Abstract of Doctoral Thesis

Title：Design of Redundant Drive Wire Mechanism with Velocity Constraint Modules to Reduce the Number of Actuators for Producing Fast and Precise Motions

ル　ナット　タム
LE Nhat Tam

This thesis proposes the design of redundant drive wire mechanism (RDWM: Redundant Drive Wire Mechanism) for producing fast and precise motions. The RDWM is configured with double actuator modules (DAMs: Double Actuator Modules) with two actuators for providing high acceleration global and high precise local motions. In the thesis, the method to configure RDWM using DAMs, the method to reduce the required number of actuators by introducing velocity constraint module (VCM: Velocity Constraint Module) and the experiment of RDWM prototype will be discussed.

First, a method to configure RDWM using DAM, a method to judge whether or not a RDWM candidate can produce the resultant force needed to achieve required motions will be shown. In the case of RDWM with DAMs is used for producing multi-directional motions, the size of the wire matrix would become large as the number of actuators increases. This takes time for judgment of the candidates. Therefore, it is necessary to introduce a simpler method for judging RDWM candidates. This problem can be done by converting the wire matrix of the candidate to new form then making the judgment using the essential part of the new form wire matrix related to the global motion.

Second, by introducing VCM as the solution to reduce the required number of actuators, a method to judge whether or not the candidates of RDWM with VCM can produce resultant force needed to achieve required motions is shown. This judgment method has three steps: (1) Static force analysis to check whether the resultant force for producing required motion can be produced in the whole motion space. (2) Kinematic analysis to find the active constraint space where the top plate can generate velocity. (3) Static force analysis to check whether the resultant force for producing required motion can be produced in the active constraint space. This study also clarifies the role of VCM in reducing the required number of actuators while keeping the orientation of the top plate. In addition, because only the essential part of the new form wire matrix is used in the judgment, the procedure will be simpler.

Third, based on the above two methods, numerical examples are shown where the method to configure RDWM candidates and the method to reduce the required number of actuators are applied. From the results of the numerical examples, the effectiveness of the proposed method is verified and the role of VCM is confirmed.
Finally, the experimental results of the 1D RDWM prototype are shown. Based on the results, the ability to produce global motion and local motion of RDWM is confirmed.