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INDUSTRIAL ROBOTS IN MANUFACTURING

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Industrial robots have been around for decades now. Over the years, advancement in technology has introduced more innovation in robots, prompting more and more industries around the world to adopt them in their workforce. They are undoubtedly becoming a valuable asset to industries and companies.

Industries have been using industrial robots to improve productivity, efficiency and to reduce costs in manufacturing.

Interestingly, over 90% of robots are used in factories and manufacturing facilities, according to inc.com.

1. What are industrial robots?
2. Why are industrial robots important?
3. What are the different types of industrial robots?
4. Frequently Asked Questions

UNIVERSAL ROBOTS

Universal Robots, one of the world's leading developers of industrial collaborative robots, strives to change how people work and live worldwide by empowering their ideas and dreams. We are dedicated to bringing safe, flexible, and easy-to-use 6-axes industrial robotic arms to businesses of every size globally.

WHAT ARE INDUSTRIAL ROBOTS?

The Robotic Industries Association has defined a robot as a reprogrammable, multi-functional manipulator designed to move materials, tools, parts or specialised devices with the help of variable programmed motions to perform a variety of tasks. Here, reprogrammable implies that the motions or auxiliary functions that the robot is programmed for can be modified without making any physical alterations in the robot. Since an industrial robot is considered multi-functional, it can perform more than one function, without making any physical alterations in the machine.

Industrial applications of robots have become increasingly common, helping industries perform mundane, repetitive, or dangerous tasks, among others, and collaborate effectively.

Common industrial applications of robots include welding, dispensing, assembling and disassembling, packaging, labelling, quality assurance, lifting, handling and more. Having robots perform these tasks improves the precision, speed, and efficiency of the tasks.

The earliest known functioning industrial robot is said to have been completed by "Bill" Griffith P. Taylor, which was a crane-like device made entirely using Meccano parts and was published in the Meccano magazine in 1938. A single electric motor powered this industrial robotic device. It had five possible axes of motion, which was quite an achievement back in those days. An axis for

an industrial robot is the direction the robot moves in. It could be linear or rotary. The automation was achieved in this industrial robot via a punched paper tape which energised the solenoids. This would, in turn, bring about the movement of the robot's control levers. The robot was programmed to stack wooden blocks in a fixed fashion.

From then to now, industrial robots have come a very long way. Technologies have advanced significantly in the past few decades, transforming industrial operations, making them considerably safer, more efficient, quicker, sharper, and collaborative.

WHY ARE INDUSTRIAL ROBOTS IMPORTANT?

Since 2010, the demand for industrial robots has constantly been growing as industries increasingly embrace automation and other technical innovations. Industrial robots have developed and improved so much over time that today, even small-volume productions can be efficiently automated, especially tasks like welding, cutting, assembly line operations, packaging, palletizing, etc. With time, investments in industrial robots have become profitable and promise to deliver immense business value.

(Source: International Federation of Robotics)

Some of the reasons why manufacturing industries adopt industrial robots in their operations include –

- Increased flexibility to changing environments and business needs.
- Better resilience to systemic shocks and production waves.
- Efficient utilisation of resources and energy.
- Enhanced productivity of operations.
- Reduced operating costs.
- Reduced capital costs.
- Better product quality.
- Improve production efficiency and productivity.
- Better space utilisation on the manufacturing floor.
- Lesser human factors involved.
- Decreased scope of human errors.

These factors can make a significant difference to industries of all sizes: small, medium or large. Every industry would want to improve their operations, reduce errors and downtime, and improve productivity and efficiency of operations while bringing down their costs. By doing so, industries can be so much more competitive and productive.

WHAT ARE THE DIFFERENT TYPES OF INDUSTRIAL ROBOTS?

There are **six** types of industrial robots based on their mechanical structure and the tasks that they perform. They are –

1. Articulated industrial robots.
2. Cartesian coordinate industrial robots.
3. Cylindrical industrial robots.
4. Spherical industrial robots.
5. Selective Compliance Assembly Robot Arm or SCARA industrial robots.
6. Delta industrial robots.

