Human Fall Detection Using Kinect Sensor

Michał Kępski – University of Rzeszow
Bogdan Kwolek – AGH University of Science and Technology

Falls are major causes of mortality and morbidity in the elderly. The existing CCD-camera based solutions require time for installation, camera calibration and are not generally cheap. In this paper we show how to achieve automatic fall detection using Kinect sensor. The person is segmented on the basis of the updated depth reference images. Afterwards, the distance of the person to the ground plane is calculated. The ground plane is extracted by the RANSAC algorithm. The point cloud belonging th the floor is determined using v-disparity images and the Hough transform.

Agenda

- Fall detection problem
- Approaches to fall detection
- Motivation and Background
- Our approach
- Fall detection algorithm
- Experimental Results
- Summary

Fall detection

- Fall Detection isolates falls from activities of daily living (ADLs).
- The goal of fall detection technology is to detect the fall occurrence as soon as possible and generate an alert.

Fall detection: facts

- Falls are major causes of mortality and morbidity in the elderly.
- From 20 to 30 percent of those who have fallen have medium to severe injuries.
- Half of those, who have fallen can not get up without help.

Fall detection: primary challanges

- Reach high performance of fall detection
- Reduce number of false alarms
- Generate alarm as quickly as possible
- Preserve user privacy

Fall detection: approaches

Since falls are usually characterized by larger acceleration compared with ADL, the existing solutions for fall detection mainly use accelerometers and gyroscopes.

- Several ADLs have similar kinematic motion patterns with real falls (false alarms).
- Inadequate to be worn during the sleep.

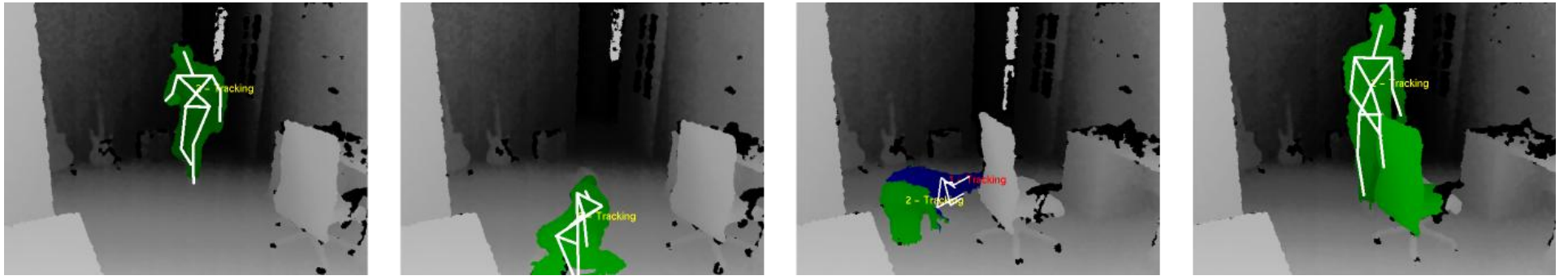
Fall detection: approaches

Many attempts have been made to detect falls using vision system, consisting of single camera, multiple cameras or omnidirectional cameras.

- CCD-camera based solutions require time for installation, camera calibration and they are not generally cheap.
- Can not work in nightlight or low light conditions.

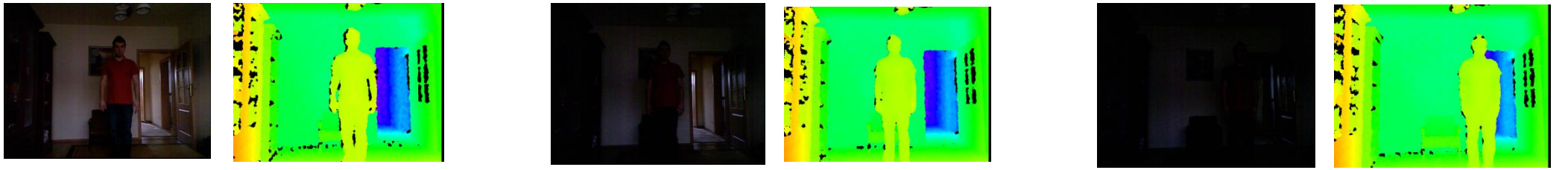
Motivation and Background

- Humans may not have consistent color and texture but have to occupy and integrated region in space.
- Software for the Kinect sensor has been developed - allows human computer interaction by skeleton tracking.
- Not applicable for fall detection:



