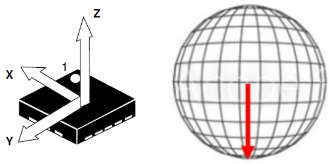
DA1432 Fall Detection using DPDM algorithm

In this News Letter you will find answers to the following questions:

- **Why is the DA1432 fall detection more reliable than conventional fall detectors?**
- **Why do most attempts to test the fall algorithm fail?**
- **Why there are few or no false positives?**

Like the DA1432, most fall detectors use a sensor that measures acceleration forces. Such sensors are tiny chips that continuously output values for all three dimensions x, y, z. One force that always acts on the chip is the gravity, the gravitational force. According to the agreement, this value is designated 1g and has the value 9.81m/s2.
The value doesn't matter at all, so let's just give this power the value 1.

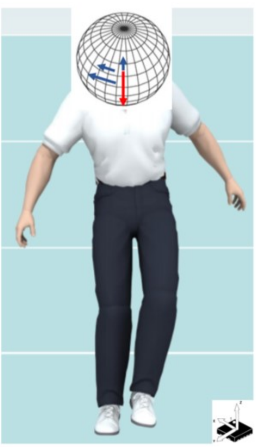
example: device is on the table
z = 1 = R is the radius of a fictional sphere
x = y = 0 (no forces in x and y direction)

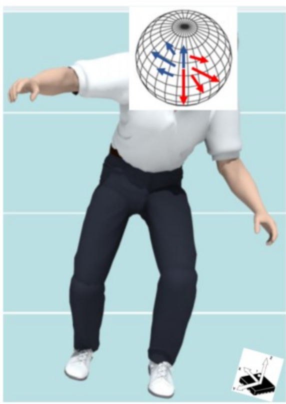


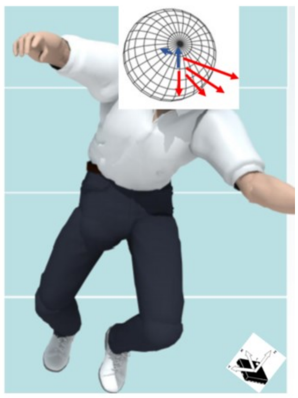
In the following, we will use this sphere representation to show which forces are decisive in order to reliably identify a “real” fall and to distinguish it from an “unreal” fall, i.e. a fall that has been caused deliberately, a fall test.

In older people, a fall usually occurs as a result of movement. It has several triggers and occurs as an interaction of individual deficits that work in pairs, such as insecurity and fear, lack of strength and reaction speed, limited body awareness and posture. If the movement is disturbed, a sequence of events occurs that can lead to a fall.

Let's look at this episode, the **phases of a “real” fall**





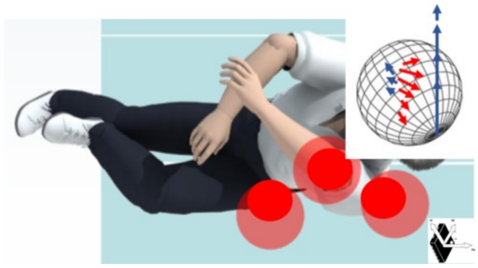


Data Collection ………………………………… …………….. 250ms

Short loss of equilibrium	delayed compensatory movement	reach of „tipping point“
Sensor Data 40% Reliability	Sensor Data 85% Reliability	Sensor Data 90% Reliability
time progress : undefined	time progress: 0 … 0,15 Sec	time progress: 0,15 … 0,25 Sec

We will see later that a fall is already significantly described by the spectrum of the x-y-z effective forces from a compensatory movement within 250 ms.
This data has a reproduction reliability of 85% -90%, which is very good.

This is followed by the fall down and the impact.



Data Collection 250ms ………………………………… ………. 550ms

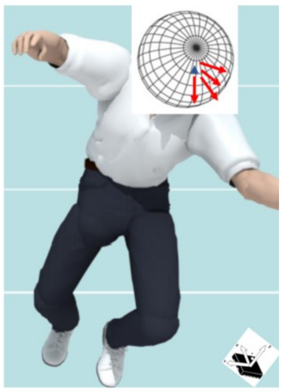
Fallen, often with lateral rotation
Sensor Data 55% Reliability
time progress: 0,25 … 0,55 Sec
there are many forms of falling
e.g. sideways, backwards, ...

