Journal of Advances and Scholarly Researches in Allied Education

Vol. VIII, Issue No. XVI, Oct-2014, ISSN 2230-7540

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AN INTERNATIONALLY INDEXED PEER REVIEWED & REFEREED JOURNAL

www.ignited.in

Journal of Advances and Scholarly Researches in Allied Education
Vol. VIII, Issue No. XVI, October-2014, ISSN 2230-7540

Mechatronics, Robotics and Control: Application of Mechatronics in Automation

Patil Varsha Indas[1]* Dr. Sugumar R.[2]

[1]Student

[2]Asst. Prof.

Abstract – This study deals with mechatronics, robotics and control, control self-tuning systems of objects with concentrated and distributed parameters. The real-time motion control of robot manipulators, Robot manipulators have complex nonlinear dynamics that might make accurate and robust control difficult. Fortunately, robots are in the class of Lagrangian dynamical systems, with the intention that they have several tremendously nice physical properties that make their control simple.

Mechatronics is a combination of electronics, software system and automation system. The manufacturing enterprises thoroughly rely upon the incorporation of PC and hardware advancements for better items and procedures. As the circumstance turned out to be extremely aggressive it was important to isolate the hardware and automation branches. This division of the two branches prompted an interdisciplinary way to deal with present mechatronics. Mechatronics can be referring as Elctroautomation system or control car system.

Keywords: Mechatronics, Intelligent Robotics, Robot Motion Robotics and Control

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1. INTRODUCTION

Mechatronics is an idea of Japanese source (1970's) and can be characterized as the mix of Automation System. With different branches of framework, for example, hardware, PC to control the movements of computerization frameworks .Mechatronics item configuration gives upgraded estimation of the robotization item. It includes use of electrical, robotization, control and PC framework to create items, procedures and frameworks with more prominent adaptability, ease in upgrade and capacity of reconstructing. It simultaneously incorporates every one of these controls. Mechatronics can likewise be named as supplanting of mechanics with gadgets or improve computerization items with hardware. For instance, in late vehicles, mechanization fuel infusion frameworks are presently supplanted with electronic fuel infusion frameworks. This substitution made the autos more effective and less contamination. Likewise, there are number of mechatronics items, for example, PC based vernier caliper, PC based measuring parity, and programmed stream of water through tap. With the assistance of microelectronics and sensor propel improvement, mechatronics frameworks are giving elevated amounts of accuracy and unwavering quality. It is presently conceivable to move (in x – y plane) the work table of a current creation machine device in a stage of 0.0001 mm. By work of reprogrammable microcontrollers/microcomputers, it is currently simple to add new capacities and abilities to an item or a framework. The present residential clothes washers are "clever" and four-wheel traveler cars are outfitted with security establishments, for example, air-packs, stopping (closeness) sensors, hostile to burglary electronic keys and so on.

1.1 Application of Mechatronics in Automation

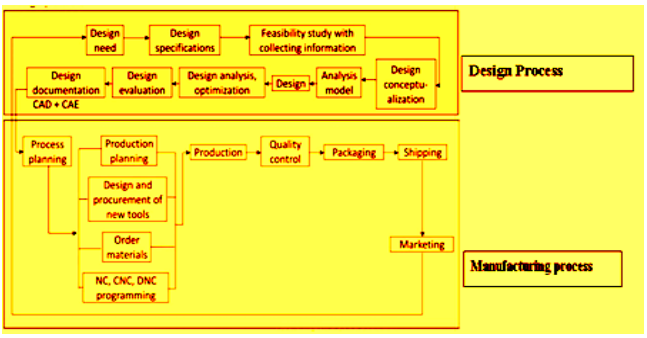

Fig: Operations involved in design and manufacturing of a product

There are numerous exercises engaged with the item producing process. These are appeared in figure. These exercises can be ordered into two gatherings ,i.e., plan and assembling activities. It is consequently

