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COLLABORATIVE ROBOTS FOR INDUSTRIES

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ABSTRACT

A collaborative robot, or cobot, is a type of robot intended to physically interact with humans in a shared workspace. Collaborative robots are experiencing rapid market growth in this sector of the robotics industry. The primary driving force behind this growth is a consistently decreasing price. Many collaborative robots are available for under $45K, making them a viable solution in a wide range of applications, inside and outside of the factory setting, for companies big and small. Advances in edge computing have made collaborative robots more flexible and easier than ever to implement. Often, little to no programming is required to install them, reducing integration costs. Increasing flexibility opens up a wide range of new tasks and applications that collaborative robots can effectively automate. The collaborative robots market is growing quickly and lucrative opportunities await those who can find success in this dynamic industry.

LOGISTICS/AMR

Collaborative robots used in logistics are almost exclusively used in the picking and placing of objects. They're often deployed in large warehouses or fulfillment centers where accurate, consistent, and quick movement of goods proves challenging. Collaborative robots for fulfillment can be stationary or mobile, but the major area of growth lies in autonomous mobile robots (AMR). In 2017, installations of logistics robots increased 162% over 2016 levels, according to the International Federation of Robotics (IFR) World Robotics 2018 Service Robots report. In 2018, sales of these systems will increase by 66% over 2017 levels to reach a total market value of $3.9 Billion. Much of this growth can be attributed to mobile robots for fulfillment – approximately 90% of logistics automation systems sold in 2017 were mobile robots for fulfillment. Collaborative logistics robots used in warehousing and fulfillment processes can significantly increase productivity, reduce wasted motions, generate labor savings, and improve the overall safety of a facility. This is particularly true of AMRs, which can navigate dynamic settings, effectively locate and pick objects, more intelligently deliver these objects to human workers, and operate more quickly than manual picking and placing. In some instances, AMRs can improve the number of units per hour (UPH) picked by almost threefold. Collaborative logistics robots, particularly AMRs, have a bright future ahead of them, as the technology has only recently matured to the point of commercial adoption. The near-future holds robust growth for this type of collaborative robot, presenting numerous opportunities for those who can gain a foothold in this emerging market.

MACHINE TENDING

Collaborative robots (cobots) play a central role in modern-day machine tending. A high-growth industry, machine tending currently represents the largest application of cobots for industrial automation. Cobots are being leveraged by manufacturers to increase productivity, improve product quality, and maximize output consistency. Typically, machine tending involves a human worker loading parts into a machine to execute a task. The worker then removes the finished product and reloads another part. Not only does this waste an enormous amount of time that could have been spent more productively, it also increases the risk of injury or accidents due to the nature of the repetitive tasks. Cobots work side-by-side with humans in various robotic machine tending applications for fast production change-overs and increased accuracy. Human workers no longer have to perform hazardous, repetitive tasks. Instead, their skills can be better utilized to perform value-added tasks to ensure quality control through CNC machine integration. Robotic machine tending is used for loading and unloading parts during the following applications, including but not limited to:

- Welding and grinding
- Injection molds
- Milling and turning
- Compression molds
- Stamping
- Punching, forging, trimming

Although the production process for the various applications may differ, the main function of loading and unloading parts remain the same. Collaborative robots can be used for virtually any machine tending applications. They offer many automation advantages, including fast deployment, easy programming, lower space requirements, and lower acquisition costs. Taking over the repetitive tasks that put humans at risk, they also offer safety and labor benefits that ultimately help to improve production. As the most popular use of collaborative robots for factory automation, machine tending with cobots represents a high-growth industry.

PICK AND PLACE

Pick and place collaborative robots (cobots) are being used by a growing number of industries due to their ability to perform highly repetitive, precision tasks. These cobots are able to work safely alongside humans for increased productivity, improved product quality, and high-speed material handling. Many pick and place cobots are also able to work autonomously, which means even greater productivity as well as workforce flexibility. Easy to program and quick to set up, pick and place cobots are leveraged for a variety of applications, depending on the manufacturer's needs. Those with a small profile and lightweight design can be easily moved to new processes or deployed in tight spaces. The most common applications are:

- Assembly
- Bin picking
- Finishing tasks like deburring, grinding, and polishing
- Inspection
- Material handling
- Packaging, palletizing and depalletizing
- Specialized process tasks, for which end effectors are designed

Pick and place cobots offer a number of time and cost-saving benefits. Performing high-speed, precision tasks, cobots typically deliver increased productivity and quality, as well as labor savings. They also reduce safety hazards to humans by taking over taxing, repetitive tasks.

With the design of specialized end-effectors and the cobot's increasing capabilities, pick and place collaborative robots will continue to experience market growth with widespread adoption across industries for a greater variety of applications.