Impact with injury points
Sensor Data 20% Reliability
time progress: undefined

The fall itself has no significant data profile due to various forms such as sideways, backwards, forwards, twisted. The reproduction of the data is still greater than 50%, but this is not sufficient for a reliable analysis. The impact itself is the least suitable for an evaluation, although the impact is supposedly the most significant signal of a fall (see **blue** arrow up). This has to do with the fact that the sensor chip measures digitally, that is, in equidistant time segments. In this case every 2.5 milliseconds. This seems like a lot, but the impact occurs analogously, i.e. at any time, and that could also be exactly between two measuring points. In addition, the fall of the product to the ground also generates the same data pattern, i.e. a false alarm.

You want to test the DA1432 fall detection by falling down.

Let's take a look at this episode, the **phases of a "fake" fall**



Data Collection 400ms

no loss of equilibrium
preparation for fall
time progress : undefined

no explicit compensatory movement
Sensor Data 50% Reliability
time progress: 0 … 0,25 Sec

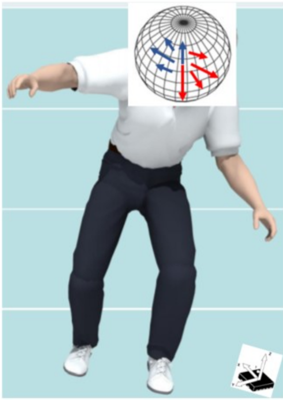
prepare to let yourself fall
Sensor Data 50% Reliability
time progress: 0,25 … 0,40 Sec

The fall simulation usually lacks the compensation movement and the overturning moment. We just let ourselves go as best we can. We will see later that although the sensor data has a correlation with a real fall, the reliability of the reproduction is only 50%. The fall itself and the impact are very similar to the real fall and cannot be reliably used in terms of data.

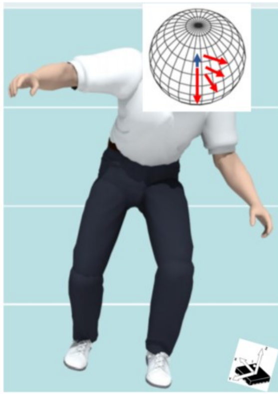
Let's compare the significant data of a fall with trying to simulate a fall.

The compensatory movement

It can be clearly seen that there is no significant compensation movement in a fall simulation. The range of effects of the forces is significantly reduced than in a real fall. The course of a simulation is a consciously controlled process. The reproduction is therefore only about 50% and strongly dependent on the test person. It is different with a real fall: the compensatory movement takes place in the subconscious and cannot be influenced. The reproduction is therefore almost 90%.



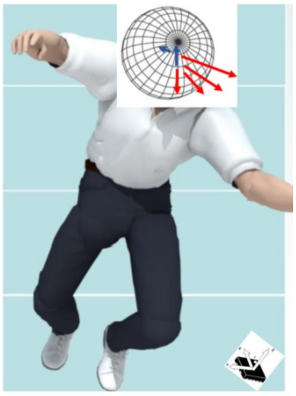
real Fall



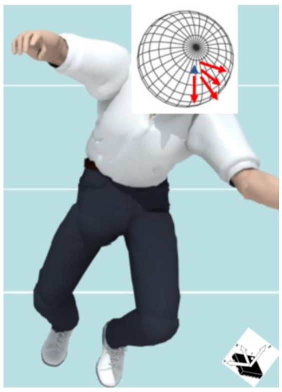
non-real Fall

The tipping point

A real fall has a significant tipping point, which then turns into a fall (falling to the ground). In a fall simulation, it is usually a "rounder" sequence of movements before the person drops. You can see this very clearly in the forces at the transition from compensatory movement to the tipping point. The range of effects of the forces is also significantly reduced here than in a real fall.



real Fall



non-real Fall

This is the essential part of the explanation why test subjects have great difficulty simulating the crucial part of a real fall. It all looks similar, but it is not in the crucial details. As astonishing as it sounds, the decisive factor takes place within the first 350 milliseconds after the compensatory movement. And that is also the difference between the DA1432 and the usual fall detectors. They analyze the end of a fall, especially the service. However, these are very diffuse data with little reproduction.

So such fall alarms have to evaluate more generously, which increases their false alarm rate. And that is very dangerous because you then no longer take a real fall report seriously. Other fall alarms try to overcome this problem with so-called "postures", i.e. gestures after the impact. But is that really reliable? There are innumerable gestures. It doesn't always have to be unconsciousness that is supposed to trigger a fall alarm.

[Source: Prof. Dr. med Christian Zippel]

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