr. S. PRAKASH, M.E., Ph.D.** at **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechatronics.

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ABSTRACT

Check weighing is an essential quality control process that involves verifying the weight of products at various stages of production. Automated Guided Vehicles (AGVs) are increasingly being used in manufacturing environments to streamline material handling and reduce human labor costs. Check weighing automated guided vehicles (CWAGVs) combine these two technologies, providing an efficient and automated method for checking the weight of products as they move through the production process.

A CWAGV system typically consists of a mobile robot equipped with a weighing mechanism that can be used to measure the weight of products placed on it. The AGV can be programmed to transport products to specific locations for weighing, either automatically or under the supervision of an operator. The system is designed to provide accurate and reliable measurements, ensuring that products meet the required weight specifications.

The benefits of a CWAGV system are numerous. Firstly, it eliminates the need for manual weighing, which can be time-consuming and error-prone. This reduces the likelihood of production errors and increases productivity. Secondly, the system can be integrated with other manufacturing processes, such as labeling and packaging, creating a seamless and efficient production line. Finally, the system can be easily programmed to handle different product types and sizes, making it versatile and adaptable to changing production requirements.

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LIST OF ABBREVIATION

S.NO	ABBREVIATION	MEANING
1	AGV	Automated Guided Vehicle
2	CWAGV	Check Weighing Automated Guided Vehicle

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CHAPTER 1

INTRODUCTION

1.1 AUTOMATED GUIDED VEHICLES (AGV):

Automated Guided Vehicles (AGVs) are mobile robots that can navigate autonomously through a facility or a warehouse, without the need for human guidance or intervention. These vehicles are equipped with sensors, controllers, and other electronic components that enable them to detect obstacles, follow predefined paths, and communicate with other devices or systems. AGVs have been around for several decades and have become an increasingly popular choice for industrial automation in recent years due to advances in technology and increased demands for efficiency and productivity. AGVs are designed to perform a variety of tasks such as material handling, transportation of goods, and parts assembly. They can be programmed to navigate complex environments and follow specific paths, either through pre-defined markers or by using on-board sensors like cameras, LIDAR, and ultrasonic sensors to detect their surroundings. These sensors also allow AGVs to avoid obstacles, including people, and to interact safely with other machines or equipment in the facility. In addition, AGVs can communicate with other devices and systems, allowing them to coordinate and optimize their movements and tasks.

AGVs come in different shapes and sizes, depending on their intended use. Some AGVs are small and designed for indoor use, while others are large and designed for outdoor use. Some AGVs have flat platforms for transporting goods or materials, while others have robotic arms for assembly or inspection tasks. AGVs can be powered by batteries, fuel cells, or other energy sources and can be programmed to perform a wide range of tasks, making them versatile and adaptable to various applications.

Overall, AGVs offer many benefits to manufacturing, warehousing, and logistics operations, including increased efficiency, productivity, and safety. They also reduce the need for human labor, making operations more cost-effective and scalable. With ongoing technological advancements, AGVs are

likely to become an increasingly important tool for industrial automation in the future.

1.2 CHECK WEIGHING:

Check weighing is a process that involves verifying the weight of a product or material to ensure it meets specific quality and regulatory requirements. This process is commonly used in manufacturing and packaging industries to ensure that the final product is of the correct weight and meets regulatory standards.

The check weighing process involves the use of precision weighing scales, which are capable of accurately measuring the weight of an item to within a specific tolerance level. The product or material is placed on the weighing scale, and the weight is compared to a pre-determined acceptable weight range. If the weight is within the acceptable range, the product or material is considered to have passed the check weighing process. If the weight falls outside of the acceptable range, the product or material is rejected, and corrective action is taken.

Check weighing can be performed manually or using automated systems such as check weighing machines or check weighing AGVs (Automated Guided Vehicles). Check weighing machines are stationary systems that can weigh and sort products automatically, while check weighing AGVs are mobile robots equipped with weighing scales that can move products or materials and perform check weighing tasks automatically.

Check weighing is an essential process in many industries, including pharmaceuticals, food and beverage, and consumer goods. In pharmaceuticals, check weighing is used to ensure that medication doses are accurate, while in the food and beverage industry, check weighing is used to ensure that products meet weight and labeling requirements. In consumer goods, check weighing is used to ensure that products are not underweight, which can lead to customer dissatisfaction and even legal action.

1.3 CHECK WEIGHING AGV:

In today's competitive manufacturing industry, companies are constantly seeking ways to improve their production processes to reduce costs, increase efficiency, and maintain high-quality standards. One critical aspect of quality control in manufacturing is check weighing, which involves verifying the weight of products at different stages of production. Automated Guided Vehicles (AGVs) are emerging as a reliable and cost-effective solution for material handling in manufacturing environments. The combination of check weighing and AGVs has led to the development of check weighing AGVs (CWAGVs), which provide an innovative and automated solution for ensuring product quality and accuracy.

Check weighing involves comparing the weight of a product to a predetermined weight range to ensure it meets the required specifications. It is a crucial process in various industries, such as food and beverage, pharmaceuticals, and consumer goods. This process can be time-consuming and prone to human error when done manually. Additionally, manual check weighing can be labor-intensive, leading to high labor costs, especially in industries with high production volumes.

Automated Guided Vehicles (AGVs) are autonomous mobile robots designed to transport goods within a factory or warehouse. They are equipped with sensors and software that enable them to navigate through the facility and avoid obstacles. AGVs have become increasingly popular in manufacturing environments as they can significantly reduce labor costs, increase productivity, and enhance safety. They can handle repetitive and tedious tasks, allowing human operators to focus on more complex activities that require higher cognitive skills.

Check weighing AGVs (CWAGVs) combine the benefits of check weighing and AGVs. They are designed to transport products to specific locations for check weighing, eliminating the need for manual handling and reducing the risk of errors. The CWAGV system is equipped with a weighing mechanism that can accurately measure the weight of products, ensuring they meet the

required specifications. The integration of CWAGVs in manufacturing processes results in improved accuracy, faster production, and enhanced safety.

Principle:

The principle involved in check weighing AGVs is relatively straightforward. The AGV is equipped with a scale that can measure the weight of the load it is carrying. The AGV is programmed to move the load to a designated location, typically a weighing station or a conveyor belt, where the weight of the load is automatically checked.

