Review of Evolution and Future of Humanoid Robots

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Abstract— Humanoid robotics is an emerging research field that has received significant attention during the past years and will continue to play an important role in robotics research and many applications of the 21st century and beyond. Humanoid robotics is a branch of research in robotics where it deals with human-shaped robots capable of mimicking human actions and intelligence. In this paper we will review the humanoid platform development from the ancient time to present time. It also discusses about various already made prototype of humanoid robots and the scope of humanoids in the near future.

Keywords: Humanoids, Evolution of Humanoid Robot, Assistive Technology, Artificial Intelligence

I. INTRODUCTION

Nowadays robots become very powerful elements in industry because of its capability to perform many different tasks and operations precisely. Moreover it does not need the common safety and comfort like human. Besides these industrial robots, significant advances have been made in the development of biologically inspired robots or social robots. Humanoid is naturally expressed from the functional mobility of the human body. However, the complex nature of the skeletal structure as well as the human muscular system cannot be reproduced in this system. A humanoid robot therefore has fewer degrees of freedom (DOF) than a human body. Though humanoids are neither intelligent enough nor autonomous, they currently represented as one of the mankind's splendid accomplishments. It is the single greatest attempt to produce an artificial, sentient being. In the recent years manufacturers are making various types of humanoid robots which are more attainable to the general public. Applications of humanoid robots are well established in the field of Health care, Defense, Education, and Entertainment. Even in education sector humanoid are introduced in order to assist the faculty to teach the students. Regardless of the application area, one of the common problems dealt with in humanoid robotics is the understanding of humanlike information processing and the mechanisms of the human brain in dealing with the real world. The development of such robots requires coordinated and integrated research efforts that span a wide range of disciplines. It has been increasingly recognized by industry and research community that robots for personal use must become more humanlike to have a chance of being accepted by non-specialists.

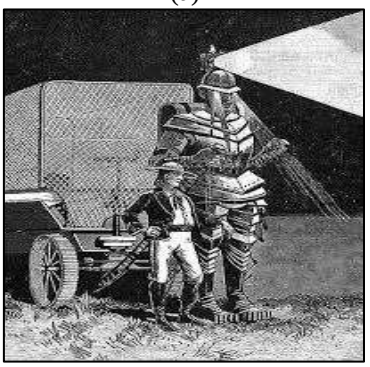
This is reflected in national humanoid robot projects occurring in Japan, Korea, and Europe, and in various extensive research programs In the United States. Major Japanese companies, such as Honda and Toyota, have already developed humanoid Robots. Although these platforms have not yet been turned into commercial products, it is clear that robots becoming part of our future personal and professional environments will need to possess many humanlike features. One of the reasons for this interest is the belief among many that intelligent and social robots will provide a growth industry as well as enhance the creation of new, human-centered technologies to improve the quality of life for humans. Another reason is that intelligent and social Robots represent a key application of today s technology from an economical and societal point of view. The Research on building such systems will both engage in the production of these new technologies and also contribute to the education and training of individuals who will be able to exploit these new technologies.

II. EVOLUTION OF HUMANOID ROBOT

A. Early research on Humanoid

Leonardo de Vinci who is considered as the first man, have drawn a humanoid mechanism in 1495. Also called as Leonardo's robot, or Leonardo's mechanical knight. The robot knight could stand, sit, raise its visor and independently manoeuver its arms, and had an anatomically correct jaw. The entire robotic system was operated by a series of pulleys and cables. Construction and development period of humanoid begins in the 19th century when John Brainerd invented the Steam Man in 1865. It was moved by steam-engine and used to pull carts. In 1885 the Electric Man was built by Frank Reade Junior which was more-or-less an electric version of the Steam Man. This paved a way for more and more development of Human Robots in the 20th Century.

(a)



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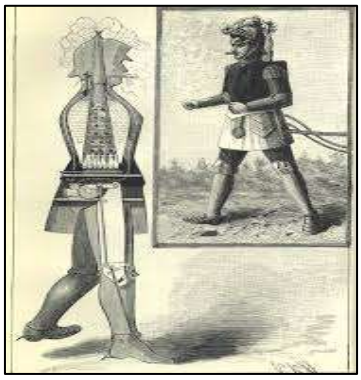

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Fig. II: (a) First humanoid by Leonardo in 1495, (b) Electric man in 1885, (c) Steam Man in 1865

III. DEVELOPMENT OF HUMANOID IN 20TH CENTURY

A. *Waseda Legged (WL)*

Professor Kato's robotic team of Waseda University in Japan developed a whole family of Waseda Legged (WL) robots during 20th century. The fundamental function of bipedal locomotion was applied on the artificial lower-limb WL-1 which was constructed on 1967. WL-3 was created on 1969 having electro hydraulic servo actuators. Master-slave method based control mechanism was constructed and it was able to manage human like movement in swing and stance phase. Automatic biped walking and the ability to change direction of walking were experimented and made possible.

