Deep Learning for IMU Classification

Devin Setiawan, Liken Hananto, Maisoon Rahman

1. Project Overview / Introduction

Our project focuses on the development and evaluation of deep learning models for classifying human activities using data from Inertial Measurement Units (IMUs). IMUs are widely used in wearable devices and can capture detailed motion signals such as acceleration and angular velocity. ***Our primary task is to classify three types of activities: no activity, walking, and bending, based on time-series IMU data.*** This project aims to leverage both lab-collected IMU datasets to train deep learning models capable of robust activity recognition. We seek to explore a range of architectures to understand the trade-offs in model complexity, accuracy, and real-time performance. Given the increasing interest in deploying AI models on edge devices (e.g., wearables, smartwatches), we will also consider strategies for model compression and transfer learning to evaluate the feasibility of deployment in resource-constrained environments. Our final output will include a performance comparison of several models, an implementation of a working classification pipeline, and a detailed reflection on challenges and insights during the implementation process.

2. Objectives

The primary objectives of the project are:

1. Develop and train deep learning models to classify IMU signals into three activity categories: no activity, walking, and bending.
2. Evaluate model performance (e.g., accuracy, F1-score) across different architectures and setups using lab-collected and public datasets.
3. Analyze the impact of different model architectures on classification performance.
4. Present evaluation results through tables and visualizations that highlight the effectiveness of each approach.

Time permitting, we will also:

1. Investigate personalized models using transfer learning, where a global model trained on multiple users is fine-tuned for individual-specific data.
2. Explore model compression techniques such as quantization and pruning to reduce model size and assess feasibility for deployment on edge devices.

3. Expected Outcomes

We expect to deliver:

1. A complete deep learning pipeline for IMU-based activity classification.
2. Quantitative performance comparison across different model architectures and configurations.
3. Insights into the impact of personalization and model compression on classification performance.
4. A final report summarizing the methodology, results, and key takeaways from our experimentation.

4. Team Members and Roles

The team members are Devin Setiawan, Liken Hananto, and Maisoon Rahman.

- Maisoon Rahman will focus on model architecture implementation, especially convolutional and transformer-based designs.
- Liken Hananto will handle data preprocessing, evaluation metrics, and baseline model implementation.
- Devin Setiawan will explore transfer learning approaches and investigate model compression techniques.

While individual team members will lead specific parts of the project, all team members will collaborate on all tasks throughout the project. The named roles simply indicate who is taking primary responsibility or initiative in those areas, but we intend this to be a joint effort with shared contributions across components.