Investigation of the Optimal Sensor Location and Classifier for Human Motion Classification

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2022 IEEE 12th International Conference on Control System, Computing and Engineering (ICCSCE) | 978-1-6654-8339-1/22/$31.00 ©2022 IEEE | DOI: 10.1109/ICCSCE54767.2022.9935635

***Abstract* – Human motion monitoring by means of wearable technologies is not uncommon nowadays. This demonstrates the growing awareness of the importance of healthy lifestyle. Human body motion involves the movement of multiple muscles and joints. However, the optimal location of sensor placement on the body to record the motion in daily activities has not been well understood. This study aims to find the best sensor location for this purpose among three locations on the body, that is on the back, shank, or wrist. In addition, this study seeks to find the best classification algorithm for human daily activities. The data recorded at these three locations were analysed using several classification algorithms in both Orange software and MATLAB. The results show that the sensor on the wrist provided the best classification result, thereby suggesting that wrist is the best place on the body to place the sensor for human motion monitoring. With regards to classification algorithm, we found that Neural Network provides the most accurate classification as compared to other algorithms. Future development of wearables should look into integrating classification algorithm in the system, thus the human motion monitoring will provide a richer information and not only limited to number of steps and calories burned.**

Keywords* – *wearable sensors, human motion, human physical activity, machine learning

I. INTRODUCTION

According to an article published by the World Health Organisation (WHO) [1], Malaysia has the highest rate of obesity and overweight among Asian countries with 64% of male and 65% of female population being either obese or overweight. This is an alarming situation that needs to be properly addressed by relevant stakeholders such as the government agencies and NGOs. One of the causes of this problem is the unhealthy lifestyle among Malaysians [2]. There is a need to promote a healthy lifestyle among Malaysians by creating an awareness of their activities throughout the day, as well as how much calories they have burnt as compared to how much calories they have taken each day.

Wearable technology is being widely used nowadays as fitness tracker. More and more smart bands and smart watches have been introduced into the market. In 2019, the value of wearable industry is estimated at 25 billion USD, an increase of more than threefold from 2016 [3]. More and more people are wearing smart bands or smart watches nowadays. This shows that it has become a trend that people would like to know about how their days went, activity-wise. People now love to analyse how many steps they have taken in a day, and how many calories they have burnt. When it comes to runners, they would like to know how far they have run, and the calories burnt. However, the statistics provided by these wearables, most of the times are limited to only number of steps and calories. It would be better if the wearable could provide the person wearing it a detailed statistics of his/her movements in a day, such as how far this person has walked, how far has he run, how many stairs did he climbed, how long was he sitting down, how long was he typing on a computer or laptop. This detailed information can be made available through a classification of these different type of activities by means of a machine learning model.

To formulate a model to classify the motion, huge amount of data is required. Here comes a research question, where should we place the sensor (inertial measurement unit) on the body? This is another research area that has not been really understood. Some studies experimented with the sensor placed on the chest, while another study put the sensor on the back. A more common sensor placement is on the wrist. This is the focus of this study, that is to find where the best location is to place the sensor, and to understand why this location provides a better data for activity classification.

The rest of the paper is organized as follows. Following section discussed the related works. Section III delineates the methodology used and the experimental

This work was supported by the Research Management Center of Universiti Malaysia Pahang.