INFORMATION OF THE DOCTORAL THESIS

Thesis title:

RECOGNIZING ABNORMAL (FALL) ACTIVITIES
USING WEARABLE SENSORS

Speciality: Computer Engineering

Code of specialty: 9.48.01.06

Name of PhD candidate: Nguyen Tuan Linh

Committees:

1. Doctor: Vu Van Thoa

2. Associate Professor, Doctor: Pham Van Cuong

Academic Institution: Posts and Telecommunications Institute of Technology

NEW FINDINGS OF THE THESIS

This thesis has proposed a simple yet effective fusion method to combine wearing sensors for fall detection. The sensors, including accelerometer, gyroscope and magnetometer, are combined with those weights showing the importance to contribute to the performance. The results of an empirical experiment, 94,18% accuracy achieved with the Random Forest model, indicates that the fusion of sensors have significantly improved the performance compared to the single sensor. In addition, we proposed to use the regression of nonlinear multiplication function algorithm to train machine learning models to tackle the challenge of data shortage and imbalance data for abnormal motion detection systems. Experiments on a complex data set were conducted to evaluate the effectiveness of the proposed method with 20 activities covering different normal and anomalous movements.

Next, the thesis has proposed a model of deep learning, a combination of convolutional neural networks (CNN) with short long-term memory networks (LSTM) to improve the performance of the system. The CNN-LSTM architecture takes the advantage of the time-spatial characteristics of the sensor data to automatically learn and represent the feature map over heterogeneous sensor data. The experiment results have shown a significantly results compared to other methods. Moreover, a framework for fine-grained human normal and abnormal activity recognition by fusing skeleton and inertial data at feature level using deep temporal convolutional networks (TCN) is proposed. The features learnt and represented through convolutional layers are fed into two fully connected layers for the production of the activity label probabilities. An extensive experiment is conducted on two public multi-modal datasets, CMDFALL and UTD-MHAD, to evaluate the TCN architecture. The results demonstrate that our TCN can achieve 83% F1-score on the CMDFALL dataset and 96.98% accuracy on the UTD-MHAD dataset. With the effectiveness of the proposed framework, it can be a fundamental component for practical applications such as situated services that acquired fine-grained human normal and abnormal activities as well as a complementary method for sequential heterogeneous sensor data modeling and feature learning.

APPLICATION AND USED IN THE REAL WORLD OR FUTURE WORKS

Improvement of the proposed deep learning models is one of our plans. In addition, we will utilize knowledge distillation models to learn more efficiently while consuming less resources (lightweight) by proposing a teacher model which guides the student model to effectively learn weight sets from those of the teacher model. By doing that, the thesis will provide background knowledge towards the end-to-end applications that can be run directly on wearable devices at reasonable costs to support the monitoring of Parkinson's patients and the elderly with motor diseases.

Confirmation of representative Scientific supervisor

Assoc. Prof. Pham Van Cuong, PhD

PhD. Candidate

Nguyen Tuan Linh