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Review Paper On Humanoid Robots In Manufacturing

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Abstract – The review is based on the literature on manufacturing-related humanoid robots. A compelling argument is made for the subjects related to human-robot interaction. This included a discussion of control methods for humanoid robots that is used in manufacturing after discovering that vision is the most common perception system among sensor heads for these kinds of robots. Thus, offer historical context and information on the creation and uses of robotic heads today. When feasible, information is arranged chronologically to highlight trends in control methods, mechanical architecture, scholarly publications, and general philosophy and discovered there are two primary humanoid robot heads that we suggest categorizing as either non-expressive face robots or heads, or robot heads with expressive faces. By this we present their own features and offer a few humanoid robot heads used in human–robot. Robots that can move on their own to achieve their objectives are called mobile robots. An overview of these robots with a focus on manufacturing applications is given in this study. It explains the many types of mobile robots that are employed as well as the standards that should be met when choosing to deploy mobile robots.

Index terms – Advance applications, Fundamental ideas, Introduction, Human robot interaction

I. INTRODUCTION

Despite the lack of a clear definition, the term "mobile robot" is frequently used to describe a device that may autonomously travel between locations in order to do a predefined set of tasks (see, for instance, Tzafestas [1]). Automated use losses reconnaissance vehicles (AGVs) are utilized by the military and the healthcare industry for various purposes including as drug delivery, search and rescue operations, security guard duties, residential floor cleaning, and grass mowing. AGVs, or automated guided vehicles, are used in the industrial industry. Robots that resemble humans offer many applications. These vehicles were developed in 1953 and are also known to as AGVs, or automated guided vehicles [2]. When mobile or fixed robots operate in a human-populated environment, the human-machine interface—or, more precisely, the human-robot interaction—becomes increasingly important, rises when mobile or stationary robots act in a setting where humans are present. Robots and their uses are primarily intended to assist humans, whether in work settings, homes, production areas, or recreational settings. The deployed robots have evolved in each of these domains, and this has included interface enhancement or improvement. The study of human-robot interaction is expanding [3].

II. HUMAN-ROBOT COMMUNICATION

Human-machine interfaces enable interaction between humans and machines. The name "human-robot interface" alludes to the previously described notion, as robotics is the topic of this review. According to Gautam et al., a human-machine interface is "a approach, that is utilized to interface machines with human activities."[4]. Zhang provides an explanation of HMI in relation to robotics, stating that it is a terminal that enables human control, monitoring, data collection, and programming of the robotic system. " The main objective of the interface is to communicate knowledge from the equipment to the user along with the user toward the machine [5]. Industrial robots are described as "an autonomously regulated programmable multiple times, multifunctional manipulator, customizable in at least three angles, which is capable of being either fixed in place or mobile" [6]. This classification

distinguishes between two types of machines for use in applications involving industrial automation. Human-robot interaction is defined as "the communication of information and action in between human and machine using a user interface" in a recent International Federation of robotics' (IFR) report on service robots. As stated by Haddadin & Croft [8], the term's meaning changes when the word "physical" is included. This refers to the type of cooperation that can occur between a person and a robot and can be favourable, collaborative, or cooperative. By Goodrich & Schultz [7], media for interactions between humans and robots is described. This covers voice and natural language, hand and face gestures, non-verbal auditory alarms, physical engagement, haptics, and visual displays. The majority of the time, these media options are combined to allow for information sharing between humans and robots. Multimodal systems use multiple human senses to input or output information. Simple nonverbal cues like gestures are considered to be a useful conduit in noisy production settings. Many times, gestures are seen as the common mode of communication between employees. They are made up of motions of body parts serve as a medium of communication that informs an observer of information or intentions [9]. To carry out the gesture identification, two Typical methods used are as follows: motion-based or methods based on vision. As soon as the human motion were when made by a robot hand, the majority of the motions were correctly identified by the individuals involved [10].

Figure 1: Industrial arm works on car body

III. FUNDAMENTAL IDEA OF HUMANOID ROBOTS

"Android handheld devices are humanoid machines that are built to have the appearance of a male human, and gynoid robots are creatures of humanity intelligent machines built to represent a female human." A humanoid robot is one that generally resembles a human being" according to Wikipedia [11]. Some Humanoids have two legs, two arms, a torso, a head, and a mouth. These robots are made to function safely and independently in accordance with their surroundings. Humanoids' functionality is dependent on artificial intelligence theory. To function, they have distinctive qualities. Their body parts employ a variety of sensors to detect their surroundings. Rotating actuators are used to move the muscles and joints of the various body parts. Cameras are used by humanoids for the imaginative actions. The goal and use for which it is to be used must be determined before designing and producing it. It is important to be aware of hardware and software technologies. Despite this, creating the Humanoids is a difficult task. A humanoid is the result of the combination of artificial intelligence, neuroscience, and image processing. Despite this, the manufacturers still face a number of difficulties in creating human robots. For the past twenty years, people have been attempting to comprehend the workings and mechanism of human robots [12]. Undoubtedly, there are robots in every shape and size, but the ones that mimic and behave like humans are the most fascinating to watch. When the world was afflicted with the COVID-19 pandemic, numerous nations utilized humanoid robots. In Wuhan, China, a smart field hospital opened its doors in early March. Even some robots assisted the staff nurses by taking over their tasks and performing deliveries and simple cleaning. When their employees were placed under quarantine, industrial robots assisted with production [13]. A selection of humanoid robots are shown here:

1. **Robotic Avatar:** Toyota first unveiled this robot in 2017. It has the ability to imitate its human operator's movements.

