DAINAM UNIVERCITY
INFORMATION TECHNOLOGY

Implementing AIoT Applications in Monitoring and Analyzing Fall Actions: A Safety Solution for Users

Supervisor lecturer: M.A Trung-Hieu Le, Lect Van-Nhan Nguyen

Thi-Hong-Ngoc Pham, Duc-Thuong Nguyen , Dao-Nguyen-Giap Nguyen , Hai-Phong Nguyen

Dainam University, Hanoi, Vietnam

Github: https://github.com/phamthihongngoc/phat-hien-te-nga.git

Introduction

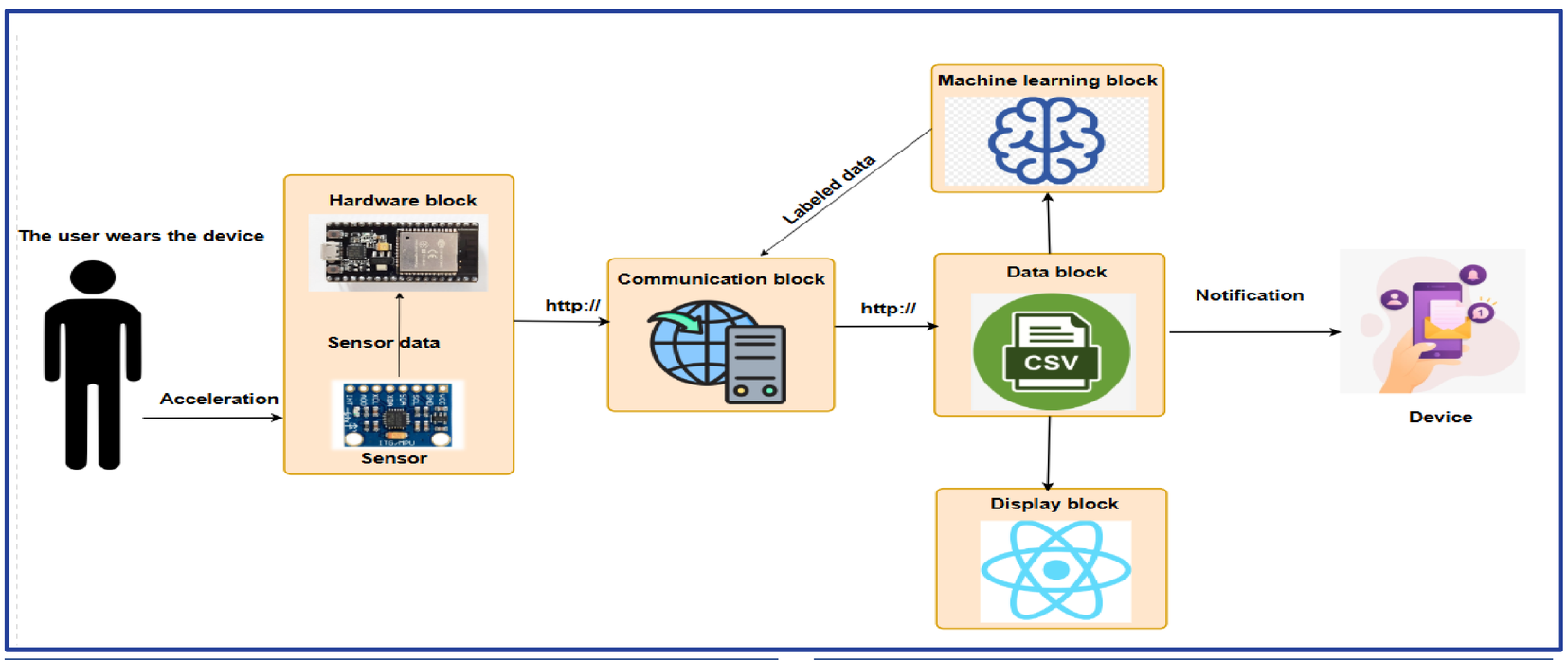
Detecting falling actions:

- The goal is to analyze fall actions accurately through sensor data.
- There is significant potential for application in various fields: healthcare, home device control, etc..

