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Reconfigurable Industrial Robot

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Abstract

Small and medium scale industries are a backbone to the industrial sector which producesintermediate goods and services. Most of these industries are limited to human power. To increase the productivity of these sectors automation is important. Considering the demand of varying working parameters, reconfigurable robots are the best for their need. This paper discusses the architecture for designing and development of reconfigurable robots in industries. In this paper we describe a conceptual design of a robot whose configuration can be changed manually according to the workspace in demand.

Keywords:*Industrial robots; Interchangeable robots; Robotics; Reconfigurable Robots*

1. INTRODUCTION:

An industrial robot is a programmable machine which revolutionised the industrial sector in late 19th century. Industrial robots are flexible to carry out wider variety of tasks and can be reprogrammed in its workspace. These robots are particularly used for pick & place, material handling, and for carrying machining processes. The most common robot used in industries is the robotic arm which can be considered to correspond to human autonomy. Industrial robots are a boom to heavy and medium industries but not for small industries. Small industries have a continuous change in work environment which generates a need to change the workspace of the robot. The workspace represents the portion of space around the base of the manipulator that can be accessed by the endpoint. Since most of the robots used in today's industries are specific to their workspace they are not flexible to change their workspace and are considered as risk prone investments in small industries.

The shape and size of the workspace depends on the arm configuration, structure, degree of freedom, size of link, and design of joint. The physical space that can be swept by a manipulator (with arm and end-effector) may be more or less than the arm endpoint workspace, the volume of the space swept is called work volume and the surface of the workspace describes the work envelope. The workspace of a robot can be altered when the relative motion between the various links are changed. Each link in a robot has either a Prismatic or a revolute motion with respect to other link. The relative motion between various links determines the configuration of a robot. According to joint configuration and arrangement of links, four well distinguished basic structural configurations are possible for the arm and are named according to the coordinate system employed or the shape of the work space they sweep. These four basic configurations are:

- Cartesian (rectangular) configuration- all three P joints,
- Cylindrical configuration- one R and two P joints,
- Polar configuration-two R and one P joint,
- Articulated (Revolute or Jointed arm) configuration- all three R joints.

These configurations have work spaces in shapes of a cuboidal, a cylindrical, a partially spherical and spherical. There are also hollow cylinder type work volumes that are available. Depending upon the working environment, a suitable robot is chosen based on work space, precision and job size.

Each configuration has a fixed workspace that limits the reachability of the end-effector. In order to increase the work envelope of the workspace, a robot has to be designed in such a way that it can be incorporated in any of the above mentioned configurations depending upon the need. Present day industries require a promising robot whose configuration can be completely transformed to any of the configurations either automatically or manually. In our paper we propose various standards that are required to design a completely interchangeable configuration.

2. ARCHITECTURE:

Robots are driven to perform more and more variety of highly skilled jobs with minimum human assistance or intervention. This requires them to have much higher mobility, manipulability, and dexterity than conventional machine tools. The mechanical structure of a robot, which consists of rigid cantilever beams connected by hinged joints forming spatial mechanism, is inherently poor in stiffness, accuracy, and load carrying capacity. The errors accumulate because joints are in serial sequence. These difficulties are overcome by advance designing and control techniques. The serial-spatial linkage geometry of a manipulator is described by complex nonlinear transcendental equations. The position and motion of each joint is effected by the position and motion of all other joints. Further, each joint has to powered independently, rendering modelling, analysis, and design to be quite an involved issue.

The weight and inertial loads on each link is carried by the previous link. The link undergo rotary motion about the joint, making centrifugal and Coriolis effects significant. All these make dynamic behaviour of the robot manipulator complex, highly coupled, and nonlinear. The kinematic and dynamic complexities create highly unique control problems that make control of a robot a very challenging task and effective control design a critical design. These are the general milestones involved in designing every industrial robot manipulator. Even in designing a reconfigurable robot these play major role. The following steps can be considered as axioms in designing a reconfigurable robot

- In a robotic arm consisting of three links at least two of the joints should be capable of producing both linear and rotatory motions between the connecting links to ensure that the robot meets all the configurations.
- Only one of the two motions of the joint is to be used at a time in order to maintain stability in the design at the joint and meet all the configurations possible for a robot manipulator.
- These motions at the joints are achieved with the help of mechanisms which requires actuators to control and sensors to monitor the relative motion between linkages. All of them are commonly mounted on that joint itself. It is advantageous if the actuators are not exactly placed on the joint. This can be achieved by transmission systems through belts and chain drives.
- The entire efficiency of the robot depends upon the work output of the robot for the given input. Increase in weight on linkages in order to accommodate multiple relative motions relates to the use of high power actuators to control its motion. These high power actuators come in heavy weights. This decreases the efficiency and also the overall weight of the robot increases.
- Hence it is advised to use only single actuator at every joint if power transmission is not possible. The joint has to be designed in such a way that when the position of the actuator changes the relative motion between the linkages also changes. This can be both autonomous or manual depending of various factors like utility, cost, overall weight of linkage.
- The relative motion between the linkages has to be clamped safely in order to avoiding the fall of the linkage due to gravity in the absence of restoring force. That is when the position of an actuator is changed in-order to provide a rotatory

motion between the links then the linear motion between the links has to be constrained with respect to the link.

- The complexity of the design can be decreased when the position of actuators on the joints are changed manually.

Automation can be used in changing the position of the actuators which the help of hydraulic and pneumatic actuators. But if it is automated then this leads to increase in weight of the robot.

3. CONCLUSION:

From the factual data available on the increase of usage of robots in industries for past few years, it is the eminent that the need for robots in industries will be increasing in coming years.

TABLE 1: Estimated worldwide annual supply of industrial robots

YEAR	SUPPLY	YEAR	SUPPLY
1998	69,000	2005	120,000
1999	79,000	2006	112,000
2000	99,000	2007	114,000
2001	78,000	2008	113,000
2002	69,000	2009	60,000
2003	81,000	2010	118,000
2004	97,000	2011	150,000

According to the World Industrial Robotics 2011 report, there were 1,035,000 operational industrial robots by the end of 2010. This number is estimated to reach 1,308,000 by the end of 2014.Recent advances in robotic technology have increased the accuracy and repeatability of robot but no advances were made to increase the usage of it in every possible sector and meet the dire needs of the customers.

Interchangeable configuration robots possess future prospects to the increasing demand in the future. This field will definitely increase the demand of deployment of robots in small and medium industries.

4. REFERENCES:

- Kumar .A and K.J Waldron, “The Workspaces of Mechanical Manipulators,” Journal of Mechanical Design, 103, 665-672, Jul 1981.
- K.B. Kim, “Introduction to the Special Issue on Design and Applications in Robotics,” Robotica , 17(1), 1-2, 1990.
- R.K. Mittal, I.J Nagrath, Robotics and Control, Tata McGraw-Hill, New Delhi, 2003.