Apr 1st, 10:45 AM - 11:05 AM

Artificial-Intelligence-based Approaches for Estimating Irregular Walking Surface with Wearable Sensor

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Walkability of a neighborhood is associated with public health, economic and environmental benefits. Sidewalk walking surface condition is a significant indicator for walkability assessment as it supports pedestrian travel and physical activity. However, current walkability assessments are subjective, inefficient and ineffective because they are conducted through visual inspection or collecting pedestrian survey. Therefore, an objective and real-time automated approach is necessary. To contribute towards that, the goals of this study are to identify the optimal location for sensor placement and to explore the feasibility of using machine learning and deep learning approaches for the purpose of classifying good and irregular walking surfaces with a single accelerometer.

In this research, we conducted experiments on 12 subjects with sensors attached to three different locations and collected walking data on good and irregular surfaces. We found that the optimal location for sensor placement is on the ankle. Utilizing acceleration data from right ankle, we extracted gait features and trained five machine learning classifiers for our machine learning approach and Long Short-Term Memory (LSTM) neural network for our deep learning approach. In our machine learning approach, we found that SVM was the best model because it was the most generalizable subject-wise and was able to achieve an average AUC of 80% when evaluated using leave-one-subject-out as test set protocol. As for the deep learning approach, LSTM model trained with gait features was found to achieve more superior results compared to LSTM model trained with raw acceleration data. However, when compared with SVM, SVM was able to achieve slightly better results. These results demonstrated the SVM or LSTM model trained with accelerometer-based gait features can be used as an objective tool for walkability assessment.