Contract n° AAL 2010-3-020

Deliverable D2.2

Final hard- and software for vision based tracking

Version 1

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Abstract	The aim of this document is the description of the final hard- and software for vision based tracking.

DOCUMENT CHANGE LOG

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Version 1	28 June 2013	First version of document

1. INTRODUCTION

Since the type of this deliverable is defined as "hard- and software", this document summarizes the specification briefly. This document describes the technology and algorithms to be used as final version of the fearless system after pilot phase A – however, modifications according to the results of the pilot phase B may change details of the implementation.

2. OVERVIEW ON MAIN SYSTEM WEAKNESSES

The following system weaknesses were identified during the pilot phase A and solutions to overcome the limitations of the very first prototype were developed. Hence, already during the first pilot phase, an improved system could be presented and already tested at the end of pilot phase A. This allows reducing the number of problems of pilot phase B, since already some experience could be gained.

Problems due to	Consequences	Solution
Expensive hardware	System not affordable	Change to cheaper hardware
Unstable internet (UMTS) connection	Alarm sending not robust	Use of only one single UMTS stick type, Use mifi instead of USB sticks
Tracking problems due to the use of the NITE tracker	False positives, missed falls	Implementation of new tracking and fall detection algorithm
Sunlight	missed falls	Implementation of new tracking and fall detection algorithm being more robust to sunlight

Table 1: Main system weakness

2.1. FALSE ALARMS

During the first long-term tests at the homes of elderly, it was found that the tracker provided by OpenNI / NITE does not provide robust results. Since the fall detection algorithm [1] was based on the tracking results of NITE, tracking problems results in false and missed alarms using the fall detection. These tracking problems occur due to the wrong detection of people, i.e. tables and chairs were detected as persons and thus were tracked – illustrated in Figure 1 and Figure 2. Depending on the orientation of these objects, false alarms were raised. Furthermore, initialization of the tracker was too slow (up to a few seconds) to be applied for a fall detection system since entering the field of view and falling down immediately was not detected by the system.

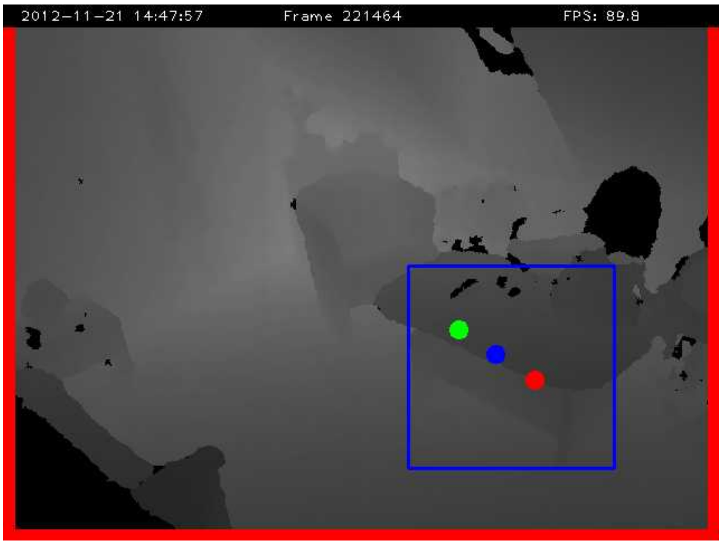

Figure 1: A table is detected as a person and tracked by OpenNI. Due to the orientation of the table, a false alarm was triggered.

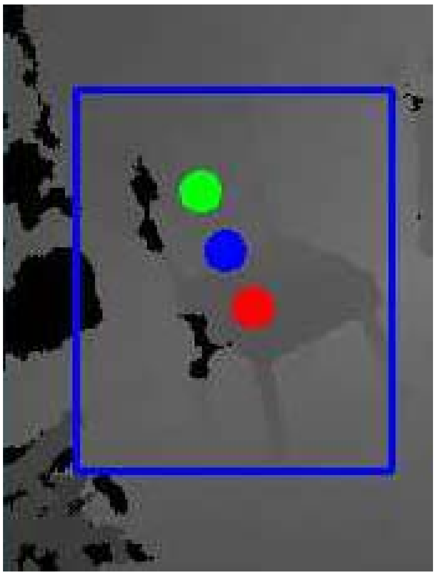

Figure 2: Detection of a chair as person

2.2. DATA TRANSMISSION

Data transmission from the intermediate station to the telematics platform was performed using one of the following methods:

- Using already existing internet connections (LAN/Wi-Fi)
- Using different types of UMTS HSPA Sticks and local cell phone providers (orange AT, Vodafone IT)
- Using a MiFi module to connect to a cell phone provider via a Wi-Fi

Using already existing LAN internet connections are the most robust connection during the field pilots. Problems with the Wi-Fi connections were reported since no feedback about the signal strength was shown by the system; hence the system was placed in an area where the signal strength was not sufficient. However, this problem was corrected immediately since no test image after starting the system was sent to the platform and no connection to the system was possible. Using UMTS connections either via UMTS sticks or a MiFi module caused the biggest problems, since e.g. some IP addresses are public; others are not – depending on the provider. Furthermore, different configurations depending on the type of the UMTS stick were needed – some sticks need the operating system to be configured in order to connect to the internet, others connect to the internet using the firmware on the UMTS stick.

