The abstract of the doctoral thesis

Dynamic Compensation Using High-speed Visual Feedback Based on Relative Coordinate
(相対座標における高速視覚フィードバックに基づくダイナミックコンペンセーション)

黄　守仁

(Body) High-performance interactive manipulations such as high-speed and accurate endpoint regulations towards a dynamically uncertain target in a large workspace by the robotic system are very attractive for manufacturing industry. However, it has been rather challenging for a traditional big industrial robot to accomplish such regulations, not only due to the difficulty in building the real-time feedback system, but also due to the mechanical defects like backlash as well as the nonlinear dynamics, especially under high-speed motions, while most of the commercial industrial robots are controlled without modeling the complex dynamic models. In order to deal with this problem, this thesis proposes a dynamic compensation concept that is realized by fusing the high-speed visual feedback (1KHz) based on relative coordinate information and a high-speed lightweight compensation actuator (for fine regulation) to cooperate with the main traditional robot (for coarse regulation). The methodology of the proposed concept is that: the high-speed vision sensing in terms of task-space can inspect the uncertain target as well as the dynamic uncertainties brought by the main robot (the main plant) under high-speed motions, and by the compensation actuator (the compensation plant), which is capable of high-speed response, the uncertainties can be compensated based on the relative coordinate visual information between target, main plant and compensation plant. The robotic system developed based on the proposed concept is referred as the dynamic compensation robotic system (DCRS). As the basic application, the 1D dynamic picking for a flying object is addressed by a 1-DOF DCRS. With the proposed pre-compensation fuzzy logic control (PFLC) algorithm and the cooperation algorithm, dynamic picking (catching) of a flying object with small clearance is realized. As the extension, the application task - 3D peg-and-hole alignment with large position and attitude uncertainty is addressed by the monocular approach and binocular approach with the introduction of a high-speed active peg as well as the high-speed visual feedback based on the dynamic compensation concept. Both tasks show that the system can realize high-speed as well as accurate interactive manipulation without much calibration and without modeling of the system's dynamics.