The Importance of Robotic Technology in Engineering Industries, Medical and Radioactive Environment

Dr. D. Nagarathinam

Principal, Theni Kammavar Sangam College of Technology, Theni – 625 534.

Abstract:- ***R****obotics is the science and the study of robots. Robotics is a fascinating new field of study, and a rapidly growing one too, as robots are being used more and more in different fields, including industry, research labs, and even in homes. They are most useful in places and situations where it is dangerous for people to work, like in atomic power plants, diffusing a bomb, or working in mines. Moreover, it is often cheaper and easier to use robots rather than humans-especially for some jobs. This paper thoroughly discusses the classification of robots, important parts of the robots and the application of Robotic technology in the present era to reach the phase where the industries will have less human intervention. Also an emphasis is given on understanding the basic design and methodology of the robots.*

Keywords: *Robots, Industrial robots, Da Vinci Surgical System, Sophia, Radioactive environment.*

1. INTRODUCTION:

The term comes from a Czech word, robota, meaning "forced labor" or "slave" or "drudgery, servitude **(1)"** The word robot first appeared in a 1921 play by Czech writer Karel Capek, R.U.R.: Rossum's Universal Robots. A robot is a machine designed to execute one or more tasks automatically with speed and precision [(2)]. Robots can be made to look like humans or animals, but this is not always the case. Today's robot, on the other hand, has artificial intelligence and can perform many tasks-but the fact remains that automatons are surely the ancestors of the present-day sophisticated robots **(2)**.

Robots are developed to reduce human effort and to maximize the quality of work. They find their application in various fields. Industrial robots, For example, do not have a human form at all, but they do the jobs that human beings used to do previously. Automation cannot change any of its movement and it does not have any intelligence of its own.

In Japan during the year 1928, the Gakutensoku robot was designed and constructed by Makoto Nishimura **(3)**. Japan is still a leader in robotic production. Automation and robotics are familiar concepts in Japan and it is used either to replace or enhance human labor. Prof. Ichiro Kato of Waseda University initiated humanoid robots WABOT project in 1967 and completed the WABOT -1 in 1971, the world's first full-scale humanoid intelligent robot with two arms, walked on two legs and sees with two camera eyes **(4)**. Japanese companies are leading in the development of robotic technology **(5)**. FANUC industry, Kawasaki, Sony, and the Yaskawa Electric Corporation have traditionally been at the forefront in robotic development during Japan's economic rise. The main reason for Japan's postwar economic success is automation and the integration of robotic technology into industrial production. Kawasaki started the commercial production of industrial robots over 40 years ago **(6)**. Out of 700,000 industrial robots in worldwide, 500,000 of them were from Japan **(7)**. Japan initiated an eight-year national development program in 1984 **(8)**. This $150m program includes the development and maintenance of robots for the nuclear industry. Japan exported some $1.6 billion worth of industrial robots in 2016 i.e. more than the five biggest exporters like Germany, France, Italy, United States, and South Korea combined. In 2012, between 1,235,000 and 1,500,000 industrial robots were in use **(9)**. Japanese industrial robot manufacturers delivered more than half of industrial robots supplied in 2017. Japan is the world's leading supplier of industrial robots according to the World Robotics - Industrial Robot Report 2018. In 2017 Japanese industrial robot manufacturers delivered almost 55% of industrial robots. In 2016 Japanese industrial robot manufacturers supplied more than 39% of industrial robots. There are more than 297,200 industrial robots are working in Japan during 2017 whereas in China more than 473,400 robots are working in 2017 **(10)**.

2. CLASSIFICATION OF ROBOTS:

Robotics is the interdisciplinary branch of engineering and science which includes mechanical engineering, electrical engineering, computer science, and others. It deals with the design, construction, and as well as computer systems for their control, sensory feedback, and information processing. Robotics Engineering is a specialized type of Engineering. It is also known as, Automation Engineer, Robotics and Automation Engineer, Automation Robotics Engineer. There is two basic classifications of robots. 1. Fixed robot and 2.Mobile robot.

A fixed robot is attached to a platform and it remains in one place while doing the task assigned to it. The mobile robots are becoming more common in a commercial

setting [11]. Mobile robotics is usually considered to be a subfield of robotics and computer science engineering. The mobile robots can move one place to another either on wheels or on legs or by crawling. Hospitals and warehouses use mobile robots to move materials from one place to another. The study of the robot is an interdisciplinary branch which involves sensors, remote controller and automation.

3. COMPONENT OF A ROBOT:

A robot essentially consists of the following 5 important parts or components:

- A controller connected to a computer,
- An arm,
- Drive, (Engine)
- End effectors, (Acted as a hand attached to the robotic arms – tools)
- actuators and sensors.

3.1 An Arm:

The arm of a robot as an important part of the robotic Architecture. Most of the robotic arms resemble the human hands having fingers, wrists, and elbows. A servo motor is used to actuate the arms.

