cas à l'établissement et au site où a été préparée la thèse (unité, laboratoire, équipe, entreprise des (co)directeurs et encadrants). Les rapporteurs ne peuvent pas être membre du CSI.

Minglei Zhu

control-based design of robots

It is well-known that parallel robots have a lot of applications in industry for their high stiffness, high payload, can reach higher acceleration and speed. However, because of their complex structure, their control may be troublesome. When high accuracy is needed, the detailed robot model is necessary. However, even detailed models still suffer from the problem of inaccuracy in reality because of robot assembly and manufacturing errors. Sensor-based control approaches have been proven to be more efficient than model-based controllers in terms of accuracy since they overcome the complex robot models and incon- sistency errors. Nevertheless, when applying the visual servoing, there are always some problems in the control process, such as the controller singularities. Thus, this thesis proposes a control-based design methodology which takes into account the accuracy per- formance of the controller in the design process to get the optimal geometric parameters of the robot.

This thesis applied the control-based design methodology to the optimal design of three types of parallel robots: Five-bar mechanisms, DELTA robots, Gough-Stewart platforms. Two types of controllers are envisaged for the control of the motions of the Five-bar mech- anisms: leg-direction based visual servoing and line-based visual servoing. For DELTA robots and Gough-Stewart platforms, three types of controllers are selected: leg-direction- based visual servoing, line-based visual servoing and image moment visual servoing. Based on these selected controllers, positioning error models taking into account the error of observation coming from the camera are developed and the controller singularities are studied. Then, design optimization problems are formulated in order to find the optimal geometric parameters and camera placement for these three types of parallel robots for each type of controller. Co-simulations of the robots optimized for the corresponding controllers are performed to check the accuracy performance of the robots obtained from the optimization.

Two DELTA robot prototypes are designed and the experiments are performed with these two robots in order to validate the controller accuracy. The experiment results confirm the controller performance obtained from the co-simulation and prove that the image moment visual servoing is the best controller for the control of DELTA robotcompared with leg-based visual servoing.

Keywords: parallel robots, visual servoing, control-based design, hidden robot, image moment