If the weight of the load is within an acceptable range, the AGV continues on its programmed path to the next destination. If the weight of the load is outside the acceptable range, the AGV can be programmed to take appropriate action, such as diverting the load to a reject station or notifying an operator to inspect the load.

The principle involved in check weighing AGVs is based on the concept of dynamic weighing, which involves weighing an object while it is in motion. Dynamic weighing is a useful technique in applications where it is impractical or impossible to weigh an object statically, such as in conveyor systems or in applications where the weight of the object changes over time.

In addition to the scale, check weighing AGVs may also be equipped with sensors or cameras to detect and identify the load they are carrying. This information can be used to ensure that the correct load is being transported and to provide additional data for quality control and inventory management. Overall, the principle involved in check weighing AGVs is to automate the process of verifying the weight of materials or products as they are transported, improving efficiency, accuracy, and safety in manufacturing and logistics operations.

About MGEE Industries:

MGEE Industries is a well-established company that is located near Puducherry in India. The company specializes in the design, development, and manufacturing of automations for various industries. AGVs are vehicles that operate without human intervention, using advanced technologies such as sensors, GPS, and mapping systems. They are used to transport materials and goods within a facility or warehouse, and they have become increasingly popular in recent years due to their efficiency, precision, and safety.

The company has a team of experienced engineers and technicians who work together to develop innovative and reliable AGV solutions for their customers. They have expertise in various areas such as mechanical engineering, electrical engineering, software development, and robotics. This allows them to provide comprehensive solutions that are tailored to the specific needs of their clients.

Our final year project involved developing a check-weighing AGV for the company. This type of AGV is used to automatically weigh items as they are transported within a warehouse or production facility. The AGV is equipped with sensors and measurement devices that allow it to accurately determine the weight of the items it is carrying. This is particularly useful in industries such as food and beverage, pharmaceuticals, and logistics, where accurate weight measurements are essential for quality control and inventory management.

To develop the check-weighing AGV, we likely worked closely with the team at MGEE Industries. This would have involved several stages, including designing the AGV, selecting the appropriate sensors and measurement devices, programming the vehicle's navigation and weighing systems, and testing the AGV's performance in a simulated or real-world environment.

The project have given us valuable experience in the design and development of advanced automated systems. We have gained a deep understanding of the various technologies and components that are involved in developing an

AGV, as well as the challenges and opportunities that come with developing such systems. Additionally, we have gained experience in project management, teamwork, and problem-solving, which are all essential skills for a career in engineering or robotics.

CHAPTER 2

LITERATURE SURVEY

"Development of Check Weighing System using AGV in a Confectionery Plant" (M. Sasaki et al., 2016) - This study presents the development of a check weighing AGV system in a confectionery plant. The system consists of an AGV with a weighing mechanism and a control unit that can communicate with a central server. The authors report that the system reduced the number of workers required for check weighing tasks, resulting in significant cost savings.

"Development of an Autonomous Check Weighing System for Production Lines Using AGV" (H. Yamashita et al., 2018) - This study describes the development of an autonomous check weighing system using AGVs in a production line. The system employs a collaborative approach between AGVs and a centralized server to optimize the check weighing process. The authors report that the system improved productivity and reduced errors.

"Implementation of Automated Check Weighing System Using AGV in Pharmaceutical Industry" (S. Jagadeesh et al., 2018) - This study explores the implementation of a check weighing AGV system in a pharmaceutical industry. The authors report that the system improved the accuracy and efficiency of the check weighing process, reducing the risk of errors and the need for manual labor.

"Integration of Automatic Check Weighing System with AGV in a Packaging Line" (N. Singh et al., 2019) - This study presents the integration of an automatic check weighing system with an AGV in a packaging line. The system employs a machine vision system to verify the identity of the product and its weight. The authors report that the system reduced manual handling and improved accuracy.

"A Framework for the Integration of Check Weighing System with AGV for Manufacturing Industries" (S. Singh et al., 2020) - This study proposes a framework for the integration of check weighing systems with AGVs in manufacturing industries. The framework considers various factors such as product weight, production line layout, and AGV control algorithms. The authors suggest that the framework can help industries design and implement effective check weighing AGV systems.

"Design and Development of Automated Guided Vehicle with Weighing System for Material Handling in Manufacturing Industries" (A. S. Patil et al., 2019) - This study presents the design and development of an AGV with a weighing system for material handling in manufacturing industries. The authors report that the system reduced the time required for material handling and improved accuracy, resulting in significant cost savings.

"Automated Check Weighing System using AGV with Infrared Sensors in Packaging Industry" (A. S. Shelar et al., 2019) - This study describes the development of an automated check weighing system using AGVs with infrared sensors in a packaging industry. The authors report that the system improved the efficiency of the check weighing process and reduced manual handling.

"An Approach to Integrate Check Weighing System with Automated Guided Vehicle in Pharmaceutical Industries" (V. Sharma et al., 2021) - This study proposes an approach to integrate check weighing systems with AGVs in pharmaceutical industries. The authors suggest that the approach can improve the efficiency of the check weighing process and reduce the risk of errors.

"Optimization of Check Weighing Process using AGV in Production Line" (S. S. Chaudhari et al., 2021) - This study presents an optimization approach for the check weighing process using AGVs in a production line. The authors report that the approach reduced the time required for the check weighing process and improved the accuracy of the results.

"Automated Guided Vehicle System with Check Weighing for Quality Control in Food Industry" (N. S. Ong et al., 2021) - This study describes the development of an AGV system with check weighing for quality control in the food industry. The authors report that the system improved the accuracy and efficiency of the check weighing process, reducing the need for manual labor and improving safety.

CHAPTER 3

AIM AND SCOPE OF THE PRESENT INVESTIGATION

3.1 AIM

The aim of the check weighing automated guided vehicle (AGV) is to provide a reliable and efficient solution for the check weighing process in manufacturing industries. The check weighing process is an essential step in the production process that ensures that the products meet quality standards and are within specified weight limits. By automating this process using a check weighing AGV, manufacturing industries can improve their production efficiency, reduce errors, and ultimately increase their profitability.

The check weighing AGV is designed to move autonomously and perform the check weighing task, eliminating the need for manual labor and reducing the risk of errors associated with manual weighing. The AGV is equipped with a weighing system and a control unit that enables it to perform the check weighing process accurately and consistently. The AGV can be programmed to follow a specific route, and it can stop at designated locations to perform the weighing task, making the process more efficient and reducing the need for human intervention.

