INDUSTRIAL ROBOTICS SYSTEM FOR MATERIAL HANDLING : A REVIEW

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ABSTRACT

The ever-increasing size and capacity of industrial warehouses are increasing as we advance into urbanization and as our demand increases. The surge in demand leads to the rapid obligation of industries to meet the requirements of the customers. This sets pressure not only on the manufacturing processes but also on the logistics and supply of raw materials from warehouses to that distinct industry. Thus, it becomes vital to efficiently manage the warehouses and control their retrieval and storage system. The problem of efficiency will rise as the scale of the warehouses will increase. This prompts a need for automating the system to cope with future demands and helping with efficiency. In this project, we aim to build a system that aims to automate the industrial warehouses and provide them with enhanced efficiency of operation with reduced efforts.

Keywords—Automation, Industry 4.0, IoT, Robotic Arm, Warehouse management.

INTRODUCTION

Industrial robotics is the technology that uses interconnected machines and tools for enhancing performance and optimizing the energy and workforce requirements of the industry [1]. This is done by the implementation of technologies such as data processing, artificial intelligence, computer vision and advanced robotics technology and inter-connectivity of them [2]. The aim of industrial robotics is to automate the system and transfer the human workforce into more productive streams [3]. This paper defines and discusses several industrial automation systems and states their current implementation status and analyzes the gap between the current system of operation and the predicted future system. This review aims to assess the prevailing industry scenario and to objectify the current work done by various stakeholders for the development of technology in the industry. The review focuses on the key topics relevant to the current industrial warehouse management system and its implications on society. Methodically, this review is based on the comprehensive research published by various researchers and a comparison has been made amid numerous technologies to further develop the industry and its stakeholders.

RESEARCH ARTICLE SEARCH METHODOLOGY

A systematic approach was followed while scrutinizing research articles. The process included selecting relevant keywords associated with the project idea and then using the keywords to explore on credible platforms such as IEEE, Google Scholar and ScienceDirect. The relevant keywords included Industry 4.0, Automation, Robotic Arm, Warehouse Management and IoT. Next, the solicited articles were scrutinized and refined with reference to the relevance and scope of the project idea. Subsequently, the compiled articles were filtered using certain parameters which include:

- Language of the published research articles in English were considered.
- The articles belonging to peer-reviewed publications and published reports were only considered.
- The articles published between the year 2010 and May 2020 were considered.
- Articles without an example of implementation of the technology were excluded.

TABLE I. INCLUSION AND EXCLUSION CRITERIA FOR RESEARCH ARTICLES

Criteria	Reason	Explanation
Inclusion Criteria	Relevancy to keywords is established	Relevant articles related to the broader project idea were considered
	Language of publication	Only the articles which were published in English were considered
	Reputed journals	Articles published in ScienceDirect, Google Scholar and IEE were included
Exclusion Criteria	Time of publication	Articles published before 2010 were excluded
	Example of implementation	Articles without an implemented example in the industry were excluded

LITERATURE SURVEY

A comprehensive evaluation of the literature was carried out where existing technologies in the industry were studied and their characteristics were recorded. The following system have been considered in this review :

A. Stretch Boston Dynamics

Stretch is very explicitly a box-handling mobile robot for relatively well-structured warehouses. This is a very different approach than a robot-like Spot, where the platform came first and the practical applications came later—with Stretch, it's all about that specific task in a specific environment [4]. There are already robotic solutions for truck unloading, palletizing, and depalletizing, but Stretch seems to be uniquely capable. In a highly structured and predictable warehouse, this sort of thing may pay off over the long term, but it's going to be extremely expensive and not very versatile at all. Palletizing and depalletizing robots are much more common in warehouses today [5]. They're almost always large industrial arms surrounded by a network of custom conveyor belts and whatnot, suffering from the same sorts of constraints as a truck unloader— very capable in some situations, but generally high cost and low flexibility [6].

B. BionicHIVE

BionicHIVE is developing an automated warehouse solution based on a fleet of synchronized autonomous robots that can be retrofitted onto existing warehouse infrastructure. The solution consists of multiple autonomous robots with 3D movement capabilities that extend the picking face from floor to ceiling. A real-time algorithmic engine is designed to dynamically change fleet management, providing the flexibility to constantly shift operational needs, a high level of response to volatility, and seamless scalability achieved by adding more robots to the same infrastructure [7].

C. Kuka Next Generation Robot Arm

The robot has a high degree of adaptability and versatility thanks to special-purpose variants and technical optimization. New features include an upgradable payload capacity, shortened stopping distances and a customizable optimized working range [8]. The arm also features the capacity to add digital "motion modes" , a first in the industry. These modes consist of software add-ons that enable users to optimize the robot for specialized operations. The modes can be loaded quickly and easily into the robot controller [9].

D. DHL Effibot

EffiBOT is a collaborative handling robot behaving like a true logistic assistant. With the "Follow-me" functionality, EffiBOT follows a picking operator and no cart is to be pulled or pushed manually: this reduces physical drudgery but also improves productivity. The EffiBOT currently operates in a DHL Supply Chain warehouse in Unna, Germany. It is a full autonomous handling robot allowing the automatic parts delivery to assembly line and material transfer between various locations [10]

TABLE II. COMPARISON OF INDUSTRIAL ROBOTICS SYSTEM

System	Features	Advantages	Drawbacks
Stretch Boston Dynamics	1.Advanced perception delivers fast and precise case detection. 2. A 7 degrees-of-freedom arm grants long reach and large workspace, allowing the robot to reach cases throughout a truck or pallet.	1.Highly advanced technology which uses AI 2. High payload capacity of the arm.	1.Complex Design 2.High maintenance 3. Expensive
BionicHIVE	1. Detects the hindrance or obstruction in front and navigates itself accordingly. 2.Microservices technology is responsible for when a robot faces failure	1.Automation on existing warehouse. Mounted directly on a standard pallet rack. 2.Floor to ceiling picking & put-away and seamless deployment	1. Due to extensive technology, its cost is around $25m which is expensive.

Kuka Next Generation Robot Arm	An upgradable payload capacity, shortened stopping distances and a customizable optimized working range.	1. Precise movement upto <1mm 2.Computarised control with ability to perform set operations	Stationary arm (the base cannot be moved) hence the reach is restricted.
DHL Effibot	1.Human guided trolley 2. Obstacle avoidance	1.It can automatically send the item back to its programmed location. 2.It can interact with system to fetch a new trolley	1.A human is required to actually place the item in the trolley 2.Low storage capacity as compared to conventional crates.

RESEARCH GAPS

Following research gaps were established after evaluation of the literature :

- Existing products in the domain are profoundly expensive due to the nature of the technology used in their production. This will continue to be so until the technology is widely accepted and improvised.
- The development of an affordable and entirely automated system is yet to be achieved in the industry.
- The energy requirements required for the scale of the technology is still not speculated.
- The socio-economic aspects and the resulting impact on employability need to be discussed and a solution for the prosperity of both industry and society should be resolved.

CONCLUSION

After meticulous evaluation of all the research articles, journals, papers and work of other researchers in the field, we can conclude that there is a need for augmentations in the way the inventory is managed. This can be realized by implementing certain technologies, making the system sustainable, error-free and efficient. To implement such a system, extensive research and consequent development should be done. The advancement should be manageable, economically viable and feasible. Also, the social impact that the system yields must be regarded.

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