Research Paper Engineering

Robotics Kinematics

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ABSTRACT

The present paper intention is to develop a kinematical foundation for our next works in industrial robots (IR) modular design. The mentioned analyze of the actual results in modular robots design gives us the possibility to establish our research program. The idea of this paper is to develop a kinematical formalism which will be use in the next dedicated to this subject. The structure of the paper contains a presentation of our ideas about modular robots design, which will be followed by the presentation of our researches direction. From these directions the researcher will focus on the implication of the modularity on robots kinematics and will propose a new formalism.

KEYWORDS Robotics, kinematical formalization, modularity, robot designs.

INTRODUCTION TO ROBOTS, ROBOTICS AND KINEMATICS:

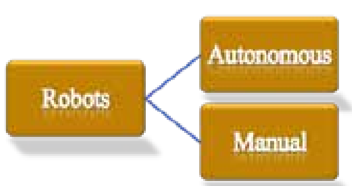
WHAT IS ROBOT?

A reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks**.**

OR An automatic device that performs functions normally ascribed to humans or a machine in the form of a human.

Robot can be divided into two types:

i] Autonomous
ii] Manual



Components of Robots:
1. Structure:
The structure of a robot is usually mostly mechanical and can be called a kinematic chain.

The chain is formed of links (its bones), actuators (its muscles), and joints which can allow one or more degrees of freedom.

2. Power source:
Suitable power supply is needed to run the motors and associated circuitry Typical power requirement ranges from 3V to 24V DC 220V AC supply must be modified to suit the needs of our machine Batteries can also be used to run robots

Robots are driven by different motors :- DC Motors, Stepper Motors, Servo Motors.

3. Actuation :
Actuators are the "muscles" of a robot, the parts which convert stored energy into movement.

The most popular actuators are electric motors.

4. Manipulation :
Robots which must work in the real world require some way to manipulate objects; pick up, modify, destroy, or otherwise have an effect. Thus the 'hands' of a robot are often referred to as end effectors, while the arm is referred to as a manipulator.

Some manipulators are: Mechanical Grippers, Vacuum Grippers, General purpose effectors.

5. Locomotion:
It is concerned with the motion of the robot.

Robot contains different types of drives:- Differential drive, Car type, Skid steer drive, Synchronous drive.

The user interface must allow the robot construction
- Obtain an optimal configuration related to this task
- Configuration self recognition
- Model building (kinematics and dynamics)
- Translate the user task into a robotic task
- Control law building
- Structure and sensors calibration

The user interface must allow the robot employment:
- Program the robot
- Allow the robot maintenance

The idea to use the user modular concept is possible only if appropriate interfaces are designed. We have considered that the first step on this direction is to imagine a kinematical tool which is able to describe the mentioned modularity. More precisely we intend to construct a formalism which will describe the in ematics of all particular construction which can be obtained from the main platform.

The Purpose of Robots:
Dangerous task : Space exploration, chemical spill cleanup, disarming bombs, disaster cleanup

- Boring and/or repetitive task: Welding car frames, part pick and place, manufacturing parts.
- High precision or high speed task: Electronics testing, Surgery, precision machining.
- Dirty Task.
- Impossible Task

WHAT IS ROBOTICS?
It is a field of Engineering that covers the mimicking of human behavior. Robotics includes the knowledge of Mechanical, Electronics, and Electrical & Computer Science Engineering.

Or in Simpler version-
Robotics is the study of the design, construction and use of robots.

Asimov's Laws of Robotics(1942):
- A robot may not injure a human being, or, through inaction, allow a human being to come to harm.
- A robot must obey orders given it by human beings, except where such orders would conflict with the First Law.
- A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

WHY ROBOTICS?
- To maximize the speed.
- It can work hazardous/dangerous environment.
- To perform repetitive task.
- To achieve efficiency
- To give accuracy of results.
- To gain Adaptability.

WHAT IS KINEMATICS?
The analytical study of the geometry of motion of a mechanism:

- with respect to a fixed reference co-ordinate system,
- without regard to the forces or moments that cause the motion.

Kinematics is the branch of classical mechanics that describes the motion of points, bodies (objects) and systems of bodies (groups of objects) without consideration of the forces that cause it The term is the English version of A.M. Ampere's cinématique, which he constructed from the Greek κίνημα, kinema (movement, motion), derived from κινεῖν, kinein (to move).

The kinematics researches are important because they offer the possibility to solve problems like: direct kinematics where we impose the desired movements in the robot joints and we obtain the effecter's movements; inverse kinematics where we impose the effecter's movement and we compute the joint movements; the working volume, where we can obtain the space where the robot task can be accomplish etc. We will mention here that the kinematics is a starting point for the dynamic analyze and the control system design. Our results are based on homogenous transformations described.

Kinematics is only the first step towards robot control !
In order to control and programme a robot we must have knowledge of both its spatial arrangement and a means of reference to the environment. Kinematics describes the analytical relationship between the joint positions and the end-effectors position and orientation.