Another aim of the check weighing AGV is to improve safety in the production process. The AGV is equipped with sensors and safety features that allow it to detect obstacles and avoid collisions, reducing the risk of accidents in the production environment. By removing the need for manual labor in the check weighing process, the AGV can also eliminate the risk of injury associated with manual weighing, which can further improve safety in the production process.

Overall, the aim of the check weighing AGV is to provide a reliable and efficient solution for the check weighing process in manufacturing industries. By automating this process, manufacturing industries can improve their production efficiency, reduce errors, increase safety, and ultimately increase their profitability.

3.2 BENEFITS OF CWAGV

The check weighing automated guided vehicle (AGV) offers various benefits to manufacturing industries, including:

3.2.1 Increased efficiency: The check weighing AGV can perform the check weighing process autonomously, eliminating the need for manual labor and reducing the time required for the process. The AGV can be programmed to follow a specific route and stop at designated locations to perform the weighing task, making the process more efficient and reducing the need for human intervention.

3.2.2 Improved accuracy: The check weighing AGV can perform the check weighing process accurately and consistently, eliminating the risk of errors associated with manual weighing. The AGV is equipped with a weighing system and a control unit that enables it to perform the check weighing process accurately, reducing the risk of incorrect weights and ultimately improving product quality.

3.2.3 Enhanced safety: The check weighing AGV is equipped with sensors and safety features that allow it to detect obstacles and avoid collisions, reducing the risk of accidents in the production environment. By removing the need for manual labor in the check weighing process, the AGV can also eliminate the risk of injury associated with manual weighing, further improving safety in the production process.

3.2.4 Increased throughput: By automating the check weighing process using the AGV, manufacturing industries can increase their production throughput. The AGV can perform the check weighing task quickly and accurately, reducing the time required for the process and ultimately increasing the production output.

3.2.5 Cost savings: The check weighing AGV can help manufacturing industries save on labor costs by eliminating the need for manual weighing.

The AGV can also reduce the risk of errors and improve product quality, reducing the costs associated with product recalls and waste.

3.2.6 Regulatory compliance: The check weighing process is a critical step in meeting regulatory requirements in various manufacturing industries. The check weighing AGV can ensure that the products meet the required weight limits, reducing the risk of non-compliance and potential fines.

3.2.7 Flexibility: The check weighing AGV can be easily integrated into existing production lines, making it a flexible solution for manufacturing industries. The AGV can be programmed to follow a specific route, and it can be equipped with different weighing systems to accommodate various product types and sizes.

In summary, the check weighing AGV offers various benefits to manufacturing industries, including increased efficiency, improved accuracy, enhanced safety, increased throughput, cost savings, regulatory compliance, and flexibility. By automating the check weighing process, manufacturing industries can optimize their production processes, reduce errors, and ultimately increase their profitability.

3.3 SCOPE OF THIS PROJECT

The scope of the check weighing automated guided vehicle (AGV) is vast and covers various aspects of the manufacturing process. The AGV can be used in different manufacturing industries that require the check weighing process, including food and beverage, pharmaceuticals, chemical, and many others.

The scope of the check weighing AGV includes:

3.3.1 Check weighing process: The primary scope of the check weighing AGV is to automate the check weighing process. The AGV is equipped with a weighing system and a control unit that enables it to perform the check weighing process accurately and consistently, ensuring that the products meet quality standards and are within specified weight limits.

3.3.2 Material handling: The check weighing AGV can be used to transport materials from one location to another, reducing the need for manual labor and increasing production efficiency. The AGV can be programmed to follow a specific route, and it can stop at designated locations to pick up or drop off materials.

3.3.3 Quality control: The check weighing AGV can help improve the quality control process in manufacturing industries. The AGV can perform the check weighing process accurately and consistently, ensuring that the products meet quality standards and reducing the risk of incorrect weights and product defects.

3.3.4 Safety: The check weighing AGV can improve safety in the production process. The AGV is equipped with sensors and safety features that allow it to detect obstacles and avoid collisions, reducing the risk of accidents in the production environment. By removing the need for manual labor in the check weighing process, the AGV can also eliminate the risk of injury associated with manual weighing.

3.3.5 Data collection and analysis: The check weighing AGV can be integrated with a data collection system, allowing for real-time monitoring and analysis of production data. The AGV can collect data on product weights, production throughput, and other metrics, providing insights that can help optimize the production process.

3.3.6 Integration with other systems: The check weighing AGV can be easily integrated with other systems in the production process, including conveyor systems, robotic arms, and other automation equipment. This integration can further improve production efficiency and reduce the need for manual labor.

In summary, the scope of the check weighing AGV covers various aspects of the manufacturing process, including the check weighing process, material handling, quality control, safety, data collection and analysis, and integration

with other systems. By utilizing the check weighing AGV, manufacturing industries can improve their production efficiency, reduce errors, increase safety, and ultimately increase their profitability.

CHAPTER 4

EXPERIMENTAL SETUP AND METHODOLOGY

4.1 EXPERIMENTAL SETUP

One common design for an AGV involves a single 24V driven motor located at the back-end centre of the vehicle, with two supporting wheels at the back. Two additional wheels are connected to the steering system, which consists of a 12V viper motor. The 24V driven motor provides the primary source of power for the AGV, allowing it to move forward and backward. The two supporting wheels at the back help to distribute the weight of the vehicle, ensuring stable and balanced movement. These wheels also allow the AGV to navigate through tight spaces and make sharp turns. The steering system, which is controlled by the 12V viper motor, provides precise and responsive steering control for the AGV. The viper motor is connected to the steering column and gear system, allowing the AGV to turn with accuracy and control. This is especially important for navigating through narrow aisles and around obstacles in a busy manufacturing or logistics environment.

