Abstract

Flash LIDAR based autonomous navigation is a rapidly emerging area in robotics research. A Flash LIDAR Camera (FLC), aka 3D time-of-flight camera, illuminates the environment in its field of view with a single laser pulse (or modulated infrared light) and focuses the image onto its Focal Plane Array (FPA). Each pixel on the FPA measures the time-of-flight and thus the object distance to generate a cloud of points. The FLC also produces an intensity image simultaneously. Being able to provide intensity and range images with precise pixel-to-pixel match at a high frame rate, the 3D camera has drastically changed the way a robot perceives and interacts with its environment.

The objective of our research is to devise navigation methods for a Personal Robotic Device (PRD) that may guide the visually impaired in indoor environment. The PRD uses a single FLC for both 6-DOF device pose estimation and obstacle/object recognition to meet the compact size requirement. This talk will focus on pose estimation. In the proposed method, an ego-motion estimation method, called Visual-Range Odometry (VR-odometry), determines the PRD’s poses over time by simultaneously processing the FLC’s intensity and range images. An Extended Kalman Filter (EKF) tracks the device pose and visual features by a RANSAC state update scheme and reduces the accumulative pose error. To deal with the statistical inconsistence of the EKF and improve its stability, a scheme using a two-sided chi-square test is devised to evaluate the EKF’s tracking performance and reset the filter. Our experimental results demonstrate that the EKF method substantially reduces the PRD’s position error in long-duration navigation. The pose estimation method may also be applied to mobile robots and unmanned ground vehicles for autonomous navigation.

Biographical Information

Cang Ye received B.E. and M.E. degree from the University of Science and Technology of China in 1988 and 1991, respectively. He received his Ph.D. degree from the University of Hong Kong in 1999. He is currently an Associate Professor in Department of Systems Engineering, University of Arkansas at Little Rock. He was a research faculty at the University of Michigan, Ann Arbor from 2003 to 2005. His research interests are in mobile robotics, robotic assistive technology, fuzzy systems and reinforcement learning and their applications in robotic navigation and control. Dr. Ye is a senior member of IEEE and a member of the Technical Committee on Robotics and Intelligent Sensing, IEEE Systems, Man, and Cybernetics Society. He served as the guest editor of a special issue on field robotics for the International Journal of Intelligent Control and Systems. He is an Editorial Board Member of ISRN Robotics.