

Video Analytics Gait Trend Measurement for Fall Prevention and Health Monitoring

Lawrence O’Gorman,
Nokia Bell-labs, Murray Hill, NJ USA
Larry.O_Gorman@Nokia-Bell-Labs.com

Xinyi Liu, Md Imran Sarker, Mariofanna Milanova
University of Arkansas at Little Rock
Little Rock, Arkansas, USA
xinyiliu548@gmail.com
{[misarker](mailto:misarker@ualr.edu), [mgmilanova](mailto:mgmilanova@ualr.edu)}@ualr.edu

Abstract— We design a video analytics system to measure gait over time and detect trend and outliers in the data. The purpose is for health monitoring, the thesis being that trend especially can lead to early detection of declining health and be used to prevent accidents such as falls in the elderly. We use the OpenPose deep learning tool for recognizing the back and neck angle features of walking people, and measure speed as well. Trend and outlier statistics are calculated upon time series of these features. A challenge in this work is lack of testing data of decaying gait. We first designed experiments to measure consistency of the system on a healthy population, then analytically altered this real data to simulate gait decay. Results on about 4000 gait samples of 50 people over 3 months showed good separation of healthy gait subjects from those with trend or outliers, and furthermore the trend measurement was able to detect subtle decay in gait not easily discerned by the human eye.

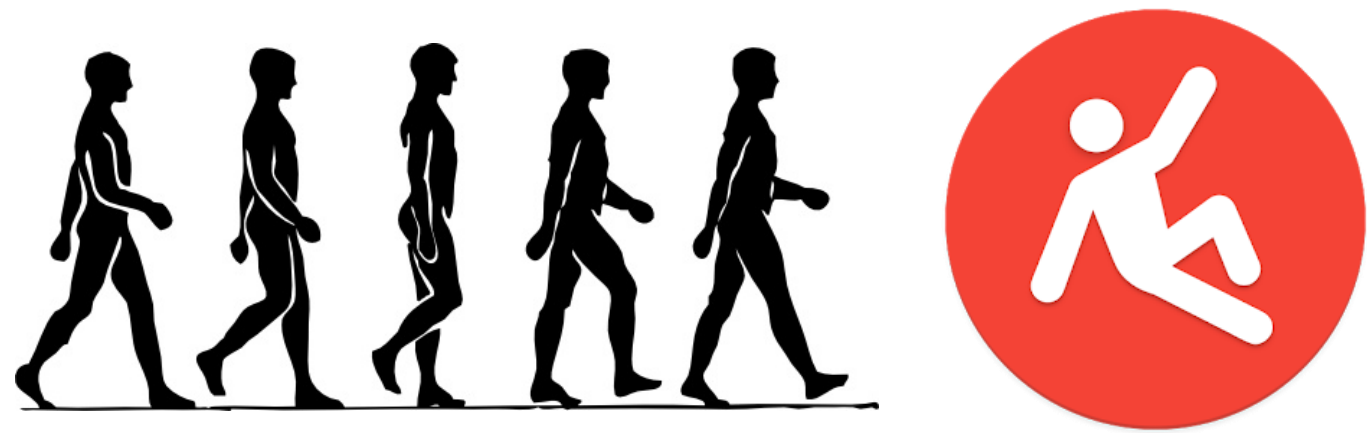
Keywords— *gait, pose estimation, gait trend, fall prevention, noninvasive health monitoring, video analytics.*

1. Problem Statement

This project originated with the request for a non-invasive system to prevent falls of clients at elder drop-in centers.

This application gave the opportunity to aim toward two novel contributions:

