Robust Homography-based Control for Camera Positioning in Piecewise Planar Environments

D Santosh Kumar and C V Jawahar

Visual Control

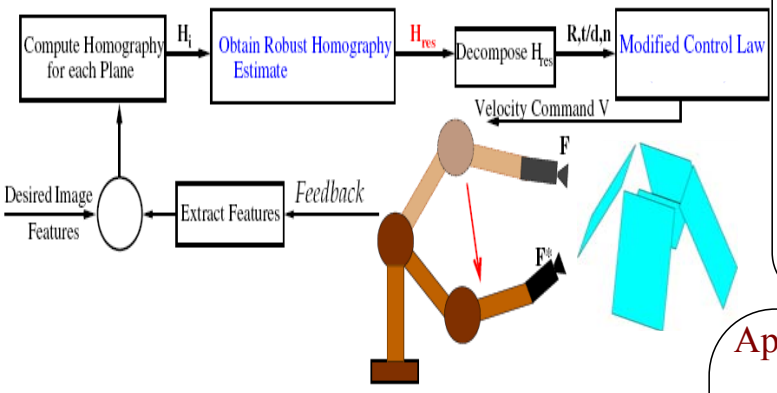
• *Task:* Control the position of a robot end-effector using visual feedback from a computer vision system
• *Method:* Compares the current image (of an object) with the desired image and the error difference is used to drive the camera towards the goal position
• *Constraint:* Produce optimal camera trajectory while ensuring object visibility using minimum a priori knowledge

Our Contribution

• An algorithm that **integrates** information from multiple homographies to **reliably** estimate the motion and structure parameters
• A **robust** control that utilizes the above parameters to compute the **optimal** path between two camera configurations

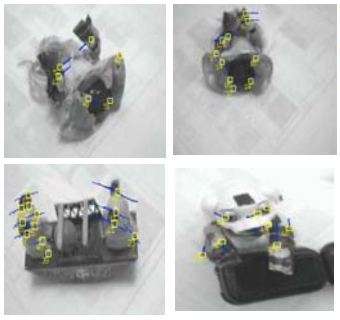
Approach

• H_{res} is computed as a linear combination of four independent homographies
• Weights are assigned such that good H_i are given high weights & degenerate ones receive low priority
• Some factors influencing λ_i: Reprojection Error (tracking errors), Determinant of H_i (singular configurations, Visible area of the plane (occlusion)

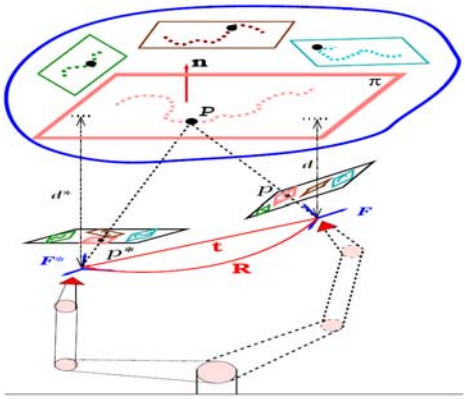


Visual Feedback-based Control: Multiple homographies are integrated to obtain a robust homography, which is used in the modified control law to gain superior performance

Application: Servoing in Non-Rigid Environments



Point trajectories on a non-rigid object

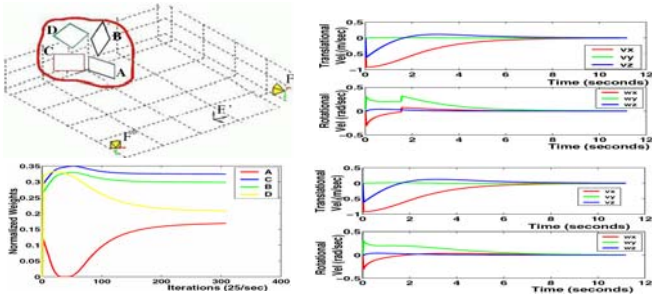


Servoing using planar curves: Curves indicate the space-time trajectory of points

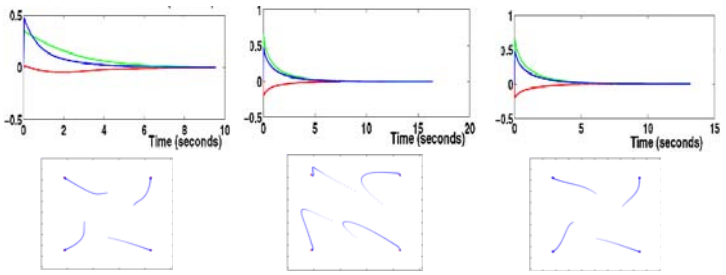
Advantages

• Can handle large camera displacements without being affected by degeneracies in the task space
• Robust to Image Measurement Errors
• No assumption of Planarity (or Non-planarity)
• No requirement of a priori knowledge
• Produces optimal camera trajectory while ensuring object visibility

Results



(a) Servoing begun using plane A reaches a degeneracy at *F* whose origin intersects the plane (b) Discontinuity in the velocity screw is due to the switching of planes (A to C) at *F*. Introducing the visibility constraint into 3D Control provides the Optimal Control



Figures on top show velocity obtained in case of 2D, 3*D* & proposed controls respectively while bottom display feature trajectory. Similarity of velocity screws in 3D & Proposed confirms the optimal trajectory behavior while near straight-line (image) feature trajectory ascertains the feature visibility

Center for Visual Information Technology
International Institute of Information Technology Hyderabad
http://cvit.iiit.ac.in