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Latest Innovation in Robotics

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Abstract: *Robotics is the science of creating and assembling tangible robots to enhance automation and creativity. Engineering and computer science are combined in the field of robotics, which deals with the creation, manufacturing, and use of robots. Robotics is undergoing a fast evolution with ground-breaking discoveries that are changing entire sectors and societal contexts. Recent advances in AI have accelerated robotics' progress toward more flexibility and autonomy. There are many different types of robotics. A robot could be an artificial intelligence (AI) device that looks like a person, or it could be a robotic application like robotic process automation, which resembles how people interact with software to carry out repetitive, rule-based tasks. The continued convergence of robotics with artificial intelligence, materials science, and other interdisciplinary domains holds the potential to open up new avenues for automation and human-robot cooperation. This study offers an overview of the most recent advancements in robotics, including significant technological innovations, cutting-edge applications, and developing trends.*

Keywords: Robotics, Automation, Artificial Intelligence, Technology, Innovation, Material Science

I. INTRODUCTION

Robotics is a branch of engineering and computer science that focuses on designing, building, operating, and using robots and computer systems for control, sensory feedback, and information processing. Robot word is originated from word Robota which means Forced Labour. The field of robotics combines science, engineering, and technology to create devices, or robots, that mimic or replace human behavior. Engineering and computer science are combined in the field of robotics, which deals with the creation, manufacturing, and use of robots. The goal of robotics is to build intelligent machines that can help people in different ways. There are many different types of robotics. A robot could be an artificial intelligence (AI) device that looks like a person, or it could be a robotic application like robotic process automation, which mimics how people interact with software to carry out repetitive, rule-based tasks. Businesses and Government agencies use Robotics in various ways. Robotics is widely used in Industrial Sector, Farming and Agricultural Sector, Healthcare Sector and also in Logistics sector [1].

New Trends in robotics includes Autonomous Mobile Robots, Intelligent Robots, and Robotics Cyber security, Internet of Robotic Things, Humanoid Robots, Automated Guided Vehicles and Assisted Robots. A subfield of engineering and science, robotics encompasses computer science, mechanical engineering, electrical engineering, and other fields. The design, building, use, and control of robots and computer systems for information processing, sensory feedback, and control are all included within the field of robotics. Artificial intelligence (AI) has allowed machines to perform tasks that humans would typically be unable to perform, such as learning from experience and adapting to new inputs. The majority of AI examples that are discussed nowadays, such as machines that can play chess to self-driving automobiles, mainly rely on deep learning and natural language processing [2].

II. GENERATIONS OF ROBOTICS

Five Types of Robot can be distinguished, in keeping with stages that robotics has gone through until the present day which includes,

First Generation: First Generation is Robot Manipulators which means they can pickup and move objects but with restricted movements. Their system is very easy to use, performing previously programmed repetitive tasks manually or in a sequential order. These tasks are typically to gather and place the components in a specified location, where their movements are limited. Since they do not have any knowledge of the environment, these systems are considered to be

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Open loop Systems since there is no feedback for checking results and errors. There are still these types of robots in use in many sectors.

Second Generation: Second Generation is Learning Robots which means these gather information from the environment to make more complex movements. The 1980s saw their emergence. Dubbed the first learning robots because of its capacity to retain movement patterns that a human operator had previously executed. They are distinguished by their ability to move and their use of specialized sensors to perceive a portion of their surroundings. As a result, they developed into closed-loop systems that could verify some of their findings and had a simple feedback mechanism. Currently, they are employed in the automobile sector primarily to carry out painting, part transfer, and assembly duties on assembly lines.

Third Generation: Third Generation is Reprogrammable Robots which means these are equipped with sensors and they use programming languages to vary their functions in keeping with the needs of any given moment. They were referred to as the sensorized control robot generation. Their primary advantage stemmed from their ability to be reprogrammed via computers, which enables them to use sensors and programming languages to create artificial vision and touch. Since this generation can adjust its work or displacement strategy due to its increased environmental awareness, the control system is closed loop. Some academics believe that the age of intelligent robots is only getting started.