Contributions

- **Propose to implement preprocessing** of **sensor data** from **MPU6050** for **fall detection. The data** is **filtered, normalized, divided** into **sliding windows, label encoded,** and **imbalanced data is handled using SMOTE, then saved** for **model training.**
- Propose a **CNN + LSTM model** to **combine spatial feature extraction** and **temporal relationship learning,** helping to **accurately recognize** fall **actions** from MPU6050 sensor data**.**

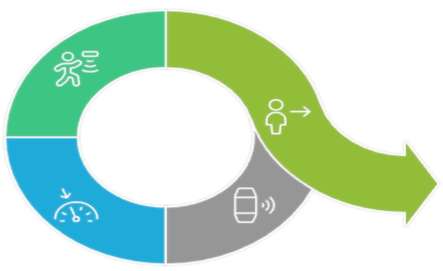
Architecture



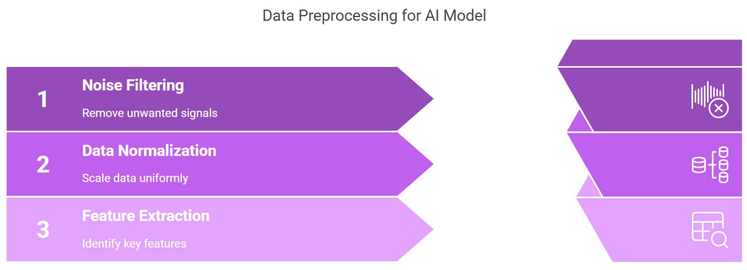
Proposed methods

Framework consists of five crucial components including:

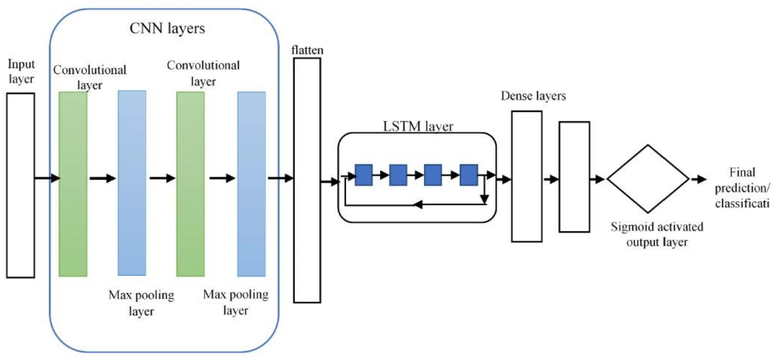
- **Processing raw data** (Filtering, retaining necessary activities, and normalizing data)..



- **Data preprocessing**.



- **Training an AI model**: Using CNN to extract spatial features and LSTM to process time series, enabling high-accuracy fall detection..



- **Deploy on embedded devices**: Optimize the model to run on ESP32, ensuring performance and energy efficiency.
- **Real-time alert**: When a fall is detected, the system sends a message alert to the phone of a family member or medical staff.

