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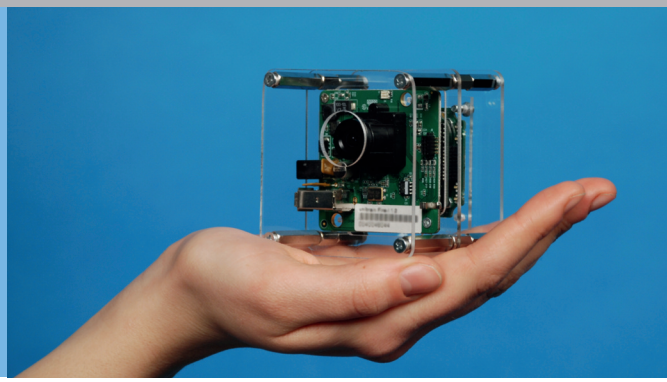

CAMERA SUPPORTED INERTIAL NAVIGATION SYSTEM

Introduction

For the past 10 years the Fraunhofer Institute for Manufacturing Engineering and Automation IPA has been developing systems and solutions in the field of inertial object-tracking and navigation with low-cost sensors. An inertial navigation system measures the orientation, velocity and position of a rigid body relative to a frame of reference. Accelerations and turn-rates are acquired relative to the reference system. Thus it is possible to localize and track objects without an outside reference and to implement target-calculations and -guiding.

The following problems with inertial sensors present new challenges for the experts from the Fraunhofer IPA:

- Position measurements taken with inertial sensors are only precise for a short period of time.
- Inertial sensors have a problem with drift in their bias.
- Correcting position errors requires an additional sensor input or a dynamic system model.

Statement of Purpose

The main objective of experts at Fraunhofer IPA is to achieve a higher degree of accuracy from inertial navigation systems and to minimize and correct sensor errors. To achieve these goals, a technique called sensor fusion is used. The term sensor fusion refers to the combination of different sensor signals into one overall picture.

The idea behind this is that the information gathered from the combined sensors carries greater weight (or has greater value) than the total data obtained from each sensor individually. Thus, by using sensor fusion, a camera can gather data that is consistent in the long term (e.g. stable features in images) and complementary to the data

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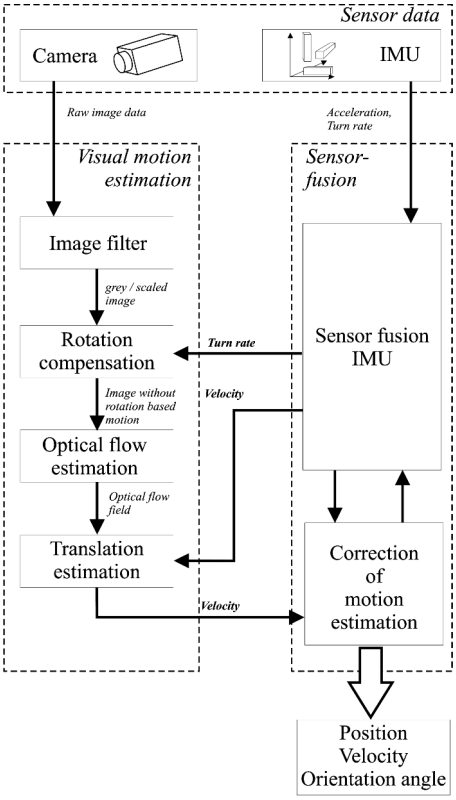

gathered by the inertial sensors. The inertial sensors, in contrast, can read more exact values for faster-changing motion. With this approach the motion of the system can be precisely measured, even when it moves very slowly or not at all.

Strategy

The idea is to combine optical sensors (i. e. cameras) with inertial sensors.

Camera-supported navigation solutions are of interest both because of their increased ability to function in real-time and their greater precision when employed in automated mechatronic systems.

Furthermore, current image processing algorithms can be handled by high-efficiency embedded systems, making the reliable estimation of motion from visual informaton possible.

Images from the camera are gathered for the purpose of measuring and analyzing movement.

The inertial measurements are used to help process the images, creating a coupled sensor fusion system that can draw on the advantages of each of the respective standalone systems.

Results

By combining a camera with an inertial measurement device, it becomes possible to gather information about the system's own movement and about the structure of the environment for the purposes of support and error correction.

In this way the accuracy of movement estimations can be increased and errors in sensor measurements can be better compensated for. Camera support of inertial navigation systems works in unfamiliar environments and requires no prior modelling or guide-lines for the camera view area at all.

By integrating a camera into a mobile inertial navigation sysem, the principle of a referenceless sensor system is adhered to, in-sofar as all required sensors are contained within the module and no external reference points or equipment (such as infrared markers) are needed.