CSE 421 – Embedded Machine Learning

Q2: Human Activity Recognition via Accelerometer Data

Can Sarp Aridogan
Ahmet Renda Sendag

1. Introduction

This task implements a simple human activity recognition (HAR) system using wrist accelerometer data. The goal is to classify activity windows as Walking vs Not-Walking with a lightweight model that can be deployed on an STM32 microcontroller.

2. Dataset

We use the WISDM v1.1 raw accelerometer dataset (user, activity, timestamp, x, y, z). The label "Walking" is treated as class 0, and all other activities are grouped as class 1 (Not-Walking).

3. Preprocessing and Feature Extraction

The signal is segmented into overlapping windows using TIME_PERIODS = 80 samples and STEP_DISTANCE = 40 samples. For each window, 10 features are computed: axis means (3), positive counts (3), FFT magnitude standard deviations (3), and one frequency-domain magnitude sum.

4. Model

A single-neuron neural network with sigmoid activation is trained. This model is equivalent to logistic regression and is well suited for embedded deployment.

5. Train/Test Split

Users with ID ≤ 28 are used for training, and users with ID > 28 are used for testing to evaluate user-independent performance.

6. Results

The model achieved an accuracy of 0.6822 on the test set. The number of false negatives (Walking classified as Not-Walking) is 1290.

Confusion Matrix (rows = true label, columns = predicted label):
[[1079 1290]
[743 3286]]

7. Embedded Implementation Plan

The learned weights and bias are exported to C code. On STM32, the same features are computed, followed by a dot product, sigmoid function, and thresholding.

8. Conclusion

The experiment demonstrates that a very small model can perform human activity recognition. The approach is computationally efficient and suitable for embedded systems.