Dataset

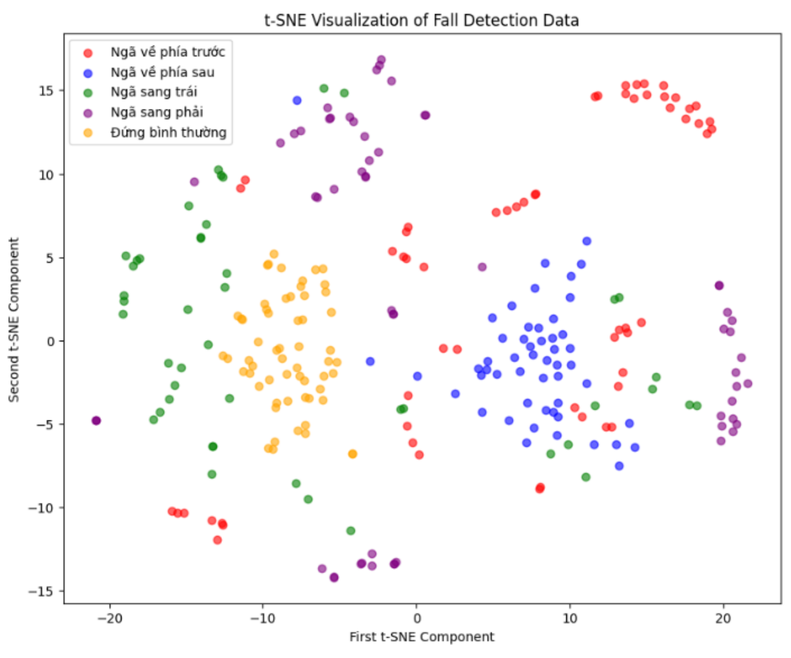
Action Human dataset:

- The dataset of fall actions in individuals for analysis, detection, and sending alerts via text messages on mobile phones.
- Three-axis acceleration signals and three-axis angular velocity signals.

The data has 5 types of action labels:

- Fall forward: 6,855 samples
- Fall left: 2,542 samples
- Fall backward: 1,228 samples
- Fall right: 915 samples
- Standing: 660 samples

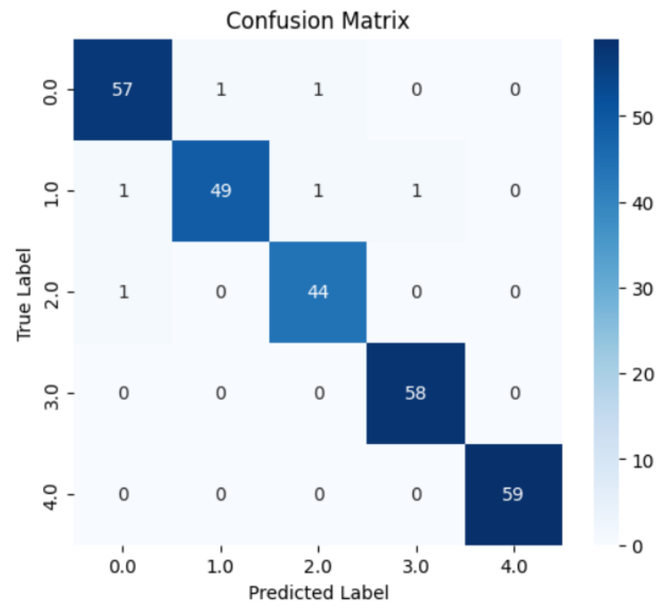
Attribute	Quantity
Classes	5
Frequency	50
Subject	1
Training set	1092
Testing set	273



Results

Performance comaparison on Action Human dataset

Action class	Precision	Recall	F1-score	Support
0.0 (Lean forward)	96.6%	96.6%	96.6%	59 mẫu
1.0 (Lean back)	98.0%	94.2%	96.1%	52 mẫu
2.0 (Lean to the left)	95.7%	97.8%	96.7%	45 mẫu
3.0 (Lean to the right)	98.3%	100%	99.1%	58 mẫu
4.0 (Stand normally)	100%	100%	100%	59 mẫu



Composite index

Index	Value
Accuracy	0.9817
Macro avg Precision	0.9805
Macro avg Recall	0.9811
Macro avg F1-score	0.9807
Weighted avg Precision	0.9818
Weighted avg Recall	0.9817
Weighted avg F1-score	0.9817

Conclusions and future works

Conclusions: The AIoT system for fall detection and monitoring has high accuracy, quick response, and stable operation, helping to monitor health and improve the quality of life for the elderly through deep learning applications and optimization on embedded devices.

Future works: Expand the data to increase accuracy, integrate advanced AI to recognize context and reduce false alerts, and apply it to smart wearable devices for comprehensive health monitoring.