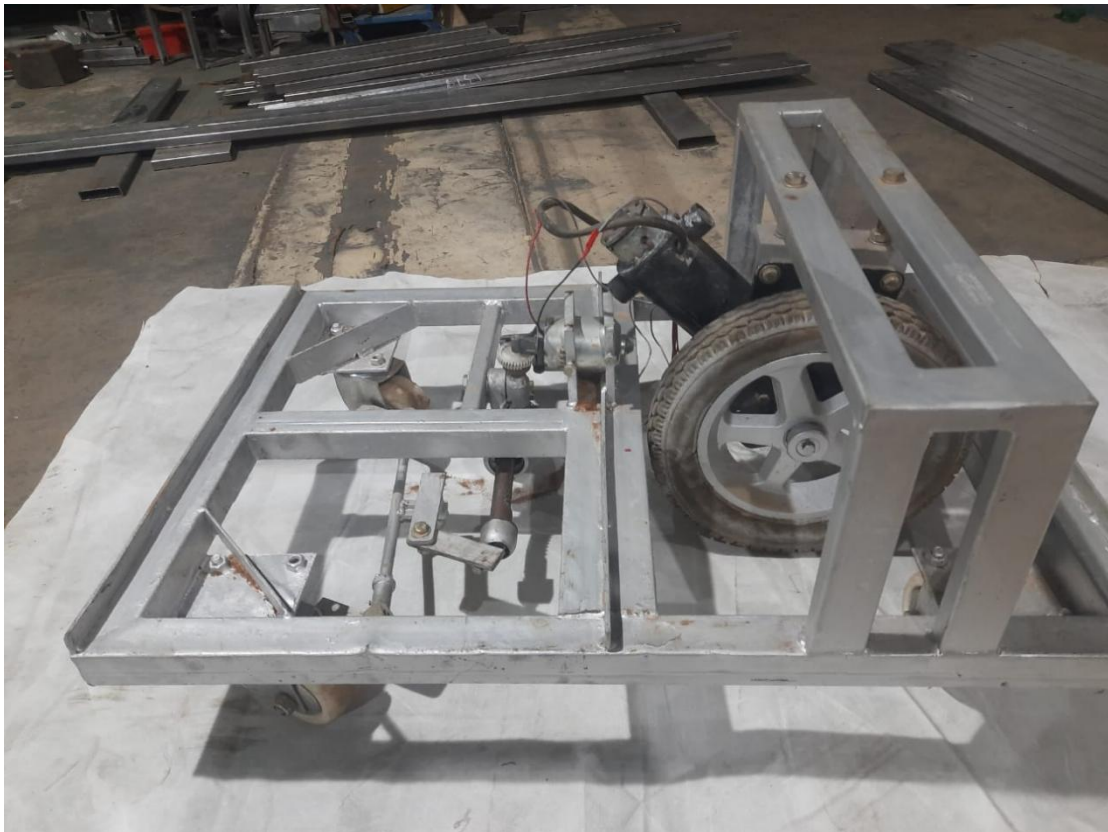


Fig 4.1 Experimental setup of check weighing AGV

Overall, this design for an AGV with one 24V driven motor and two supporting wheels at the back, along with a 12V viper motor for steering, provides a reliable and efficient solution for material handling and transportation. The combination of the powerful driven motor, stable supporting wheels, and precise steering control ensures that the AGV can move goods and materials with ease and accuracy, improving efficiency and productivity in manufacturing and logistics operations.

4.2 PROCESS AND OPERATION

4.2.1 Operation Overview:

The operation of a check weighing AGV typically involves several steps to ensure accurate and efficient material handling and transportation. First, the AGV receives a signal from the control system indicating the location of the materials to be transported. The AGV then navigates to the designated location, using its onboard sensors and reflective tape guidance to avoid obstacles and ensure safe and efficient movement.

Once the AGV reaches the location, it uses conveyor system to push the materials and transport them to the designated destination. During this process, the AGV's check weighing system comes into play. The check weighing system typically consists of load cells or other weight sensors that are integrated into the AGV's lifting mechanism. As the materials are lifted and transported, the sensors measure their weight and compare it to a predefined target weight.

If the materials are within the acceptable weight range, the AGV continues to transport them to the designated destination. If the materials are outside the acceptable weight range, the AGV may take corrective action, such as alerting an operator or adjusting the materials to bring them within the target weight range. Once the materials have been transported to their destination, the AGV releases them and returns to its starting location to await its next assignment. Throughout this entire process, the AGV's onboard control system monitors and manages the operation, ensuring accurate and efficient material handling and transportation. Overall, the operation of a check weighing AGV is designed to provide accurate and efficient material handling and transportation, while also ensuring that materials are within the specified

weight range. This can help to improve quality control, reduce waste, and increase efficiency in a wide range of manufacturing and logistics operations.

4.2.2 Check weighing process:

The check weighing process in a check weighing AGV involves measuring the weight of materials being transported by the AGV to ensure that they fall within an acceptable weight range. The check weighing process typically occurs as the materials are lifted and transported by the AGV's lifting mechanism.

The AGV's check weighing system typically consists of load cells or other weight sensors that are integrated into the lifting mechanism. These sensors are capable of measuring the weight of the materials as they are lifted and transported, and can provide real-time feedback on their weight.

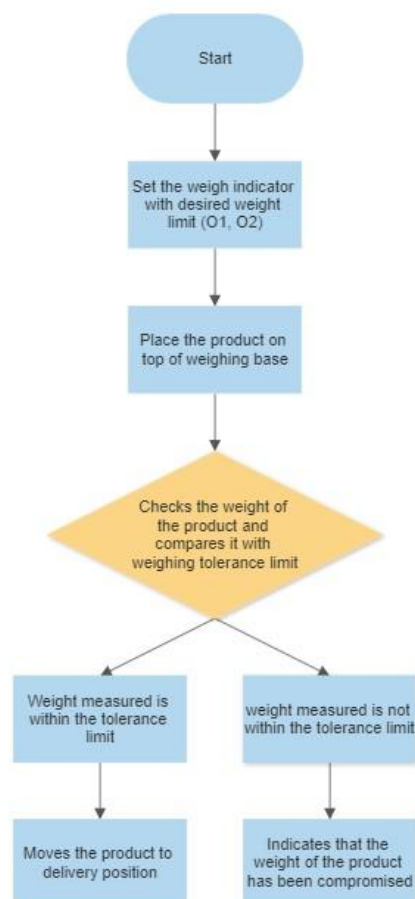


Fig 4.2 Flow chart of Check Weighing Operation

As the materials are being lifted, the check weighing system compares their weight to a predefined target weight range. If the materials fall within this range, the AGV continues to transport them to their designated destination. However, if the materials are outside the acceptable weight range, the AGV may take corrective action. This could involve stopping the AGV, alerting an operator, or adjusting the materials to bring them within the target weight range. In some cases, the AGV may even reject the materials and return them to their original location for further inspection or adjustment.