QUALITY INSPECTION

Collaborative robots (cobots) are used for a variety of quality inspection applications to detect flaws and integrity of an assembly or system. Often utilized in manufacturing to conduct visual inspections on products and assemblies at various stages of the manufacturing process, cobots are also used by the transportation and energy industries to inspect machinery and systems to ensure safe, reliable operations. Equipped with 2D or 3D vision sensors, robotic inspection cobots are capable of inspecting several aspects of a single part with accuracy and precision. They typically are lightweight and have a small footprint, making them easy to deploy and re-deploy to meet a variety of changing factory needs. They are also easy to program, usually requiring no programming experience. As with other cobots, robotic inspection cobots can be used for repetitive tasks, protecting human operators from safety concerns and freeing them to take on more cognitive tasks. Offering flexibility, higher productivity and precision, industrial inspection cobots are leveraged by a number of industries, including automotive, transportation, metal fabrication, machinery, food & beverage, and agriculture. They are particularly beneficial to ensure that regulated and strict quality standards are met, enhancing product reliability and protecting against costly recalls.

PACKAGING AND PALLETIZING

Packaging and palletizing collaborative robots (cobots) are being leveraged in numerous industries to optimize fulfillment processes. Packaging cobots, often used for lightweight operations, place objects or products in cases or trays. Case palletizing collaborative robot systems have compact, streamlined designs that deliver both precision and speed for the stacking of boxes, bottles, bags, pallets, and cartons ranging from medium to heavy payloads. Meeting strict packing standards, packaging and palletizing cobots offer an effective, mistake-free solution to the demands of ergonomically unfavorable, repetitive work. They help to avoid employee injuries by facilitating the lifting of heavy loads with the assistance of lightweight collaborative robotic arms. Among their many advantages, packaging and palletizing collaborative robots offer:

- **Versatility**
  A packaging and palletizing cobot can be redeployed and reprogrammed to adapt to a wide range of payload requirements. Due to its size and lightweight design, the robotic arm can be used in new constellations once the workflow demands decrease.
- **Lower Maintenance**
  Palletizing cobots have components that are equipped with low-wear drive trains. Due to their robust and streamlined design, palletizing cobots have lengthy maintenance intervals.
- **Strength and Speed**
  Packaging and palletizing cobots offer the ability to lift heavy payloads at a good speed, reducing cycle times, increasing the stacking rate of boxes, and achieving greater dynamic performance.
- **Compact Design**
  Their space-saving size enables the quick integration of packaging and palletizing cobots into existing systems to streamline performance and increase production efficiency.

Packaging and palletizing collaborative robots offer many advantages for streamlining processes to enhance efficiencies and reduce costs. They are intrinsically safe, easy to deploy and use, and exceptionally useful as an aid to perform tasks that could potentially harm their human co-workers.

PROCESS AUTOMATION

Collaborative robots (cobots) for process automation offer a cost-effective solution with a high return on investment. Designed to operate cooperatively alongside humans, they alleviate task demands while enhancing production efficiencies. Specially designed end-effectors allow cobots to perform process tasks which are deemed monotonous, strenuous, hazardous, or time consuming for humans. Common process tasks include dispensing, material handling, machine tending, lifting, and welding.Repetitive process tasks must be performed with precision and in a timely manner. Human employees may require significant training time to perfect the movements required to complete the task. Conversely, the programming of one cobot to complete the movements can be easily copied to others, significantly reducing the time, and costs, to achieve the precision required. Collaborative robots for process automation offer many benefits, including:

- **Ease of Programming**
  The simplified programming process can be accomplished easily with a polyscope graphical user interface (i.e.: touchscreen). The robot operator uses the touchscreen to move the cobot arms and end-effectors, which teaches the cobot how to perform the various movements and when to switch between the movement types.
- **Support & Safety for Human Workers**
  Cobots can relieve human workers from hazardous, monotonous, or exhausting work. Able to sense humans and obstacles, cobots work safely and cooperatively with human workers.
- **Precision Performance**
  Collaborative robots have the ability to perform repetitive tasks with precision at a faster rate than humans.
- **Smaller Footprint**
  Many systems feature a compact design that takes up significantly less floorspace. They have no safety fencing requirements.
- **Low Cost & Speed of Implementation**
  A low-cost investment with high return, cobots typically cost less than $40,000. Their simplified programming means they can be deployed quickly and easily by a robot operator.

The many benefits of collaborative robots, particularly their ease of use and low cost of implementation, expand possibilities especially for smaller manufacturers. Leveraging cobots for process automation offers not only enhanced efficiencies that improve production but enhanced safety and support for human workers.

MATERIAL HANDLING

Technological advancements are increasing the capabilities of material handling collaborative robots (cobots). Not only are human workers able to work collaboratively side-by-side with material handling cobots, new exoskeleton technologies allow them to be worn by human workers. Protecting human workers from occupational injuries while augmenting their physical capabilities, material handling cobots offer efficiencies that speed production, reduce injury and liability, and minimize costs.