ARTICULATED INDUSTRIAL ROBOTS

Articulated industrial robots are the most commonly used industrial robots. They resemble a human arm, which is why they are called 'robotic arm' or a manipulator arm. The articulated robots have special rotary joints, at least three, due to which they can achieve a full range of motion. They rank high on flexibility and dexterity and can offer very precise and controlled movements, which can be very useful for industries.

CARTESIAN COORDINATE INDUSTRIAL ROBOTS

The cartesian coordinate industrial robots are called so because their axes are correlated to the cartesian coordinate system. The cartesian robots are also called rectilinear robots, gantry robots, and X-Y-Z robots. These industrial robots have three linear joints which can move in the three different graphical axes – the x-axis, the y-axis, and the z-axis. They have a unique, rigid structure with three unique prismatic joints and three rotary joints. The linear joints enable the cartesian robots to perform simple movements with significant advanced precision and repeatability. They cannot perform any major extensive movements and are considered to be some of the cheapest industrial robots. These features make

the cartesian robots ideal for assembly line operations that involve performing simple jobs repeatedly but quickly and with precision.

CYLINDRICAL COORDINATE INDUSTRIAL ROBOTS

The cylindrical coordinate robots have a rotary joint at the robot's base and at least one prismatic joint that connects the links in the robot. The cylindrical coordinate industrial robots can move vertically and horizontally in a sliding motion. They work effectively in compact workspaces without compromising the speed or effectiveness of the operation.

SPHERICAL COORDINATE INDUSTRIAL ROBOTS

The spherical coordinate robots are some of the first robots that were deployed in industrial facilities. They only have rotary joints. Common applications of the spherical coordinate robots include machine tending in die-casting, plastic injections, extrusions, and welding.

SELECTIVE COMPLIANCE ASSEMBLY ROBOT ARM OR SCARA INDUSTRIAL ROBOTS

The SCARA robots have two parallel joints, which enables them to move in the x-y plane. They also have rotating shafts that are fixed vertically at the effector of the robot. SCARA robots are very commonly used on assembly line operations and are a perfect fit for tasks that require lateral movements.

DELTA INDUSTRIAL ROBOTS

Delta industrial robots are also called parallel link robots because they have parallel links to a common base. They are primarily used for tasks that require direct control and high manoeuvres. They use the four-bar linkage system, also called the parallelogram linkage system.

CLASSIFICATION OF INDUSTRIAL ROBOTS BASED ON ARCHITECTURE

Industrial robots are also classified based on their architecture. Based on this, industrial robots have two types of –

1. Serial architecture, and
2. Parallel architecture.

SERIAL ARCHITECTURE ROBOTS:

Serial architecture robots, also called serial manipulators, are the most commonly used industrial robots. It comprises a series of links connected by motor-actuated joints that go all the way from the base to the end-effector, hence the name – serial architecture robots. Examples of serial architecture robots include SCARA robots and Stanford manipulators.

PARALLEL ARCHITECTURE ROBOTS:

Parallel architecture robots, also called parallel manipulators, comprise short and simple chains that rigidly prevent unwanted movements. This way, if there is an error in one chain's positioning, then it is averaged out in conjunction with the other chains and that's the big difference between serial architecture robots and parallel architecture robots. With serial architecture robots, the error would be cumulative rather than averaged out. Each of the actuator chains in a parallel architecture robot can move in its degree of freedom. Simultaneously, the unwanted movements are restricted by the effect of other actuator chains in the robot. Thus, parallel architecture robots are considerably close-looped and stiff relative to their components.

FREQUENTLY ASKED QUESTIONS

What are the common characteristics of industrial robots?

A huge majority of the robots functioning across the world today are industrial robots. These industrial robots have certain common characteristics, making them suitable for use in industries and manufacturing facilities. The characteristics of industrial robots are –

1. **Programmability-** Industrial robots need to be programmable and reprogrammable to keep up with the changing work environments of an industrial or manufacturing setting. The robots need to be programmable without requiring changes in their physical structure.