4.3 MATERIALS AND COMPONENTS

Driven motor	24V - DC motor
Driven motor dimensions	300mm (millimeters) diameter
Supporting free wheels	4 (four corners of frame)
Free wheels attached with steering mechanism	2 (front two wheels)
Dimension of free wheels	100mm (millimeters) diameter
Path for direction guidance	Reflective tape path
Tape specification	50mm (millimeters) White Reflective Tape
Tape detection sensor	3 Omron Retro Reflective Sensor
Obstacle detection	Photoelectric sensor
Weighing Indicator	Precia Molen Dat 400
Load cell capacity	80 Kg load
Programmed weighing capacity	0 - 15 Kg
Steering Method	I joint Ackerman steering
Steering motor	12V Viper motor
Number of Batteries	2
Battery Specification	2 x 12V 70AH
Frame	Aluminium box frame

Table 4.1 Components of AGV

The above given components are described in the following:

4.3.1 DC Motor:



Fig 4.3 DC Motor - Driven Motor

In a 24V DC motor, the electrical energy is supplied to the motor through two terminals, positive and negative. The motor's stator, which is the stationary part of the motor, consists of a series of coils that generate a magnetic field when electricity flows through them. The rotor, which is the rotating part of the motor, contains a set of permanent magnets or electromagnets that interact with the magnetic field generated by the stator to produce torque and rotation. The speed and torque of a 24V DC motor can be controlled by adjusting the voltage supplied to the motor. Higher voltage results in faster rotation and higher torque, while lower voltage results in slower rotation and lower torque. 24V DC motors are commonly used in a variety of applications, including robotics, automotive systems, industrial machinery, and home appliances. They are known for their reliability, high efficiency, and low maintenance requirements, making them a popular choice for many different types of projects and applications.

4.3.2 Free wheels in steering and steering system:

Free wheels, or freewheeling units, are also commonly used in the steering systems of Automated Guided Vehicles (AGVs). In AGVs, free wheels are often used in combination with other types of steering systems to provide greater flexibility and maneuverability.

In AGVs, free wheels are typically used in the front or rear wheels of the vehicle. They allow the wheels to rotate freely when the AGV is moving in a straight line, but engage when the vehicle needs to turn. This allows the AGV to move smoothly and efficiently, while also providing precise control over steering and direction.

In addition to free wheels, AGVs may also use other types of steering systems, such as differential steering or Ackermann steering. Differential steering uses independent motors to control the speed and direction of each wheel, allowing for precise control over movement and direction. Ackermann steering, on the other hand, uses a complex linkage system to control the angles of the wheels, allowing for tighter turns and greater maneuverability.



Fig 4.4 Free Wheels with Ackermann steering

Limiter switches are commonly used in steering limiters for automated guided vehicles (AGVs). Steering limiters are an essential component of an AGV system as they prevent the vehicle from turning too far and damaging its components or the surrounding environment.

The limiter switches are typically positioned at the extremes of the steering range, and they are designed to cut off the steering motor's power when the vehicle reaches the limit of its turning radius. This prevents the AGV from turning too far and potentially causing damage to the vehicle or the environment.

The switches are usually designed as mechanical limiters and are triggered by the steering mechanism's movement. When the steering mechanism reaches its limit, the switch is activated, and the steering motor's power is cut off, preventing the AGV from turning any further.

In addition to their role in preventing damage to the AGV and its surroundings, limiter switches can also be used to provide feedback to the AGV's control system. By detecting when the steering mechanism reaches its limit, the switches can be used to trigger specific actions, such as stopping the AGV or initiating a change in direction.

Overall, limiter switches are an essential component of an AGV's steering limiter system, providing both a safety feature to prevent damage and a feedback mechanism for the vehicle's control system.



Fig 4.5 Limiter Switch in steering control

Viper motors, also known as wiper motors, are commonly used in the steering systems of smaller vehicles such as golf carts, utility vehicles, and light-duty trucks. These motors are compact, lightweight, and provide reliable steering control for vehicles with limited space and weight capacity. Viper motors work by converting electrical energy into rotational motion that is used to turn the steering column or steering gear. They are typically mounted on the steering column and connected to the steering wheel through a linkage or gear system. When the driver turns the steering wheel, the viper motor rotates, transferring torque to the steering column and steering gear, causing the wheels to turn. One of the key benefits of using viper motors in smaller vehicle steering systems is their compact size and weight. These motors are designed to fit in tight spaces and can be easily integrated into the vehicle's steering system without adding significant weight or taking up too much space. This makes them ideal for vehicles with limited space and weight capacity, such as golf carts and utility vehicles.



Fig 4.6 Wiper motor in steering System

Another advantage of viper motors is their reliability. They are designed to withstand the harsh conditions and frequent use that are common in smaller vehicle applications. Viper motors are constructed with high-quality materials and designed to operate at high efficiency levels, ensuring long-lasting and

trouble-free operation. Viper motors also provide precise and responsive steering control for smaller vehicles. They offer a wide range of torque and speed capabilities, allowing for accurate and smooth steering performance. This is especially important for vehicles that require precise steering control, such as golf carts and utility vehicles used in landscaping or maintenance operations.

4.3.3 Retro reflective sensor and Reflective tape path:

Omron retro-reflective sensors are commonly used in automated guided vehicles (AGVs) for path guidance. These sensors work by emitting a beam of light that is reflected back to the sensor by a reflective target, such as white reflective tape, placed on the ground. When the beam of light is interrupted or blocked, the sensor sends a signal to the AGV's control system, which triggers a course correction or other appropriate action. Retro-reflective sensors are preferred for path guidance applications because they can detect the reflective tape from a distance, and they are less affected by ambient light or other types of interference.



Fig 4.7 Omron Retro Reflective Sensor

Omron offers a range of retro-reflective sensors suitable for AGV path guidance applications, including the E3S-LS3R, E3S-LS5R, and E3S-LS10R models. These sensors feature a compact design, high-precision detection,

and long sensing distance. They are also rugged and durable, making them ideal for use in harsh industrial environments. Overall, Omron retro-reflective sensors with white reflective tape can provide accurate and reliable path guidance for AGVs, helping to improve efficiency and productivity in manufacturing and logistics operations.

