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4-DOFs Parallel Mechanism for Minimally Invasive Robotic Surgery

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Abstract : This paper deals with the design process and the dynamic control simulation of a new type of 4-DOFs parallel mechanism that can be used as an endoscopic surgical manipulator. The proposed mechanism, 2-PUU_2-PUS, is designed based on the screw theory and the parallel virtual chain type synthesis method. Based on the structure analysis of the 4-DOF parallel mechanism, the inverse position equation is studied using the inverse analysis theory of kinematics. The design and the stress analysis of the mechanism are investigated using SolidWorks software. The virtual prototype of the parallel mechanism is constructed, and the dynamic simulation is performed using ADAMS TM software. The system model utilizing PID and PI controllers has been built using MATLAB software. A more realistic simulation in accordance with a given bending angle and point to point control is implemented by the use of both ADAMS/MATLAB software. The simulation results showed that this control method has solved the coordinate control for the 4-DOF parallel manipulator so that each output is feedback to the four driving rods. From the results, the tracking performance is achieved. Other control techniques, such as intelligent ones, are recommended to improve the tracking performance and reduce the numerical truncation error.

Keywords : parallel mechanisms, medical robotics, tracjectory control, virtual chain type synthesis method
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