Chapter 13

Embedded Activity Monitoring Methods

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Abstract

As the average age of the population increases worldwide, automated tools for remote monitoring of activity are increasingly necessary and valuable. This chapter highlights embedded systems for activity recognition that provide privacy, do not require major infrastructure, and are easy to configure. The strengths and weaknesses of popular sensing modes that include RFID, motion, pressure, acceleration, and machine vision are discussed. A new activity detection system is also described for high privacy area like the bathroom and bedroom environment.

13.1 Introduction

The population of elderly individuals is rising in industrialized countries. In the current economic scenario, many families find it very difficult to maintain close contact with parents and aging community members. This population becomes dependent on care providers to manage health issues and provide security in daily life activities. Human labor is the standard approach to take care of elderly individuals; however, it is very expensive and sometimes not available. The development of automated systems that range from high-end robots to simple motion sensing devices evolved from this mismatch in supply and demand for the delivery of in-home care. Cost effective and reliable systems are described in the following sections to monitor activity and behavior patterns without overly intruding and changing the personal life of the seniors.

Three basic elements of Activity Recognition System are: 1) Collection of raw data using sensors and implementation of low-power embedded circuitry for long-term deployment.
2) Signal processing of low-level data to remove noise and implement security screens. 
3) Classification of activity based on low-level sensor data and previously gathered information with the help of various machine-learning algorithms and data mining techniques.

The methods discussed and proposed are all sensor based embedded systems. Each of the described systems is capable of detecting basic activities such as walking, sitting, running, lying down, and falling down. Detection of these features enable aging in place so that individuals are safe and secure in their homes and do not need to move into assisted living communities. Additionally, the technology enables remote management of chronic illness and provides a safe environment for recovery after surgery in an outpatient setting.

13.2 Related Work

Pervasive intelligent environments are an active area of research from the Gator Tech house at the University of Florida [1] and the Maverick smart house at the University of Texas Arlington [2] to a wide variety of monitored spaces throughout the world. The focus of this section is to highlight leading activity detection methods and discuss new and better ways to sense activity with minimal infrastructure requirements.

13.2.1 Machine Vision

Vision tracking is one of the most common approaches for activity recognition. This method uses cameras at various locations and employs either manual or automated image processing. The manual approach for image processing involves a human operator. Data is monitored from various cameras to detect unusual activity. A single person scans multiple camera outputs from different homes in the community for any discrepancies in regular activity patterns and emergency situations. This approach is very labor intensive. It requires constant monitoring and also requires training to detect events of concern.

Another approach involves cameras equipped with embedded systems that utilize image-processing algorithms. The survey paper provided by Weiming Hu et al. [3], discusses the issues involved in surveillance applications using machine vision. Motion detection is the first step in automated vision processing that requires environment modeling, motion segmentation, and object classification. Once the subject is isolated from the environment, object tracking is the next step. Four leading techniques are region-based tracking, active contour-based tracking, feature-based tracking, and model-based tracking. The next step in image processing is to determine the activity. Natural language is one method to describe