Robot Technology- A Review

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ABSTRACT
The evolution of robotics in industries reflects a trajectory of technological advancements and theoretical breakthroughs. From the early stages of industrial robotics to the anticipated developments in the mid-21st century, this Paper discuss the progression and potential of robotics within industrial contexts. Initially rooted in stationary hydraulic arms and statistical formulas for vision programs, industrial robotics underwent significant transformations, driven by innovations such as microprocessor-controlled manipulators and autonomous mobile robots. The emergence of consumer-oriented robots capable of navigating environments and executing household tasks portends a future where universal robots with lizard-like minds become commonplace by 2030. Further projections suggest the advent of second-generation robots with trainable capabilities resembling those of mice, followed by third-generation robots with sophisticated mental faculties akin to monkeys by 2040. These future iterations promise to integrate physical, cultural, and psychological factors, enabling robots to learn through simulation-based rehearsals and develop consciousness. By melding powerful reasoning programs with advanced machines, fourth-generation robots may attain human-like intellectual prowess, reshaping industrial landscapes and propelling automation to unprecedented levels of efficiency and adaptability.

***Keywords:* -** Robot, Industrial robot, Toy Robot, Mobile Robot, Robotics Research

I INTRODUCTION

In the ever-evolving landscape of technology, robots have emerged as pivotal players, permeating various aspects of our daily existence. From the bustling floors of manufacturing plants to the intimate corners of our homes, these mechanical marvels have become integral components of modern life. However, their integration into society raises compelling questions about the future of work, human-machine interaction, and societal dynamics.

As we stand at the precipice of unprecedented technological advancements, the role of robots continues to captivate our imagination and provoke thoughtful discourse. While the notion of a world dominated by artificial intelligence may seem far-fetched, projections from industry experts shed light on the increasing prevalence of robots in our lives and workplaces.

This exploration delves into the multifaceted implications of the growing presence of robots, examining trends, forecasts, and the complex interplay between technology and society. By navigating through these insights, we seek to unravel the evolving relationship between humans and machines, and contemplate the possibilities and challenges that lie ahead in this era of automation and innovation.

A robot is an automatically operated machine that substitutes human effort, even if it doesn't necessarily look like a human or perform tasks in a human-like manner. Furthermore, robotics is the field of engineering focused on the creation, construction, and functioning of robots.

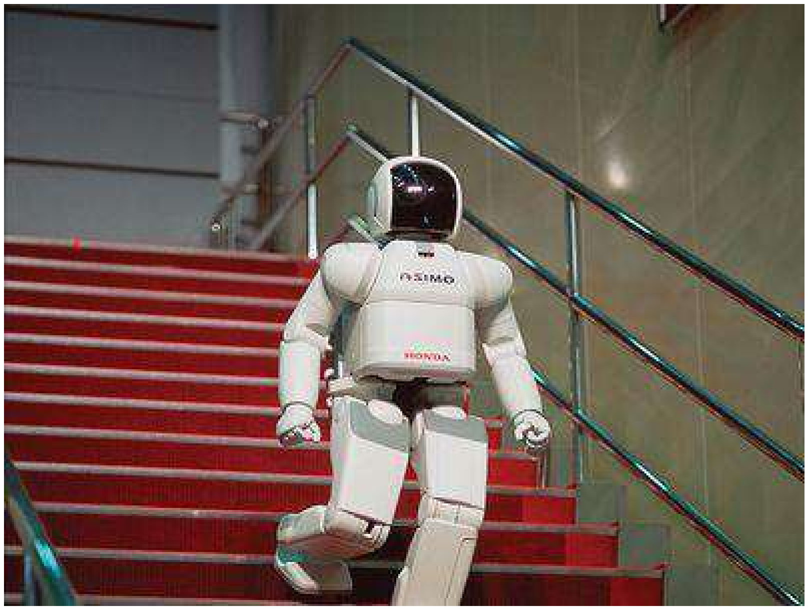

Fig.1: - Humanoid Robot

The idea of artificial humans existed before recorded history, but the contemporary term "robot" comes from the Czech word **"Robota"** (meaning "forced labor" or "serf"), as used in Karel Čapek's play R.U.R. (1920). In the play, robots were created as manufactured humans, ruthlessly exploited by factory owners until they rebelled and ultimately brought about the downfall of humanity. Whether they were biological, akin to the creature in Mary Shelley's Frankenstein (1818), or mechanical was not specified, yet the mechanical aspect inspired generations of inventors to construct electric humanoids.

