ABSTRACT

Falls among the elderly, especially in bathroom environments, are critical events that often go undetected in real time. Mitigation efforts through inertial sensor-based (IMU) wearable technology are a potential alternative, but still face challenges in terms of detection Akurasi*, computational efficiency, and integration limitations with embedded devices. This study aims to design a machine learning-based fall detection system that is not only accurate but also feasible for implementation on wearable devices.*

The methods used include IMU data acquisition at a frequency of 100 Hz, data processing through a 3-second Sliding window technique with 50% overlap, and extraction of statistical features and Hjorth parameters from six accelerometer and gyroscope channels. The labeling process is performed automatically using a mobility-based threshold. The extracted data is then balanced and normalized before machine learning model training.

A Stacking ensemble model was applied with Random Forest and Gradient boosting as base learners, and Logistic regression as the meta learner. The training results were converted into a C structure for implementation in a wearable device. The evaluation results showed that the Stacking model was able to achieve a f1-score 0.92, outperforming the individual base learner models.

The implementation on an embedded device was successfully run and was able to display "FALL" on the serial monitor. This proves that the fall detection system design is not only effective in theory but also practical for deployment on wearable devices.

Keywords: Fall detection, embedded system, Hjorth descriptor, IMU, machine learning, Stacking ensemble