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Design and Implementation of a 3RRR Parallel Planar Robot

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Abstract
Parallel manipulators have a rigid structure and can pick up the heavy objects. Therefore, a parallel manipulator has been developed based on the cooperative of three arms of a robotic system to make the whole system suitable for solving many problems such as materials handling and industrial automation. The three revolute joints are used to achieve the mechanism operation of the parallel planar robot. Those revolute joints are geometrically designed using an open-loop spatial robotic platform. In this paper, the geometric structure with three revolute joints is used to drive and analyze the inverse kinematic model for the 3RRR parallel planar robot. In the proposed design, three main variables are considered: the length of links of the 3RRR parallel planar robot, base positions of the platform, and joint angles' geometry. Cayley-Menger determinants and bilateration are proposed to calculate these three variables to determine the final position of the platform and to move specific objects according to given desired trajectories. The proposed structure of the 3RRR parallel planar robot is simulated and different desired trajectories are tested to study the performance of the proposed stricter. Furthermore, the hardware implementation of the proposed structure is accomplished to validate the design in practical terms.

Keywords
Parallel Manipulators, Cayley-Menger determinants, Kinematic Characteristics, Bilateration.

I. Introduction

Parallel manipulators (PM) are a closed-loop mechanism consists of two platforms: one is a mobile point, namely, mobile end-effector and the other base platform, called a fixed base. These platforms are linked together by at least two independent arms or chains. The importance of closed-loop mechanism over the open-loop one falls in achieving precision performance, better structural rigidity, reduced inertia of moving parts, and high load-bearing capacity. Due to those advantages, researchers and industrial sectors have been applying parallel manipulators in many important applications. Based on the types of utilized joints which are used to create the kinematic chains that connects the mobile and fix platform , the PM is classified into seven types of configuration [1]: PPR, PRR, RRR, RRP, RPP, RPR, and PRP where P refers to Prismatic joint and R refers to Revolute joint. Typically, the three degrees of freedom planar 3-Revolute–Revolute–Revolute (3RRR) parallel robot is generally composed of mobile end-effector (MEE) and three fixed points that are connected by three manipulator arms, each arm consisting of two free links that are connected by revolution joint. At each fixed point, a motor is used to actuate the arm. The axes of the three revolution joints intersect at a common point called the center of rotation. Actuators are used to change the angles of the parallel manipulator arms provides three degrees of freedom rotational motion that produce changing the location of MEE.