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Review on – General Concepts of Robotics and Their Uses in Pharmaceutical Industries.

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A B S T R A C T

Robotics has its share of success stories as well as frustrating ones. The century of robotics is the twenty-first century [1]. For a very long time, robots have held new possibilities. Robots are playing a bigger and bigger role in every aspect of life in society, working together in the fields of supply chain management, manufacturing, food production, building services, and medicine and healthcare. In today's world, robotics is a crucial technology. From medical science to other scientific fields, robots are becoming an integral part of science. The robot is performing precise and difficult tasks with ease and without suffering any harm. Robots are now the primary symbol of human cooperation in today's world. This essay provides an overview of robotics as a science, technology, and system. We also cover the history of robotics technology, science, and systems. In addition, we cover the components used in robot manufacturing, the structure of robots, their benefits, drawbacks, and uses. We discussed the applications of robotics technology in this paper because, in the current context, robot vision systems are primarily used for inspection purposes in industries like gauging, flaw detection, and component presence verification. This paper provides a brief overview of the potential applications of robotics in both domestic and commercial settings in daily life.

Keywords: Robotics, Manufacturing, Human Cooperation, Transportation, Colaborating.

Introduction

Robotics is a branch of engineering and science that encompasses computer science, electronics engineering, mechanical engineering, and other fields that deal with machines. [2]. Although these robots can be used for any task, they are employed in delicate situations for things like bomb disposal and detection. The robots that have adopted human facial features are most likely able to walk, talk, understand, and most importantly, perform tasks that humans can. These robots can interact with the real world directly and are frequently employed in place of people to carry out repetitive and boring jobs. Due to their compliance and flexibility, soft robots can perform multiple tasks in unexpectedly changing environments and conditions, potentially outperforming traditional rigid-bodied robots. Soft robots have not yet reached their full potential, though; in many aspects, including manipulation and movement, nature still possesses far greater sophistication. Future research should concentrate on comprehending the principles underlying the design and operation of soft robots in order to identify what constrains their performance and impedes their transfer from laboratory to real-world settings. The main difficulties with complex materials, precise modeling, sophisticated control, and intelligent behaviors should also be taken into account in these investigationsThis review serves as a foundation for future research in this area by analyzing the principles behind advanced actuation and sensing modalities, modeling approaches, control schemes, and learning architectures for soft robots. We then review the areas of application of these approaches and summarize how they can be used to develop intelligent soft robots. In conclusion, we offer forward-looking viewpoints regarding the primary obstacles that must be overcome initially to progress soft robotics and genuinely enhance our community.

What is the Robotics?

An interdisciplinary field of computer science and engineering is robotics [3]. The ultimate result of science, engineering, and technology is robotics, which is what we call robots. These devices are employed in many different industries, including manufacturing, construction, healthcare, and many more. They are even capable of carrying out extremely repetitive and difficult for humans jobs like space travel and navigating hazardous environments. In dangerous environments, robots can replace workers in production processes. However, it took until the 20th century for robots to become significantly more useful and effective. Robotics has a long history of being observed to behave and carry out tasks similarly to humans. Robotics is a rapidly developing technology that can replace humans in tasks like minesweeping, bomb disposal, and shipwreck exploration. STEM education also makes use of robotics as a teaching tool (science, technology, engineering, and mathematics)[5]

Fundamentals of Robotics

Parts of the robot system are as follows with brief description

1) Controller

The component of a robot that controls all of the mechanical system's movements is called the controller. as depicted in the figure below. Via a number of sensors, it also gets input from its immediate surroundings. Typically, a microprocessor connected to input/output and monitoring devices forms the core of a robot controller. The actuators, amplifiers, and controllers that make up the motion control mechanism are activated by the controller's commands. A motor or valve that transforms power into movements for robots is called an actuator.

2) Power Supply

The energy needed to run the controllers and actuator comes from the power supply. It could be a compressor or pump that provides hydraulic or pneumatic power, or it could be a device that converts ac voltage to the dc voltage needed by the robot's internal circuits. Pneumatic, hydraulic, and electrical power supplies are the three main categories. Electricity is the most widely used energy source when it comes to industrial robots. The least common is hydraulic power, and compressed air is the second most common. These main energy sources need to be transformed into the quantity and shape needed for the particular kind of robot being utilized. Electrical power is needed for both the control unit's electronic component and any electric drive actuator. A robot with pneumatic actuators requires compressed air, which is usually supplied by a compressor driven by an electric motor.

A. Hydraulic Drive - A hydraulic drive system is a transmission or drive system that powers hydraulic machinery with pressurized hydraulic fluid. The transfer of energy from flow and pressure—rather than from the kinetic energy of the flow—is referred to as hydrostatic. Three components make up a hydraulic drive system: the generator (such as a hydraulic pump), which is powered by a windmill, an electric motor, or a combustion engine; the actuator (such as a hydraulic motor or hydraulic cylinder), which powers the machinery; and valves, filters, and other components for system guidance and control.