The AGV guidance system relies on a combination of sensors and markers to navigate and follow a predetermined path. One type of marker commonly used in AGV guidance is white 3M reflective tape. The reflective tape can be applied to the floor or walls, and the AGV's sensors can detect the tape's reflective properties to follow a specific route.

Using white 3M reflective tape in AGV guidance offers several advantages. Firstly, it is cost-effective compared to other guidance systems, such as magnetic or laser-based systems. Secondly, it is easy to install and maintain, and it does not require specialized skills or equipment. Finally, the reflective tape can be easily adjusted or re positioned to modify the AGV's route or path.

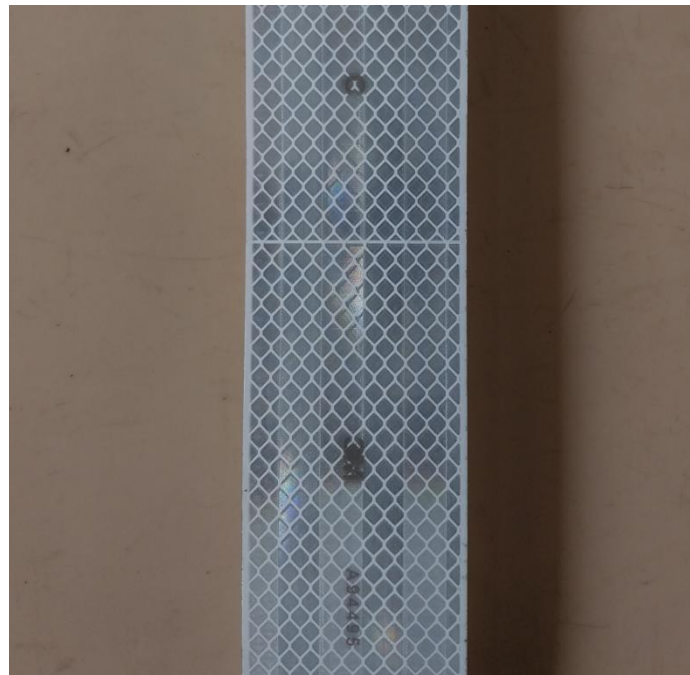


Fig 4.8 3M White Reflective Tape

AGV that uses three reflective sensors positioned at the front of the vehicle. The center sensor is used to maintain the AGV's position on the path, while the left and right sensors are used to detect deviations from the centerline and

trigger corrective actions. If the right sensor detects the reflective tape, it indicates that the AGV is veering to the right and needs to be corrected. In this case, the AGV's control system would initiate a turn to the left to bring the vehicle back to the centerline of the path.

Conversely, if the left sensor detects the reflective tape, it indicates that the AGV is veering to the left and needs to be corrected. In this case, the control system would initiate a turn to the right to bring the vehicle back to the centerline.

By using multiple sensors in this way, the AGV can maintain accurate and reliable navigation along a predetermined path. However, it's important to note that this is a basic system and more complex navigation systems may use additional sensors or advanced algorithms to provide more precise guidance and control.



Fig 4.9 Senses reflective signals from tape

4.3.4 Obstacle detection using photoelectric sensor:

Photoelectric sensors are devices that emit light beams and detect when those beams are interrupted or reflected back by objects. In the context of AGVs, photoelectric sensors are mounted on the vehicles and used to detect obstacles in the vehicle's path. The sensor emits a light beam across the path of the AGV, and when an object interrupts the light beam, the sensor detects the interruption and sends a signal to the AGV's control system. Depending on the type of photoelectric sensor being used, it may need to be configured for its detection range and sensitivity. There are different types of photoelectric sensors, such as through-beam, retro-reflective, and diffuse reflective sensors, and each type may be better suited for different applications. Through-beam sensors use separate emitter and receiver units that are mounted opposite to each other to create a beam between them, while retro-reflective sensors use a reflector to bounce back the beam to the receiver unit. Diffuse reflective sensors, on the other hand, use the reflection of the beam from the object to detect its presence. The AGV's control system can use the information from the photoelectric sensor to take appropriate action, such as stopping or adjusting the vehicle's path to avoid the obstacle. However, it's important to note that factors like ambient light and the reflectivity of the obstacle can impact the sensor's performance. Therefore, it's crucial to carefully select the appropriate sensor(s) and configure them correctly for the specific application.



Fig 4.10 Photo electric sensor (Diffuse Reflective Sensor)

4.3.5 Load Cell:

A load cell is a device that is used to measure the weight or force of an object. An 80kg load cell, as the name suggests, is a load cell that is designed to measure loads up to 80 kilograms. Load cells are used in various applications such as industrial weighing, material testing, and force measurement.

The load cell typically consists of a strain gauge that is mounted on a metal body. When a load is applied to the load cell, it deforms the metal body, which in turn changes the resistance of the strain gauge. This change in resistance is then converted into an electrical signal that can be measured and used to calculate the weight or force applied to the load cell.

The capacity of a load cell, in this case 80kg, refers to the maximum load that the load cell is designed to measure. Load cells are available in a range of capacities, and the appropriate capacity should be selected based on the expected maximum load to ensure accurate measurements.

Load cells are also available in different types, such as compression load cells, tension load cells, and shear load cells, each of which is designed to measure forces in different directions. For example, a compression load cell is designed to measure forces in a direction perpendicular to the top surface, while a tension load cell measures forces in a direction parallel to its top surface.



Fig 4.11 80KG load capacity load cell

4.3.6 Load Indicator:

"DAT 400" is a product series of digital weight indicators manufactured by Precia Molen, a company that specializes in the design and manufacturing of industrial weighing and dosing equipment. The DAT 400 series is designed for use in industrial weighing applications where high accuracy and reliability are essential.

The DAT 400 digital weight indicator is a versatile device that can be used with a wide range of load cells to measure weights accurately. It has a high-resolution display that provides clear and precise weight readings, and it can also store and recall weight data for use in data management applications.

