

Activity and Environment Classification using Foot Mounted Navigation Sensors

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ABSTRACT

Military personnel and first responders, such as fire fighters or police officers, are often equipped with foot mounted location devices in order to coordinate efforts or assist others in distress. Since GPS alone does not provide sufficient continuity and accuracy in all environments, navigation systems often include additional sensors (e.g. accelerometers, gyros, barometers and magnetometers) to improve performance. These sensors can be used in parallel to classify certain activities that can be of interest to supervisors. Often, activity classification is performed using sensors mounted on the upper body without the use of GPS signals, whereas this paper classifies activities using both GPS and sensors mounted on the foot of the user.

The following activities and environments, some of which are subsets of others, are classified herein: walking, running, stationary, moving up stairs, moving down stairs, driving, passengers in car, on concrete, kicking, jumping down, moving on bike, crawling, indoors/outdoors, leaving building/coverage and entering building/coverage. Using a five second window, the probability of each activity is given.

Each activity probability is quantified through several metrics. These include cadence, pitch and roll, high accelerations, magnetic field variation over gait, average speed, GPS carrier to noise ratio (C/N_0), satellite availability and position accuracy. The paper fuses each activity probability through Bayesian statistics. Several independent and mutually exclusive rules are included to enhance accuracy estimating the true activity. The ultimate classified activity and environment is based on a combined Bayesian model.

Data collected simulates the activities of a person during an average day. Three test subjects are used in hour long data collections. Initial results indicate a high probability of detecting walking, running, stationary, etc. activities regardless of the environment, but challenges remain in detecting the environment in specific scenarios. Video camera data is then combined with classification to provide a more robust and sensitive analysis. Limitations are also thoroughly discussed.

KEYWORDS: Activity classification and recognition, motion analysis, pedestrian pattern recognition, position, offender management, first responder.