A 3-D Vision-Based Man-Machine Interface For Hand-Controlled Telerobot

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Summary

This work presents a robust telerobotic system that consists of a real-time vision-based operator hand tracking system (client) and a slave robot (server) which are interconnected through a LAN. The tracking system: 1) monitors the operator hand motion and 2) determines its position and orientation which are used to control the slave robot. Two digital cameras are used to monitor a four-ball-based feature frame that is held by the operator hand. To determine the three-dimensional (3-D) position a tracking algorithm based on uncalibrated cameras with weak perspective projection model is used. This allows finding 3-D differential position and orientation of the operator hand. The features of the proposed system are: 1) a metric for color matching to discriminate the balls from their background; 2) a uniform and spiral search approach to speed up the detection; 3) tracking in the presence of partial occlusion; 4) consolidate detection by using shape and geometric matching; and 5) dynamic update of the reference colors. The operator can see the effects of the previous motion which enables making the necessary corrections through repetitive operator hand-eye interactions. Evaluation shows that the static and dynamic errors of the tracking algorithm are 0.1% and 0.6% for a centered workspace of 20/sup 3/ in/sup 3/ that is 40-60 in away from the cameras. Running the tracking algorithm on two PCs in parallel allowed: 1) a parallel image grabbing delay of 60 ms; 2) a stereo matching delay of 50 ms; and 3) a global refresh rate of 9 Hz.