Demo Abstract: Multi-modal Fall Detection within the WeCare Framework

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ABSTRACT

Falls are identified as a major health risk for the elderly and a major obstacle to independent living. Considering the remarkable increase in the elderly population of developed countries, methods for fall detection have been a recent active area of research. However, existing methods often use only wearable sensors, such as acceloremeters, or cameras to detect falls. In this demonstration, in contrast to the state of the art solutions, we focus on the use of multi-modal wireless sensor networks within the WeCare framework. WeCare system is developed as a solution for independent living applications by remotely monitoring the health and well-being of its users. We describe the general structure of WeCare and demonstrate its fall detection method. Our set-up not only includes scalar sensors to detect falls and motion but also consists of embedded cameras and RFID tags and uses sensor fusion techniques to improve the success of fall detection and minimize the false positives.

1. INTRODUCTION

With their remote monitoring capabilities, wireless sensor networks offer promising solutions for home care and independent living applications and improve the quality of the care provided to the users especially for the rapidly growing population of elderly. For instance, vital signs of an individual, such as blood pressure and heart rate, can be monitored in real time with the attached sensors on his body and can be transmitted to the caregiver or to the doctor over a wireless network in case of an emergency.

WeCare system [2], being developed by our group, offers a wireless sensor network based solution for independent living. The multimodal sensing environment of WeCare provides a combination of different sensing modalities. Besides scalar sensors, such as temperature, motion or biosensors, the WeCare framework consists of embedded cameras, audio sensors and RFID tags. Embedded cameras provide surveillance and information-rich descriptions of the activities of the residents. RFID tags are used for location tracking, i.e. in which room the residents are, and to activate the associated embedded cameras in the room if an emergency is detected. Biosensors, such as the ones measuring blood pressure or heart beat rate, monitor the health status and well-being of the residents. Complementary ambient sensors are used to provide contextual information about the environment. The system is connected to the Internet and GSM network which enables remote monitoring of the residence by the users or caregivers.

WeCare system provides six fundamental services: (i) Activities of daily living monitoring, (ii) Medication intake monitoring, (iii) Medical status monitoring, (iv) Fall and movement detection, (v) Misplaced object tracking and (vi) Location tracking. In this demonstration, we focus on the fall and movement detection service. Falls are identified as a major health risk for the elderly and a major obstacle to independent living. The most common approaches for fall detection are based on accelerometers carried on the body or cameras located within the living environment of a subject to be monitored [3, 5, 4]. As mentioned in [4], focusing only on large acceleration may result in many false positives due to activities similar to a fall, such as quickly sitting. On the other hand, continuous monitoring with cameras may violate privacy. Considering these, the WeCare system uses both accelerometers and embedded cameras, which get activated in case of an emergency, for fall detection and this demonstration encompasses the fall detection service.

2. WECARE FRAMEWORK AND TESTBED

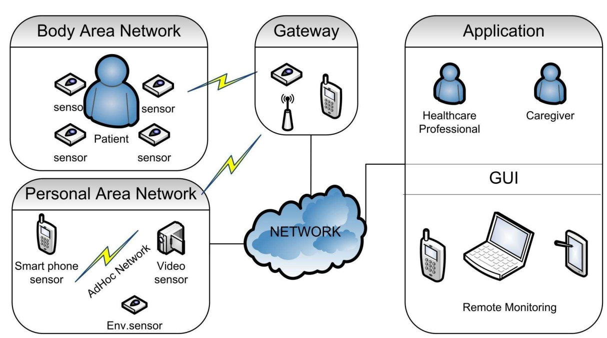

Figure 1: WeCare System Framework

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Figure 2: WeCare Testbed

WeCare is a wireless sensor network based application for independent living and remote healthcare monitoring of the elderly and the children especially. WeCare framework, shown in Figure 1 consists of 3 main components: i) Body Area Network (BAN), that consists of sensors carried or worn by the person such as RFID tags, ECG sensors and accelerometers worn by the patient, ii) Personal Area Network (PAN), that consists of sensors deployed around such as video cameras, temperature and light sensors, iii) Gateway to the Wide Area Networks (WAN) which can be a PDA or a mobile phone.

WeCare testbed [1] is located in a $55m^2$ laboratory in Bogazici University. The testbed is similar to a smart home that consists of three rooms decorated as a living room, a bedroom and a kitchen. It is equipped with Crossbow IMOTE2 wireless motes with ITS400, UTAG-12 active RFID tags, GENETLAB SenseNodes, UDEA RWID-R12 active RFID reader and AXIS 207W network cameras. Figure 2 shows snapshots from the testbed including the equipment and the design.

3. DEMO DESCRIPTION

In this demo, we present a fall detection method using both wearable accelerometer sensors and embedded cameras. We use the IMOTE2 wireless mote with ITS400 sensor board for acceleration. 2 IMOTE2 motes are attached on the subject's body, one on the trunk and one on the waist as shown in Figure 3 and AXIS 207W network camera is used for capturing video . In the demonstration, the user is asked to perform activities such as walking, jumping, lying down, sitting and quickly sitting which should be distinguished from a fall by the system. The performance of the system is evaluated by successfully detecting falls and by minimizing the false alarms (i.e., other activities reported as fall).

Figure 3: Snapshots from experiments in the WeCare Testbed

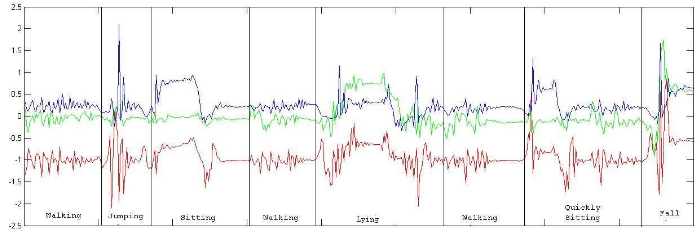

Figure 4: Activity Recognition with Accelerometers

An example snapshot from a set of evaluations is shown in Figure 3. Accelerometer data is thresholded to detect major drops (Figure 4) and classify the activities. Video images are preprocessed to separate the blob corresponding to the human object from the background (Figure 5). An ellipse model is fitted to this blob. The eccentricity and orientation of this ellipse are used as features to classify falls. Accelerometer and video data are fused by using a decision fusion mechanism. These results are collected from a set of experiments performed on 4 different subjects, 2 female and 2 male, in the WeCare testbed. Those videos and results recorded during the tests will be displayed in the demo.

Figure 5: Activity Recognition with Video

4. ACKNOWLEDGMENTS

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5. REFERENCES

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