Automation in Material Handling System: A Review

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ABSTRACT

The increasing demand for operational efficiency, cost-effectiveness, and enhanced productivity has fueled a significant shift towards automation in material handling processes. This abstract explores the dynamic landscape of automation technologies within the realm of material handling, encompassing industries such as manufacturing, logistics, and warehousing. From the integration of robotics and artificial intelligence to the implementation of advanced sensor technologies, automation is reshaping traditional material handling methodologies.

The abstract delves into the diverse applications of automation, examining how smart conveyor systems, automated guided vehicles (AGVs), and robotic arms are optimizing the movement, sorting, and storage of materials. The incorporation of real-time data analytics, machine learning algorithms, and Internet of Things (IoT) devices contributes to the development of intelligent systems that can adapt to dynamic operational environments.

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1. INTRODUCTION

Material handling plays a crucial role in manufacturing processes, influencing efficiency, productivity and overall operational performance. In recent years, there has been a significant shift towards automation in material handling within the manufacturing sector. With an emphasis on how automation in material handling affects manufacturing processes, this review of the literature attempts to investigate and evaluate the current research in this area.

2. LITERATURE REVIEW

2.1 P. Telek Robots are stationed at the gates, smart solutions abound in homes, and increasing numbers of automated devices are being applied to industrial, service, and other operations. But because of the handling machines' operating requirements, the handling process scenario is a little unique. The majority of automation duties and issues involve discontinuous handling machinery, and using them necessitates far more work in terms of planning and execution. This article provides an overview of the uses and specifications of automated material handling equipment, with a special emphasis on those elements that have the potential to affect several material handling machine parameters and handling procedures. Finding the specifications of material handling equipment is the aim of this study. The outcomes could aid in creating more effective handling systems and automated handling equipment.

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automated devices are being applied to industrial, service, and other operations. But because of the handling machines' operating requirements, the handling process scenario is a little unique. The majority of automation duties and issues involve discontinuous handling machinery, and using them necessitates far more work in terms of planning and execution. This article provides an overview of the uses and specifications of automated material handling equipment, with a special emphasis on those elements that have the potential to affect several material handling machine parameters and handling procedures. Finding the specifications of material handling equipment is the aim of this study. The outcomes could aid in creating more the MH automation in logistical hubs. Therefore, the purpose of this article is to evaluate and choose intelligent machine learning solutions for logistics centers that plan deliveries for the city area's supply.

2.3 Nithin Jarralde J The efficient and dependable properties of magnetic levitation, or "Mag Lev," have made it a viable technology for material handling in enterprises. It uses magnetic fields in a frictionless, non-contact manner to cause objects to float and move. Mag Lev systems lower operating expenses and boost production while offering a hygienic and secure environment for material transportation. Thisarticle examines the current status of Mag Lev technology in material handling and discusses possible uses for it across a range of sectors. The article discusses the basic ideas of Mag Lev and its different forms, such as electromagnetic, electro dynamic, and superconducting Mag Lev. The study also emphasizes the drawbacks and advantages of each type as well as how challenging it is to apply them in professional settings. A few successful Mag Lev application examples in the manufacturing, logistics, and transportation sectors are also given. Mag Lev is a technology that can be used in industries for material handling because of its effectiveness, safety and reliability. Wide spread adoption could lead to notable increases in environmental sustainability, cost savings, and productivity.

2.4 Alexander G et al Initiatives to automate vehicles for material handling (such, forklifts, harvesters, excavator's loaders etc.) have grown dramatically over the past few years. Since industrial material handling situations are often highly specialized, the contexts in which these vehicles operate are often complicated, leading to a fragmented body of knowledge and a dearth of literature compared to, say, the automation of passenger cars. It was developed utilizing specialized expertise, the pre-existing design spaces and context for automation of machines and vehicles. The design space is divided into distinct subspaces for context and interaction, which, respectively, encapsulate the scenario and every point of interaction. There includes a discussion of the implications, prospects, and constraints for the study and design of AMHV.