2. **Personification-** Industrial robots mimic human motions and movements. They could be mimicking any human movements like that of a human leg, arm wrist, etc. Industrial robots also have specific sensors such as force sensors, load sensors, contact sensors, vision sensors and acoustic sensors which can control these human-like movements.
3. **Multi-functional-** Industrial robots need to be flexible and should also be able to support a wide range of functions. By making a few changes in the manipulators, the industrial robots should be all set to support another function than they originally used to. Thus, they need to be built and designed accordingly.
4. **Intelligence-** Modern industrial robots need to be smart and intelligent. They need to be able to understand the environment they are functioning in. They also need to capture valuable data about the operations they are performing and constantly adapt to deliver the best performance.
5. **Multi-axes movement-** An industrial robot needs to move in three or more axes in linear or rotary mode. These axes, however, could be fixed or mobile depending on the application of the particular industrial robot.

WHAT ARE THE COMMON APPLICATIONS OF INDUSTRIAL ROBOTS IN MANUFACTURING?

Some of the most common applications of industrial robots in manufacturing are –

1. **Arc welding or robot welding** – Industrial robots, when used for arc welding, make the operations smoother but also help overcome the hazards of arc burns and hazardous fumes to the personnel, ensuring the safety of the workforce.
2. **Spot welding** – Employing industrial robots for spot welding majorly helps improve the time involved in performing spot welding and also helps ensure personnel safety.

3. **Material handling** – By deploying industrial robots in material handling, industries can reduce direct labour costs, ensure personnel safety, and improve the speed of operations through automation.
4. **Machine tending** – Industrial robots can improve the speed and efficiency of loading and unloading the raw materials into and from the machinery on a manufacturing floor, making them the perfect choice for machine tending.
5. **Painting** – Once industrial robots are employed to perform painting tasks in manufacturing, it is commonly called a robotic painting. Robotic painting uses automation brought about by industrial robots to improve the quality and consistency of the product. Robotic painting helps reduce re-work and losses, thereby significantly bringing down the costs involved.
6. **Product handling** – In any manufacturing facility, a product would require being handled multiple times from the time the raw material enters the production process to the time when the product is finally shipped off to the customer. This handling could involve multiple tasks, such as picking, packaging, palletizing, etc. Employing industrial robots for this has improved speed and accuracy and significantly brought down the production costs involved in the process.
7. **Assembly line operations** – Assembly line operations have been extremely common in modern manufacturing. The merits and demerits of assembly lines, especially concerning the human workforce, have been explored on multiple occasions by multiple agencies. Employing industrial robots on assembly lines is a blessing for production efficiency and speed and relieves the human workforce of the immense stress and pressure. Moreover, with industrial robots working the assembly lines, production and operation costs nosedive too.
8. **Mechanical operations** – Today, industrial robots come with an added feature of dexterity. This has enabled manufacturing facilities to automate countless mechanical tasks which would otherwise have been extremely difficult to automate. These mechanical tasks include cutting,

grinding, deburring, buffing, polishing, etc. As an added advantage, a task that would take a human worker a few minutes to perform can now be performed by an industrial robot in seconds!

9. Sealing tasks – In a manufacturing facility, consistent quality is essential and could make or break the company.

One important function in manufacturing, though often considered menial, is sealing. This involves multiple tasks like glueing, adhesive sealing, spraying, etc. Industrial robots can perform sealing tasks with ease and improve productivity, efficiency, speed, and consistency along the way.

WHAT ARE THE ADVANTAGES AND DISADVANTAGES OF USING INDUSTRIAL ROBOTS IN MANUFACTURING?

