|  |  |
| --- | --- |
| Elderly Fall Detection System  Documentation  E.F.A.S | Abstract  This document will cover the usage and configuration of EFAS. While most of the program is self-explanatory, this document will cover everything in depth.  EFAS V1.0.0.0 |

Contents

[Requirements 3](#_Toc514947051)

[Hardware 3](#_Toc514947052)

[Software 3](#_Toc514947053)

[Sensor Placement 3](#_Toc514947054)

[The Connection Process 3](#_Toc514947055)

[Connecting to the Sensor 3](#_Toc514947056)

[No Sensor Mode 3](#_Toc514947057)

[Sensor Calibration 4](#_Toc514947058)

[Obtaining GPS Fix 4](#_Toc514947059)

[The main Dashboard 4](#_Toc514947060)

[Live Data 4](#_Toc514947061)

[GPS Fix 4](#_Toc514947062)

[Accelerometer 4](#_Toc514947063)

[Orientation 4](#_Toc514947064)

[Settings 4](#_Toc514947065)

[Thresholds 5](#_Toc514947066)

[Settings 5](#_Toc514947067)

[Alert 5](#_Toc514947068)

[Diagnostics 5](#_Toc514947069)

[Fall Detection 6](#_Toc514947070)

[Manual Recording 6](#_Toc514947071)

[Usage 6](#_Toc514947072)

[Recording Destination 6](#_Toc514947073)

[Analyse Recording 6](#_Toc514947074)

[Total Acceleration 6](#_Toc514947075)

[Pause on Fall 6](#_Toc514947076)

[Live Mode 7](#_Toc514947077)

[Maximum Acceleration 7](#_Toc514947078)

[Acceleration Trigger 7](#_Toc514947079)

[Position Trigger 7](#_Toc514947080)

[Orientation Compensation 7](#_Toc514947081)

[Sensor disconnection 7](#_Toc514947082)

[Recording / File Contents 7](#_Toc514947083)

# Requirements

## Hardware

The hardware requirements to use EFAS, is an XSENS Sensor Capable of Accelerometer, Euler Orientation (with 4.17 Automotive on board Filter), and GPS (GLONASS).

The sensor that is confirmed working with the software is the XSENS Mti-G-710.

## Software

The software requires the Microsoft .NET 4.5.1 Framework to be installed, this can be downloaded from Microsoft’s own website.

In addition, it requires that the Sensor be Installed properly using the XSENS Drivers. Once installed, the Sensor should show in the Windows Device Manager.

If your sensor does not show up after driver installation, restart your computer for the installation to take effect.

The ‘EFAS.exe’ requires certain files in order to start up. These are:

* AGauge.dll
* xsensdeviceapi\_csharp64.dll
* xsensdeviceapi64.dll
* xstypes64.dll

In addition, it requires ‘trigger\_sound.wav’ in order to play sound alerts.  
These files should be located next to ‘EFAS.exe’.

## Sensor Placement

When placing the sensor on the body, it can be located anywhere on the hip, as long as it stays in the same position during use, and does not tilt separately from the hip. Placing it inside a leather phone pouch and clipping it to a belt is effective during testing. Try and have the cables go behind the person, so they do not bend/become tangled in them.

# The Connection Process

Connection to the XSENS Sensor requires very little interaction.

## Connecting to the Sensor

To connect to the sensor, open EFAS. The moment it finds the sensor, it will attempt to connect to the sensor and configure it. If the sensor cannot be configured, it is recommended to unplug it from your computer, and plug it back in. This is because the sensor can refuse to go into configuring mode.

## No Sensor Mode

If you do not have a sensor available, and would like to use the other features of the software without using a sensor, there is a “No Sensor” button available to press.   
You will have 5 seconds to press this before the program will search and connect to available sensors.

Any functions that require a sensor will not be available during ‘No Sensor Mode’, for obvious reasons. The program will still allow you to test alerts, and analyse recordings.