2.5 R. Priyadharshini et al there is not much space for error in this article, and time is a very valuable resource these days. We cannot waste resources like time and money producing subpar goods. This implies that, in contrast to traditional human responses, quick decisions made with precision are becoming increasingly valuable in today's industry. To ensure the successful completion of much more complex processes and techniques, even a basic activity like moving a product between two sites must be completed promptly, efficiently, and with the least amount of resources. It's becoming obvious that a fast, flexible, transportable solution with minimal margin for error is required. Our approach to overcoming this specific challenge is a material transporter with six wheels and a three-degree-of-freedom robotic arm. Additionally, the bot features an integrated storage container where goods may be securely keptwhile it is being moved. Through IoT and a specially designed smartphone application, the bot may be operated with a smartphone.

2.6 Hildur Einarsdottir et al the productivity and usage of fish are thought to have increased from roughly 60% to 80% in the last ten years, according to research on the majority of automated fish factories. Nonetheless, physical labor is still used in several processing processes. These include operations like quality control and fillet trimming. Despite their apparent simplicity, these tasks are actually rather difficult. An example from the automobile sector is provided to further clarify. Almost all of the processes involved in assembling a car are automated at auto factories. Depicts an assembly line of several robotic arms, each precisely programmed to carry out a specific, well-defined duty, on an automotive factory floor. .. Every component is static (and rigid), thus there isn't much variance between individual car pieces. This makes it easy to automate processes like attaching a door to the car frame. On the other hand, the physical form, weight, color, and size of each fish vary. Fish differ in their state of rigor mortis, a postmortem alteration that causes the muscles in their bodies to stiffen. This variation is caused by a number of factors, including environmental temperature and pre-rigor stress. Each fish's rigor cycle will accelerate or decelerate depending on the variations in the raw material core temperature. An automated filleting machine must be capable of handling the ramifications.

2.7 Ali Golabchi et al This is a work-related paper. Exoskeletons are designed to help reduce work- related motion sickness (WMSDs) by providing workers with support and assistance while minimizing their exposure to ergonomic hazards. They have recently been implemented to industrial job sites. Because industrial exoskeletons are a relatively new technology, a full assessment of all relevant factors must be done before

using it in the construction industry in order to ensure a successful and efficient uptake. Since the most frequent cause of lower back injuries is Manual Material Handling (MMH) duties. Throughout the trial, information is obtained on the following topics: general fit and comfort, efficacy, Level of Discomfort (LOD), Rate of Perceived Exertion (RPE), and levels of interference and limitation. The participants reported that the lower back and other body parts were less unpleasant with the exoskeleton suit, with the exception of the chest, which they felt was an overall success. The findings do,however, highlight the significance of taking into account the particular activity at hand (dynamic vs. static MMH, for example).

2.8 Sahlabadi the use of a quasi-experimental methodology and involved 40 guys. First, the prevalence of MSDs among workers was ascertained by gathering demographic data and administering the Nordic questionnaire. The Manual Handling Assessment Chart (MAC) was then used to evaluate MMH tasks. A brief instruction program was created to encourage wellness. Finally, three months following the training intervention, the identical MMH tasks were reassessed. Across all tasks, the largest prevalence of work the shoulder (62.5%) and lumbar back (77.5%). Individual lifting, the form arrangement, received a comparable score. After the training, the anticipated danger level dropped by 12, 9, and 6 points, respectively. The findings suggested that low-technology work situations could benefit just as much from educational initiatives. More generally, educational interventions against WMSD risk in MSDs can be intelligently planned using the MAC technique. This strategy of health promotion is essential for providing human resources with care.