2. **Sophia:** Developed by Hanson Robotics in Hong Kong, Sophia is a well-known social humanoid. At five years old, she serves as a robot ambassador, assisting in cutting-edge research and human-robot interactions. It has the ability to walk, sing, and even display over 60 different facial expressions and emotions [14].

3. **Delivery Robot:** It's a headless robot with numerous sensors and nibble limbs. It can manoeuvre around a variety of obstacles, including stairs. It can walk upright most of the time, but it can also balance on one foot. It can also stack and pick up boxes weighing up to forty pounds. It can fold itself for small storage.

4. **Research Humanoid:** At the Iranian University of Tehran, Surena IV is an adult human robot with the ability to recognize faces and objects and walk at a speed of 700 meters per hour.

5. **Robotic bartender:** A robotic bartender is employed by a company. It was created in Spain by Macco Robotics. Its two arms, head, and torso resemble those of a human. In an hour, it can serve 300 glasses of bear.

6. **Educational Robot:** Soft Bank's Pepper robot Robots can be used as nannies, receptionists, or reading assistants. Tethys, an instructional integrated development environment (IDE) that teaches students to code, has been added to Pepper. Students can program the humanoid to move, gesture, speak, and display various messages on its screen in real time after learning the software. The company believes that by launching this program, it will motivate a new wave of engineers and roboticists.

IV. PLANNING AND COORDINATION

Numerous industrial vehicles may be used in a typical production setting to move materials or components that are still in the process between workstations. In more sophisticated operations, these vehicles may also be used to position robotics or gadgets that perform direct work on the components. Such vehicles have a lot of moving parts that need to be planned and coordinated. In the business today, coordination is handled as an offline issue that needs to be resolved once the cars are programmed. This strategy is used for several reasons. Among these include the need to keep production at a steady pace and safety worries. When individuals must quickly switch between jobs and when there is a possibility that they will share a workspace with automobiles, the offline approach fails. Consequently, there is an increased demand for techniques that aim to preserve efficiency and security while permitting the cars to alter their paths to facilitate coordinated movements and guarantee the avoidance of obstacles. These kinds of implementations depend on control systems that are more intelligent and adaptive, with better situational awareness and sensor feedback [15]. A lot of effort has been put into attempting to schedule and synchronize the movements of several mobile vehicles. Because industrial AGVs are utilized in less organized areas and in circumstances where their duties are not completely known beforehand, planning and coordinating Autonomous Ground Vehicle and mobile robots has grown more difficult. Because centralized methods are computationally intractable, distributed approaches are becoming more popular, though centralized computation-based methods still exist. Decentralized techniques typically rely on agents and can employ a range of temporal and spatial zones, with plans calculated independently for each. Digani et al. provide an example of a zone-based strategy [16].

V. ADVANCE APPLICATION AND AGVS

As mobile robots and associated sensors get better, there are more and more applications that can benefit from their use. Other reasons propelling this expansion are the industry's overall quest for greater automation and the development of safety laws that allow humans and robots to operate side by side. Consequently, several mobile robot prototypes have been constructed for manufacturing purposes. These include material-tracking cars, mobile manipulators, and aerial material-handling drones.

AGVs are used in a new way by Hildebrandt and colleagues [17] to track and optimize item the placement in a warehouse. The authors assume that all stock items are equipped with RFID (radio frequency identification) tags, and that a team of mobile robots can find stock items and localize their own positions inside the facility using the RFID tags. The robots move around the facility and are able to track inventory, identify preferred routes, and spot opportunities for optimizing vehicle trajectories and storage locations by tracking the movement of items.

One of many instances where a positive byproduct of how good the improvement of item arrangement in a warehouse occurs when items are delivered and afterwards returned to storage is the Kiva Mobile Fulfilment System [18]. For instance, over time, items that are needed more often will be kept closer to the delivery area because the robots search for convenient locations to store them instead of depending on preset ones.

As an extension of mobility, mobile robot research has been discussed throughout this document in between sections on mobile manipulator research. Due to the differences in safety requirements between AGVs and robot arms as well as the potential to expand research, standards committees are debating mobile manipulators (Marvel and Bostelman [19]). A timeline from Bøgh, et al. [20] is depicted in Figure 3, giving an idea of the variety of mobile manipulator systems under investigation or have been before. Hvilshøj and colleagues [21] talk about advanced automobiles that have the ability to control robotic arms and sensors for component handling and navigation.