3.2 End Effector:

The end effector is the hand which is connected to the arm. Depends upon the applications/ uses the robotic the end effector can be of various shapes and sizes.

3.3 Controller:

The controller is connected to the computer network systems, so that the robot may work together with other robots or machines. The controller functions as the "brain" of the robot.

3.4 Drive:

Most of the robotic drives are made by using D.C. motors. The drive is the engine of the robot. It enables mobility and movements between the joints of the arm.

3.5 Actuators:

They are generally muscles of a robot. The actuators mechanism can be achieved by using electric motors/ hydraulic systems/ pneumatic systems, or any other system that can apply forces to the system.

3.6 Sensors:

The sensors are used as a converter that measures a physical quantity and converts it into a signal which can be read by an observer. The Sensors which are used in a robot are vision sensors (Camera), tactile and proximity sensors line sensors, Temperature sensors, light sensors and sound sensors.

4. ADVANTAGE OF ROBOTS:

1. Robots increase productivity, safety, efficiency, quality, and consistency of products.
2. It can work in hazardous environments like Atomic Reactors.
3. A robot does not require any environmental comfort
4. Robots can work continuously without sickness and illnesses.
5. Robots can have the accuracy and precision of components at all times.
6. Robots are more accurate than humans; they may have milli or micro-inch accuracy.

5. APPLICATION OF THE ROBOT:

5.1 Industrial Robot:

It is used for manufacturing industries. It finds application in a variety of tasks namely assembling of components, material handling process, and inspection operations. Typical applications of robots include welding, painting, assembly, dismantle, etc. The most commonly used industrial robots are Delta Robots, Unimate Robots, SCARA Robots, Cartesian co-ordinate robots, etc.

Delta Robots involves the movement of material or parts from one location to another. Examples are part placement, palletizing and/or de-palletizing, machine loading and unloading. Unimate Robot finds application in Automobile industries for assembling of parts. SCARA Robot finds application in material handling industries. A look inside the BMW factory in Munich, Germany where they have been making vehicles since 1952.

Fig.1. BMW's robot army makes 1,000 cars a day. Courtesy: CNN.com

5.2 Spacecraft Robot:

Robotic arms on spacecraft are used to move very large objects in space. Spacecraft. The robots follow the commands which are sent by the researchers and do the work by themselves. People send them commands. This type of robot includes the lunar rovers that explore the surface of Mars.

5.3 Medical Robot:

The robots are used in the medical sciences. They include surgical robots, Rehabilitation robots, Bio robots, etc. The minimally invasive surgery robots are used in Cardiac Surgery, Colorectal Surgery, General Surgery, Thoracic Surgery, Urologic Surgery, Gynecologic Surgery, Head and Neck Surgery. These robots use the surgeon's activators on one side to control the "effector" on the other side. Today's robots assist in high precision surgeries such as brain and heart surgery. In 1999 American Intuitive Surgical Company introduced the **Robotic Da Vinci Surgical system (Fig.3).** It is a robotic surgical system designed to help the surgeons perform surgeries with just a small incision. This system has been successfully used all over the world. It is especially used in Cardiac valve repair. This robotic surgery is cheaper and safer than traditional surgeries.

Fig.3. Robotic Da Vinci Surgical System Courtesy: RoboCatz.com

5.4 Humanoid Robot:

Humanoid robots are quite popular and they look exactly like humans. Sophia is the first humanoid robot**. Fig.4**. **Shows Sophia, the Humanoid Robot.** Sophia was introduced to the United Nations on October 11, 2017 by Hanson robotics and can carry out a wide range of human actions. She has very expressive eyes and her Artificial Intelligence revolves around human values. She has an equal sense of humor. This particular humanoid was designed to look like the late British actress, Audrey Hepburn. Sophia has attended several interviews, conferences and is now one of the world's most popular humanoids. Sophia appeared at the Australian Engineering Conference to discuss robot rights [13]

Fig.4. Sophia, the Humanoid Robot. Courtesy: Create Digital.

5.5 Manbo Robot or Sunfish Robot:

In nuclear history there were three major nuclear power plant accidents i.e. 'The Three Mile Island (TMI) accident' in 1979, 'Chernobyl tragedy' in 1986, and the most recent Fukushima Daiichi Power Plant misfortune at Fukushima in 2011.

The Fukushima Daiichi nuclear disaster was a nuclear accident due to an earthquake and tsunami on 11th March 2011 in Japan. A 14-meter-high Tsunami was generated due to the earthquake after 46 minutes later [14]. The Tsunami waves and flood sweep the Fukushima plants and the Units 1-4 reactor buildings were with seawater, which filled the basements and knocked out the emergency generators which caused nuclear accidents.

