Seamless and reliable personal navigator

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Sponsor: National Geospatial-Intelligence Agency (NGA)

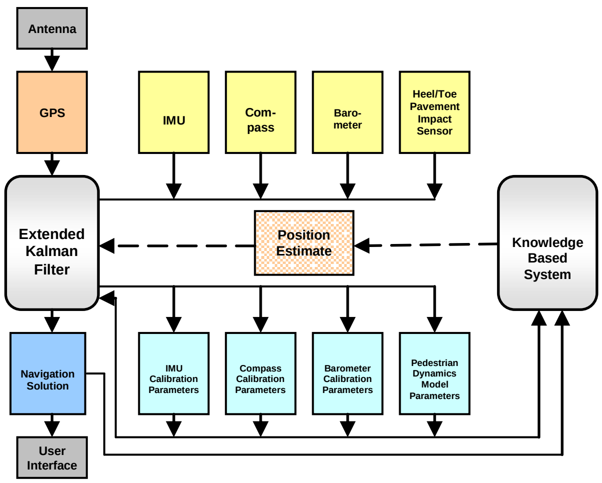

Figure 1. Personal navigator: calibration mode

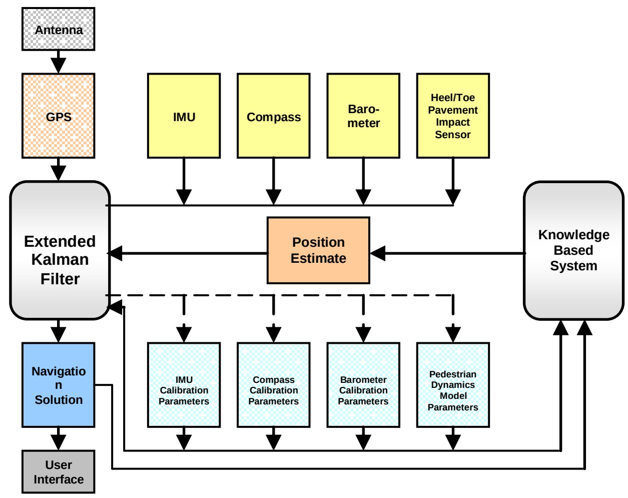

Figure 2. Personal navigator: dead-reckoning navigation supported by the human dynamics model

The primary objective of this project is to develop a prototype of a seamless and dependable personal navigator personal navigator based on multi-sensor integration, augmented by the human locomotion model that supports navigation during GPS gaps, to support navigation and tracking of ground military and rescue personnel. Recent developments in sensor technology are reaching the point when such systems may soon become feasible for implementation and consequently for operational deployment. This research formulated the theoretical foundations for such systems by developing the algorithmic concept of a basic GPS-based, micro-elector-mechanical inertial measurement unit (MEMS IMU)-augmented personal navigator system with an open-ended architecture, which would be able to incorporate additional navigation and imaging sensor data, extending the system's operations to indoor environments. The general architecture of the intelligent DR navigation system is shown in Figure 3, and Figure 4 shows the current prototype implementation.

The core of the Dead Reckoning (DR) navigation component is the Knowledge Based System (KBS) that models the human locomotion (Figures 1-2) used for navigation. The human locomotion model is considered as navigation sensor, with the step length (SL) and step direction (SD) as primary parameters. It has been demonstrated that in the absence of GPS signals, the sensors used in the current prototype can sense the body locomotion in terms of its dynamics and geometry that represent an implicit function of SL and SD. A practical implementation of the DR system based on human dynamics proposed here is a KBS.The system is trained during the GPS signal reception, and is subsequently used to support navigation in dead reckoning mode when GPS signals are blocked. The current design of KBS includes Artificial Neural Networks (ANN) and fuzzy logic, to estimate dead-reckoning components of the overall dynamic and parametric models. The general architecture of the intelligent DR navigation system prototype is shown in Figure 3 and Figure 4 shows the current prototype implementation.

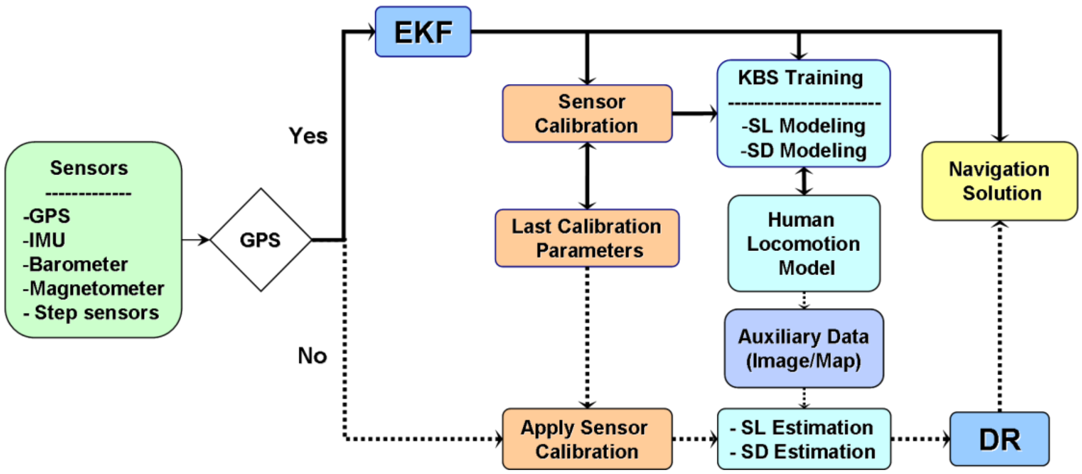

Figure 3. DR module of the personal navigator architecture.

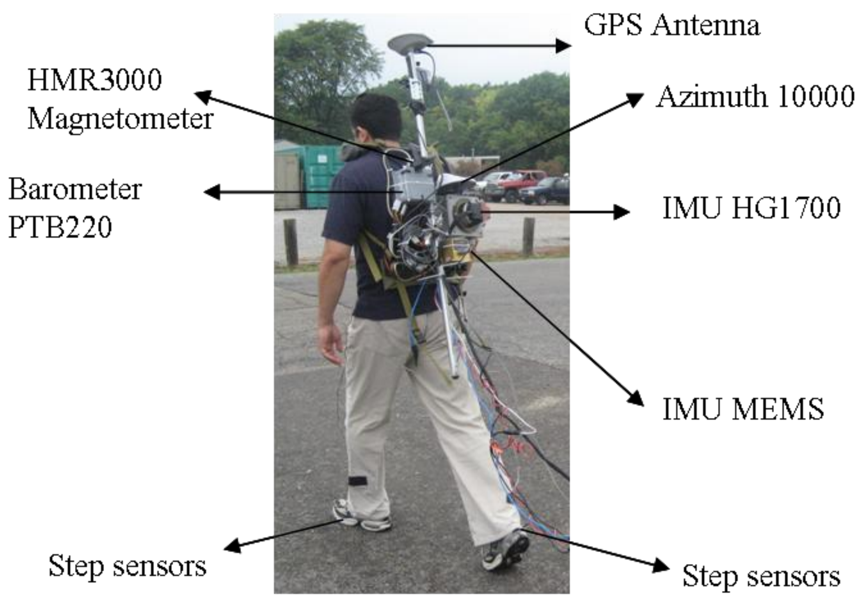

Figure 4. Multi-senor assembly in a backpack configuration.

The performance test to date showed that CEP 50% < 5 m in positioning performance could be consistently achieved for several hundred meter long trajectories with mild slopes and moderate operator maneuvering, under no GPS conditions.