Use of pattern classification algorithms to interpret passive and active data streams from a walking-speed robotic sensor platform

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Abstract

In order to perform useful tasks for us, robots must have the ability to notice, recognize, and respond to objects and events in their environment. This requires the acquisition and synthesis of information from a variety of sensors. Here we investigate the performance of a number of sensor modalities in an unstructured outdoor environment, including the Microsoft Kinect, thermal infrared camera, and coffee can radar. Special attention is given to acoustic echolocation measurements of approaching vehicles, where an acoustic parametric array propagates an audible signal to the oncoming target and the Kinect microphone array records the reflected backscattered signal. Althogh useful information about the target is hidden inside the noisy time domain measurements, the Dynamic Wavelet Fingerprint process (DWFP) is used to create a time-frequency representation of the data. A small-dimensional feature vector is created for each measurement using an intelligent feature selection process for use in statistical pattern classification routines. Using out experimentally measured data from real vehicles at 50 m, this process is able to correctly classify vehicles into one of five classes with 94% accuracy. Fully three-dimensional simulations allow us to study the nonlinear beam propagation and interaction with real-world targets to improve classification results.