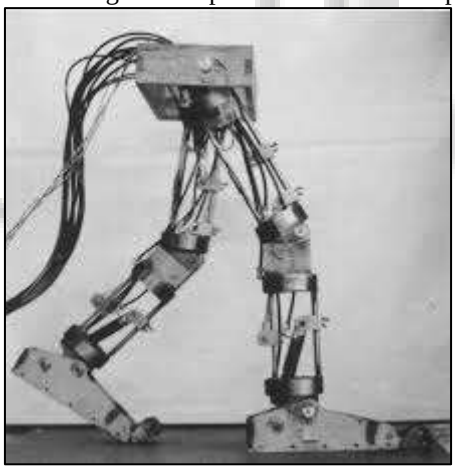

Fig. III: (A) Wasseda Legged Prototype

B. *BIPER*

In 1980s, Miura and Shimoyama developed a bipedal robot family called BIPER which was statically unstable but dynamically stable in walking. BIPER-4 robot had non-motorized articulation at the ankles, very big feet and no articulation at the knee [8]. The analogy of an inverted pendulum's movement was used to define its gait. From 1984 to 1988, Sano and Furusho's team worked on the BLR-G2 robot which had 9 DOF and was controlled by DC motors. The maximum speed of progression of the robot was 0.35ms-1.

C. *ASIMO (Advanced Step in Innovative Mobility)*

In Japan HONDA company built a whole range of bipedal robots from 1986. First there were E0 to E6 then humanoid robot called P1 to P3 and finally the most intelligent humanoid robot called ASIMO (Advanced Step in Innovative Mobility). First version of ASIMO was 1.2m high having 26 DOF and was moved by electric motors. The latest version is developed in 2005 having 1.3m high and 34 DOF. It can recognize moving objects, surrounding environment, sounds, and faces. It can also understand the gestures and postures portrayed by others. The latest model of this robot achieved the ability to climb stairs and also to run which was a critical task of humanoid research.

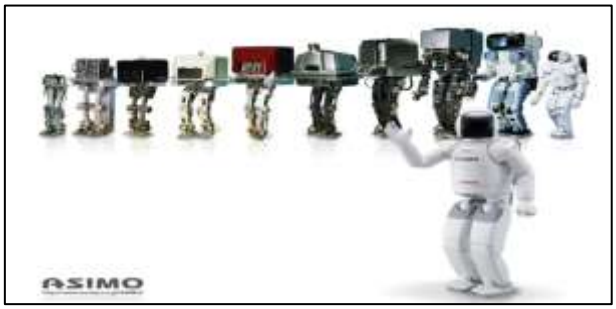

Fig. III: (C) ASIMO Robot Family

D. *SCARA (Selective Compliance Assembly Robot Arm)*

SCARA robots were first developed in the 1980's in Japan and the name SCARA stands for Selective Compliance Assembly Robot Arm. The main feature of the SCARA robot is that it has a jointed 2-link arm which in some ways imitates the human arm although it operates on a single plane, allowing the arm to extend and retract (fold) into confined areas which makes it suitable for reaching inside enclosures or pick-and-place from one location to another. This robotic arm further helped in developing the modern versions of robot with the arm movement.

Fig. III: (D) SCARA

E. *Bipedal Robot*

The first Bipedal Robot having only legs and feet was studied in 1993 at Strasbourg University, France. Bipedal robot BIP2000 was designed and constructed jointly by the INRIA Rhone-Alpes and LMS Poitiers. It was 1.8 meter high and weight was 105kg. It was having 3 DOF and was able to walk at the speed of 0.36km/hr. With the aiming to establish walking and running gait, the RABBIT project was started in 1998 with CNRS Grenoble, France bipedal robot community. The system had a few DOF and each of the gearboxes of the motors was capable to produce a maximum torque of 150 Nm which was necessary for running gaits.

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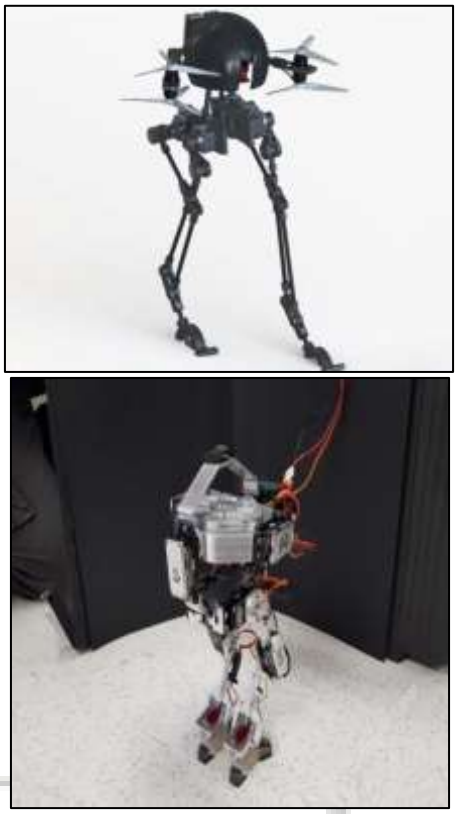