Human Augmentation with Exoskeletons

Full-body exoskeletons, designed to lift heavy payloads of up to 200 pounds, are worn by humans to provide additional strength and endurance for repetitive tasks involving heavy tools or components. Featuring highly flexible, lightweight materials, exoskeletons enable workers to perform precision tasks without restriction of movement, minimizing exertion and reducing the chance of strain or injury. The exoskeleton is controlled using advanced actuators, sensors, and materials coupled with highly-sophisticated software control algorithms.

Delivering Higher Quality at a Faster Rate

Material handling collaborative robots are used to automate the most physically demanding, hazardous, repetitive, and monotonous tasks on a production line. By enhancing human capabilities, material handling cobots increase production efficiencies to deliver higher quality at a faster rate. Capable of handling a wide range of payloads, collaborative robots are being used by an ever-expanding number of industries for a variety of material handling needs. These industries include, but are not limited to, automotive, biotechnology, electronics, food and beverage, medicine, laboratories, pharmaceuticals, and semiconductors.

INDUSTRY CLEANING

Collaborative robot (cobot) janitors offer a more cost-efficient and productive means of managing the industrial cleaning demands of large facilities. By doing the dull, dirty, and dangerous work at a more consistent and faster rate than humans, industrial cleaning robots help to optimize efficiencies and minimize occupational injuries. Human workers are freed up to take on less risky, higher-value tasks such as tidying spaces.

Protecting Profitability

Industrial cleaning is an extremely profitable industry. Airports, commercial and retail facilities, warehouses, healthcare facilities, and educational institutions must cater to large crowds on a consistent basis. Contracted to ensure a building adheres to ISSA (International Sanitary Supply Association) rules and regulations, professional cleaning services must ensure cleanliness at all times or risk losing the contract. Collaborative robot janitors provide the support to human workers needed to ensure obligations are met.

Increased Efficiency, Transparency & Accountability

Collaborative robot janitors deliver accurate productivity metrics that facilitate informed decision-making. Professional cleaning services benefit from the greater operational control that allows them to optimize for increased efficiency, transparency, and accountability.By taking on the monotonous, potentially hazardous tasks that may injure humans and require more of their time to complete, industrial cleaning cobots offer operational efficiencies that help to minimize occupational injuries and safeguard profitability.

SPACE EXPPLORATION

Space exploration agencies like NASA have employed robots in various capacities of research for decades. As technological advances enhance collaborative robot (cobot) capabilities, NASA and other leading institutions dedicated to space research are developing new ways to leverage them. NASA has announced prospective plans to explore Titan, Saturn’s moon, with a total of 12 miniature shapeshifting cobots. Designed for Titan’s challenging environment, such as freezing temperatures, lakes, caves, seas, cryovolcanoes, and rain of liquid hydrocarbons, the cobots will be equipped with a propeller, enabling them to fly or swim. Currently, a 3D-printed prototype is being tested at NASA's Jet Propulsion Laboratory (JLA). The cobots are designed to explore places out of reach to humans and less sophisticated robots. The shapeshifting collaborative robots will be able to join together automatically to create a chain designed to explore caves, fly independently, and split, creating two flying drones. Titan's terrain is varied and largely unexplored, so the JLA team is designing the cobots with versatility in mind. Collaborative robots are proving to be extremely versatile in space exploration. MIT (Massachusetts Institute of Technology) has developed cobots that can construct elaborate structures in space. Building these structures on Earth and transporting them to space is cost-prohibitive and logistically difficult. MIT's cobots are designed to build structures such as space stations, houses, airplanes, and other intricate structures, autonomously in space. Continued technological innovations and miniaturization, along with advances in Artificial Intelligence (AI), are facilitating unique, exciting, and expanded possibilities for space exploration with cobots. Formerly far flung ideas like reaching new planets and investigating planetary surfaces in intricate detail are becoming a reality thanks to collaborative robots.

CONCLUSION

Industry 4.0 is a fascinating development in automation, and is indeed worthy of its place in the history of the industrial revolutions that have taken place since the advent of waterand steam-powered mechanization nearly a century ago. It is impossible to separate the birth of cobots from the evolution of robots in general and of robotic automation in particular. Because of this, cobots share a history and many ideas with the whole universe that the term Industry 4.0 is currently used to cover. LEARN MORE To find out more about Universal Robots, cobots and how cobots can benefit Industry 4.0 environments and beyond Visit www.universal-robots.com or contact esben@universal-robots.com Still, the fundamental collaborative nature of cobots – the fact that they are designed to collaborate with human operators instead of eschewing workers the way that Industry 4.0 would – places cobots somehow outside, if not diametrically opposed to, the Industry 4.0 worldview.

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