Fourth Generation: Fourth Generation is Mobile Robots which means they are the first intelligent robots that can perceive their surroundings in real time. This generation of intelligent robots, which resembles the fourth generation but has the capacity for real-time decision-making, mobility, and task completion. Compared to earlier generations, the processing of data gathered by ever-more-accurate sensors was significantly superior. Its creation was mostly influenced by the usage of fuzzy logic and neural network analysis models, which were crucial at the turn of the 20th and 21st centuries, when computing and electronics were expanding at an exponential rate. They were employed in a wide range of tasks across many industries, including services, entertainment, and industrial applications. Many are starting to show humanoid characteristics these days.

Fifth Generation: Fifth Generation is Robots with Artificial Intelligence where this is the stage that's currently under development. They are intended to mimic human beings and they are autonomous. It is the most recent generation of robotics to date. The key feature is the application of sophisticated artificial intelligence with autonomous learning, which allows it to mimic and create models of behavior, reasoning, and performance in even the most unpredictable and dynamic environments, all without the need for human intervention. This disproves the myth that robots are limited to doing repetitive jobs. Because of their remarkable adaptability, these robots may be used in countless applications. It is the responsibility of the coming generations to carry on developing this generation. [3]

III. NEW TRENDS IN ROBOTICS

The following are a few new developments in robotics: Integration of AI and Machine Learning: Advanced machine learning (ML) and artificial intelligence (AI) techniques are finding their way into robotics more and more. A robot is a machine that normally performs several functions on its own, and in particular through interaction with the environment and by using sensory data to make decisions. Computer science, electrical engineering, mechanics and artificial intelligence are some of the fields contributing to robotics technology.

3.1 Autonomous Mobile Robots

A mobile robot that can navigate and react to its surroundings without direct human supervision is called an autonomous robot. Before being used, AMRs are preprogrammed; usually, this involves mapping their working area to develop transport patterns. These robots are equipped with sensors so they can avoid impediments, such as people and forklifts, and link with other robots and networks. Compared to autonomous guided vehicles, which follow a predetermined path using track-like systems comprised of wires, magnets, or lasers, they provide greater flexibility [4]. A robot that is able to comprehend and navigate its surroundings on its own is known as an autonomous mobile robot. AMRs are not like autonomous guided vehicles (AGVs), which depend on tracks or pre-planned routes and frequently need human supervision. Examples of Autonomous Mobile Robots are shown in Figure 1.

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Figure 1 Autonomous Mobile Robots

AMRs can perceive and move around their surroundings without the need for wired electricity by utilizing a complex array of sensors, artificial intelligence, machine learning, and computation for path planning. Given their cameras and sensors, autonomous medical robotswill employ navigation techniques like collision avoidance to slow down, stop, or reroute their path around unexpected obstacles like fallen boxes or throngs of people so they can carry out their tasks.

3.2 Collaborative Robots

A cobot, or collaborative robot is a type of industrial robot designed to work securely next to people in a shared workspace. Autonomous robots, on the other hand, are programmed to consistently carry out a single job, operate autonomously, and stay motionless. Thanks to developments in mobile technology, artificial intelligence (AI), machine vision, cognitive computing, and touch technology, it is now feasible for smaller, less powerful robots to safely carry out a variety of jobs in close proximity to human workers and to be aware of their surroundings. Cobots are designed not just to safeguard the security of their human colleagues but also to pick up duties fast through reinforcement learning and demonstration. Cobots are widely used in manufacturing to perform a variety of functions, such as assembly, material handling, machine tending, packaging automation, and product quality check [5]. Increased accessibility is made possible by these collaborative robot advantages, both in terms of cost and usability. Collaborative robots, also known as cobots, are frequently employed to carry out physically demanding or repetitive activities so that humans may concentrate on less hazardous jobs .Collaborative Robot is shown in Figure 2.