Figure 2. A timeline showing the evolution of mobile manipulators (image courtesy of MTECH, Aalborg University, Denmark [49]).

The idea of shipment of little items by drone up to 2.2 kg (5 lb) has recently sparked interest in the use of small drone multirotor copters in material handling [22]. This Dutch concept (see Figure 3)

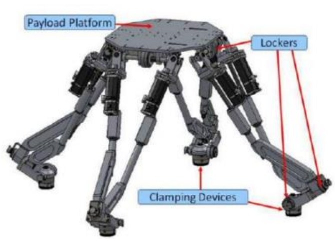

Figure 3. A screenshot from a simulation film that demonstrates the usage of drones for palletizing (from [46]).

allows for quick deployment, requires less infrastructure to set up, and should be able to sustain a relatively high throughput. Battery and control development will be propelled forward by companies such as Amazon [23].

Menegaldo et al. [24] provide a description of a crawling mobile robot. The robot's purpose is to examine the outside surfaces of massive oil ship hulls and floating production, storage, and unloading platforms. Magnetic tracks allow for locomotion over the hull moreover, the system is managed powered by a pair of networked PCs and an assortment of specialized gear that can run ultrasound devices, cameras, inertial platforms, motors, and other appliances. The navigation algorithm integrates inertial and odometric sensors through the use of an extended Kalman filter (EKF) sensor-fusion formulation.

Combinations of mobility techniques might be required if the floor is uneven or the work area is cluttered. For instance, Michaud et al. [24] describe a robot that combines tracks for mobility on both hard and soft surfaces with legs for climbing over obstacles or adjusting robot height. Mihankhah et al. [25] address autonomous control for this kind of tracked mobile robot in order to navigate and cross obstacles (such as stairs). These kinds of robots could be used for mobile manipulation or material handling in highly unstructured environments like aircraft manufacturing, shipbuilding dry docks, or other large-scale, small-batch manufacturing projects.

Yang et al. describe a substitute for a conventional mobile robot with an onboard manipulator in [30]. The robot is made up of four parallel legs, each of which has a clamping device at the end. In the work environment, a set of supporting pins is positioned at predetermined points. By removing a leg from one pin and reattaching it to another, the robot moves and maintains a precise position at all times. Since it can climb, it is not limited to staying on a level surface. When the platform mounted on the legs reaches its destination, it can carry and manipulate tools to complete work; it is not necessary for all of the legs to be clamped.

Figure 4. CAD model of a four-legged, parallel, walking robot with locking mechanisms (lockers) as needed for walking or load manipulation on some passive joints and clamping devices at the end of each leg [29].

VI. SUMMARY AND CONCLUSION

There is much more to the field of mobile robotics than what has been covered in this document. It includes self-driving cars on land and in the air, mobile robots that can fly and navigate water, and a variety of interior uses unrelated to manufacturing. Because funding for research has historically been available in areas of interest to the military and emergency services, research in the United States has primarily concentrated in these areas. Recently, there has been an increase in interest in using mobile robots to help people or perform tasks because of the belief that robotic solutions could be profitable. While Australia has done significant work in mining and agriculture, Japan has focused, until recently, on humanoid robots, and research in Europe has been more varied and has addressed more manufacturing needs. Research from all of these areas is beginning to come together to create systems that are more capable of autonomous action and mobility. Consequently, it is reasonable to anticipate that the quantity of mobile robots in the manufacturing sector will rise and that the tasks assigned to them will become increasingly intricate.

This will enable a variety of manufacturing applications that are currently prohibitively expensive or difficult to implement. For instance, it will be feasible to reposition smaller, general-purpose tools around the component and fabricate it in a novel way, rather than needing large, specialized machine tools to fabricate large components. Highly accurate position measurements will be needed for this, but the tools for doing so already exist and are being used in robotics applications. Not needing massive "monument" machine tools also means that the assembly line can be set up more creatively, which eventually allows for dynamic reconfiguration when the product mix changes. Automating tiresome jobs like kitting and palletizing, as well as removing hazardous or ergonomically difficult jobs from people, are further benefits of deploying mobile robots.

But before these capabilities can be put to use, suppliers must be able to ensure the features and scope of applications of their goods, and buyers need to be able to compare products and choose the ones that best fit their requirements. Performance metrics and procedures, which are still in their infancy, will be necessary for this. Additionally, the tasks that the robots will perform will need to be easily and adaptably programmed. They will also need to be able to change tasks quickly in response to changes in the product mix and handle the significantly less restricted work environments that come with people working alongside robots. Additionally, standards will need to be improved and harmonized, particularly when manipulators and dexterous end-effectors are incorporated into mobile robots.

Even though there is progress being made on all fronts, new manufacturing capabilities are probably going to be introduced gradually. More concentrated research is required in the field of manufacturing robotics, particularly with regard to mobile robots that possess the ability to autonomously plan their routes, precisely locate themselves, and possess an adequate number of sensors and manipulators to perform tasks akin to those performed by humans in unstructured factories.

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