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Robots in The Chemical Industry

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ABSTRACT: *Robots are quickly providing an indispensable function in the safe operation of chemical laboratories. They are now performing tasks which traditionally could harm or kill humans. Tasks such as handling explosive chemicals to radioactive substances, are now successfully (routinely) performed by robots. This paper provides a brief introduction of the use of robots in the chemical industry.*

KEY WORDS: *robots in chemical industry, industrial robots, robotics*

I. INTRODUCTION

The highest percentage of newly ordered industrial robots is occurring in the chemical industry due to its much larger production scale and fast-growing market demand. When industrial robots are placed into production, they have been replacing the human workforce, keeping chemical manufacturing competitive. They have the advantages of increasing productivity and reducing the occurrence of accidents at work.

Robots are usually computer controlled and must be taught (or programmed) everything they do. They are available in many sizes and configurations. They are used in education, laboratories, medicine, space exploration, industry, and social services. Japan leads the world in the production of industrial and imaging robots, dubbing Japan "The Robot Kingdom".

II. ROBOTS

Czech playwright Karel Čapek coined the word robot in 1922, while science-fiction American writer Isaac Asimov used the word robotics in 1940. Isaac Asimov came up with three laws of robotics:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.

2. A robot must obey orders given it by human beings except where such orders would conflict with the First Law.

3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

These laws are designed into every robot. Early robots were simple mechanical automated machines. Modern robots employ microprocessors and computer technology. They can be programmed and "taught" to perform certain tasks. Industrial robots are reprogrammable, multipurpose robots designed for industrial automation applications. They are taking on more "human" traits such as sensing, dexterity, remembering, and trainability. Artificial intelligence deals with developing robots that are capable of imitating human reasoning. The microprocessor and memory modules of the robot control systems "remember." Computer control has permitted robots to perform more precise industrial operations such as seam welding, spray painting, and precision assembly. Vision systems in conjunction with artificial intelligence have enabled robots to "see." Mounting a camera on the robot helps in a variety of applications such as robotic guidance and inspection [1]. There are various types of industrial robots. These include articulated robots, Cartesian robots, SCARA robots, and other robots such as cylindrical robots, polar robots, delta robots, and parallel robots [2]. Some robots do not demand special training for their programming. Industrial robots are generally immobile and are used for automation, welding or material handling. Mobile robots are used in entertainment, security, personal assistance, or surveillance [3]. Climbing robots are recent developments in industrial robots. They are designed for different industrial environments. They navigate inside petro-chemical storage tanks and climb on the hulls of steel ship for inspection of weld [4].

III. APPLICATIONS

Robots are applied in many fields such as manufacturing, medicine, drones (Unmanned Aerial Vehicles), autonomous underwater vehicles, oil and gas industry, pharmaceutical industry, automotive industry, space exploration, movies, spot or arc welding, and painting.

Pharmaceutical industry*:* Robots are being designed and used for the pharmaceutical industry. They are well-suited for the assembly work and drug discovery tasks in a pharmaceutical environment. They protect the integrity of pharmaceutical products and the health of employees [5]. Robots are also used in pharmaceutical research. Processes such as NMR can now have sample preparation done by robotic arm.

Manufacturing: Robots are well-suited for automation of the processes which are composed of repetitive and monotonous movements. Industrial robots are transforming revolutionizing the manufacturing and process industries. As they become smarter, faster and cheaper, they are taking on more jobs - such as picking and packaging, testing or inspecting products, or assembling minute electronics. Manufacturers also use robots to paint several things such as cellular phones, appliances, caskets, and electrical cabinets.

Industrial laboratory: Laboratory processes are well-suited for robotic automation as the processes are composed of repetitive actions such as dispensing acids, mixing, heating, centrifuging, filtering, and weighing. Robots can be built to automate the laboratory procedures. They can be used for specimen processing and operation of satellite labs [6]. A laboratory robot generally consists of an arm, a hand, and a pair of fingers which are programmed to duplicate the sample preparation usually performed by a laboratory technician.

Oil and gas: The use of robots in different stages of offshore production has improved EH&S (environment, health, and safety) standards and economic benefits. Oil spill particularly in the offshore environment is regarded as the biggest known ecological threat. Robots can be used for remote sensing and recovering spilled oil. The new trend is using mobile robots to inspect offshore platform [7].

IV. ADVANTAGES AND DISADVANTAGES

Robots have a number of advantages. Perhaps the most important advantage of using robots is to shield people from working in dangerous environments. Reducing liability by removing people from hazardous chemicals is a concept that chemical companies can easily use to justify investing in robots. Industrial robots enable automation, which leads to faster processing. They increase productivity by reducing the waiting and idle time on machining centers. Repeatability and reproducibility are improved. Efficiency is generally improved as robots can work continuously. Also, there is a reduction in material waste. A robot can successfully replace human operators, allowing them to be reassigned to more creative jobs.

Robots have some disadvantages. The high cost of some industrial robots has inhibited their adoption. The installation and start up cost for automation can be expensive. There can be job shortages as automation may replace staff members [8].

ISSUES AND CHALLENGES: Cost is a very important factor that drives the use of robots. Robots designed for industrial applications today must be very precise and accurate. One major challenge facing adoption of robots in chemical industry is lack of software or hardware standards. Industrial robotic devices require sound knowledge of computer programming and electronic interfaces and only a few engineers are trained in these disciples [9]. As robots interact with the material world and are controlled by software, we must address patents and copyright law, which are the main intellectual property rights that concern robots. The existing legal infrastructure will need to adapt and be updated to meet the current demands of the robotics age [10].

V. CONCLUSION

The population of robots is growing steadily because robot applications have ventured into exploring new horizons such as space exploration, movies, medicine, and underwater searches. As the number of chemicals used in the chemical industry continues to increase, the demand for robots to handle these chemicals will increase to minimize potential health and environmental risks associated with them.

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