Figure 2 Collaborative Robots

3.3 Humanoid Robots

A robot that resembles the human body in shape is called a humanoid robot. The design may serve utilitarian goals like interacting with human tools and surroundings, experimental goals like researching bipedal movement, or other goals. While some humanoid robots may just duplicate a portion of the body, such as the waist up, most humanoid robots have a torso, a head, two arms, and two legs. Additionally, some humanoid robots have heads made to resemble human faces, including lips and eyes. Humanoid robots are sophisticated artificial devices that resemble humans. Over the last ten years, the development of humanoid robots has accelerated due to the growing interest in these machines and the

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most recent and significant technological developments made by engineers in the fields of robotics, locomotion, and artificial intelligence. A humanoid robot is a professional service robot that resembles a human body in shape and is designed to interact with human tools and provide customer service. These robots are also used for inspection and maintenance; they have skin and eyes but are not made of flesh or bones. The latest iterations of these robots can talk, walk, and express a wide range of emotions [6]. Humanoid Robots in Pictorial are shown in Figure 3.

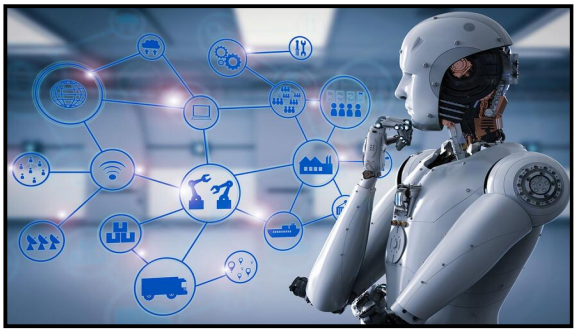

Figure 3 Humanoid Robot

3.4 Internet of Robotic Things

IoRT, or the Internet of Robotic Things, is a concept that merges robotics and the Internet of Things (IoT). Robots are connected to the internet to enable automation, communication, and teamwork. While robotics focuses on production, interaction, and autonomous behavior, the Internet of Things (IoT) provides sensing, monitoring, and tracking capabilities. Connected robot performance is powered by edge computing platforms, which gather and distribute data to enable feedback-driven processes.

With recent advances in edge IoT, robot manufacturers can now move computing closer to the data source. Robots in diverse situations can now actively participate in a wide range of applications and exchange/share data with humans, other robots, and IoT/ IIoT devices thanks to the Internet of Robots (IoRT). Robots are able to act and react appropriately on their own, perceiving events and changes in their environment. These capabilities allow robotic objects in the energy, mobility, buildings, manufacturing, and other sectors to become more intelligent by enabling the convergence of their actual, digital, virtual, and cyber characteristics. They also enable the creation of smart environments. Artificial Intelligence (AI), Digital Twins (DT), Distributed Ledger Technologies (DLTs), Intelligent Connectivity, Distributed and Federated Edge/Cloud Computing, Virtual/Augmented Reality (VR/AR), and Swarm Technologies are all combined in the Internet of Robotics (IoRT). Through the Internet and other connection network protocols, these technologies enable uniquely addressable intelligent things to interact and communicate with one another. IoRT is a highly potent age that is already playing a significant part in our transportation, safety, healthcare, and industry [7].Internet of Robotic Things in Pictorial are shown in figure 4.

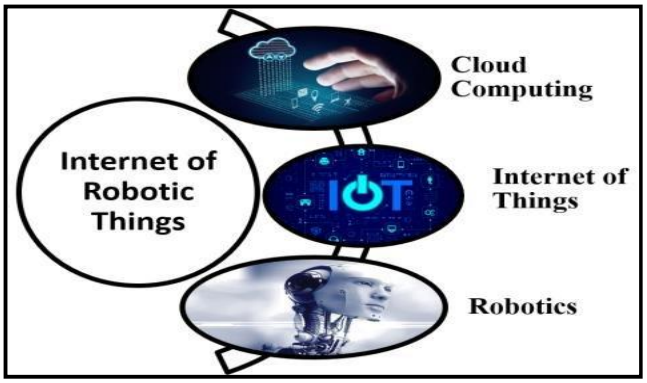

Figure 4 Internet of Robotic Things

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3.5 Swarm Robotics

The study of designing robot groups that function independently of external infrastructure or centralized control is known as swarm robotics. When a group of robots interacts locally with each other and with their surroundings, the collective behavior of the robots in the swarm is the outcome. Principles from swarm intelligence inform the design of robot swarms. These guidelines encourage the development of flexible, scalable, and fault-tolerant systems. When multiple tasks need to be completed simultaneously, high redundancy and the avoidance of a single point of failure are sought, yet setting up the infrastructure needed to operate the robots is technically impractical, swarm robotics seems like a potential solution. Swarm Robots in Pictorial are shown in figure 5. In swarm robotics, a group of robots work together to solve problems by assembling useful structures and behaviors that resemble those seen in swarms of bees, birds, or fish. The transition to industrial applications hasn't been accomplished satisfactorily yet, though. The body of literature on practical swarm applications that use genuine swarm algorithms is thin. Basic swarm behaviors are those that are typically observed when only a portion of swarm algorithms are utilized [8].

