A machine learning algorithm to predict knee joint loading in real time

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1. Introduction and Motivation

Knee joint loading plays an important role in the pathogenesis of knee osteoarthritis (OA). People with OA will walk with higher loading at the knee. As knee joint loading is difficult to be measured dynamically, knee adduction moment (KAM) is used as an alternative evaluation of knee joint loading. Therefore, a decrease in KAM is assumed to indicate a reduction in knee joint loading.

However, KAM is usually measured with sophisticated and expensive equipment set in laboratory, which limits the utility in the clinical settings. The objective of this study is to use some wearable sensors set in patients' ankle to collect data, and then develop an algorithm to estimate KAM in real time with these data. This algorithm will simplify KAM measurements and maintain the accuracy, thus making it possible to monitor patients' knee joint loading at any time, which can also be implemented to analyze and correct patients' gait.

Comparing to previous method, the limitation of location will be relaxed in this approach. Flexible and cheap system can be easily set up in clinical settings to do measures and to predict KAM in people with medial knee OA. Identifying those people who are more likely to experience high medial knee loads has a great practical significance for clinicians to design proper therapeutic regimens.

2. Approaches and Techniques

To predict KAM with enough accuracy, a lot of data needs to be collected first, to train the algorithm and to be compared with those collected by full motion laboratory.

In this study, we will use 4 wearable sensors with accelerator, gyroscope and fusion in each one. The protocol of the sensors is Bluetooth low energy, which has sufficient communication rate and strong cruising ability.

In the first step, we need to build a system to receive and store the data from multiple sensors at the same time. A mobile phone will be used

as a receiver of sensors' data and then send the data to server via MQTT protocol, which has low latency. Some trials will be conducted in this method and previous one. After comparison and some corresponding changes, experiment subjects will be real OA patients to collect data we need for training algorithms.

Next step is to analyze data and try to predict KAM with an efficient model. Some feature selection machine learning algorithms and neural networks will be used to train the model accordingly. Accurate KAM will be used to evaluate knee joint loading.

For more flexible and convenient use, we will develop a mobile application for patients. It can monitor patients' gait in real time. When high knee joint loading is detected, alert will be triggered.

3. Reference

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