DEVELOPMENT OF A MOVEMENT CLASSIFIER USING INERTIA AND EMG SENSORS

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INTRODUCTION

Falls are a leading cause of unintentional injuries and deaths, especially in the elderly. To detect falls early and accurately is important for reducing fall-related socioeconomic cost. Inertia sensors, such as accelerometers and gyroscopes, have been used to distinguish falls from activities of daily living (ADLs) [e.g. 1,2]. Using inertial sensors could detect a fall in 300-400 ms after the fall occurs [3]. However, by using electromyography (EMG), it is possible to reduce this time to around 200 ms, since there are some unusual EMG signals to be found after subjects unexpectedly lose their balance [4,5]. In addition, muscle activities could also be used to distinguish active from passive movements, hence improving the accuracy of identifying ADLs. The purpose of this study is to develop a wearable combined sensor, using accelerometers, gyroscopes, and EMG, with algorithms that can identify different activities of daily living, including fall events.

METHODS

Figure 1 shows the schematic design of our developing wearable movement classifier system. A combined sensor consisted of tri-axial accelerometers (ranged ±5g), tri-axial gyroscopes (ranged ±500°/sec), and electromyography sensors is used to detect user's movements.

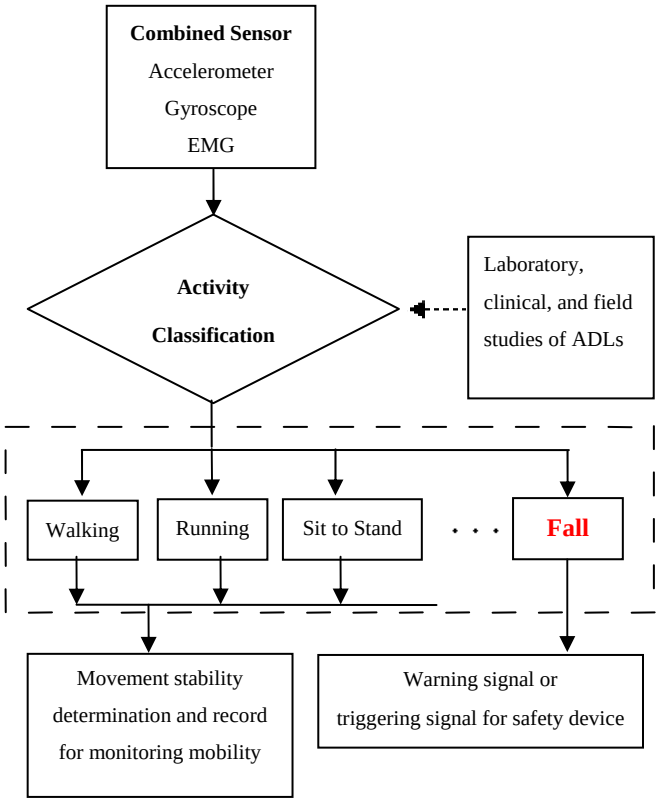

Figure 1: The concept of the movement classifier.

Algorithms, developed using LabVIEW 8.5 (National Instruments, Texas, USA), for classifying ADLs, such as walking and sit to stand, and identifying fall events are being developed according to the findings from previous and on-going laboratory, clinical and field research studies. After a non-fall activity is classified, indicator of stability will be calculated online and the record of activities can be stored and used for monitoring user's mobility. In addition to using as a movement classifier, our system can also be used as a fall detector by distinguishing unusual movements from ADLs. The addition of EMG sensors to inertia sensors allows our system to have 100-200 ms time advantage in detecting fall onset over a system using only inertia sensors, and potentially to send timely trigger signals to activate wearable safety device to prevent injuries or deaths from falls.

RESULTS AND DISCUSSION

We have established a prototype with algorithms that could distinguish normal overground or treadmill walking/running from fall initiations. In addition, the movement classifier can also quantify online the level of whole-body stability during walking/running, which could provide feedbacks to the user. We are conducting more laboratory and field studies to obtain biomechanical parameters of other ADLs, such as sit to stand/stand to sit, using bathroom facilities, etc. Furthermore, laboratory induced falls, to mimic slip and trip falls, while performing ADLs are employed to test the accuracy and speed of fall recognition. This developing system will be used as a base of a monitoring device integrated with fall arresting/protecting mechanism for the elderly and individuals who need long-term care.

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