2.9 H Ali et al Robotic grippers are getting more and more popular because of how many uses there are for them in automation. The implementation of vision-based smart grippers is still being researched today. Due to its effective use, the Internet of Things (IoT) has combined its many concepts with the gripper as it becomes more commercialized. Therefore, the objective of this project is to create a vision-based sensor- equipped IoT-integrable smart gripper. The idea behind combining IoT with vision-based smart grippers is to enable authenticated users to view real-time video or photos from the gripper while viewing it from any device, anywhere. This is especially useful for handling critical materials. A vision sensor camera is incorporated into this system, It gives the robot the knowledge it needs to perform the next task by autonomously detecting and recognizing objects of different shapes and weights. The electronic system has integrated and adopted modules for power, communication, control, sensor and actuator, and user interface. The program interfaces with a Raspberry Pi B+ camera to function as an Internet of Things platform. A set of tests demonstrates that the vision-based gripper with IoT is capable of detecting andidentifying items, after which it may transmit a command or information directly to the robot to carry out the object's gripping and lifting phase to the designated destination.

2.10 Xiaoqing Han Robots are utilized extensively in manufacturing and possess vision, decision- making, and execution abilities. Mobile robots are becoming more and more common in practical production as the primary component of material handling robots. These factors are taken into account when designing the 5 Degree oF freedom robot in this study. The robot is equipped with the Cortex-M3 kernel, which comprises modules for task setup, image recognition, patrol, mobility, and multifunctionality. To increase the robot's movement stability and control accuracy. The outcomes of the experiment demonstrate that the robot is capable of performing tasks such as information presentation. Its features include material grasping, high automation, compact size, and easy maintenance. Its wide range of capabilities can handle labor-intensive and hazardous production activities, and its high degree of automation can boost output.

2.11 Wang B et al numerous industrial uses, particularly in the automotive, aviation, and consumer goods industries, heavily rely on fabric and textile materials. Process bottlenecks, workplace safety risks, and economic loss result from the current absence of autonomous solutions for quick and efficient fabric handling procedures that may be adapted to different applications. Soft robotic grippers are an innovative bio-inspired device that opens up new possibilities for fabric handling task automation. This work develops tendon-actuated an elastomer-based soft gripper for fabric pick and place applications using a model-based design methodology. To simulate, alter, and validate the gripper design FEA is used. The effects of certain design variables are examined. The under actuated structure's detailed motion patterns are acquired. Following design establishment, a prototype is created using over molding and additive manufacturing techniques to verify the simulation results and physically test the gripper's operation.

2.12 Martin Dahl et al Advanced algorithms for perception and control, along with a range of autonomous devices, are anticipated features of future automation systems. It will be required for human operators to collaborate with collaborative robots to carry out assembly jobs and for roaming robots to manage material transfer. When adopting such robots, human operators must maintain the flexibility theyoffer. To do this, autonomous robots must be intelligently coordinated, meaning they must be backed by an intelligent automation system. Handling the vast number of potential error scenarios that can occur as a result of the environment's variable and occasionally unpredictable character is one of the challenges in designing intelligent

automation systems. A control framework called Sequence Planner aids in the creation of intelligent automation systems. This study defines Sequence Planner and evaluate its error- handling capabilities when an intelligent automation system is being executed. A Sequence Planner- developed automation system is put through several error-prone scenarios.

2.13 Zakarya Soufi et al The design of MHS is being updated by the advent of an industry 4.0 technology. There is a lack of industry consensus regarding the most efficient way to design such a system, and industry methods in MHS management and design are highly diverse. This essay explores the importance of comprehending the relationships between the various elements of material handling system design and suggests identifying the main issues that need to be resolved. Field studies were carried out with five different companies, and the literature was analyzed. A cross analysis findings to determine the variations and recurring themes in the literature and the field study. Consequently, new MHS design approach research directions are suggested. MHS analysis MHE selection, MHE deployment and Material handling standards make up its four primary issues. Every challenge has a connection to additional possible topics.

2.14 Adriana F. Melo et al One strategy that many businesses are using to meet their objectives for increasing productivity, optimizing floor space, adhering to stricter safety regulations, and assigning employees to value-added tasks is the automation of material handling. Thus, this study's objective was to evaluate the condition of current technology and the completed goods material flow for a company that distributes car components in order to decide whether or not to invest in material handling automation. Discrete event simulation was used in the analysis to assess the various layout strategies in conjunction with the performance of the mobile robots. With at least three robots, it was demonstrated that the tandem arrangement was the most advantageous method for the examined plants. Based on the investigation,recommendations were made for enhancements to the automation of the labeling and material flow procedure.

