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A Comparative Study of Machine Learning Models for Kinect-Based Data in Movement Classification

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Abstract

This thesis conducts a detailed comparative study of several Machine Learning models, with a focus on their application to Kinect-based data for classifying human movements. The primary aim of this research is to evaluate these models to determine the most effective ones for accurately classifying movements recorded through Kinect sensors.

This study begins with a introduction to Kinect technology, highlighting its ability to capture detailed movement data. Following this, an examination of a range of Machine Learning models, such as Support Vector Machines, Random Forest, Linear Regression, and so on. Each model is tested to evaluate its accuracy, processing efficiency, and robustness in accurately classifying various movements.

The core of this comparative analysis is a diverse dataset consisting of several movements captured through a Microsoft Kinect. The research methodology involves several steps: processing the Kinect data, extracting key features that are characteristic of specific movements, and applying the selected models to this improved data. Performance evaluation of each model using standard metrics like accuracy, precision, recall, and the F1 score, which provide a complete picture of their effectiveness.

Over this study, valuable understandings are gained into the specific strengths and limitations of each model in the context of Kinect-based movement classification. The findings reveal that some models prove enhanced performance in certain situations, which is influenced by factors like the complexity of the captured movements and the characteristics of the dataset.

This thesis acts as a useful guide for researchers and professionals. It helps them pick the best models for similar work and sets the stage for more research in this area. This study contributes to the advancement of accurate and efficient Kinect-based data movement classification using Machine Learning methods, leading to more progress in this field.

Contents

Chapter 1

Conclusions and Future Work

In this chapter the conclusions of the thesis will be presented, along with the limitations and the future work that can be done to improve the results and research for better models.

1.1 Summary of Findings

The following are the main findings of the thesis:

- Raw data recorded from the Kinect sensor is suitable for the task of movement classification, but it is not enough to achieve a high accuracy and the training time is very high.

- Feature Engineering is a crucial step in the process of improving the accuracy of the models and reducing the training time.

- The best performing models in this thesis are Multi Layer Perceptron and Linear Discriminant Analysis with a score of **0.82** using 10 movements and **0.92** using 9 movements after removing one of the similar movements.

- Splitting the data based on the patient ID is the correct approach to avoid data leakage and overfitting.

- Using a sequence of frames as input for the model is not a good approach for this task, due to every movement having a different number of frames which does not allow to have same size sequences that fit best with Machine Learning models.

- Using the 3D visualization of the movements it was found that the movements Mat-Walk and Hoop-Walk are very similar, with the only difference being the object that the patient is walking over. Models struggle to differentiate between these two movements and it is recommended to remove one of them from the dataset for better results.

1.2 Limitations of the Study

1.3 Recommendations for Future Research

Bibliography