On 13th March 2011, the nuclear safety agency of Japan investigates the cause of a white cloud of smoke rising above the Fukushima Daiichi plant. A government official said a partial meltdown may be occurring at the damaged Fukushima Daiichi plant, sparking fears among people. Today robots are widely used in the nuclear industry particularly in radioactive space or area to perform the repetitive work or to execute hazardous tasks that are dangerous to human beings. First, profitability is the motivation to switch from a regular worker to an automated system and the second one is the safety of the workers.

Plant operator Tokyo Electric Power Company (TEPCO) has sent in a pair of US-made crawler **PackBot robots** to examine areas but it failed [16]. The **second Scorpion robot** had failed, getting caught on debris or suffering circuit malfunctions from excess radiation [17]. The

swimming robot shown in Fig.1 was co-developed by electronics and energy giant Toshiba and the government's International Research Institute for Nuclear Decommissioning. Scientists want to know the melted nuclear fuel's exact location and understand structural damage. The newer version, of a robot called the Mini-Manbo, or "little sunfish," was made of radiation-hardened materials with a sensor. **Fig.5. Shows the Mini Manbo Sun Fish Robot (Swimming Robot) for Inspection.**

This tiny robot named Mini Mambo (miniature sunfish) is a submersible robot developed to inspect a nuclear plant in Fukushima and capture footage of melted uranium in Unit 3 [18, 19]. The size of this robot is that of a shoe, and uses tiny propellers to hover and glide through the water in a manner similar to an aerial drone. After three days of careful navigation, the Manbo finally reached the heavily damaged Unit 3 reactor of the Fukushima Daiichi plant [20].

Fig.5: Mini Manbo (Sun Fish) Robot: Swimming Robot for Inspection

Courtesy: Japantimes.co.jp

6. CONCLUSION:

Technological advancement in robotics has ever-increasing need and contribution in the productivity, safety, efficiency, quality, and consistency of products. This increasing robotic advancement trend is not only associated with the revolution in robotics and automation but also human safety in a radioactive environment. Robots are used under extreme conditions on offshore oil and gas installation and nuclear radioactive environment. In India, MHRD is sponsoring through National Mission on Education through Information and Communication Technology (NMEICT) by the e-yantra project conducted by IIT Mumbai [21] to train the teachers and students on Robotics and Embedded Systems by conducting workshop.

REFERENCES:

1. Dan Kincaid, The Arizona Republic, In Czech, 'Robot' means Drudgery, Deseret News, July 2014.
2. http://www.searchpriseal.techtarget.com>definition> robot
3. "Japan's first-ever robot". Yomiuri.co.jp. Retrieved 2014-02-08.
4. http://www.humanoid.waseda.ac.jp/booklet/kato 2-j.html.
5. Robotics and Mechatronics: Proceedings of the 4th IFToMM International Symposium on Robotics and Mechatronics, Editors: **Zeghloul**, Saïd, **Laribi**, Med Amine, **Gazeau**, Jean-Pierre (Eds.) 2016. page 66.
6. "Japan has long Robotics History". Archived from the original on 2011-07-19. Retrieved 2010-04-05.
7. "A (Social) History of Robots (and maybe some consequences of same)" (PDF). Retrieved 2010-04-05.
8. Report by the Technology Transfer, U.S. Department of Energy, Robotics and Nuclear Power, Washington.D.C, June 1985.
9. "2012: Second highest number of robots sold in 2012". www.ifr.org. Archived from the original on 2016-03-27.
10. http://ifr.org > post > why-japan-leads-industrial-robot-production.
11. "Information Engineering Main/Home Page". *www.robots.ox.ac.uk*. Retrieved 2018-10-03
12. http://www.sciencedirect.com>topics>engineering>medical
13. Create Digital, Meet Sophia, the Humanoid Robot that has the World Talking, April19th, 2018.
14. "Fukushima faced 14-metre tsunami". World Nuclear News*. 24 March 2011.* Archived *from the original on 16 June 2011*. Retrieved 24 March 2011.
15. IAEA technical report, "Nuclear power plant outage optimisation strategy-Third party Liability at Nuclear Power Plant", Published on Behalf of Nuclear Pool Forum, December 2017.
16. http://www.readersupportnews.org>5276-rsn-special-coverage-disaster-in-japan
17. Robot to Examine fuel Debris in Fukushima Unit, 29th January 2019, World Nuclear News.
18. http://www.design-engineering.com>Automation.
19. http://www.theverge.com>fukushima-nuclear-power-plant-robot-radiactice.
20. Fackler, Martin "Report Finds Japan Underestimated Tsunami Danger". *The New York Times*. Retrieved 18 August 2019.
21. www.e-yantra.org.

BIOGRAPY:

Dr. D. Nagarathinam has been working as the Principal at Theni Kammavar Sangam College of Technology for the last 8 years. Worked as the Principal for 20 years at various engineering colleges.