B. Electric Motors - Electric motors power the great majority of robots; portable robots typically use brushed and brushless DC motors, while industrial robots and CNC machines use AC motors. These motors are frequently chosen for systems with lower loads and rotation as the primary mode of motion.

C. Linear Actuator - Different kinds of linear actuators have faster direction changes and move in and out rather than spinning, especially when very large forces are required, as in industrial robotics. Usually, compressed air (for pneumatic actuators) or oil (for hydraulic actuators) are used to power them.

D. Series Elastic Actuators - For better force control, the motor actuator may incorporate a spring into its design. It has been utilized in a number of robots, most notably humanoid walking robots.

E. Muscle wire - Muscle wire, sometimes referred to as shape memory alloy, nitinol, or flexinol wire, is a substance that, when exposed to electricity, contracts (less than 5%). They have been applied to a few small robot uses.

F. Piezo Motors - Piezo motors and ultrasonic motors are modern substitutes for DC motors. These operate on a radically different principle, in which linear or rotary motion is produced by microscopic piezo ceramic elements vibrating thousands of times per second. There are various methods of operation. One type steps the motor in a straight or circular path by using the piezo elements' vibration. Another kind drives a screw or causes a nut to vibrate by using piezo elements. These motors have speed, available force for their size, and nanometer resolution. These motors are currently in use on certain robots and are available for purchase.

G. Sensing - Robots can obtain data from sensors regarding specific environmental measurements or internal parts. This is necessary for robots to carry out their duties and react appropriately to changes in their surroundings. They are employed for a variety of measurement purposes, to alert robots to potential hazards or malfunctions, and to deliver real-time data about the tasks they are carrying out.

H. Vision - The science and technology of seeing machines is known as computer vision. Computer vision is a branch of science that studies the theory underlying artificial systems designed to extract information from images. The image data may be in the form of camera views or video sequences, among other formats. The majority of real-world computer vision applications use computers that are pre-programmed to perform specific tasks, but learning-based approaches are starting to proliferate. Image sensors, which identify electromagnetic radiation—typically manifested as either visible light or infrared light—are the foundation of computer vision systems. Solid state physics is used in the sensor design process. Optics provides an explanation of how light travels and bounces off surfaces.

I. Mechanical Gripper - The gripper is among the most widely used effectors. Its most basic form consists of just two fingers that can be opened and closed to grasp and release a variety of tiny objects. For instance, fingers could be constructed from a chain with a metal wire woven through it. The robonaut and shadow hands are two examples of hands that function and look more like human hands.

Three Laws of Robotics

1. A robot must follow human instructions unless they are in direct opposition to the First Law.

2. As long as doing so does not violate the First or Second Laws, a robot must defend its own existence.

3. A robot is not allowed to hurt people or, by standing by, permit people to suffer harm [9].

Advantages of Pharmaceutical Robots

1. Accuracy : Compared to human counterparts, robotic systems exhibit higher accuracy and consistency.

2. Lack of fatigue : A robot can complete a task requiring 96 human hours in 10 hours with greater consistency and better outcomes.

3. Reliability : Robots don't need to stop or get tired because they can operate around the clock, seven days a week.

4. Return on investment (ROI) : ROI has a short turnaround time. Also, there are the advantages of more production options due to the improvement in quality and application speed.

5. Affordability : More pick and place robotic cells are being installed for automation applications as a result of technological advancements and the decreasing cost of robotics.

6. Production : Using robots increases throughput speeds, which has an immediate effect on output. Robots have the potential to produce more than a human worker because they can work continuously without stopping for breaks, naps, or vacations.

7. Quality : Robots can significantly raise the caliber of a product. Applications are run consistently, precisely, and highly reproducibly. It may be difficult to attain this degree of consistency in any other manner.

8. Speed : Robots operate quickly and effectively, wasting neither time nor motion. Robots are able to change productivity by increasing throughput without hesitation or breaks.

9. Flexibility : There are many uses for packaging. It is simple to reprogramme a robot. The capabilities of packaging robots have been extended by advancements in their End of Arm Tooling (EOAT) and vision technologies.

10. Safety : Robots make work environments safer. Employees are transferred to supervisory positions, eliminating the need for them to carry out risky tasks in dangerous environments.

11. Savings : Lower costs are a result of increased worker safety. Employers are less concerned with insurance and healthcare. Additionally, robots perform tirelessly, saving important time. Because of their precise movements, less material is wasted.

12. Redeployment : Although they can adapt to changes in product life cycles, robots' flexibility is typically gauged by their capacity to manage numerous product changes over time.

13. Decreased risk of contamination : Removing individuals from the screening procedure lowers the risk of sample dropout and contamination when handling samples in lab settings. These tasks are completed far more quickly and accurately by robotics.