The term "robotics" made its first appearance in Isaac Asimov's science-fiction story "Runaround" (1942). Asimov's subsequent robot stories, including "Runaround," established a new standard of plausibility regarding the challenges of developing intelligent robots and the technical and social issues that might arise. "Runaround" also introduced Asimov's renowned Three Laws of Robotics:

(a) Robot may not harm a human being, or, through inaction, allow a human being to come to harm.
(b) A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.
(c) A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

In 1970, Japanese roboticist Masahiro Mori introduced the concept that as the human likeness increases in the design of an object, so does the observer's affinity for it, leading to the phenomenon known as the "uncanny valley." According to this theory, as the artificial likeness approaches perfect accuracy, affinity drops sharply and is replaced by a sense of eeriness or uncanniness. However, affinity then rises again once true human likeness—resembling a living person—is achieved. This sudden decrease and subsequent increase, prompted by the feeling of uncanniness, creates a "valley" in the level of affinity.

II INDUSTRIAL ROBOT

Industrial robots, while not humanoid in appearance, exhibit flexible behavior and possess certain humanlike physical attributes, designed primarily for industrial applications. The first stationary industrial robot was the programmable Unimate, an electronically controlled hydraulic heavy-lifting arm capable of executing arbitrary sequences of motions. It was conceived in 1954 by American engineer George Devol and further developed by Unimation Inc., a company established in 1956 by American engineer Joseph Engelberger. In 1959, a prototype of the Unimate was introduced at a General Motors Corporation die-casting factory in Trenton, New Jersey. In 1961, Condec Corp. (after acquiring Unimation the previous year) delivered the world's first production-line robot to the GM factory, tasked with the duty of removing and stacking hot metal parts from a die-casting machine—a task considered undesirable for humans. Unimate arms continue to evolve and are sold by licensees globally, with the automotive industry remaining the primary purchaser.

Fig.2: - Industrial Robot at a Factory

In the late 1960s and 1970s, more sophisticated computer-controlled electric arms guided by sensors were developed at the Massachusetts Institute of Technology (MIT) and Stanford University. These arms were utilized alongside cameras in research on robotic hand-eye coordination. Victor Scheinman of Stanford, collaborating with Unimation for General Motors, engineered the first such arm used in industrial settings. Known as PUMA (Programmable Universal Machine for Assembly), these arms have been employed since 1978 to assemble automotive subcomponents like dash panels and lights. PUMA inspired numerous imitations, and its descendants, both large and small, continue to be utilized for light assembly in electronics and other industries. Since the 1990s, small electric arms have gained significance in molecular biology laboratories, where they precisely handle test-tube arrays and perform intricate pipetting sequences.

Mobile industrial robots, known as AGVs (Automatic Guided Vehicles), also emerged in 1954. In that year, a driverless electric cart produced by Barrett Electronics Corporation began transporting loads around a grocery warehouse in South Carolina. AGVs typically navigate by following signal-emitting wires embedded in concrete floors. In the 1980s, AGVs adopted microprocessor controllers, allowing for more complex behaviors than those achievable with simple electronic controls. In the 1990s, a new navigation method gained popularity for warehouse use: AGVs equipped with scanning lasers triangulate their position by measuring reflections from fixed retro-reflectors, at least three of which must be visible from any location.

While industrial robots initially emerged in the United States, the industry did not flourish there. Unimation, one of the pioneering companies, was acquired by Westinghouse Electric Corporation in 1983 and ceased operations a few years later. Cincinnati Milacron, Inc., another major American hydraulic-arm manufacturer, sold its robotics division to the Swedish firm Asea Brown Boveri Ltd. in 1990. Adept Technology, Inc., a spinoff from Stanford and Unimation focusing on electric arms, remains the sole surviving American firm in the field.

Foreign licensees of Unimation, particularly in Japan and Sweden, continue to thrive. In the 1980s, companies in Japan and Europe aggressively entered the robotics market. Japan, spurred by the prospect of an aging population and resulting worker shortages, began experimenting with advanced automation, creating a demand for robot manufacturers even before it yielded clear returns. By the late 1980s, Japan, led by robotics divisions of companies like Fanuc Ltd., Matsushita Electric Industrial Company, Ltd., Mitsubishi Group, and Honda Motor Company, Ltd., emerged as the global leader in industrial robot manufacturing and usage.

In Europe, high labor costs similarly drove the adoption of robotic substitutes, with industrial robot installations in the European Union surpassing Japanese installations for the first time in 2001.

III ROBOT TOYS

The market for industrial and service robots, designed for office and home environments, has been limited due to a lack of reliable functionality. However, toy robots have thrived despite their unreliable performance, providing entertainment rather than task completion, a concept that has existed for millennia (see automaton). In the 1980s, microprocessor-controlled toys capable of responding to sounds or light emerged, with more advanced versions in the 1990s capable of recognizing voices and words.