Fig. III: (E) Bipedal Robot

IV. RECENT DEVELOPMENT ON HUMANOID

A. *Atlas*

Atlas is a bipedal humanoid robot primarily developed by the American robotics company Boston Dynamics .The robot is designed for a variety of search and rescue tasks. The design and production of Atlas was overseen by DARPA, an agency of the United States Department of Defense, in cooperation with Boston Dynamics. One of the robot's hands was developed by Sandia National Laboratories, while the other was developed by iRobot. Atlas is about 175 cm (5 ft 9 in) tall and weighs around 82kg. To control Atlas, an operator provides general steering via a manual controller while the robot uses its stereo cameras and lidar to adjust to changes in the environment. Atlas can also perform certain tasks autonomously. It is one of the most smartest and advanced robot in the world right now. It can walk, jump, run, open doors, close valves and now even do parkour.

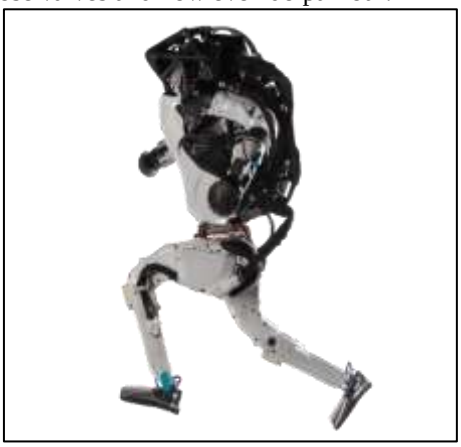

Fig. IV: (A) Atlast Robot

B. *Sophia*

Sophia is a social humanoid robot developed by Hanson Robotics, Hong Kong-based company. Sophia was first turned on February 14, 2016. She is integrated with advanced AI algorithms to behave more like humans. She is capable of displaying more than 60 facial expressions and can make active conversations on predefined topics. Sophia uses speech recognition technology to communicate. . It has AI algorithms that help it to learn constantly to improve the efficiency of its conversations. Sophia was named the United Nations Development Programmer's first-ever Innovation Champion for Asia and the Pacific. Sophia has also become a public figure addressing various competitions and news channels and making various appearances on various T.V platforms.

C. *REEM*

REEM is the latest prototype humanoid robot built by PAL Robotics in Spain. These robots are capable of recognizing, grasping, and lifting objects. REEM-C is the latest advanced humanoid robot by PAL robotics. It has a height of 165cm, weighing 8kg and capable of handling payload of 1kg. It works on Real time OS and Ubuntu LTS technology. REEM-C is prototype now has advanced gait algorithms with an average speed of 1.4km/h and can lift up to 12 kg of payloads.

Fig. IV: (C) REEM Robot

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Fig. IV: (D) Sophia Robot

V. FUTURE OF HUMANOID ROBOT

It has been well documented that there will be an increase in the number of robots over the next decade. In the next two decades robots will be used as the replacement of humans in most the manufacturing and service jobs. Economic development will be primarily determined by the advancement of robotics. The United States, along with Canada, Japan, South Korea, and the United Kingdom, will be leading the way in robot adoption. In near future humanoids will exhibit emotion, forge relationships, make decisions, and develop as they learn through interaction with the environment. Robots that can incrementally acquire new knowledge from autonomous interactions with the environment are the main target to accomplish. Humanoid robots, while being one of the smallest groups of service robots in the current market, have the greatest potential to become the industrial tool of the future. Humanoid Robotics also offers a unique research tool for understanding the human brain and body.

Japan is currently one of the great players in this technology which showcase that it can become the economic leader in the near future. Also, NASA is using its Valkyrie robot for similar tasks, albeit on future missions to Mars. These robots can perform way better than humans in dangerous works like underground mining, war-zones, medical, construction, space exploration etc. These robots can help assists humans in industries, mining activities and during interplanetary explorations. The robotics industry is experiencing exponential growth worldwide and stands poised to become one of the most exciting and expansive markets for technology in the twenty-first century. Robots will soon be everywhere, in our home and at work. They will change the way we live. This will raise many philosophical, social, and political questions that will have to be thought and answered.

VI. CONCLUSION

As, we have seen the users have already appreciated the role of humanoid robots in the field of healthcare and education etc. Humanoids are surely the future. This paper reviewed the evolution of the humanoids by covering some topics which helped us in understanding major breakthroughs that happened in the research over the years. Artificial Intelligence and Robotics are powerful combination that overcomes the current drawbacks or finds new possibilities to improve the efficiency of robot's performance. Still, there is a long way to go in-order to make this technology more reliable, cost-effective and available to all.

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