Our approach

- Use Microsoft Kinect Device
- Utilize depth maps only
  - Preserve user privacy
  - Invariant to light conditions



Fall detection algorithm

Algorithm

Offline phase:

- Calculation of background reference image
- Determining the ground plane

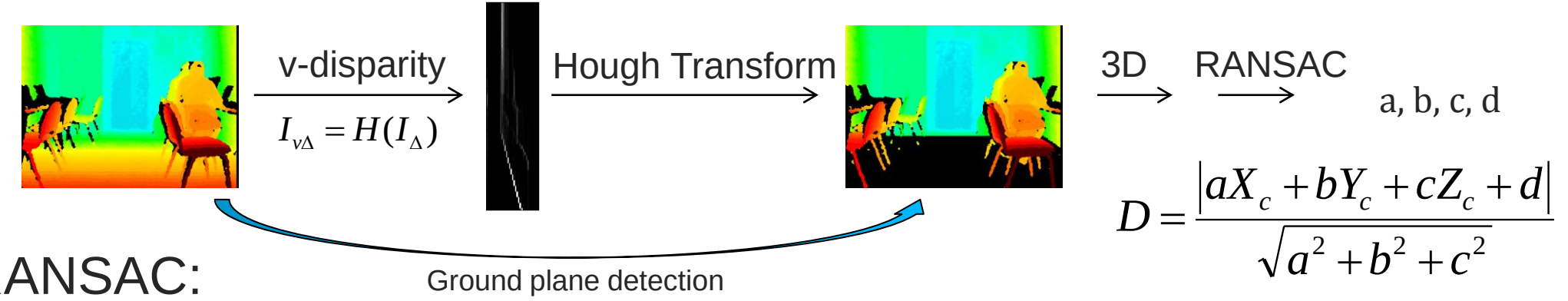
Online phase:

- Person detection
- Background actualization
- Calculation of the distance between the person's center of gravity to ground plane
- Detection of the fall occurrence

Fall detection algorithm: offline

V- disparity:

V-disparity [Labayrade, 2002] image calculation for plane detection:



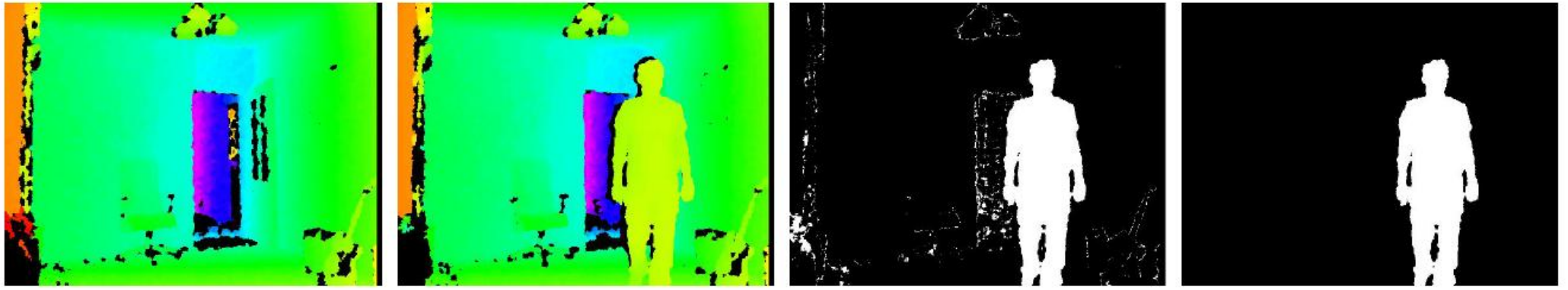
$$D = \frac{\left|aX_c + bY_c + cZ_c + d\right|}{\sqrt{a^2 + b^2 + c^2}}$$

RANSAC:

The offline phase of the algorithm utilizes RANSAC [Fischler, 1981] for plane coefficients calculation.