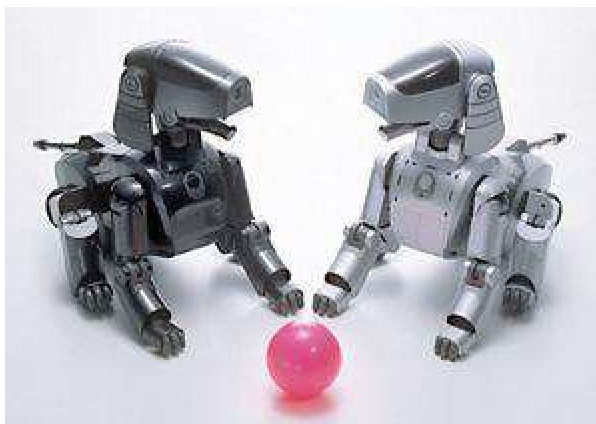

Fig.3:- entertainment robot (AIBO entertainment robot, model ERS-111).

In 1999, Sony Corporation introduced AIBO, a doglike robot equipped with two dozen motors to control its legs, head, and tail, two microphones, and a color camera, all coordinated by a powerful microprocessor. AIBOs were more lifelike than any previous models, capable of chasing colored balls, learning to recognize their owners, and exploring and adapting to their environment. Despite the initial cost of $2,500, the first run of 5,000 AIBOs sold out immediately over the Internet.

IV ROBOTICS RESEARCH

Dexterous industrial manipulators and industrial vision trace their origins to advanced robotics research conducted in artificial intelligence (AI) laboratories since the late 1960s. However, despite advancements, these achievements still lag behind the ambitious goal of creating machines with comprehensive human-like capabilities. While techniques for object recognition, manipulation, reliable navigation, and action planning have succeeded in certain specific contexts, they have often faltered in more general situations.

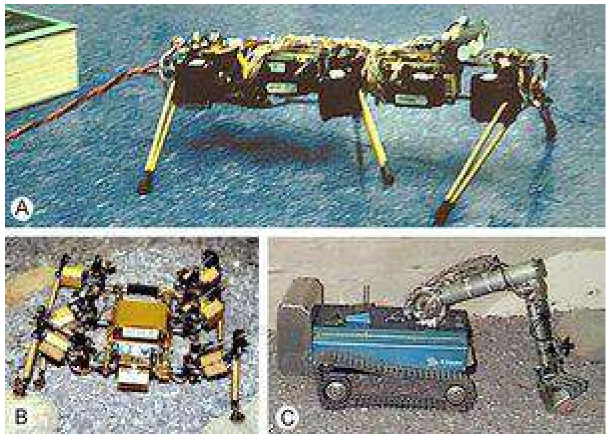

Fig.4:- three stages of mobile robot development for the Mars Rover Research Project

(Three stages of mobile robot development for the Mars Rover Research Project: (A) Genghis, (B) Attila, and (C) Pebbles, displayed in MIT's development of a mobile robot to reconnoiter the Martian surface.)

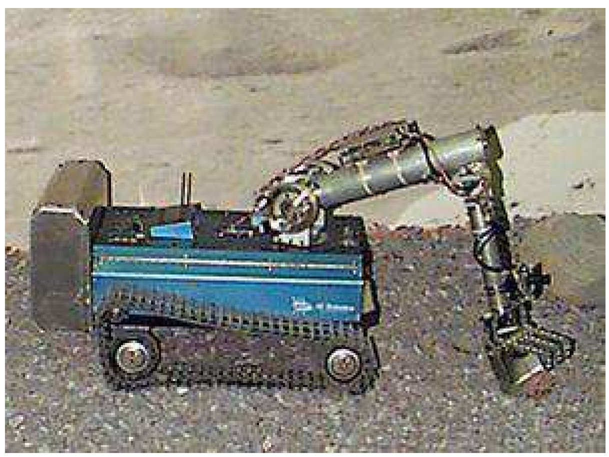

Fig.5:- Pebbles the robot

(Pebbles, a tractor like robot utilizing a vision-based control system developed during the late 1990s as part of MIT's Mars Rover Research Project. Pebbles, which is about the size of a domestic cat, negotiates around obstacles with the aid of a single camera, the robot's only sensor. With its arm attached, Pebbles can collect samples or handle dangerous objects.)

In the early 1970s, the initial robotics vision programs utilized statistical formulas to identify linear boundaries within robot camera images. They employed clever geometric reasoning to connect these lines into probable object boundaries, thereby constructing an internal model of the environment. Additionally, geometric formulas were used to correlate object positions with the required joint angles for a robot arm to grasp them, or the steering and drive motions for navigating a mobile robot around or towards the object. However, this approach was laborious to program and often encountered failures when unexpected complexities in the images misled the initial steps.

