Intel ISEF 2011 OFFICIAL ABSTRACT and CERTIFICATION

Indoor Ground Manifold Tracking through Low-Cost Stereoscopy

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Optical systems for three-dimensional position and orientation tracking of a mobile platform are typically limited due to cost and computational complexity. In this project, an inexpensive webcam stereoscopic system was developed to estimate and track the state variables describing the position and orientation of a mobile platform as it was arbitrarily moved above a ground surface. This was achieved through real time processing of feature points on the ground surface manifold observed by the stereoscopic vision system collocated with the platform. An algorithmic tracking loop was implemented to optimize the estimate of each state variable simultaneously through the minimization of alignment error between feature points back projected onto a virtual representation of the ground manifold. Using the estimated state variables, the trajectory of the mobile platform was estimated through a frame by frame integration of the differential motion. Additionally, an automated calibration procedure was devised to compensate for webcam geometric misalignment and image plane distortion. Utilizing linear and radial testing, the state variable estimates were shown to be highly accurate with a position error on the order of 0.2% and an orientation angle error on the order of 0.01 radians. As the developed system is cost effective, accurate and operates in real time, there are a multitude of possible applications including enhanced guidance systems for mobile robotics and independent indoor navigation for the visually impaired.

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