3. IMPROVEMENTS ON HARDWARE

Different depth sensors (Pmd CamCube, FOTONIC P70, Argos 3D and Asus Xtion pro) were evaluated an analysed in order to choose the best fitting sensor. The Asus Xtion pro was identified to be the most appropriate sensor, especially in terms of cost-effectiveness and thus was chosen to be used within the *fearless* system. Nevertheless, due to the rapid development of different depth sensors on the market, new sensors with higher performance and lower costs may be introduced to the market soon. Hence, the market situation is analysed regularly. In contrast to the original work plan, no audio signals are processed in the final hardware since this raises privacy issues and due to the availability of 3D depth sensors, audio signals are not necessary to be processed to improve the robustness. This issue was already discussed during the mid-term review meeting in Vienna and the consortium as well as the CMU agreed on this change. The hardware for the intermediate station to be used during phase B is cheaper, smaller in size and weight, has less power consumption and the start-up of the system is faster.

MacMini (phase A)	Pandaboard ES (phase B)
2,5 GHz Dual-Core Intel Core i5	Dual-core ARM Cortex-A9 MPCore (up to 1.2 GHz)
4 GB RAM	1 GB low power DDR2 RAM
10/100/1000 Ethernet	Onboard 10/100 Ethernet
WLAN 802.11n	802.11 b/g/n (based on WiLink™ 6.0)
500 GB Serial-ATA	Samsung SD 16GB
Costs: 600€	Costs: 232€
Size: 19.7cm X 19.7cm x 3.6cm	Size: 12.0cm x 10.5cm x 5.5cm
Weight: 1.22kg	Weight: < 500 g
Power consumption: inactive 11 W, max. 85 W	Power consumption: max. 4 W

Table 2: system comparison

4. IMPROVEMENTS ON SOFTWARE

In order to be able to overcome the problems described in chapter 3.5, a new tracker was developed by COG and CVL. This tracker is based directly on the depth data and thus can be fully configured and optimized to the specific needs of *fearless*. The workflow of the new algorithm is depicted in and consists of the following steps:

Figure 3: Workflow of the new tracking and fall detection algorithm

Initialization

- Analyze scene
- Identify objects to sit or lie on

Motion Detection

- Tracker initialization
- Detect Regions of Interest

Top View Transformation

- Possible due to 3D data
- Better occlusion handling

Tracking

- Large objects are tracked (persons)

State-Machine

- Defines the state of the fall detection system
- active/inactive
- fall/no fall

Reasoning Algorithm

- Verify state machine
- E.g. why person disappeared

In order to respect the privacy of elderly, further anonymzed illustrations showing the top-view of the scene containing more information about the actual state of the person were introduced and implemented. The colour indicates the distance to the floor (dark grey = person on the ground, white = high distance to the ground floor), the shape indicates whether the person is lying or in an upright position. Figure 4 shows a person standing in an upright position, indicated by the white colour and the shape of the person. Figure 5 indicates a person lying (shape) on the floor (dark grey) and hence a fall is detected.

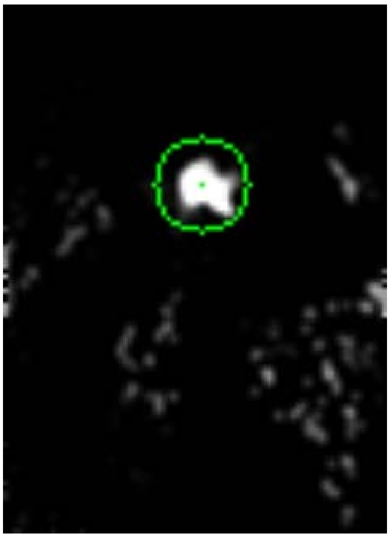

Figure 4: Person standing upright

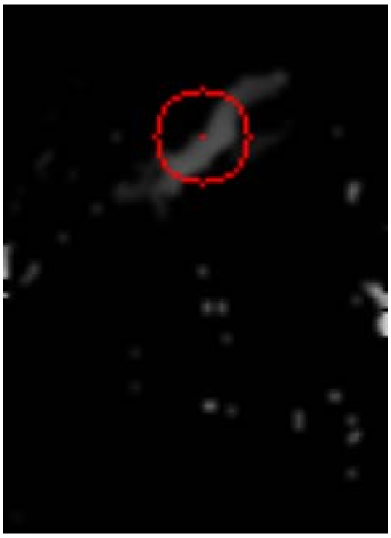

Figure 5: Person lying on the floor after a fall