



StepHolter User Guide

October 2024

Introduction

StepHolter is an app designed and created by *Prof. Fabio Conteduca* and *Eng. Renato Marega* to analyze leg movements and to make simple gait analysis using an Android or iPhone smartphone.

It supports most Android smartphones with minimum version 8.0. Unfortunately, some economic Android smartphones don't have the needed sensors (accelerometers and gyroscopes) or have too low-quality sensors. In these cases, the app might give very inaccurate data. If you get unexpected data, please try using the app on other smartphones with better sensors.

StepHolter can be connected to the server companion web application at www.stepholter.it

Installation

Download the app StepHolter for Android from Play Store.

Running the App

To run the app you must first understand the calibration steps, necessary to allow the app to learn the position of the leg.

When you open the app for the first time, a tutorial shows the steps for calibration. It is important to accurately follow these steps to get good test results. The tutorial will appear every time you restart of the app, until you check "don't show again", but you can still review the tutorial by calling it from "Settings".



To run the test of a gait, you need to walk straight for a few steps. Find a place where you have a straight path for a few meters and stand at the beginning of the path, facing the direction of your walk, and tap "GO" from the menu.

Collecting gait data

You should fix the smartphone to the leg, as much as possible attached to the tibia, through a band, a strap or a tape, or even by inserting the smartphone into a close-fitting sock. Take care to keep the red action button available to be touched.

To collect the significant data on some steps, you must always start with a calibration phase, to let the app learn where is the tibia and where are its sagittal plane, frontal plane and longitudinal axis.

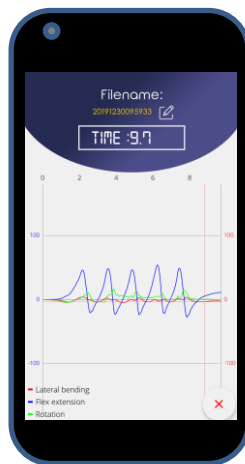
Calibration steps:

1. keep the leg facing toward your walking direction and tap the red button to start
2. keep the leg vertical and wait for the first beep (~5 secs.)
3. after the first beep, keeping the foot still, bend the knee forward 20 degrees or more and wait for the second beep
4. after the second beep, return the leg to the previous vertical position and wait for the third beep
5. after the third beep, pivoting on the heel, rotate the leg outwards 45 degrees or more and wait for the fourth beep
6. after the fourth beep, return the leg to the vertical position and wait for the fifth beep

Collecting phase:

After the fifth beep, take a few steps forward walking normally without turning left or right and when you're done stop. The app will collect the details of your movements until you tap the button again or until the maximum time is reached (60 secs by default), so you can either tap the button or wait standing for the maximum time.

Your app screen will have a chart with the trend of your tibia angular movements (frontal,



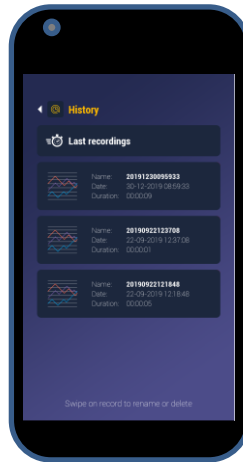
lateral and rotational on its axis). You can shift and zoom the chart to look them at your convenience.

In the chart you can see the movement of the leg decomposed in:

- *Lateral bending*: the angle from the sagittal plane. Positive when external.
- *Flex extension*: the angle along the sagittal plan starting from the initial position. Positive when the knee is forward
- *Rotation*: the rotation angle on the tibia axis. Positive when external.

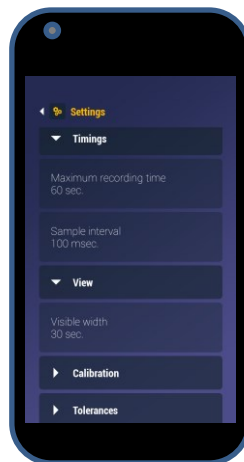
History

You will find in the history all recorded tests. By tapping one record, you can review the graphic chart of the test. By swiping one record, you'll find the icons to delete or rename it.



Settings

This section only describes the basic settings. Some settings are described in the "Advanced settings" section. It is recommended not to change the advanced settings before a good knowledge and experience in using the app.



Basic settings:

- **Timings**
 - *Maximum recording time*: you can choose the test timeout. By default, it is set to 60 seconds. Most of the time you will likely stop the test manually much sooner, but you can change this value if necessary
 - *Sampling interval*: the sampling interval is set to 100 ms by default. If you need short and detailed analyzes, you can set it to 50ms. On the other hand, if long recordings are needed, you can set it to 200 ms to save space.
- **View**

- *Visible width*: you can choose the visible range of the chart. After that time, the oldest data will scroll left out of view. In any case, at the end of the recording, if the recording time is shorter than the selected width, all the data will be visible. The default is 30 seconds
- **Edit name**: to define or to modify your name to be used in the server charts and reports
- **Set default settings**: to restore times, view and advanced settings to default values. This may be necessary mainly after modifying advanced settings
- **Tutorial**: to view again the tutorial
- **User Guide**: to view this document

