Human Detection using Ultrasonic Doppler Vibrometry

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Abstract

This paper considers the problem of distinguishing a walking human from other moving or stationary objects in near real-time using Bayesian model comparison and data obtained from an ultrasonic Doppler vibrometer (UDV). Here we describe our initial experimental and analytical work to develop an automated non-invasive model-based approach for recognizing people based on their measured velocity signal while walking. Our experimental set up uses an ultrasonic Doppler vibrometer as a non-contact means for obtaining data related to the velocity of the moving body components. The main advantages of using an ultrasonic vibrational measurement system is high resolution, low cost, and ease of installation. In the UDV an ultrasonic transducer directs a 50 kHz acoustic wave to the moving body surface. The returned acoustic signal, frequency modulated by the velocity of the body components, is received by a co-located transducer whose output is sampled to produce the output data time series. Our experiment is laboratory based and intended to determine basic capabilities. The presence of a characteristic and approximately sinusoidal back motion component in the observed velocity of a walking human is used as a basis for distinguishing a walking human from other moving objects. We have two models, one representing data attributed to human bulk velocity and back velocity and the other model representing a constant (possibly zero) bulk velocity. In the walking human model, the back motion can be linked to whole body motion. For the detection of walking human, we make use of the Bayesian inference approach, where models are compared by computing their posterior odds ratio. In this paper we present parameters estimation results for the walking human model and discuss our initial model selection results.