Predicting Ground Reaction Forces Using Two-Dimensional Pose Data from Open-Source Models

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This report presents the problem statement I am currently working on and the proposed strategy for the project. The primary objective is to estimate the ground reaction forces using two-dimensional pose data extracted from diverse open-source models.

Problem Statement

The primary goal of this project is to develop a predictive model for estimating Ground Reaction Forces (GRFs) based on Two-Dimensional Pose Data obtained from Open Source Pose Estimation Models, such as OpenPose. Ground Reaction Forces are crucial biomechanical parameters that provide insights into the interaction between a subject and the supporting surface during various activities. By leveraging pose data from open-source models, the aim is to establish a reliable and accurate method to predict these forces, contributing to a better understanding of human movement and potentially enhancing applications in fields like sports science, rehabilitation, and biomechanics.

Proposed Strategy

1) Data Collection and Preprocessing

Acquire Two-Dimensional Pose Data: Utilize open-source pose estimation models to obtain pose data from a diverse set of activities and subjects.

Collect Ground Truth GRF Data: Gather corresponding Ground Reaction Forces data synchronised with the pose data. This may involve using force plates or other biomechanical measurement devices.

Preprocess Data: Clean and preprocess the pose and GRF data, addressing missing values and outliers and ensuring proper synchronisation between the two datasets.

2) Model Development And Evaluation

Choose a Model Architecture: Select a suitable machine learning model for regression tasks. Options may include advanced models like neural networks.

Train the Model: Split the dataset into training and validation sets. Train the chosen model using the training data, adjusting hyperparameters as needed.

Address Overfitting: Implement regularisation techniques or explore ensemble methods to mitigate overfitting, ensuring the model generalises well to new data.

Model Evaluation: The performance of the machine learning model will be evaluated using appropriate metrics such as accuracy and confusion matrices.

3) Fine-Tuning and Optimization

Iterate and Refine: Analyze the model's performance and iteratively refine the model architecture, feature selection, and preprocessing steps based on validation results.

Hyperparameter Tuning: Fine-tune hyperparameters to optimise the model's predictive capabilities.

4) Deployment and Integration:

Deploy the Model: Once satisfied with the model's performance, deploy it for real-time predictions or batch processing as needed.

Integration with Applications: Integrate the model into relevant applications, such as biomechanical analysis software, sports performance monitoring systems, or rehabilitation platforms.

Overview of Work Completed

In the first part of the project, I read a bunch of papers and explored different projects related to figuring out how to predict Ground Reaction Forces (GRFs) from Two-Dimensional Pose Data. One interesting paper I checked out was about estimating muscle forces in real time using wearable sensors and a Hill-type model[1].

I delved into the Hill-type model mentioned in the paper, which helped me understand how muscles work and how to estimate forces, especially in the lower legs. I also checked out some projects like OpenSim[2], which helps simulate body movements and others like bio_imitation gym[3] and muscle_energy_model[4], which focus on mimicking how muscles work.

During my exploration of open-source pose estimation models, I focused on models like OpenPose, aiming to understand their practical implications. The examination included a detailed look at the OpenPose model, offering insights into its strengths and limitations.

Moving from theory to practice, I successfully implemented a pose prediction system using the OpenPose 584000 Caffe model, with all relevant codes written in Python. In addition, I explored alternative open-source libraries for pose estimation, including MoveNet and MediaPipe. This exploration aimed to broaden my understanding of available tools and identify potential alternatives that could be useful.

All the Python codes written for the work done till now have been uploaded to GitHub and can be accessed through the following link: GitHub Repository

The efforts in the literature review, practical implementation with OpenPose, and exploration of alternative models form a foundational stage for the project. This approach ensures a practical understanding of available technologies, guiding informed decision-making as I continue working towards accurate GRF predictions from Two-Dimensional Pose Data.

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