## Sensor Calibration

If you connect a sensor, there will be a 20 second calibration period during the first connection. This is required to increase accuracy. During this period, it is vital that the person wearing it stand still and upright. Movement during the calibration period will result in loss of accuracy over longs periods of use.

This can be skipped using the available skip button.

## Obtaining GPS Fix

Once the calibration has finished, the GPS Fix will be obtained. The program will not let you continue until a GPS Fix has been obtained at least once. While waiting, take the time to ensure that the GPS Antenna is plugged in and tight.

# The main Dashboard

Once the program has loaded, you will be greeted with the main Dashboard. This will show you the available features listed below.

## Live Data

This is the first Tab shown on the main Dashboard. It shows you the data received by the sensor, including Orientation and Acceleration. Take note of the earth’s gravity shown on the Z accelerometer Axis. The Fall detection information is only active when Fall Detection is turned on, and is shown as a 5 second delay.

### GPS Fix

The GPS will constantly update, even when your GPS signal drops. You can view your Longitude and Latitude on the top-right of the program. If your GPS Fix is recent (less than 10 seconds old), the satellite icon will show as Red, indicating that your GPS is active. If you lose your GPS Fix, and your GPS coordinates become older than 10 seconds, the satellite icon will become black. Falls will use the latest known GPS coordinates when sending alerts, along with if the GPS Fix is old or new.

### Accelerometer

Shown on the first tab is the acceleration experiences by the user, measures in meters per second squared. Total acceleration is all of this added together.

### Orientation

The orientation is shown as Euler orientation. With X being the Roll, Y being the pitch, and Z being the Yaw. If you were lying down when the sensor was connected, you can reset the orientation into the standing position by standing up straight, and then pressing the “Orientation Reset” button.

The Z (Yaw) axis drift prevention is not important when calculating fall position, as the Z axis is recalculated based on the data received during the wall.

# Settings

EFAS has multiple settings, allowing you to fine tune the program.

### Thresholds

This is the vital point of the program, the threshold for acceleration is the total acceleration felt across all accelerometer axis (X, Y, Z). This is added up and compared to the set Threshold found in the settings page. It is measured in meters per second squared.

Active daily living (ADL) sees up to 35-40 m/s2 during rough tasks such as falling into a car seat.

Falls onto hard and soft surfaces (wood and concrete) both see acceleration values of 100-105 m/s2.

The default threshold set to the program is 70m/s2, which has proven to be an effective threshold to avoid false positives. The accelerometer threshold value can be changed during operation.

### Settings

The settings group has 3 options. Including the ability to Automatically start fall detection on startup. The option to record falls found by the fall detection to its corresponding file (located in the “/falls/” folder). And the option to Trigger an Alert on a fall.

### Alert

The alert section is responsible for how the alert is sent out. All the options can be selected at the same time, resulting in the same alert being sent via different methods. These methods currently include:

* Sound (the “trigger\_sound.wav” file is played).
* Diagnostics Log Entry (An entry is added to the diagnostics box in the diagnostics tab).
* Text File (the fall is logged into its own text file located in the “alert\_text\_files” folder).
* HTTP Get (this submits the alert via a HTTP Get request to the specified web address).
  + Check the “fall\_found.php” file located next to the program for an example of how it receives the data.
  + HTTP and HTTPS are both supported.
  + Errors are logged via the diagnostics box.
  + The HTTP PHP Get Variables are as follows
    - $\_GET["long"] // Longitude
    - $\_GET["lat"] // Latitude
    - $\_GET["stalegps"] // If the GPS is stale(old), then true
    - $\_GET["time"] // time of fall
    - $\_GET["fallposition"] // fallen body position
    - $\_GET["test"] // if alert is a test, then true

Pressing the “Test Alert” button will trigger the selected alerts, however they will be run with “live” set to false, meaning that the text/file/website log will show it as a test, instead of a real fall. The sound, however, will sound no different.

## Diagnostics

The diagnostics tab shows the Connected Sensor ID, Baud Rate (speed) and USB Address.   
No sensor mode will cause these to not be visible.

