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Research Insight: Developments in Automation

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BACKGROUND

Automated systems are usually required human to interact. For example, an automatic bank teller machine must receive instructions from customers and act accordingly. In some automated systems, a variety of different instructions from humans is possible, and the decision-making capability of the system must be quite sophisticated in order to deal with the array of possibilities. This article covers the fundamentals of automation, including its historical as well as modern development. Also, a brief description is presented on the development of robotics as a part of modern automation technology.

The term automation was coined in 1946 to define the enhanced use of automatic devices and controls. D.S. Harder, an engineering manager at the Ford Motor Company coined the term. The word is used in manufacturing context, but it is also applicable to outside manufacturing in relation with a variety of systems in which there is an important substitution of mechanical, electrical, or computerized action for human effort and intelligence.

In general usage, automation can be well-defined as a technology related with performing the process by means of preprogrammed instructions with automatic feedback control to confirm proper execution of the instructions. The resulting system is capable of operating without human intervention. The development of this technology has become dependent on the computers and related technologies. Consequently, automated systems have become increasingly refined and complex. Advanced systems represent a level of capability and performance that surpass in many ways the abilities of humans to accomplish the same activities.

HISTORICAL DEVELOPMENT OF AUTOMATION

The innovation of computerization has developed from the related field of automation, which had its beginnings in the Industrial Revolution. Motorization alludes to the substitution of human (or creature) control with mechanical force of some shape. The main impetus behind motorization has been mankind's penchant to make apparatuses and mechanical gadgets. A portion of the essential authentic improvements in motorization and computerization prompting to cutting edge robotized frameworks are depicted here.

Early Developments

The principal tools made of stone depicted the ancient man's endeavors to direct his own physical ability under the control of human knowledge. It took several years for the improvement of mechanical gadgets and machines, for example, the wheel, the lever, and the pulley, by which the force of human muscle could be amplified. The following expansion was the improvement of controlled machines that did not require human quality to work. Cases of these machines incorporate

windmills, waterwheels and simple steam-driven devices. More than 2000 years ago, the Chinese created trip-hammers controlled by streaming water and waterwheels. The early Greeks tried different things with basic response engines controlled by steam. The mechanical clock, speaking to a fairly complex get together with its own particular inherent power source (a weight), was created around 1335 in Europe.

Windmills, with systems for naturally turning the sails, were produced amid the Middle Ages in Europe and the Middle East. The steam motor spoke to a noteworthy progress in the advancement of fueled machines and denoted the start of the Industrial Revolution. Amid the two centuries since the presentation of the Watt steam motor, controlled motors and machines have been formulated that acquire their vitality from steam, power, and concoction, mechanical, and atomic sources.

Each new advancement in the historical backdrop of controlled machines has carried with it an expanded necessity for control gadgets to outfit the force of the machine. The most punctual steam motors required a man to open and close the valves, first to concede steam into the cylinder chamber and afterward to fumes it.

Later a slide valve instrument was conceived to naturally finish these capacities. The main need of the human administrator was then to manage the measure of steam that controlled the motor's speed and power. This prerequisite for human consideration in the operation of the steam motor was wiped out by the flying-ball senator. Created by James Watt in England, this gadget comprised of a weighted ball on a pivoted arm, mechanically coupled to the yield shaft of the motor.

As the rotational speed of the pole expanded, radiating power brought on the weighted ball to be moved outward.

This movement controlled a valve that diminished the steam being encouraged to the motor, subsequently abating the motor. The flying-ball senator remains a rich early case of a negative criticism control framework, in which the expanding yield of the framework is utilized to diminish the action of the framework.

Another important development in the history of automation was the Jacquard loom (see photograph), which demonstrated the concept of a programmable machine. About 1801 the French inventor Joseph-Marie Jacquard devised an automatic loom capable of producing complex patterns in textiles by controlling the motions of many shuttles of different colored threads.

The selection of the different patterns was determined by a program contained in steel cards in which holes were punched. These cards were the ancestors of the paper cards and tapes that control modern automatic machines.

The concept of programming a machine was further developed later in the 19th century when Charles Babbage, an English mathematician, proposed a complex, mechanical “analytical engine” that could perform arithmetic and data processing. Although Babbage was never able to complete it, this device was the precursor of the modern digital computer.

Modern Developments

A number of significant developments in various fields have occurred during the 20th century: the digital computer, improvements in data-storage technology

and software to write computer programs, advances in sensor technology, and the derivation of a mathematical control theory. All these developments have contributed to progress in automation technology.

Electronic Digital Computer

Development of the electronic digital computer (the ENIAC [Electronic Numerical Integrator and Computer] in 1946 and UNIVAC I [Universal Automatic Computer] in 1951) has permitted the control function in automation to become much more sophisticated and the associated calculations to be executed much faster than previously possible.