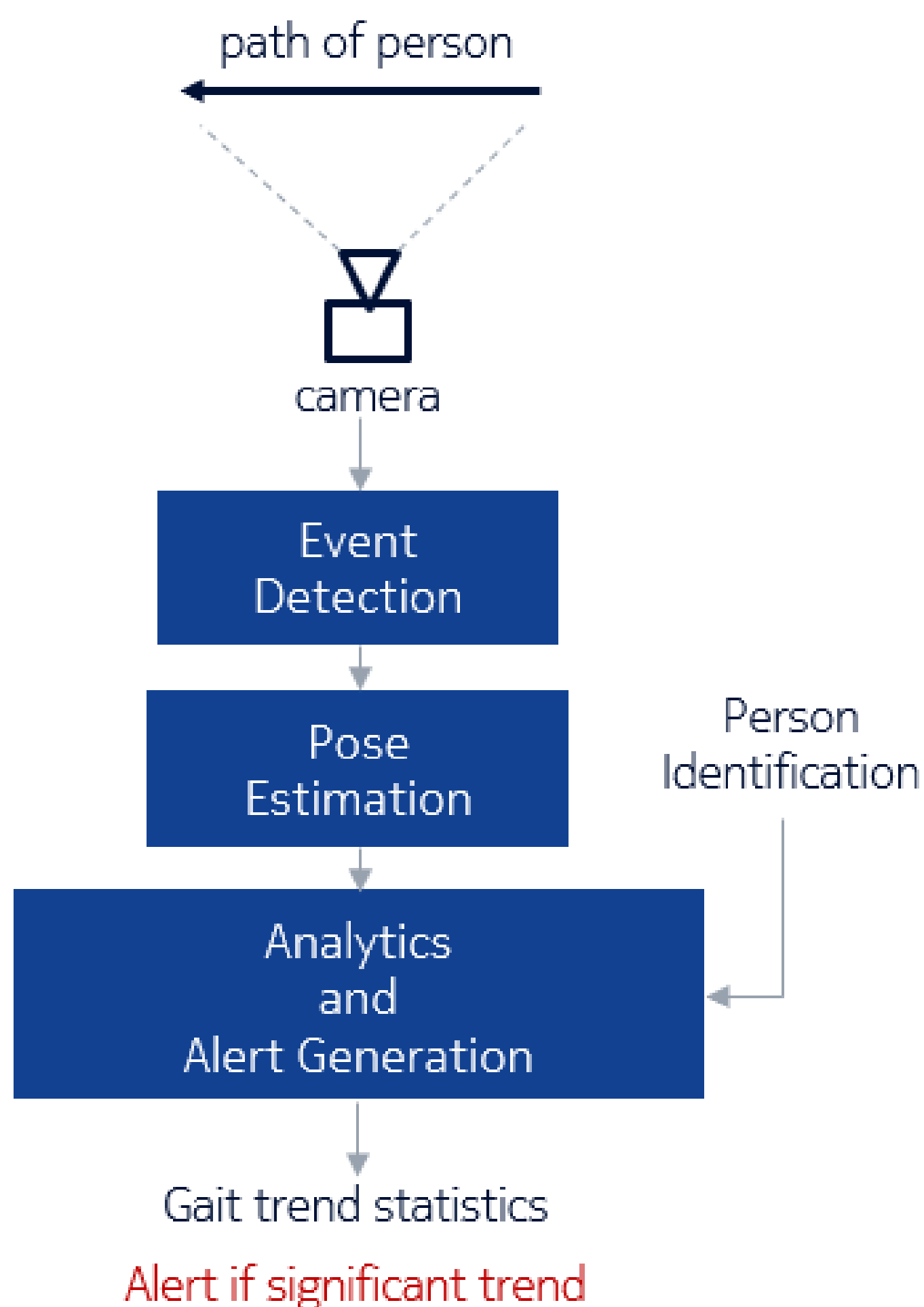
- 1. **Prevent** falls before they happen. Most gait systems only detect falls.
- 2. Analyze over time, using **gait trend analytics**. Most gait systems perform one-time analysis.



2. System

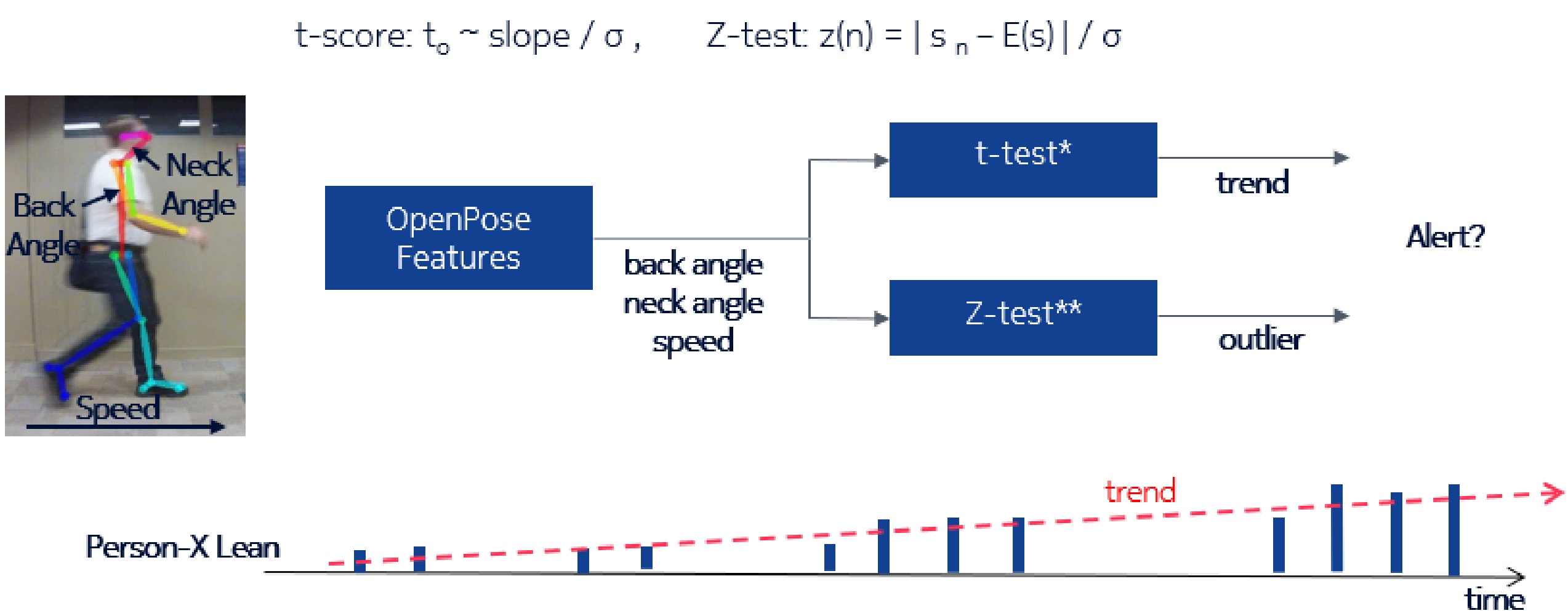
The system has 3 modules:

- 1. **Event Detection** – Detect person walking across camera view by motion “tripwires”.
- 2. **Pose Estimation** – “Skeletal features” are extracted using the OpenPose tool.
- 3. **Trend Analytics** – gait features are examined over time. A non-zero trend of gait features may indicate a health change.



3. Methodology

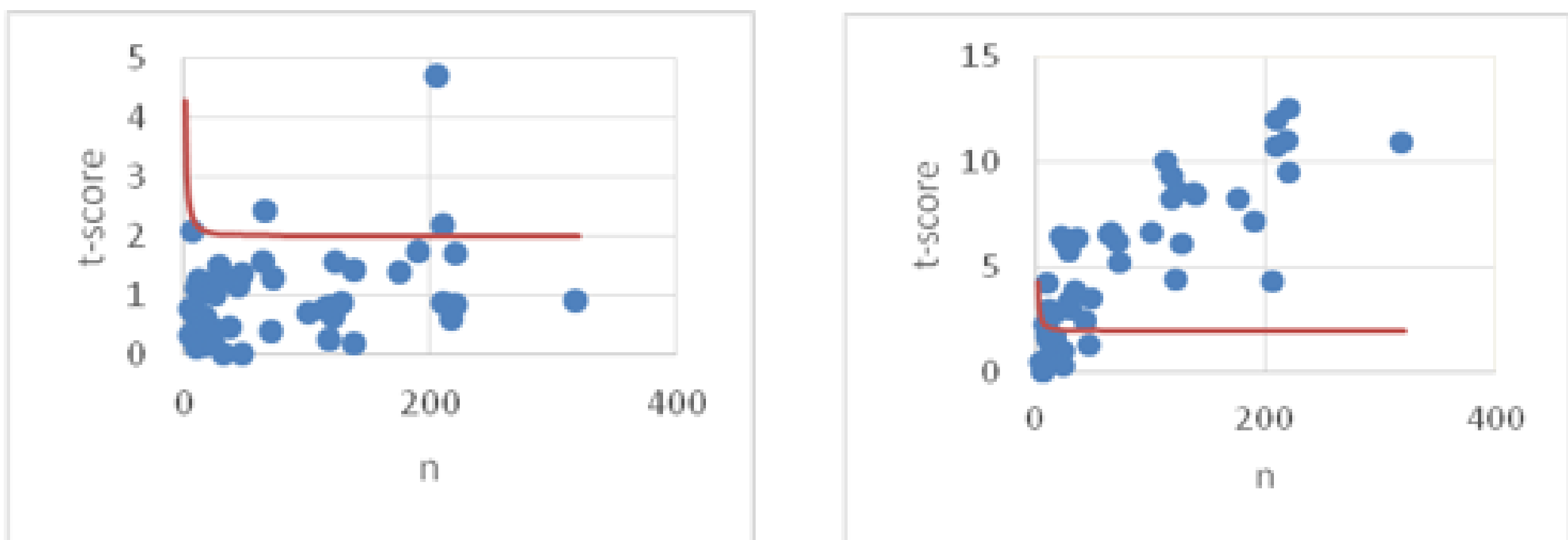
We use standard statistical tests: *t-test* to detect non-zero trend (slope) and *Z-test* to detect significant outlier events. OpenPose features used for gait measurement are back and neck angles shown.



4. Experiments and Results

3937 gait events, 50 labeled persons, two 3-month periods

Plot on left shows “null hypothesis”, t-scores for gait measurements for healthy subjects. 48 of 50 are below 95% confidence threshold, indicating 0-slope. Plot on right shows same healthy-person data with 3° gait decay added over sampling period. This is easily detected with the t-test. Note that this small a gait decay is not easily discerned by the human eye.



5. Conclusion

Measuring gait trend, individuals can be monitored over time, and when gait feature decay is detected of a significant trend (non-zero slope), intervention can be enacted to prevent a fall before it takes place.

The paper discusses other applications besides this preventative one, for instance a tool to improve gait among people of any age and health..