Performance Investigations on Mechanical Design and Motion Control of Planar Parallel Manipulators

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The major contributions of the research work:

1. Comparative kinematic performance study on isotropy, manipulability, stiffness and payload aspects of the 18 possible square shape/U-base 3 degree of freedom planar parallel manipulators is performed. This study helps the designer to identify the best/feasible planar parallel manipulator for the given task. It can also be used as a tool for designing a planar motion platform (x, y and θ motions) as per the designer's requirement on the basis of their applications.
2. Two new/improved motion control schemes namely an improved sliding mode controller and a PID-like fuzzy logic controller are introduced to improve the overall motion control performance in terms of their robustness and adaptive aspects.
3. Development of a four axis vertical milling machine with an extension of the proposed manipulator (PPR-PRP-PRP) as a work table and its performance is demonstrated at different working conditions.

This research also involves the study of quantitative estimation of error in parallel manipulators due to inaccurate placement of actuators, misalignments and sensor set point errors. Here we are studying a new family of manipulators which are having U-shaped square base and having three serial kinematic chains. Their performances in different configurations are studied numerically and experimentally, it helps to find out the best configurations among them in presence of errors. For perform trajectory tracking operations in manipulators having errors, task space based motion control schemes are studied and developed in this work. These planar parallel manipulators have a potential to serve in the field of manufacturing, positioning, material handling, physiotherapy etc. One of the potential applications of these manipulators is in the field of lower limb rehabilitation. In which a passive leg exoskeleton is guided with the help of a parallel manipulator. These manipulators having better stiffness and speed serve to the required purposes very efficiently.

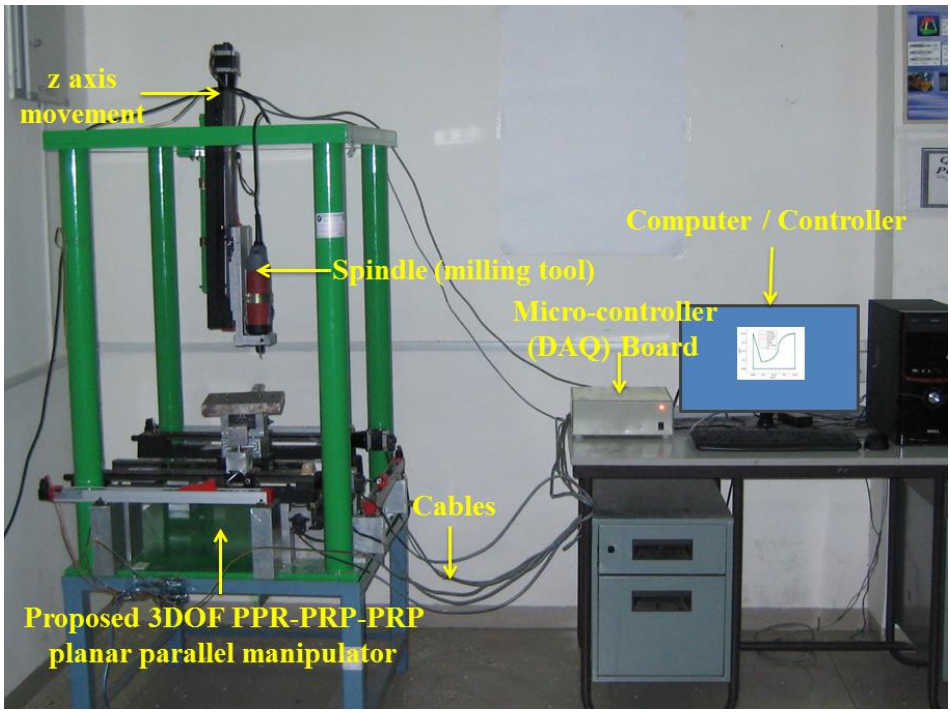

Figure 1One of the best kinematic configurations implemented in machining applications

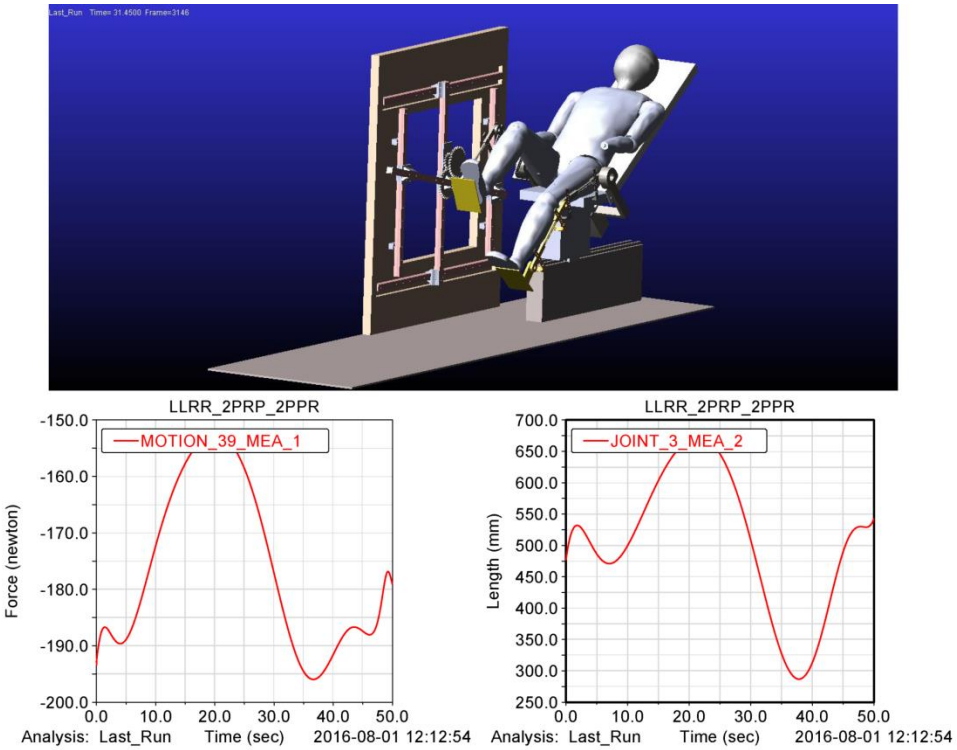

Figure 2 The proposed lower limb rehabilitation system based on this research outcome