Integrated Circuits

The development of integrated circuits in the 1960s propelled a trend toward miniaturization in computer technology that has led to machines that are much smaller and less expensive than their predecessors yet are capable of performing calculations at much greater speeds. This trend is represented today by the microprocessor, a miniature multi-circuited device capable of performing all the logic and arithmetic functions of a large digital computer.

Computer Technology

Along with the advances in computer technology, there have been parallel improvements in program storage technology for containing the programming commands. Modern storage media include magnetic tapes and disks, magnetic bubble memories, optical data storage read by lasers, videodisks, and electron beam-addressable memory systems. In addition, improvements have been made in the methods of programming computers (and other programmable machines). Modern programming languages are easier to use and are more powerful in their data-processing and logic capabilities.

Sensor Technology

Advances in sensor technology have provided a vast array of measuring devices that can be used as components in automatic feedback control systems. These devices include highly sensitive electromechanical probes, scanning laser beams, electrical field techniques, and machine vision. Some of these sensor systems require computer technology for their implementation. Machine vision, for example, requires the processing of enormous amounts of data that can be accomplished only by high-speed digital computers. This technology is proving to be a versatile sensory capability for various industrial tasks, such as part identification, quality inspection, and robot guidance.

Control Systems

Finally, there has evolved since World War II a highly advanced mathematical theory of control systems. The theory includes traditional negative feedback control, optimal control, adaptive control, and artificial intelligence. Traditional feedback control theory makes use of linear ordinary differential equations to analyze problems, as in Watt's flying-ball governor. Although most processes are more complex than the flying-ball governor, they still obey the same laws of physics that are described by differential equations.

Optimal control theory and adaptive control theory are concerned with the problem of defining an appropriate index of performance for the process of interest and then operating it in such a manner as to optimize its performance. The difference between optimal and adaptive control is that the latter must be implemented under conditions of a

continuously changing and unpredictable environment; it therefore requires sensor measurements of the environment to implement the control strategy.

ADVANCEMENT IN TECHNOLOGY OF ROBOTICS AS A PART OF AUTOMATION

Automation technology has developed to a point where a number of other technologies have established from it and have achieved a recognition and status of their own. Robotics is one of them; it is a specialized branch of automation in which the automated machine possesses certain anthropomorphic or some similar human-like, characteristics.

The most typical humanlike characteristic of a modern industrial robot is its powered mechanical arm. The robot's arm can be programmed to move through a sequence of motions to perform useful tasks, such as loading and unloading parts at a production machine or making a sequence of spot-welds on the sheet-metal parts of an automobile body during assembly.
As these examples suggest, industrial robots are typically used to replace human workers in factory operations.

Development of Robotics

Robotics is based on two related technologies: numerical control and teleoperations. Numerical control (NC) is a method of controlling machine tool axes by means of numbers that have been coded on punched paper tape or other media. It was developed during the late 1940s and early 1950s.

The first numerical control machine tool was demonstrated in 1952 in the United States at the Massachusetts Institute of Technology (MIT). Subsequent research at MIT led to the development of the APT (Automatically Programmed Tools) language for programming machine tools.

Teleoperator

A teleoperator is a mechanical manipulator that is controlled by a human from a remote location. Initial work on the design of teleoperators can be traced to the handling of radioactive materials in the early 1940s. In a typical implementation, a human moves a mechanical arm and hand at one location, and these motions are duplicated by the manipulator at another location.

Artificial Intelligence

Artificial intelligence is an advanced field of computer science in which the computer is programmed to exhibit characteristics commonly associated with human intelligence. These characteristics include the capacity for learning, understanding language, reasoning, solving problems, rendering expert diagnoses, and similar mental capabilities.

Developments in artificial intelligence are expected to provide robots and other "intelligent" machines with the ability to communicate with humans and to accept very high-level instructions rather than the detailed step-by-step programming statements typically required of today's programmable machines. For example, a robot of the future endowed with artificial intelligence might be capable of accepting and executing the command "assemble the product." Present-day industrial robots must be provided with a detailed set of instructions specifying the locations of the product's components, the order in which they are to be assembled, and so forth.

Industrial Robotics

Industrial robotics is an automation technology that has received considerable attention since about 1960. This section will discuss the development of industrial robotics, the design of the robot manipulator, and the methods of programming robots. The applications of robots are examined below in the section

manufacturing applications of automation and robotics. Industrial robotics can be considered a combination of numerical-control and teleoperator technologies.

Numerical control provides the concept of a programmable industrial machine, and teleoperator technology contributes the notion of a mechanical arm to perform useful work. The first industrial robot was installed in 1961 to unload parts from a die-casting operation. Its development was due largely to the efforts of the Americans George C. Devol, an inventor, and Joseph F. Engelberger, a businessman. Devol originated the design for a programmable manipulator, the U.S. patent for which was issued in 1961. Engelberger teamed with Devol to promote the use of robots in industry and to establish the first corporation in robotics—Unimation, Inc.

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