TYPES OF KINEMATICS:
i] Forward Kinematics (angles to position)

What you are given: The length of each link
The angle of each joint

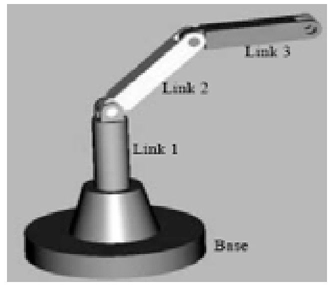
What you can find: The position of any point
i.e. it's (x, y, z) coordinates

ii] Inverse Kinematics (position to angles)

What you are given: The length of each link
The position of some point on the robot

What you can find: The angles of each joint needed to obtain That position.

MECHANISMS OF KINEMATICS:
Open Chain Manipulator Kinematics-

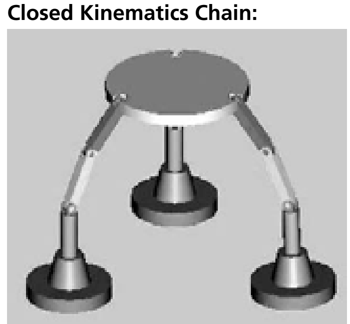


Mechanics of a manipulator can be represented as a kinematic chain of rigid bodies (links) connected by revolute or prismatic joints.

One end of the chain is constrained to a base, while an end effectors is mounted to the other end of the chain.

The resulting motion is obtained by composition of the elementary motions of each link with respect to the previous one.

Closed Kinematics Chain:



Much more difficult.

Even analysis has to take into account statics, constraints from other links, etc.

Synthesis of closed kinematic mechanisms is very difficult.

KINEMATIC CONSTRAINTS:
Kinematics constraints are constraints on the movement of components of a mechanical system. Kinematics constraints can be considered to have two basic forms,-

Constraints that arise from hinges, sliders and cam joints that define the construction of the system, called homonymic constraints, and

Constraints imposed on the velocity of the system such as the knife-edge constraint of ice-skates on a flat plane, or rolling without slipping of a disc or sphere in contact with a plane, which are called non-homonymic constraints. Constraints can also arise from other interactions such as rolling without slipping, is any condition relating properties of a dynamic system that must hold true at all times.

Below are some common examples:
Rolling without slipping
An object that rolls against a surface without slipping obeys the condition that the velocity of its centre of mass is equal to

the cross product of its angular velocity with a vector from the point of contact to the centre of mass,

$$v_G(t) = \Omega \times r_{G/O}.$$

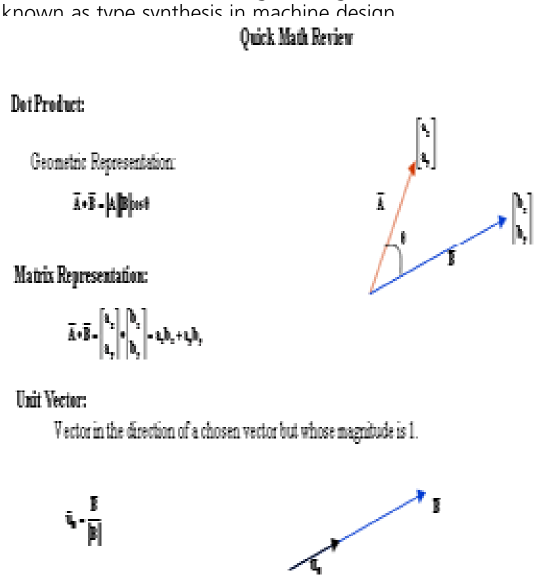
For the case of an object that does not tip or turn, this reduces to v = R ω.

Inextensible cord

This is the case where bodies are connected by an idealized cord that remains in tension and cannot change length. The constraint is that the sum of lengths of all segments of the cord is the total length, and accordingly the time derivative of this sum is zero. See Kelvin and Tait and Fogiel. A dynamic problem of this type is the pendulum. Another example is a drum turned by the pull of gravity upon a falling weight attached to the rim by the inextensible cord. An equilibrium problem (not kinematics) of this type is the centenary.

Kinematics chains

Rigid bodies, or links, connected by kinematics pairs, or joints, are called kinematics chains. Mechanisms and robots are examples of kinematics chains. The degree of freedom of a kinematics chain is computed from the number of links and the number and type of joints using the mobility formula. This formula can also be used to enumerate the topologies of kinematics chains that have a given degree of freedom, which is known as type synthesis in machine design.



CONCLUSION:

Present paper develops the research on modular robots .In this paper we have started the kinematical analysis of the modular robots. This research focuses only on robots with rotation joints which are reciprocally perpendicularly or parallel. The generality of our study have been ensured by the general form of the link which lies two successive joint and the generality of the connection type between the link and the joint. The main result that we have achieved is the algorithm which allows the mathematical construction of the homogenous transformation between the modular robots joint. This formalism gives us the possibility to solve the direct kinematics problem: to obtain the position and orientation of the modular robot end point when we impose desired trajectories in the robot joints.

FUTURE ENHANCEMENT:

Although most robots in use today are designed for specific tasks, the goal is to make universal robots, that is flexible enough to do just about anything a human can do. Scientists say that it is possible that a robot brain will exist by 2019 .Vernor Vinge has suggested that a moment may come when computers and robots are smarter than humans.

The Association for the Advancement of Artificial Intelligence has researched on this problem.

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