fundamental to computerize the assembling and get together operations of an item. Mechatronics item has great accuracy, lesser wear and less expensive in showcase. Robotization teach is utilized as far as various machines and components, whereas electrical framework as numerous electric prime movers viz. Air conditioning/DC, servo engines and different frameworks is utilized. Control framework helps in the advancement of different hardware based control frameworks to upgrade or supplant the mechanics of the mechanization frameworks. PCs are generally used to compose different programming projects to control the control frameworks, item outline , materials and assembling asset arranging, Using PC helped plan (CAD)/PC supported investigation (CAE) devices, three-dimensional models of items can without much of a stretch be produced. These models would then be able to be broke down and can be recreated to contemplate their shows utilizing numerical devices. These numerical apparatuses are by and large persistently refreshed or advanced with the genuine shows of the comparable sort of items. These activities give an inexact thought regarding show of the item/framework to the outline group at the beginning time of the item advancement. In view of the recreation contemplates, the outlines can be adjusted to accomplish better shows. Amid the ordinary outline fabricating process, the plan evaluation is for the most part done after the generation of first parcel of the items. This expends a great deal of time, which prompts longer (in months/years) item advancement lead-time. Utilization of CAD– CAE devices spares huge time in examination with that required in the ordinary successive plan process. Mechatronics based robotized frameworks, for example, programmed assessment and quality confirmation, programmed bundling, record making, and programmed dispatch help to speed up the whole assembling operation. These frameworks absolutely guarantee a supply better quality, all around stuffed and solid items in the market. Computerization in the machine apparatuses has decreased the human mediation in the machining operation and enhanced the procedure productivity and item quality. In this way it is essential to think about the standards of mechatronics and to figure out how to apply them in the mechanization of an assembling framework.

2. REVIEW OF LITERATURE:

The History of Robotics

1947 — the first servoed electric fueled teleoperator is produced

1948 — a teleoperator is created consolidating power criticism

1949 — investigate on numerically controlled processing machine is started

1954 — George Devol plans the first programmable robot

1956 — Joseph Engelberger, a Columbia University material science understudy, purchases the rights to Devol's robot and establishes the Unimation Company

1961 — the first Unimate robot is introduced in a Trenton, New Jersey plant of General

Engines to tend a bite the dust throwing machine

1961 — the first robot fusing power criticism is created

1963 — the first robot vision framework is created

1971 — the Stanford Arm is created at Stanford University

1973 — the first robot programming dialect (WAVE) is created at Stanford

1974 — Cincinnati Milacron presented the robot with PC control

1975 — Unimation Inc. registers its first financial profit

1976 — the Remote Center Compliance (RCC) gadget for part inclusion in get together is produced at Draper Labs in Boston

1976 — Robot arms are utilized on the Viking I and II space tests and arrive on Mars

1978 — Unimation presents the PUMA robot, in light of plans from a General Motors contemplate

1979 — the SCARA robot configuration is presented in Japan

1981 — the first coordinate drive robot is produced at Carnegie-Mellon University

1982 — Fanuc of Japan and General Motors shape GM Fanuc to advertise robots in North America

1983 — Adept Advance improvement is established and effectively showcases the immediate drive robot

1986 — the submerged robot, Jason, of the Woods Hole Oceanographic Institute, investigates the disaster area of the Titanic, found a year sooner by Dr. Robert Barnard.

1988 — St¨aubli Group buys Unimation from Westinghouse

1988 — the IEEE Robotics and Automation Society is framed

1993 — the exploratory robot, ROTEX, of the German Aerospace Agency (DLR) was flown on board the space carry Columbia and played out an assortment of errands under both tele-worked and sensor-based offline modified modes

1996 — Honda uncovers its Humanoid robot; a task started in mystery in 1986

1997 — the first robot soccer rivalry, RoboCup-97, is held in Nagoya, Japan and draws 40 groups from around the globe

1997 — the Sojourner versatile robot goes to Mars on board NASA's Mars Path Finder mission

2001 — Sony starts to mass framework the first family unit robot, a robot pooch named Aibo

2001 — the Space Station Remote Manipulation System (SSRMS) is propelled in space on board the space carry Endeavor to encourage proceeded with development of the space station

2001 — the first telesurgery is performed when specialists in New York played out a laparoscopic rankle bladder evacuation on a lady in Strasbourg, France

2001 — robots are utilized to look for casualties at the World Trade Center site after the

September eleventh catastrophe

2002 — Honda's Humanoid Robot ASIMO rings the opening chime at the New York Stock Exchange on February fifteenth

The primary effective uses of robot controllers for the most part included a type of material exchange, for example, infusion forming or stamping where the robot only went to a press to empty and either exchange or stack the completed part. These first robots were fit for being customized to execute a grouping of developments, for example, moving to an area An, end a gripper, moving to an area B, and so on., yet had no outer sensor capacity. More mind boggling applications, for example, welding, crushing, deburring, and gathering require more intricate movement as well as some type of outside detecting, for example, vision, material, or power detecting, because of the expanded collaboration of the robot with its condition.

Mechatronics combines electronics, controls, and computers in the design of high concert systems. Most recent products - automobiles, household appliances, printers, hard-disk drives, surgical tools, to name a few - embody numerous 'intelligent' or 'smart' features enabled by mechatronics.

