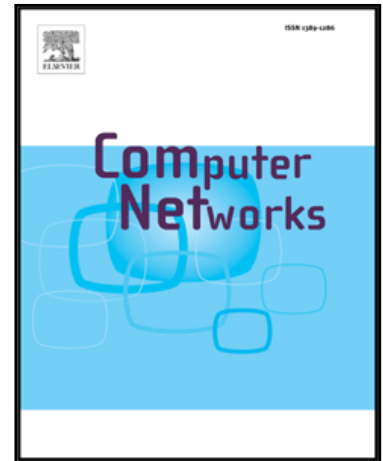


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# SHMO: A Seniors Health Monitoring System Based on Energy-free Sensing

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## Abstract

The past decades have witnessed the advancement of Wireless Sensor Networks (WSNs) promoting many potential applications in the fields of smart healthcare. Through WSNs, target areas can be monitored and activities of the elderly can be recognized with a large number of deployed sensor nodes. However, previous works suffer from their coarse portability and high susceptibility to environments. In addition, the limited energy supply for sensor nodes emerges as the biggest stumbling block and such a situation is getting worse especially considering the increasing network scale. In this paper, we provide an innovative and energy-efficient system based on energy-free RFID tags to monitor the daily activities and thus determine the physical conditions of the elderly. We achieve the activity recognition by tracking the passive RFID tags attached on the elderly based on the received backscatter signals. In general, we simplify the model of seniors daily life and only consider normal move, slow move, sitting-down and fall as the basic components. DTW and SVM are utilized to discriminate them and then a healthcare assessment system can be achieved. To verify our system, extensive experiments are conducted and experiment results demonstrate that our system achieves a high recognition accuracy of various seniors daily activities and a reliable health assessment can be reached as well.

*Keywords:* Energy-free sensing, COTS RFID, Phase, Activity recognition, Health assessment

## 1. Introduction

The world is experiencing a period of extreme population explosion causing the growing global ageing problem. More and more attentions have been attracted on how to achieve a smart healthcare system as a gradual increase in the number of aged people living alone without care. The advancement of WSNs makes it possible and holds potentials for wonderful prospects in the future [1-4]. In fact, many potential applications of WSNs have been exploited in the fields of environmental engineering, healthcare, industry, military applications, smart home, green buildings, etc. Through WSNs, target areas can be monitored and activities of the elderly can be realized with a large number of deployed sensor nodes. However, the limited energy supply for sensor nodes emerges as the biggest stumbling block and such a situation is getting worse, especially considering the increasing network scale. Hence, in order to realize WSNs in real applications, we need to find

out urgently a technology either to sustainably supply energy to sensor nodes or innovatively propose a brand-new method to realize energy-free sensing.

Previous efforts have exploited video cameras to monitor human daily behaviors in public places [5-7]. However, this method requires deploying cameras densely to capture human actions, which demands unobstructed line of sight to keep good accuracy and may violate the privacy in some cases. Furthermore, another previous work applied inertial sensors e.g. accelerator, gyroscope and inertial sensors for motion detection [8-11], which may bring inconvenience and affect the action of seniors. In addition, the current use of mobile devices for sensing is gaining popularity [12-14]. Nevertheless, due to seniors' living habits and indoor restrictions, they are less likely to carry out indoor activities with mobile phones, which may weaken the detection, let alone the health assessment.

In this paper, we present SHMO, a convenient and non-intrusive system for health monitoring by analyzing reflected backscatter signals of passive RFID tags which are attached to their worn clothes, and then provide an assessment about physical conditions for the users.

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