The manufacturing industry is often in the midst of a revolution, thanks to industrial robots. Industrial robots have transformed the manufacturing industry, and there can be no doubts about that. However, every coin has two sides and industrial robots are no exception to this dichotomy. Let us explore some of the advantages and disadvantages of using industrial robots in manufacturing –

Advantages of using industrial robots in manufacturing:

- 1. Improved quality and consistency of the products-** Like we mentioned above, in the manufacturing industry, delivering consistent quality of products is extremely important. Industrial robots rule out the scope of human errors, reduce re-work and ensure the quality is maintained run after run.
- 2. Improved productivity and output-** Every manufacturing industry strives to improve its productivity. Embracing automation by using industrial robots can help manufacturing industries achieve this. Industrial robots can work 24x7 at programmed levels without any breaks or shift changes. They are quick, dependable, non-tiring, accurate, and efficient.
- 3. Better personnel safety-** As we explored above, many tasks performed in a manufacturing facility can be hazardous for the personnel. However, once these tasks are automated

and assigned to industrial robots, human personnel do not need to get involved directly in those tasks, keeping them safe and preventing any undue mishaps on the floor.

4. **Better work environment for the workers-** Let's face it, working in manufacturing facilities can be quite stressful and the pressure can be really hard to handle sometimes. Moreover, the redundant and tedious nature of many tasks being performed on the floor can be tiring and exhausting for the workers. However, when industrial robots are used on the manufacturing floor, they can take up redundant, tedious, and even potentially hazardous tasks. This lets manufacturing workers engage in tasks that require human intervention and ingenuity while keeping them safe, reducing their stress levels, and improving the overall work environment for them.
5. **Improved bottom lines-** What is the main purpose of any business? To improve the bottom lines year over year, isn't it? And if there is something that manufacturing businesses could achieve seamlessly, it would be industrial robots. Industrial robots push up the important determining factors in the manufacturing business, such as productivity, efficiency, etc. thereby improving the business' bottom line.
6. **Better customer satisfaction-** When the customer gets a consistent quality of product throughout the order quantity, they are bound to come back to place more orders and become consistent customers. The best way to ensure a consistent product quality batch after batch is to use industrial robots.
7. **Enhanced reputation and competitive advantage-** Imagine showing your client around your manufacturing facility that has advanced industrial robots operating at top-notch efficiency. How impressed is the client going to be? We would say the client will be super-impressed and will understand how committed you are to uphold your quality standards. Industrial robots can help manufacturing businesses achieve significant competitive advantage in the market.

DISADVANTAGES OF USING INDUSTRIAL ROBOTS IN MANUFACTURING

While the advantages of using industrial robots in manufacturing galore, there are also some important disadvantages that one needs to be mindful of. These include –

1. **Huge capital expenditure-** While industrial robots look perfect, they don't come cheap by any means. They bring down the production costs and operation costs over time. One needs to carefully consider their budget and their expected ROI before investing in an industrial robot. This calls for significant investment that will not be easy to write off.
2. **Requires expertise to operate-** While everyone is worried about how robots are taking away human jobs, what one often forgets considering is the jobs it creates. Industrial robots are specialised machinery and require allied expertise to operate and make the most of the robots. Most companies will offer to train your workers to operate the robot and offer technical expertise as and when required, but this is also something manufacturing companies need to consider before investing in industrial robots.
3. **Not as flexible and useful as the human workforce-** Industrial robots cannot offer as much flexibility as a human worker. Dismantling an industrial robot from one place and assembling it at another itself can take up quite some time and resources. Moreover, for an industrial robot to yield excellent results, the supporting processes, equipment, etc., also need to be allied to accommodate the robots and their functioning.

Why are industrial robots important?

To keep up with the changing times and rapidly evolving technologies, industries need to embrace automation and robots. They not only help improve productivity and efficiency, they also minimise errors, bring down rework as well as costs in the long run. By deploying industrial robots, businesses can stay

competitive and gain a significant competitive advantage in the market.

In this era of Industry 4.0, robots are everywhere and are transforming every industry they become a part of. When done after careful consideration and planning, investing in industrial robots promises to offer multiple advantages and benefits to the manufacturing business. Industrial robots do not eliminate the need for human workers, instead, they increase the demand for skilled expert workers. Industrial robots are bringing about a revolution in manufacturing, and they are here to stay.

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We believe that collaborative robotic technology can be used to benefit all aspects of task-based businesses – no matter what their size.

We believe that the latest collaborative robot technology should be available to all businesses. The nominal investment cost is quickly recovered as our robotic arms have an average payback period of just six months.

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