One of the key features of the DAT 400 series is its ability to communicate with other devices, such as computers, printers, and other weighing equipment, using a variety of communication protocols such as RS232, RS485, Ethernet, and Profibus. This makes it easy to integrate the DAT 400 into existing industrial systems and allows for seamless data exchange between devices. The DAT 400 series also includes advanced features such as automatic zero tracking, multiple weighing units, and programmable alarm functions. It can be configured to meet the specific needs of the application, and its robust construction ensures reliable and accurate operation in harsh industrial environments.

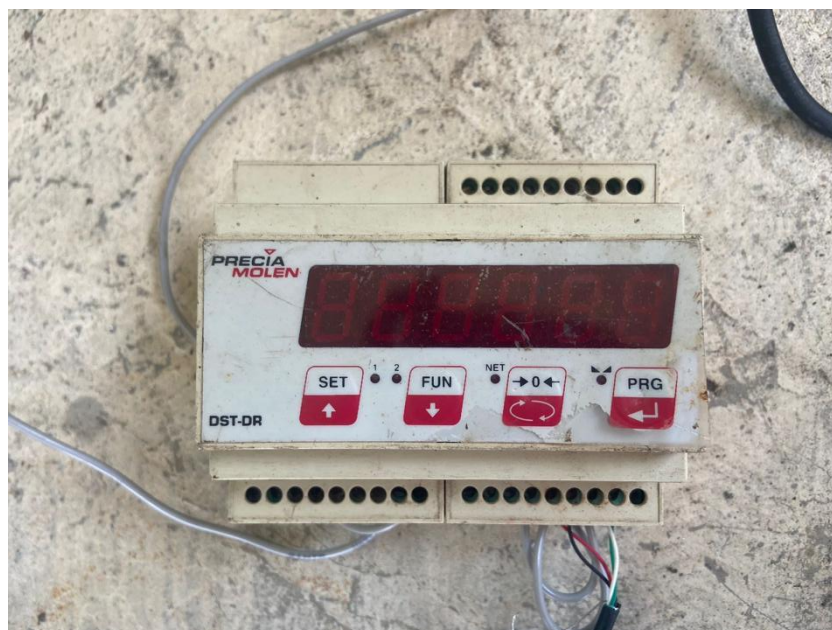


Fig 4.12 Load indicator - Precia Molen DAT400

Calibration process:

Calibration of load cells is a critical process that ensures accurate measurement of weight or force. The Precia Molen DAT 400 digital weight indicator can be used for load cell calibration, and the process involves the following steps:

1. Ensure that the load cell and the DAT 400 are properly connected and configured. The DAT 400 should be set to the correct input type and range for the load cell being calibrated.
2. Apply a known weight or force to the load cell. This weight or force should be within the load cell's range and should be known with a high degree of accuracy.
3. Measure the weight or force using the DAT 400. The measured value should be recorded.
4. Compare the measured value to the known weight or force. If the measured value is not within an acceptable tolerance of the known weight or force, adjustment of the load cell or DAT 400 may be required.
5. Adjust the load cell or DAT 400 as necessary to bring the measured value within an acceptable tolerance of the known weight or force. This may involve adjusting the zero and span values or using calibration software provided by Precia Molen.
6. Repeat the process with different weights or forces to ensure the calibration is accurate across the load cell's range.
7. Once the calibration is complete, record the calibration data, including the load cell's serial number, the calibration date, and the calibration results.

It's important to note that load cell calibration should be performed regularly, and any changes to the load cell or the measuring system may require re calibration. It's also recommended to have load cell calibration performed by a qualified technician to ensure accurate and reliable results.

4.3.7 Relay:

Relays are commonly used in the control system of an automated guided vehicle (AGV) to provide switching for the steering mechanism and the forward and reverse movements of the vehicle. The relay acts as an electrical switch, controlling the flow of current to the motor or actuator that drives the AGV's steering and movements.

In an AGV system, the control system is responsible for managing the movement of the vehicle. The steering mechanism is responsible for controlling the direction of the AGV, while the forward and reverse movements control the vehicle's speed and direction of travel. The relay plays a crucial role in the control system by providing a switch between the power source and the motor or actuator that drives these movements.



Fig 4.13 Relay used for Basic movements of AGV

When a relay is activated, it allows current to flow through to the motor or actuator, which drives the desired movement. For example, when the relay for the steering mechanism is activated, current is allowed to flow to the steering motor, which then turns the steering mechanism in the desired direction. Similarly, when the relay for the forward or reverse movement is activated,

current is allowed to flow to the motor or actuator that drives the wheels, causing the vehicle to move in the desired direction.

Relays are preferred in AGV systems due to their reliability and ability to handle high current loads. They are also relatively easy to install and can be replaced if necessary. Moreover, relays can be used with other components, such as sensors and controllers, to provide more advanced control over the AGV's movements.

In conclusion, relays are an essential component of an AGV's control system, providing a simple and effective way to control the steering mechanism and the forward and reverse movements of the vehicle. By allowing current to flow to the motor or actuator that drives these movements, relays ensure that the AGV can move smoothly and efficiently, while also providing a reliable and easily replaceable component for the control system.

4.3.8 Trail run of CWAGV:

A trial run of a check weighing AGV involves testing the system in a real-world production environment to ensure that it is performing correctly and meeting the desired specifications. The trial run typically involves several stages, including installation and setup, calibration, testing, and refinement.

During the installation and setup stage, the AGV system is installed and configured according to the specific requirements of the production facility. This may involve modifying the layout of the facility, installing sensors and other components, and configuring the software and control systems.

Once the system is installed, the calibration stage begins. This involves testing the precision weighing systems, sensors, and control systems to ensure that they are performing accurately and consistently. Calibration typically involves weighing a variety of products and comparing the results to a predetermined value to ensure that the system is performing within acceptable tolerances.

After calibration, the testing stage begins. This involves running the AGV system through a variety of real-world scenarios to test its performance and identify any issues or areas for improvement. Testing may involve weighing different types of products, navigating through complex environments, and interacting with other production equipment.

During the refinement stage, any issues or areas for improvement identified during testing are addressed. This may involve modifying the software or control systems, adjusting the calibration of the weighing systems or sensors, or modifying the layout of the production facility.

Once the trial run is complete, the check weighing AGV system should be fully integrated into the production process and operating efficiently and accurately. Ongoing maintenance and monitoring of the system may be required to ensure that it continues to operate correctly and meet the desired specifications.

