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Visual Tracking of Redundant Features

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Abstract: This paper presents how the control performance of the feature-based visual servo system is improved by utilizing redundant features. Effectiveness of the redundant features is evaluated by the smallest singular value of the image Jacobian which is closely related to the accuracy in the world coordinate system. An LQ control scheme is used to resolve the controllability problem. Usefulness of the redundant features is verified by the real time experiments on a PUMA 560 manipulator.

1. Mathematical Formulation: A mathematical description of visual servo system is given [1] and a sufficient condition for image Jacobian to be full rank is presented. With the necessary condition given in [2], this completes a necessary and sufficient condition.

2. Sensitivity: This section gives a definition of sensitivity and a theorem that claims "Closed-loop sensitivity is reduced by increasing the non-degenerated number of feature points." This theorem shows another criterion of feature point selection [3].

3. Controller: A linear LQ controller that resolves a difficulty of redundancy of features [4] is briefly reviewed.

4. Experiments: Experimental results on a PUMA 560 with three, four and five feature points (Figs.1-3) are presented. They show effectiveness of utilizing redundant features.

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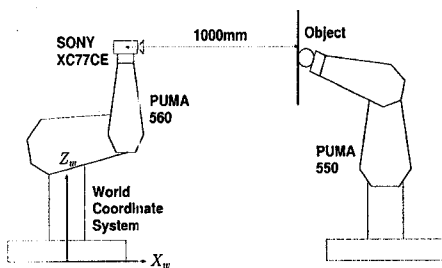


Fig. 1. Experimental Setup

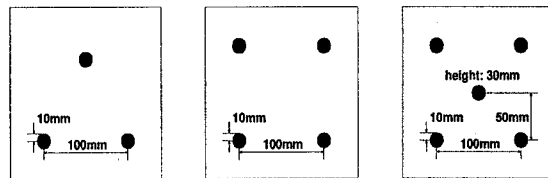


Fig. 2. Configuration of Feature Points

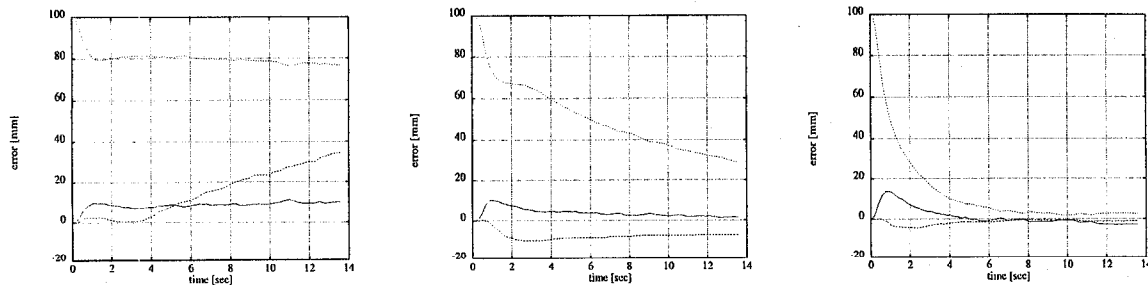


Fig. 3. Error in 3D (Vertical Step)