Figure 5 Swarm Robots

IV. APPLICATIONS OF ROBOTICS

In today's technologically advanced society, robots have captivated people's attention. It is described as the nexus between engineering and science. Robots are changing the way we interact, work, and live. Following are some Applications used in Various Fields.

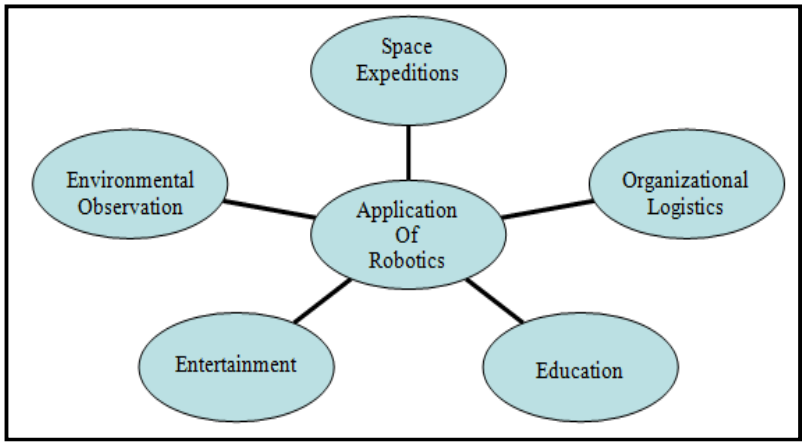

Figure 6 Applications of Robotics

Space Expeditions

When researching areas that pose a risk to people, robots are indispensable. Robots are used by space organizations on tasks related to spacecraft repair and planetary exploration. Drones, also known as unmanned aerial vehicles (UAVs), are robots that are used for mapping and disaster relief.

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Organizational logistics

Order fulfillment, inventory control, and packing are all optimized by robots. Robots with autonomy move around warehouses, carrying and delivering goods to predetermined spots. It lessens the need for manual work. By guaranteeing on-time delivery, this automation expedites the supply chain and raises customer satisfaction.

Education

With the ability to provide students practical experience in engineering, programming, and problem-solving, robotics has emerged as a crucial educational tool. Robots are also used by researchers to explore new scientific areas, such as undersea habitats, ecosystems, and even animal behavior.

Entertainment

Entertainment is another thing that robots offer. Their captivating performances in exhibits and shows enthrall spectators. Children and elderly alike like playing with social robots, which are made to interact with people. These robots help with everyday chores and provide emotional support.

Environmental observation

Sensory and camera-equipped robots are used for environmental monitoring, data collection on water and air quality, and natural disaster response. Robots assist search and rescue efforts in disaster regions by exploring dangerous surroundings to find survivors. They lessen the danger to people and increase the effectiveness of rescue operations setting. [9]

V. RESULT AND CONCLUSION

This study explains the rapid development of Robotics Trends and Applications. Robotics is a branch of engineering and computer science that focuses on designing, building, operating, and using robots and computer systems for control, sensory feedback, and information processing. New trends in robotics include Autonomous Mobile Robots, Intelligent Robots, and Robotics Cyber security, Internet of Robotic Things, Humanoid Robots, Automated Guided Vehicles and Assisted Robots. Advancements in mobile technology, artificial intelligence, machine vision, cognitive computing, and touch technology have made it possible for smaller, less powerful robots to safely perform various jobs in close proximity to human workers. Robots are revolutionizing various fields, including space exploration, organizational logistics, education, entertainment, and environmental observation. They are essential for spacecraft repair, mapping, disaster relief, and inventory control.

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