2.15 Lyu et al this study looks into approaches to enhance a 12-inch wafer foundry's outgoing quality assurance (OQA) procedures using a case study technique. Wafer OQA procedures are analyzed using the lean production technique of value stream mapping. The research guarantees that every wafer that is sent out meets the needs of the clients without wasting any. In order to pinpoint potential waste and problematic process flows, this article uses a current state map. In the interim, system simulation is being used to build the automated production module for dispatching automation, transportation and equipment for OQA processes. Based on the actual data, the To-Be model's total lots of three customers every month increased by approximately 20%, from 3,106 to 3,719 pieces. Additionally, the average product cycle time for customers A, B, and C decreased by 43.67%, 57.91%, and 58.39%, respectively. The operators' utilization rate also increased, going from 61% of 10 operator's working day and night shifts to 87.26% of seven operator's working day and night shifts. This led to a 30% decrease in labor costs. To enhance the example company's wafer OQA procedures, this study uses automation and lean production, which eliminates non-value-added operations.

2.16 Ponis et al the last ten years have seen significant changes in how we live and conduct business due to digitalization. The latest industrial revolution, known as "industry4.0," is combining the digital, virtual, and physical realms through the collision of cutting-edge technologies that provide a radical change in perspective. Although Industry 4.0 has garnered a lot of interest in recent years, there is still not a lot of literature on the issue. This paper's primary goal is to examine the state of the art at the moment and pinpoint significant trends as well as gaps in the researches of SCOPUS bibliographic database. 49 relevant papers that addressed the paper's topic matter were returned by the review. After a careful examination of the chosen articles, four major areas of the literature were identified and thoroughly explored. It is clear from the literature assessment that intralogistics and warehousing facilities are undergoing significant change. Notwithstanding the fervent discourse and allure of the topic, the literature underscores that a paramount obstacle in the scientific domain being examined is the dearth of practicalimplementations commensurate with the field's importance. The purpose of this is to demonstrate the viability of such an investment, emphasize its potential, and inspire practitioners to assess and move forward with similar technological investments.

2.17 MD Sarder In the material handling and logistics sectors, automation has grown dramatically in the last several years. The need for perfection, changing technology, and rising client expectations are some of the factors driving this increase in automation and integration. In addition to becoming more productive and efficient, the material handling and logistics sectors also raised their level of competition in the marketplace. However, this greater automation makes people more susceptible to cyber-attacks. Cyber-attacks on organizations have increased in frequency and impact over the past five years, and during the next five, this trend is predicted to triple. Businesses have a constant struggle from cyber security breaches, which jeopardizes both their competitive edge and seamless operations. According to a study, one in three small enterprises lack the necessary safeguards in place. While certain organizations are more susceptible to cyber-attacks than

others, all businesses are at risk of being attacked. In order to reduce the impact of cyber-attacks, businesses must build a resilient system and play a strategic approach to cyber defense. This essay primarily focuses on the difficulties associated with cyber security and what companies, particularly those involved in material handling and logistics, may do to overcome such difficulties.

2.18 Farayibi et al An automated mechanical lift was developed and reported for use in material handling in a factory setting. The 10 kg rated weight capacity lifting requires an electric motor of 1 hp. Power was transferred using worm gear, belt-pulley and chain-sprocket mechanism and the system was automated with limit switches and contactors. According to the system's performance evaluation, a third-order polynomial with good correlation values of 0.996 and 0.998, respectively, was used to correlate the amount of time needed to lift and lower loads weighing between 5 and 15 kg across a distance of 1070 mm. It was discovered that the trend polynomial curve showed three zones that matched the lifting behavior. The slope was 0.25 sec/kg in the first sector and decreased progressively to almost zero; in the second sector, the slope was almost zero with a consistent travel time of 5.67 ± 0.03 sec over a load rangeof 7–10.60 kg; and in the third sector, the slope increased from near zero to 0.64 sec/kg. By successfully moving things vertically, the automated mechanical lift that was designed was able to achieve the design's objective.