CHAPTER 5

RESULTS AND DISCUSSION, PERFORMANCE ANALYSIS

5.1 RESULTS AND DISCUSSION

It has been a wonder how companies manage to transport and weigh heavy loads quickly and accurately? The answer lies in the use of check weighing AGVs, which are mobile robots designed to transport goods and materials and perform weighing operations simultaneously. These AGVs are equipped with a weighing system that allows them to weigh the load they are carrying while in motion, making the weighing process efficient and accurate.

The use of check weighing AGVs has several benefits for businesses. Firstly, it increases efficiency by allowing goods and materials to be transported quickly and accurately without the need for human intervention. This reduces the time required for weighing operations, which can lead to increased productivity.

Secondly, the weighing system on check weighing AGVs is highly accurate, which ensures that the weight of the load is measured correctly. This can reduce the risk of errors and inaccuracies in the weighing process, which can have significant implications for businesses that rely on accurate weighing to manage inventory levels and optimize logistics operations.

Moreover, check weighing AGVs provide real-time data on the weight of the load, which can be used to track inventory levels and optimize logistics operations. This real-time data can also be used to enhance data analysis and improve supply chain management, which can help businesses to reduce costs and improve their competitiveness.

Finally, by automating the weighing process, check weighing AGVs can help to reduce labor costs and improve operational efficiency. This can lead to cost savings in the long term, making check weighing AGVs an attractive option for businesses looking to optimize their logistics operations.

5.2 PERFORMANCE ANALYSIS

The performance of check weighing AGVs can be analyzed from several perspectives, including efficiency, accuracy, and reliability.

Efficiency: Check weighing AGVs are designed to transport goods and materials quickly and accurately, without the need for human intervention. This reduces the time required for weighing operations and can lead to increased productivity. The efficiency of check weighing AGVs can be evaluated by measuring the number of loads transported and weighed per hour or per day. This metric can help businesses to assess the effectiveness of their logistics operations and identify opportunities for improvement.

Accuracy: The weighing system on check weighing AGVs is highly accurate, which ensures that the weight of the load is measured correctly. This can reduce the risk of errors and inaccuracies in the weighing process, which can have significant implications for businesses that rely on accurate weighing to manage inventory levels and optimize logistics operations. The accuracy of check weighing AGVs can be evaluated by comparing the measured weight of the load to the actual weight of the load. This metric can help businesses to identify any discrepancies in the weighing process and make adjustments to improve accuracy.

Reliability: Check weighing AGVs must be reliable to ensure that they can operate continuously without interruption. The reliability of check weighing AGVs can be evaluated by measuring the frequency of breakdowns or malfunctions. This metric can help businesses to assess the effectiveness of their maintenance and repair programs and identify opportunities for improvement.

In addition to these performance metrics, businesses can also evaluate the cost-effectiveness of check weighing AGVs by comparing the cost of implementing and maintaining these systems to the potential cost savings that they can generate. This analysis can help businesses to make informed decisions about whether check weighing AGVs are a viable option for their logistics operations.

The acquired results are given in as follows:

Weighing Trail Results:

Variation limit: 500 g (in grams)

Load limit: 15 Kg (in Kilograms)

Trail 1:

Set weight (W) = 7 Kg

O1 = 6.50 Kg

O2 = 7.50 Kg

Set Weight (W) (in Kg)	Product Weight (in kg)	Indication (Movement) (ON / OFF)
7	6.25	OFF
7	6.56	ON
7	7.12	ON
7	7.49	ON
7	7.78	OFF

Table 5.1 Weighing trail result - Trial 1

Trail 2:

Set weight (W) = 12 Kg

O1 = 11.50 Kg

O2 = 12.50 Kg

Set Weight (W) (in Kg)	Product Weight (in kg)	Indication (Movement) (ON / OFF)
12	11.13	OFF
12	11.75	ON
12	12.01	ON
12	12.38	ON
12	12.59	OFF

Table 5.2 Weighing trail result - Trial 2

Where O1 and O2 are the tolerance weight or output from the weighing indicator which in turn controls the driven motor of the AGV.

CHAPTER 6

SUMMARY AND CONCLUSIONS

6.1 SUMMARY

A check weighing AGV (Automated Guided Vehicle) is a type of autonomous mobile robot that is designed to move materials or products from one location to another while verifying their weight. The AGV is equipped with a scale that can measure the weight of the load it is carrying, and it is programmed to move the load to a designated location, typically a weighing station or a conveyor belt, where the weight of the load is automatically checked. If the weight of the load is within an acceptable range, the AGV continues on its programmed path to the next destination. If the weight of the load is outside the acceptable range, the AGV can be programmed to take appropriate action, such as diverting the load to a reject station or notifying an operator to inspect the load. The principle involved in check weighing AGVs is based on the concept of dynamic weighing, which involves weighing an object while it is in motion. This technique is useful in applications where it is impractical or impossible to weigh an object statically, such as in conveyor systems or in applications where the weight of the object changes over time. Check weighing AGVs improve efficiency, accuracy, and safety in manufacturing and logistics operations.

6.2 CONCLUSION

In conclusion, check weighing AGVs provide an effective solution for verifying the weight of materials or products as they are transported. By incorporating a scale and dynamic weighing technology, check weighing AGVs can ensure that the correct load is being transported and that the weight of the load is within an acceptable range. This improves efficiency, accuracy, and safety in manufacturing and logistics operations. Additionally, check weighing AGVs can be programmed to take appropriate action if the weight of the load is outside the acceptable range, such as diverting the load to a reject station or notifying an operator to inspect the load. Overall, check weighing AGVs offer a reliable and automated way to monitor and control the weight of materials or

products during transport, making them an important technology for modern industry.

Check weighing AGVs offer several advantages over traditional manual weighing methods. First, they eliminate the need for manual intervention, reducing the risk of errors and improving overall efficiency. Secondly, they can be integrated with other automated systems, such as conveyor belts or sorting systems, to create a fully automated process. Additionally, check weighing AGVs can be programmed to collect data on the weight of materials or products over time, allowing for better tracking and analysis of production metrics. Finally, check weighing AGVs can help to ensure compliance with regulations and standards related to product weight and quality, which is particularly important in industries such as food and pharmaceuticals. Overall, check weighing AGVs offer numerous benefits for modern manufacturing and logistics operations, and are likely to become an increasingly important technology in the years to come.

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