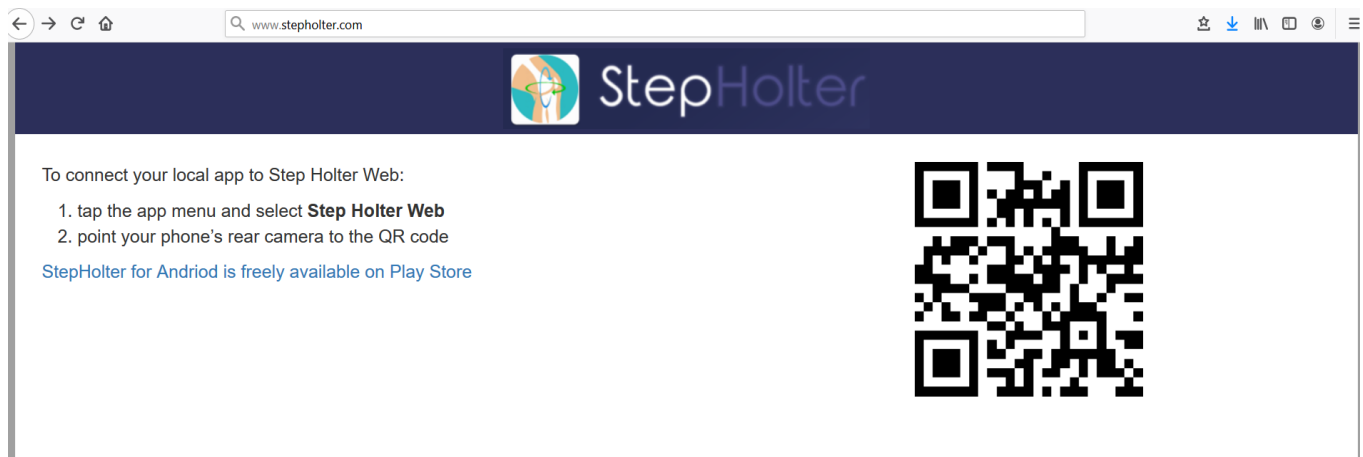
Step Holter Web

You need both the personal computer and the smartphone connected to the Internet to have them joined and work in cooperation.

The first time that you will select Step Holter Web in the app menu, you will need to enable the use of the camera and type your name. Your name is used in the title of the server charts and reports, which can be printed or saved as pdf.

Enter www.stepholter.com in your browser.

You will see a page like this:



Note: If you don't see the QR code, you may have been blocked by the firewall. Note that StepHolter Server uses secure websockets, which are usually not blocked by the firewall, but if this happens to you, port 443 must be enabled.

Scan the QR Code with the smartphone camera. StepHolter app will be immediately joined to the server.

You will see the chart of your last registration.

The web page

In addition to seeing the chart better, in the web page you can review the movements emulated by the puppet's leg. After selecting the tested leg, simply click the play/stop button or drag the mouse over the chart. You can also enable/disable specific components of the movement by clicking on the legenda.



You can also select a previous file from the selection list and analyse it again. You can also print the chart or save it as a document.

If you click "Analyze" you will see the detail of every single step.

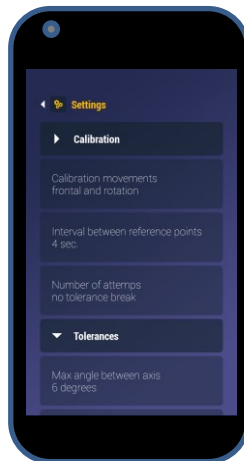
"Get Excel" button

If you plan to compare tests from multiple patients or tests at different times from a single patient, you may need to analyze a series of tests together. The "Get Excel" function will automatically generate an Excel file with a distinct row for each step analyzed, clearly identified. You can thus easily create a comparative Excel file by cutting and pasting homogeneous lines

Advanced Settings

The advanced settings are intended to better control the calibration to prevent the quality of the collected data from being compromised by an inaccurate calibration.

Note that reducing the calibration tolerance may result in greater difficulty in performing tests.



- **Calibration**

- *Calibration movements*: you can choose an alternative calibration sequence (frontal and lateral) instead of the described default frontal and rotation. It is recommended to use this alternative only when necessary, since it is difficult to obtain the correct lateral movement
- *Interval between reference points*: if you feel that the time available to take the five correct leg positions is too long or too short, you can change the interval between the beeps.
- *Number of attempts*: any calibration is accepted by default. if you want to reject inaccurate calibrations, you need to define how many attempts you want to try before stopping the process

- **Tolerances**

Tolerance constraints are activated only when a number of attempts has been defined

- *Max angle between axis*: ideally the rotation axis of the frontal movement should be orthogonal to the rotation axis of the tibia, given by the rotation movement. When tolerance constraints are active, the calibration is rejected if angle between the two axis is over 10 degrees far from being orthogonal ($<90-10$ or $>90+10$). You can modify this value to further force accuracy.
- *Max angle among starting positions*: the initial position must be taken two twice during calibration and then when recording starts. Ideally the three positions

should be on the same axis. When tolerance constraints are active, the calibration is rejected if the angle among such positions is greater than 10 degrees. You can modify this value to further force accuracy.

- *Min angle to calibrate axis*: to identify the axes of rotation well, the angle between the starting position and the ending position should be as wide as possible. When tolerance constraints are active, the calibration is rejected if one of these angle is less than 15 degrees. You can increase this value to further force accuracy or also reduce it in special cases.