The live packet estimation (body position) shows the current estimated body position based on the live data received from the sensor. Fall Detection does not need to be turned on for this to work.

# Fall Detection

Fall detection can be seen in the top left of the program. When turned off, the falling person will appear black, when enabled, the person will appear red to signal it is enabled (much like the satellite icon).

The Enable button can be used to toggle this on and off.

When you open Manual Recording / File Analyse, Fall Detection is automatically stopped/turned off.

When a fall is detected, the fall detection will use the settings specified in the settings tab to decide its actions.

There are two things that are required for a fall to be triggered.   
Those are:

* The Acceleration Trigger
* The Position Trigger

Both triggers must be tripped for a fall to occur.

See below for what these mean.

# Manual Recording

## Usage

Manual recording allows for you to specify a recording name (such as, “action-1”).  
A recording name is not required, and can be left blank.  
Once the recording has started, there is a 4 second warmup period.

After you are finished with the recording, you can press “Stop Recording”, and it will save the file into the “manual\_recordings” folder.

## Recording Destination

All manually recorded files are saved into the “manual\_recordings” folder, and can be analysed using the File Analysis feature afterwards.

# Analyse Recording

This feature allows you to analyse a fall/manual recording over and over again, using a different acceleration threshold value. A 300 second recording can be analysed in seconds. With detailed statistics on the file and its contents. Once open, press “Run Analysis” to begin the file analysis.

## Total Acceleration

This is the total acceleration threshold to be used when analysing the file. This is automatically set as your main Acceleration Threshold in your settings menu, however it is not saved afterwards, so be sure to remember your setting.

## Pause on Fall

When analysing the file, it can be beneficial to closely inspect triggered falls (if there are any). This is where the “Pause on Fall” option comes in. When enabled, the moment a fall is found, the scan will pause, allowing you to resume it using the “resume” button on the right side, next to the progress bar.

## Live Mode

When analysing the file, Live Mode will allow you to play it back in near real-time, or in other words, second by second.

You can combine Live mode and “Pause on Fall” together.

## Maximum Acceleration

This shows the maximum acceleration found during the recording. If this goes above the set Acceleration Threshold, it will cause the acceleration trigger to trip.

## Acceleration Trigger

The acceleration trigger is only tripped when the total acceleration is above or equal to the threshold.

## Position Trigger

The position trigger is only tripped when the body is on the ground and marked as “Fallen”. This can be seen under the “Body position” and/or “Fall position”.   
If the bodies centre of mass is not on the ground after the fall, the position trigger is not tripped, and the fall will not occur.

# Orientation Compensation

Because the orientation (direction the person is facing / heading) is set as 0 when first launched, walking around the house or in other directions results in the orientation being false, as their heading changes over time/activity.

In order to compensate for this, the software takes into consideration the heading of the person before they fall, to calculate a more accurate and realistic fall direction.

# Sensor disconnection

If you disconnect the sensor forcibly (removing USB connection), the program gives you a warning message and will immediately exit afterwards.

# Recording / File Contents

When a fall has occurred, or a manual recording has finished, the result is a file with a “.efas” extension.

This file contains the collected data from the sensor.   
The file contents are in XML, so they can be parsed easily.

The structure of the data is a list, with an array inside each list item.

* [0] Time – The time of the packet
* [1] Acc X – The Accelerometer value (X)
* [2] Acc Y – The Accelerometer value (Y)
* [3] Acc Z – The Accelerometer value (Z)
* [4] Gyro X – The Gyro value (X)
* [5] Gyro Y – The Gyro value (Y)
* [6] Gyro Z – The Gyro value (Z)
* [7] Ori X – The Orientation value (X)
* [8] Ori Y – The Orientation value (Y)
* [9] Ori Z – The Orientation value (Z)
* [10] GPS Long – The GPS Longitude
* [11] GPS Lat – The GPS Latitude
* [12] GPS Fix Old – The status of the GPS Fix Age (true = old, false = fresh gps)