Fall detection algorithm: online

Extraction of the Object of Interest:



Center of gravity:

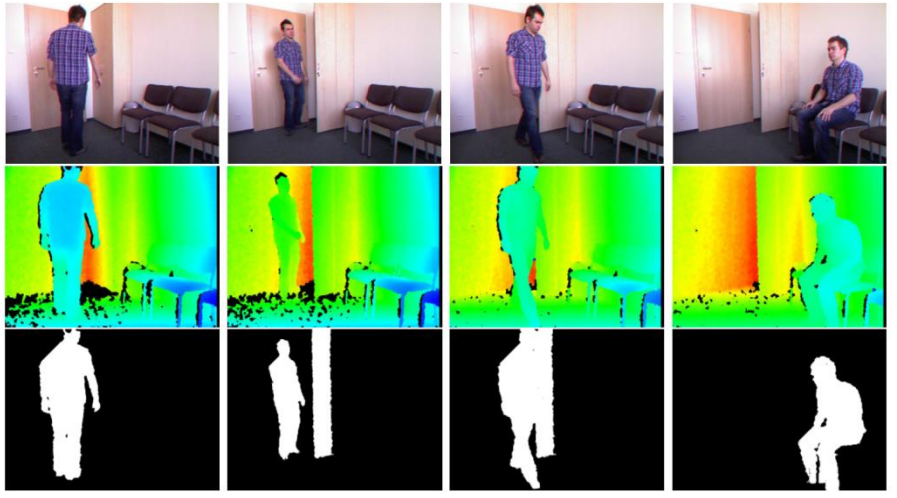
$$X_k = -\frac{Z_k}{f}(x_k - x_o + \delta x) \qquad Y_k = -\frac{Z_k}{f}(y_k - y_o + \delta y)$$

$$c(x,y) = \left(\frac{\sum_{i=1}^{n} X_i}{n}, \frac{\sum_{i=1}^{n} Y_i}{n}\right)$$

Fall detection algorithm: online

Background reference image actualization:

Temporal median filter is utilized for background actualization. The background estimate is defined to be the median at each pixel location of all the frames in the buffer.



Experimental Results

Four volunteers with age over 26 years attended in experiments and tests of our algorithm.

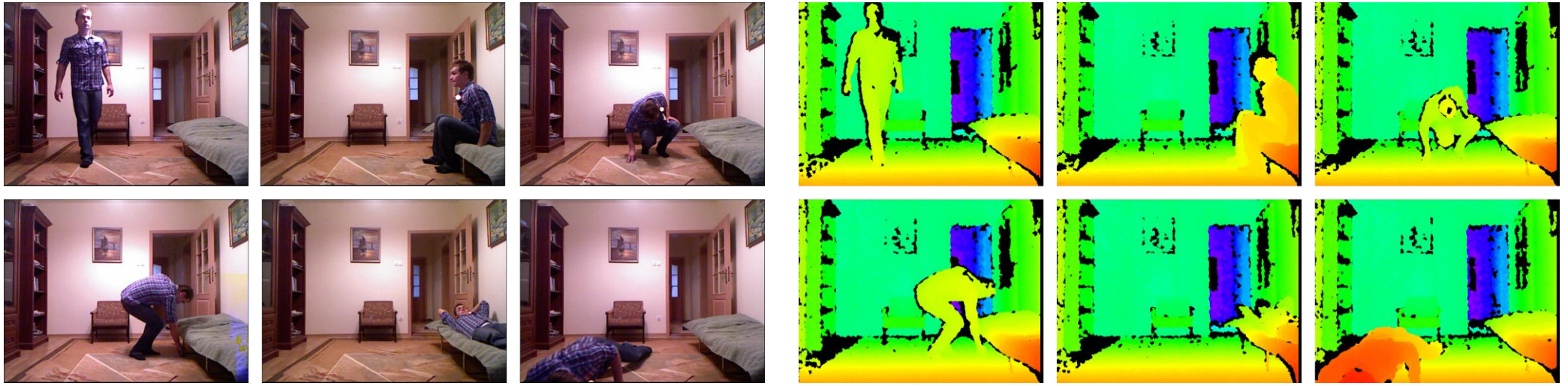
A dataset of normal activities (walking sitting down, etc.) has been composed in order to determine the threshold value.

Intentional falls were performed in home towards a carpet.

Each individual performed three types of falls three times.

All intentional falls were detected correctly.

Experimental Results



Summary

This work demonstrated our approach to fall detection using Kinect.

The detection of fall is done on the basis segmented person in the depth images.

This approach allows to achieve reliable, unobtrusive fall detection.