UNIVERSITI PUTRA MALAYSIA

PERVASIVE HUMAN FALL DETECTION AND ALERT SYSTEM BASED ON MULTILAYER PERCEPTRON NEURAL NETWORK

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science.

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Chair: Khairulmizam Samsudin, PhD

Faculty: Engineering

Falls are major health problems which affect the human life by restricting their movements and independency. With the increase in the human population, more attentions are required in order to prevent the serious effects and problems caused by fall. A system which can identify the occurrence of falls in almost every situation and alert the care center is a helpful solution to care for the human safety. The motivation behind this work is to develop a pervasive system for monitoring the human activities and identifying the occurrence of falls. In this work, a waist worn fall detection system has been developed. A tri-axial accelerometer (ADXL345) was used to capture the movement signals of the human body and detect events such as walking and falling to a reasonable degree of accuracy. A set of laboratory-based falls and activities of daily living (ADL) were performed by healthy volunteers with different physical characteristics while the sensor was attached to their waists. Personal information features which are the volunteers' personal physical features and acceleration features which are taken from acceleration data were considered as feature set. Decision tree method was used to find out the effective features for classification. In order to classify the collected falls and ADL acceleration patterns,

Multilayer Perceptron (MLP) neural network was applied for precise classification of motions and determination of fall events and ADL. The results showed that MLP can detect the falls with accuracy of 91.6 %. Finally, a pervasive fall detection system was developed as a smart phone-based application under the name of *Smart Fall Detection*© (SFD). SFD is a standalone Android-based application that works using smart phone resources such as accelerometer sensor and GPS which utilizes proposed trained MLP for fall detection. When SFD detects the fall, a help request will be sent to the specified emergency contact using SMS and subsequently whenever GPS data is available, the exact location of fall will be sent. The SFD performance showed that it can detect the falls with accuracy of 91.25 %. This work resulted in the most accurate, first and only smart phone-based fall detection application which uses MLP neural network to determine the occurrence of fall.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

PENGESANAN KEJATUHAN MANUSIA BERLELUASA DAN SISTEM ALERT BERDASARKAN PERCEPTRON MULTILAYER RANGKAIAN NEURAL

Oleh

HAMIDEH KERDEGARI

Jun 2012

Pengerusi: Khairulmizam Samsudin, PhD

Fakulti: Kejuruteraan

Jatuh adalah masalah kesihatan utama yang memberi kesan kepada kehidupan manusia yang menghadkan pergerakan mereka yang bebas. Seiring dengan meningkatnya populasi manusia, perhatian yang lebih diperlukan untuk mengelakkan kesan yang serius dan masalah-masalah yang timbul akibat kejatuhan. Satu sistem yang dapat memantau kejatuhan dalam setiap situasi dan memberi amaran kepada pusat jagaan merupakan penyelesaian yang berguna untuk menjamin keselamatan manusia. Tujuan penyelidikan ini adalah untuk membangun satu sistem berlakunya kejatuhan yang berkesan untuk memantau aktiviti dan manusia mengenal part. Dalam kajian ini, satu sistem pengesan jatuh yang di pakai di pinggang telah digunakan. Meter pecutan 3-paksi (ADXL345) telah digunakan untuk mengukur isyarat gerakan badan manusia dan mengesan aktiviti seperti berjalan dan jatuh dengan ketepatan yang munasabah. Satu set eksperimen kejatuhan di makmal dan aktiviti-aktiviti dalam kehidupan harian (ADL) telah dijalankan oleh sekumpulan sukarelawan yang sihat dan mempunyai ciri-ciri fizikal yang berbeza dengan memakai alat pengesan di pinggang mereka. Ciri-ciri maklumat peribadi yang merupakan ciri-ciri peribadi fizikal sukarelawan dan ciri-ciri pecutan yang diambil daripada data

pecutan dianggap sebagai set ciri. Pokok keputusan kaedah telah digunakan untuk mengetahui ciri-ciri yang berkesan untuk pengelasan. Untuk tujuan klasifikasi data terkumpul mengenai kejatuhan dan corak pergerakan dalam aktiviti harian, satu Perceptron Multilayer (MLP) rangkaian neural telah digunakan bagi memastikan klasifikasi yang tepat. Data yang terhasil menunjukkan yang MLP mampu mengesan kejatuhan dengan ketepatan sehingga 91.6%. Akhir sekali, satu sistem pengesan kejatuhan secara meluas telah dibangunkan sebagai aplikasi telefon bimbit yang dipanggil *Smart Fall Detection*© (SFD). SFD merupakan aplikasi Android kendiri yang menggunakan sumber dalam telefon bimbit seperti pengesan pecutan dan GPS yang bergantung kepada MLP untuk mengesan kejatuhan. Ketika SFD mengesan kejatuhan, permintaan untuk bantuan akan dikirimkan kepada nombor kecemasan yang sudah ditentukan melalui SMS dan seterusnya akan menunjukkan lokasi yang tepat apabila data GPS diperolehi. Prestasi SFD menunjukkan yang ia dapat mengesan kejatuhan dengan 91.25% ketepatan. Kajian ini telah menghasilkan aplikasi pengesan kejatuhan untuk telefon pintar yang menggunakan MLP untuk menentukan kejatuhan dengan tepat.

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I certify that a Thesis Examination Committee has met on **29 June 2012** to conduct the final examination of Hamideh Kerdegari on her thesis entitled "**Pervasive Human Fall Detection and Alert System based on Multilayer Perceptron Neural Network**" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.
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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the **Master of Science**. The members of the Supervisory Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institutions.

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Date: 29 June 2012

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