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Iterative Kalman smoother for robust 3D localization for vision-aided inertial navigation

A method for tracking 3D motion of a VINS system in real-time.

IP Status: US Patent Issued; **Application #:** 9,709,404

Applications

- Vision-aided inertial navigation system for mobile devices

Key Benefits & Differentiators

- **Better convergence rate** offered by interactive optimization
- **Better approximation** than Extended Kalman Filter
- **Superior numerical stability and position accuracy** enables high precision application
- **Suitable for resource-constrained devices** due to its superior numerical stability

Overview

Localization systems combining inertial data from an inertial measurement unit (IMU) with visual observations from a camera [i.e., vision-aided inertial navigation systems (VINS)] have become a popular choice for GPS-denied navigation (e.g., navigation indoors or in space). Among the methods employed for tracking the six-degrees-of-freedom (d.o.f.) position and orientation of a device, vision-aided inertial navigation is one of the most prominent, primarily due to its high precision and low cost. VINS have been successfully applied to spacecraft, automotive, and personal localization, demonstrating real-time performance.

Researchers at the University of Minnesota have developed a method using Iterative Kalman Smoother (IKS) for tracking the 3D motion of a mobile device in real-time. Specifically, this technology utilizes a sliding window-based estimator to track the 3D motion of a VINS system in real-time. In contrast to existing Extended Kalman Filter (EKF)-based approaches, this technology can better approximate the underlying nonlinear system and measurement models by re-linearizing and reprocessing them within the optimization window. Additionally, by iteratively optimizing over all measurements available, this technology can increase the convergence rate of critical parameters (e.g., IMU-camera clock drift) and improve the positioning accuracy during challenging conditions (e.g., scarcity of visual features). Furthermore, the resulting numerical stability allows for efficient implementations on resource constrained devices, such as cell phones and wearables.

Phase of Development

TRL: 4-5
This IKS technology has been validated for performing vision-aided inertial navigation on wearable devices with limited sensing and processing, and has demonstrated positioning accuracy comparable to that achieved on cell phones.

Technology ID
20150115

Category
Software & IT/Algorithms
Software & IT/Image & Signal Processing
Software & IT/Transportation

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Researchers

- **Stergios I. Roumeliotis, PhD**, Professor, Electrical and Computer Engineering

References

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