Mechatronic configuration endeavors to framework higher show at bring down costs, a basic objective in the tech segment in the present economy. Our mechatronic frameworks examine concentrates on:

- Micro and nanopositioning frameworks
- Haptic gadgets
- Bio-enlivened consistent frameworks

SPECIALITIES

- Nanomanipulation and nano producing
- Robotics
- Smart materials and structures
- Structural wellbeing observing
- Haptic interface and robotics
- Production and utilization of nanostructured materials
- Kinematics and union of components
- Human-robot associations
- Networked multi-operator frameworks

Self-sufficient and mechanical frameworks are regularly developing in our general surroundings; from substantial obligation designing automated arms underway chains, to robot vacuum cleaners or yard trimmers, self-driving autos and automatons to space robotics, or some other Mechatronic or self-sufficient framework. There is a solid vital course for worldwide industry in Robotics and Automated Systems (RAS) as prove by a large group of national and global procedure archives and systems.

Robotics is a generally youthful field of late propel advancement that crosses conventional framework limits. Understanding the intricacy of robots and their applications requires information of electrical framework, mechanization framework, frameworks and building framework, software engineering, financial aspects, and science. New teaches of framework, for example, fabricating framework, applications framework, and learning framework have developed to manage the many-sided quality of the field of robotics and manufacturing plant computerization.

The investigation of robotics has become enormously finished the previous twenty years, powered by fast advances in PC and sensor propel improvement and also hypothetical advances in charge and PC vision. Notwithstanding the subjects recorded above, robotics envelops a few regions not shrouded in this content, for example, headway, including haggled robots, flying and swimming robots, getting a handle on, "counterfeit consciousness", PC models,

programming dialects, and PC helped plan. A total treatment of the train of mechanical technology would require a few volumes. All things considered, right now, most by far of robot applications manage designing robot arms working in organized processing plant conditions.

About Robotics

The term robot was first brought into our vocabulary by the Czech dramatist Karel Capek in his 1920 play Rossum's Universal Robots, the word robota being the Czech word for work. From that point forward the term has been connected to an incredible assortment of robotization gadgets, for example, tele-administrators, submerged vehicles, independent land wanderers, and so forth. For all intents and purposes anything that works with some level of self-sufficiency, more often than not under PC control, has sooner or later been known as a robot. In this content the term robot will mean a PC controlled designing controller of the sort appeared in Figure. This sort of robot is basically a computerization arm working under PC control. Such gadgets, however a long way from the robots of sci-fi, are all things considered to a great degree complex electro-computerization frameworks whose systematic depiction requires propelled techniques, and which show many testing and fascinating exploration issues.

Figure: The ABB IRB6600 Robot. Photo courtesy of ABB

An official meaning of such a robot originates from the Robot Institute of America (RIA): A robot is a reprogrammable multifunctional controller intended to move material, parts, instruments, or concentrated gadgets through factor customized movements for the show of an assortment of undertakings. The key component in the above definition is the reprogram ability of robots. It is the PC mind that gives the robot its utility and flexibility. The supposed mechanical technology upset is, truth be told, some portion of the bigger PC insurgency. Indeed, even this limited form of a robot has a few highlights that make it alluring in a designing domain. Among the points of interest frequently refered to for the presentation of robots are diminished work costs, expanded accuracy and profitability, expanded adaptability contrasted and concentrated machines, and more altruistic working conditions as dull, redundant, or dangerous employments are performed by robots. The robot, as we have characterized it, was conceived out of the marriage of two prior advances: that of teleoperators and numerically controlled processing machines. Teleoperators, or ace slave gadgets, were produced amid the second world war to deal with radioactive materials. PC numerical control (CNC) was produced as a result of the high exactness required in the machining of specific things, for example, parts of high show air ship. The primary robots basically joined the robotization linkages of the teleoperator with the self-governance and programmability of CNC machines. A few points of reference headed straight toward exhibit day robot propel advancement are recorded underneath

3. MECHATRONICS SYSTEM

A Mechatronics system combines multiple technologies involving sensors, measurement systems, drives, actuation systems, microprocessor systems and software system. Microprocessor processes or utilizes the data/information gathered from the sensor system and creates the signals of appropriate level and suitable kind (current or voltage) which will be used to actuate the required actuator viz. a hydraulic piston-cylinder device for extension of piston rod in this case. The microprocessor is programmed on the basis of the principle of Hooks' Law. The schematic of microprocessor based equivalent spring mass system is shown in figure.