An effort in the late 1970s to address these limitations involved integrating an expert system component for visual analysis. Unfortunately, this mainly resulted in making the programs more cumbersome, substituting complex new challenges for simpler failures.

In the mid-1980s, Rodney Brooks of the MIT AI lab seized upon this impasse to initiate a highly visible movement that challenged the notion of machines creating internal models of their environments. Instead, Brooks and his followers developed computer programs comprising simple subroutines connecting sensor inputs to motor outputs. Each subroutine encoded a behavior, such as avoiding obstacles or moving towards a detected goal. Evidence suggests that many insects and certain parts of larger nervous systems function in a similar manner. While this approach led to the creation of engaging insect-like robots, their behavior was erratic, akin to real insects, as their sensors were occasionally misled. Additionally, this method proved inadequate for larger robots and lacked a direct mechanism for specifying long, complex sequences of actions—essential for industrial robot manipulators and future home robots.

In contrast, other researchers persisted in exploring various techniques to enable robots to perceive their surroundings and monitor their movements. One notable example involves semiautonomous mobile robots designed for exploring the Martian surface. Due to long transmission times for signals, these "rovers" must negotiate short distances between interventions from Earth.

A compelling testing ground for fully autonomous mobile robot research is football (soccer). In 1993, an international community of researchers launched a long-term program to develop robots capable of playing soccer, with progress evaluated in annual machine tournaments. The inaugural Robo Cup games took place in 1997 in Nagoya, Japan, featuring teams in three competition categories: computer simulation, small robots, and midsize robots. While simply finding and pushing the ball was a notable achievement, the event facilitated collaboration among participants, resulting in significant improvement in subsequent years. In 1998, Sony began supplying researchers with programmable AIBOs for a new competition category, providing teams with a standard, reliable prebuilt hardware platform for software experimentation.

While robot football has helped to streamline research in specialized skills, research into broader abilities remains fragmented. Sensors such as sonar and laser rangefinders, cameras, and specialized light sources are paired with algorithms that model images or spaces using various geometric shapes. These algorithms aim to determine a robot's position, identify nearby objects, and devise strategies for completing tasks. The development of faster microprocessors in the 1990s enabled the adoption of new, widely effective techniques. For instance, computers can now statistically analyze large quantities of sensor measurements to mitigate confusing readings caused by reflections, blockages, poor illumination, and other complications. Another technique involves "automatic" learning to classify sensor inputs or translate sensor states into desired behavior. While connectionist neural networks containing thousands of adjustable-strength connections are famous learners, smaller, more specialized frameworks often learn faster and more effectively. Some programs feature "adjustment knobs" to fine-tune behavior, while others employ a form of learning that recalls numerous input instances and their correct responses, using interpolation to handle new inputs. Such techniques are already widely employed in computer software that converts speech into text.

V THE FUTURE

By 2040, advancements in computing power are expected to enable the development of third-generation robots with minds akin to those of monkeys. These robots would learn through mental rehearsals conducted in simulations that incorporate physical, cultural, and psychological factors. Physical properties encompass attributes such as shape, weight, strength, texture, and appearance of objects, along with knowledge of how to handle them. Cultural elements would involve understanding a thing’s name, value, appropriate location, and purpose. Psychological factors, applicable to humans and other robots, would encompass goals, beliefs, feelings, and preferences. The simulation would monitor external events and adjust its models to ensure fidelity to reality. This approach would enable robots to learn through imitation and potentially develop a form of consciousness.

By the middle of the 21st century, fourth-generation robots may emerge with mental capacities resembling those of humans, capable of abstraction and generalization. Researchers envision achieving this by integrating powerful reasoning programs with third-generation machines. With proper education, fourth-generation robots are poised to become intellectually formidable entities.

Robots are becoming increasingly ubiquitous in various facets of our lives, from automated assembly lines in manufacturing plants to virtual assistants using conversational interfaces in our homes. However, their current applicability is limited in certain areas. The question arises: will this dynamic change in the future?

Despite concerns about the potential for artificial intelligence to supplant human intelligence and dominate the planet, such a scenario appears improbable. Nonetheless, according to projections from business network PwC, approximately 30% of jobs could be automated by robots by the mid-2030s.

Furthermore, other reports suggest that the global stock of robots could swell to 20 million by 2030, with automated workers potentially displacing up to 51 million jobs over the next decade. Therefore, while a complete takeover by robots seems unlikely, it is evident that we can anticipate a greater presence of robots in our everyday lives.

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