2.19 Cronin et al The prototype is capable of moving independently between manufacturing cells. It moves goods from one stationary conveyor to another while passing through congested and cramped corridors. The idea of a material handling system that can speak with production equipment directly is developed in this study. The creation of an automated material handling system with an AIV has the potential to boost manufacturing production and create jobs in a cutthroat industry. AIVs enhance Industry 4.0 realization and encourage flexibility on the factory floor.

2.20 Hammel et at has Automated Material Handling Systems are confronting increasing needs because of the need for greater flexibility, smaller production lots, and tool updates that result in better throughputs. Simultaneously, the interconnectedness of the transport system and technical constraints limit the possibility of upgrading its hardware. The challenges that follow with regard to AMHS control are thus the main focus of this paper, which also offers three potential solutions: optimizing empty vehicle balancing through the integration of near-future transport demands, adjusting the path selection process to balance track utilization, and coordinating AMHS with scheduling and dispatching to take bottlenecks into account.

3. OBJECTIVES

The primary objectives of the automation initiative were:

a. **Improve Operational Efficiency:** Streamline material handling processestoreducelead times and increase production throughput.

b. **Enhance Accuracy:** Minimizeerrorsin inventory management and order fulfillment through the implementation of automated systems.

c. **Optimize Resource Utilization:** Utilize automation to optimize the use of labor and other resources in material handling tasks.

4. TYPES OF AUTOMATION TECHNOLOGIES

A critical aspect of the literature review involves categorizing and discussing various automation technologies deployed in material handling. This section may cover conveyor systems, robotic systems, automated storage and retrieval systems (AS/RS), AGVs, and the integration of Internet of Things (IoT) devices. Analyzing the advantages and limitations of each technology provides a comprehensive overview.

5. EFFECT ON EFFICIENCY OF OPERATIONS

Research on the impact of automation on operational efficiency in material handling is crucial. Scholars may investigate how automation influences throughput, reduces lead times, minimizes errors, and optimizes resource utilization. Case studies and empirical evidence can be examined to highlight real- world examples of improved efficiency through automation.

6. COST-BENEFIT ANALYSIS

Understanding the economic implications of implementing automation is imperative for manufacturers. Literature on cost-benefit analyses of adopting automated material handling systems should be reviewed, taking into account initial investment, maintenance costs, and long-term operational savings. Assessing the return on investment for different automation technologies is essential for decision-making.

7. HUMAN-MACHINE COLLABORATION

As automation technologies advance, the relationship between humans and machines becomes increasingly important. Research in this area may explore the integration of human labor with automatedsystems, addressing concerns related to job displacement and the need for up skilling the workforce. The literature should also highlight successful human-machine collaboration models in material handling.

8. CHALLENGES AND BARRIERS

Identifying challenges and barriers associated with the implementation of automated material handling systems is crucial for both researchers and industry practitioners. Literature in this section may cover issues such as system integration complexities, cyber-security risks, and resistance to change. Understanding these challenges can guide the development of effective strategies for overcoming obstacles.

9. CONCLUSION

Comprehensive overview of the current state of automated material handling machines, their impact on logistics, and the challenges and opportunities they present. It discusses the increasing automation and integration in material handling and logistics industries, as well as the vulnerability to cyber-attacks that comes with this automation. The review also presents examples of automated mechanical lifts and autonomous material handling systems, showcasing the advancements in this field. Furthermore, it emphasizes the importance of evaluating the current state of material flow and available technology to make informed decisions about investing in material handling automation. Overall, the above review offers valuable insights into the trends, challenges, and advancements in automated material handling, making it a valuable resource for researchers, practitioners, and anyone interested in this field.

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