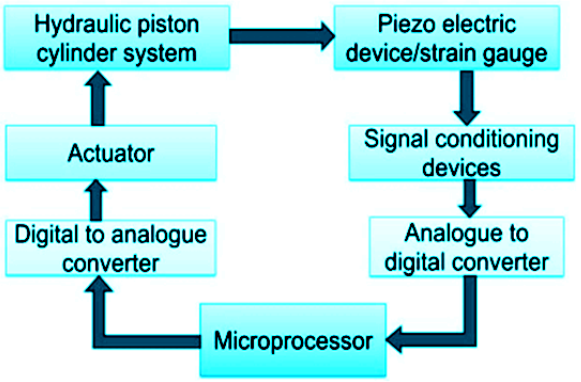

Figure 5: Microprocessor based equivalent spring mass system

The contribution to the framework is a power which can be detected by appropriate electro-computerization sensors viz. piezo-electric gadget or strain measures. These sensors make either PC based signs (0 or 1) or simple signs (milli-volts or milli-amperes). These signs are then changed over into right shape and are lessened to a correct level which can appropriately be utilized by the microchip to take make the activation signals. Numerous gadgets based assistant gadgets viz. Simple to-Computer based Converter (ADC), Computer based-to-Analog Converter (DAC), Op-amps, Modulators, Linearization circuits, and so on are utilized to condition the signs which are either gotten by the microchip from the sensors or are sent to the actuators from the chip. This mechatronics based spring-mass framework has the

information motions in the PC based shape which are gotten from the ADC and Piezo-electric sensor. The PC based activation signals made by the chip are changed over into proper analogs signals. These simple signs work the water powered pump and control valves to accomplish the coveted dislodgment of the cylinder pole.

4. NEURAL NETWORK CONTROL OF ROBOT MANIPULATORS

ROBOT manipulators have become increasingly important in the field of flexible automation. Through the years, considerable research effort has been made in their controller design. In order to achieve accurate trajectory tracking and good control concert, a number of control schemes have been developed. Computed torque control is one of the most intuitive schemes, which relies on the exact cancellation of the nonlinear dynamics of the manipulator system. Such a scheme has the disadvantage of requiring the exact dynamic model. Furthermore, the payload of the robot manipulator may vary during its operation, which may not be necessarily known in advance. To overcome these problems, adaptive control strategies for robot manipulators have been developed and have attracted the interest of many researchers, as shown in (Ghosh, et. al., 1999) and (Richard, 1998), for example. These adaptive control methods have the advantage, in general, of requiring no a priori knowledge of unknown parameters, such as the mass of the payload. Learning control schemes (Stan, 1994) have also been developed, which improve the concert of the system when the same motion is performed repeatedly, so that learning can take place. A drawback of such a control technique is that generally it is only applicable to operations which are repetitive. Recently, some developments have been made in the use of neural networks for the control of robot manipulators (Stan, 1994. Jelen, 1996. Miller, et. al., 2000. Gordan, et. al., 1997). In general, neural network control design is done in two steps. Firstly, a neural network is used to approximate the dynamic model of the system. Approximation is obtained; an appropriate control strategy using this approximation can be constructed. This approach has been shown to work well for many systems. However, it does not have any built-in capability to handle changes in the system. This is where incorporation of adaptive control is useful. Some recent works have successfully achieved this by using a suitable neural network to directly parameterize the control law (Chia-Chi, 1997). (Jang, et. al., 1997). This leads to an overall closed-loop system with good stability properties. While most of the neural network controllers require the evaluation of inverse dynamic model, as well as the time-consuming training process, it is eliminated in the approaches proposed in (David, 2001). and (Brooks, 1986). The neural networks can simply be initialized to zero by assuming no knowledge about the system. Besides that, the controller is robust and easy for real-time implementation. In this study, the control method presented in (Brooks, 1986) is further extended to the task space or the so-called Cartesian space. To apply robot manipulators to a wide class of tasks, it will be necessary to control not only the position of the end-effector, but also the force exerted by the end-effector on the object. By designing the control law in task space, force control can be easily formulated. Most controllers proposed thus far for adaptive manipulator tracking in the task space require some sort of inverse of the Jacobian matrix, for example). However, it is time-consuming and quite difficult to obtain the inverse of the Jacobian matrix. Moreover, it is prone to difficulties due to the kinematic singularities. By directly parameterizing the control law, we eliminate the need for the inverse of the Jacobian matrix.

CONCLUSION:

To meet the prerequisites for operation in dangerous situations, robots are right now tele-operated where a human administrator controls each part of the robot from a remote area. Cameras mounted at the remote worksite enable the administrator to perceive what is in the region of the robot, empowering the expected errand to be done. Developments of the robot are accomplished utilizing an ace slave course of action, where the remote slave robot takes after any movements that the administrator makes with an appropriate ace info gadget Robots are presently anticipated that would turn into the up and coming age of recovery help for elderly and impaired individuals, and one of the explored territories in assistive innovation is the advancement of wise wheelchairs. By coordinating an astute machine with a fueled wheelchair, an automated wheelchair can securely transport the client to a goal.

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Corresponding Author

Patil Varsha Indas*

Student

E-Mail – labsacademy@gmail.com