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Visual Servo Compensate for Manipulator Dynamics

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This thesis constructs the visual servo system using an industrial robot manipulator. This system is compensated for the robot manipulator dynamics. And, this thesis verifies a control law that uses transpose Jacobian PD controller with gravity compensation. The visual servo is one field of robot and vision research, and this research is very active. Visual servo problem processing a visual and a robot manipulator control on real time. We don't ignore a dynamics of visual servo system. Because the visual servo system has a robot manipulator and an in-feedback loop. The visual servo control considered compensated a dynamics. However, verification examples used real robot manipulator is not many, and we consider that not sufficient to use the Visual servo in real world. Accordingly, significance practice a verification use a real robot manipulator is very important. Accordingly, we need to construct the visual servo system. We consider a dynamic look-and-move system and a direct visual servo system with respect to robot manipulator control system. Then, direct visual servo system has the advantage of which can compensate the robot manipulator dynamics directly. And, ways to compensate the robot manipulator dynamics are Inverse kinematics method and Lyapunov base control. Lyapunov base control has the advantage of doesn't need strict computation than Inverse kinematics method. Because, Lyapunov base control uses cleverly a manipulator's property. Furthermore, introduce fixed camera form with respect to camera configuration. But, fixed camera form has two problems that fixed camera's calibration consumes labor and work-space of manipulator is restricted by a camera screen range. While, eye-in-hand form as camera configuration

can camera calibration easy, and alleviate work-space of manipulator is restricted compare fixed camera form

This thesis construct the visual servo system use fixed camera form with respect to camera configuration, feature based method, direct visual servo system and Lyapunov base control. And, this thesis verify PD controller uses transpose Jacobian with gravity compensation effective on the real visual servo system

We explain our visual servo system. The robot manipulator uses 2 planer robot manipulator is constructed by the 6DOF industrial robot manipulator limit to two joint move system. The robot manipulator's each joint's input is torque-command. The robot manipulator's joint angle send out to the controller. Camera mounted end-effector of robot the manipulator's arm and camera image send to the image-processor. The image-processor uses a motion-capture-system. The image-processor compute a center of balance of object from camera image, and computed center of balance of object send to the controller. The controller uses DSP-system and the controller was provided a control law by the host-computer. The controller compute torque-command for the robot manipulator's joint from joint angle of the robot manipulator and center of balance of object. The host-computer use IBM-PC/AT clone, It has role as a control law send to the controller. A control law is made by C language on the host-computer.

Next, we define the visual servo problem. We define following. The object position on image is ξ . The object velocity on image is $\dot{\xi}$. The target position on image is ξ_d . The robot manipulator's joint angle is q . Then, the visual servo problem is achieve $\xi \rightarrow \xi_d, \dot{\xi} \rightarrow 0$ condition at Time $t \rightarrow \infty$.

However, this thesis define these an assumption.

- The object position is constant. That is regulation problem
- The robot manipulator's joint angle which to achieves ξ_d is exist.
- J is full-rank to any q, ξ . This assumption is natural, and employ all researches of feature based visual servo.

We use PD controller with gravity compensation as solution of the visual servo problem. We use this control law in experiment, and we verify effective of this control law. We practice positioning to the object experiment, this object is set front of the camera. The object has horizontal offset to camera center at initial condition. Start visual servo to object, and we obtain error trace data on image accordingly time. We analyze data use MATLAB

Experimental result: error trace convergence to 0. This result shows that control law is proved experimental to asymptotically stable.

Summary in this section follows.

- This section studies the use of the \mathcal{L} norm with the \mathcal{L} norm to characterize the configuration of the system and the Lyapunov stability.
- This section studies the stability of the system. The Lyapunov function is used to prove the stability of the system.
 - Error convergence and the Lyapunov function are used to prove the stability of the system.

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