14. Cost : Given the number of production shifts, relatively high hourly labor rates paid to employees, and low cost of capital, the payback periods for purchasing robotic equipment in the pharmaceutical industry. An average robot installation could run up to $200,000 when accessories, conveyors, safety barriers, and labor are included. The robot would be paid for in just over a year and a half through salary savings alone if it were to replace four manual laborers who each made about $30,000 annually.

15. Work continuously in any environment : Robots have an additional benefit in laboratories because they can withstand a variety of conditions that humans would find hazardous. A robot can work continuously for 24 hours a day, 7 days a week, without taking a break.[10,11]

Disadvantages of Pharmaceutical Robots

1. Cost : The initial outlay for robots is substantial, particularly for business owners who are only able to afford brand-new robotic machinery. It is important to evaluate the cost of automation in relation to a company's overall financial plan. Frequent maintenance requirements may also be expensive.

2. Dangers and fears : Although it is thought that present robots have not advanced to the point where they represent a threat or danger to society, worries and fears regarding robots have been frequently voiced in a variety of literature and motion pictures. The main idea is that robots may be more intelligent and capable than people, and that if they did, they might grow morality and the desire to either exterminate or subjugate humanity.

3. Expertise : Training in programming and using the new robotic equipment will be necessary for staff members. Usually, this requires money and time.

4. Return on investment (ROI) : Results are not a given when using industrial robots. Without planning, businesses may find it challenging to accomplish their objectives.

5. Safety : While robots can shield workers from certain risks, their very existence can also lead to additional safety issues. It is necessary to consider these new risks [12].

Applications of Robots in Pharmaceutical Industry

Robotics is a key component of the intricate production, packaging, and research and development processes. Robots are justified by a variety of factors, including increased worker safety and higher quality. The process of finding new drugs can be sped up thanks to robotics. Many robot manufacturers have products made especially for this sector of the market.

1. Development and Research (D&R)

These days, robots are also crucial to the creation of novel medications. For example, millions of compounds are tested in high throughput screening (H.T.S.) to see which could be novel drugs. Robotics will be required to test these millions of compounds. Just as they can in any other process where a robot takes the place of a person performing a repetitive task, robotics can greatly accelerate this one.

2. Systems of Control

The majority of robots have onboard controllers that interface with the programmable logic controllers (PLCs) of other devices or with networked personal computers (PCs) on the line. An industrial VME bus controller called a robot controller is connected to PCs via Ethernet and graphical user interfaces.

3. Robotics Laboratory

With the use of this new technology, human talents can now be focused on monotonous tasks that breed error and boredom, such as selecting and submitting samples and scrutinizing the resulting data. Better data and lower costs are, of course, the intended outcomes of this automation. New experimental protocols that eliminate human fatigue and error in washing and transferring are based on laboratory robotics. This comprises radioactive, fluorescent, and luminescent analysis experiments. Pharmaceutical development is using laboratory robotics more and more to help meet the goals of cost reduction, faster drug development, and increased productivity.

4. Sanitization and Air-Cleaned Environments

It is possible to adapt robotics to operate in aseptic environments. Robots in clean rooms are equipped with features that guard against contamination of the sterile environment. Stainless steel fasteners, enclosed cables, low flake coatings on the robotic arm, and unique seal materials are some of these features. By automating the inspection, picking and placing, or loading and unloading of process tools, clean room robots lower expenses. Using robots in a clean room has several advantages.

A. Robots reduce contamination-related scrap.

B. The use of clean room supplies like bunny suits is decreased by robots.

C. By reducing dropped or improperly handled parts, robots minimize scrap.

D. Training expenses and the observance of clean room protocol are kept to a minimum.

E. By removing the aisles and accessways that are normally needed for human clean room workers, robots minimize the amount of expensive clean room space. Additionally, robots can be contained in miniature settings. This allows the rest of the plant to be relatively clean.

5. Packaging Operations

Automation speeds up and ensures consistency in packaging procedures, just like it does in other pharmaceutical operations. Specifically, robotics offers precision and adaptability. In certain packaging applications, robotics outperforms dedicated machines, such as carton loading. Pharmaceutical packaging equipment is frequently made to order to accommodate particular product configurations, like vials.

Conclusion

Conversely, the pharmaceutical sector benefits from robotic systems since its operations typically involve predictable sets of operations, low force requirements, and clean environments.The pharmaceutical industry is constantly looking for methods to lower costs, boost productivity, and produce high-quality goods. Robots can assist businesses in achieving these goals by offering flexibility, speed, repeatability, and precision. Robots can be an especially strong foundation for the expanding biotechnology industry because they can enhance discovery, pilot production, and small-scale production.

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Conflict of interest statement

The authors declare that there is no conflict of interest.

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