Title: Knee Osteoarthritis Classification System Examination on Wearable Daily-Use IMU Layout

Abstract:

This paper presents a knee osteoarthritis (OA) classification system based on wearable inertial measurement units (IMUs) and machine learning techniques. The system aims to provide a cost-effective and daily-use solution for screening knee OA. The study explores different features extracted from IMU data, including acceleration and angular velocity signals, using both handcrafted feature classifiers and deep learning methods. The results demonstrate that using three IMUs achieves a high area under the curve (AUC) value of 0.82, with a sensitivity of 86% and a specificity of 78%. The findings suggest that establishing a diagnostic system for knee OA using daily IMU devices with an on-body sensor layout is feasible.

Keywords: Inertial Measurement Unit, Layout, Knee Osteoarthritis, Screening

CCS Concepts:

- Human-centered computing: Ubiquitous and mobile computing systems and tools.

ACM Reference Format:

Chengshuo Xia, Tsubasa Maruyama, Haruki Toda, Mitsunori Tada, Koji Fujita, and Yuta Sugiura. 2022. Knee Osteoarthritis Classification System Examination on Wearable Daily-Use IMU Layout. In The 2022 International Symposium on Wearable Computers (ISWC '22), September 11–15, 2022, Cambridge, United Kingdom. ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3544794.3558459

Introduction:

The introduction highlights knee osteoarthritis as a prevalent disease in older adults. It emphasizes the importance of clinical diagnosis for knee OA and the role of machine learning tools in assisting professionals. The paper discusses the use of medical data, such as X-ray and MRI results, in diagnostic systems and the potential of biomechanical data, including IMU measurements, for distinguishing knee OA patients. The limitations of current diagnostic systems and the need for a patient-friendly and cost-effective solution are addressed.

Related Work:

This section provides an overview of previous studies utilizing IMUs in various motion detection systems, including orthopedic disease studies and patient rehabilitation. The use of IMUs in gait analysis, temporal and spatial gait metrics, and joint angle estimation is discussed. The application of IMU data in diagnosing Parkinson's disease is also mentioned. However, the paper emphasizes the differences between Parkinson's disease and knee OA and focuses on the use of IMUs for knee OA classification.

Materials:

The participants involved in the study are described, including the number of individuals in the knee OA patient group and the control group. The data collection process using IMUs is explained, along with the deployment of sensors on key body segments. The walking motion was the main activity tested, and data processing techniques, such as up-sampling and low-pass filtering, were applied to the captured acceleration and angular velocity data.

Classification System:

The binary classification task of identifying knee OA patients and normal individuals is discussed. The paper examines both handcrafted feature classifiers (using features from the time and frequency domains) and a deep learning model (baseline convolutional neural network). The performance of the system is evaluated using leave-one-out-cross-validation (LOOCV), and accuracy, AUC value, sensitivity, and specificity are calculated to assess the classification system.