Optimizing the Specifications of a Fall Detection System

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Abstract
This study aims to optimize the parameters of an IoT-based automatic fall detection system, specially adapted for the ongoing NeuroPredict core project. Given the increasing global aging population, falls among seniors have become a significant public health issue due to their high incidence rates and consequential impacts. Conventional fall detection systems often use environmental sensors and computer vision techniques, but these approaches have inherent drawbacks like privacy concerns and user discomfort, hindering their widespread adoption and acceptance. The study employed the Gait Band, a device with an accelerometer positioned around the waist. Accelerometer data were collected during various activities, including simulated falls, walking, jumping, and sitting on a chair. A comparative analysis was performed using two methodologies: the threshold method and machine learning (ML) algorithms. The ML algorithms used were Support Vector Machines (SVM) and k-Nearest Neighbors (KNN). The threshold method utilized an empirical approach to select parameter values. This comparison aimed to assess each approach's effectiveness in terms of sensitivity and specificity for fall detection. The ML algorithms demonstrated sensitivities ranging from 90.0% to 95.0% and specificities between 94.0% and 97.0%, highlighting their nuanced capabilities in identifying falls accurately. In contrast, threshold-based approaches generally showed lower precision and adaptability compared to ML models, resulting in less accurate outcomes. The SVM algorithm demonstrated slightly higher sensitivity and specificity values compared to the KNN algorithm, suggesting better overall performance in distinguishing between positive and negative cases. In addition to evaluating sensitivity and specificity, the choice between ML algorithms and threshold-based approaches in fall detection systems should also account for factors like computational complexity and real-time classification speed. This research highlights the importance of assessing various performance metrics and practical application considerations to optimize the deployment of ML algorithms versus threshold-based criteria in real-world settings for effective fall detection.

Keywords*:* Fall detection; Internet of Things (IoT); Machine Learning (ML); Elderly care