

microTRACK

A system for recording hand and finger movements during microsurgery

Developed by:

Michael Axelsson, University of Gothenburg, Department of Biology and Environmental Sciences,
Gothenburg, Sweden

PLUSPOLE AB, Göteborgsvägen 52, 431 37 Mölndal



UNIVERSITY OF GOTHENBURG

Contents

microTRACK.....	3
Installation of the microTRACK software.....	3
Sensor information and attachment.....	3
Setting up for recording.....	3
Recorded data.....	5
Viewer program	7
Supplementary information.....	8
Calculations 2x2 Movement default (fine and course).....	8
Calculation of the summary windows.....	8
Converting the .NET time used to date and time in Excel	8

microTRACK

Installation of the microTRACK software

If it is the first time you use the system you need to install the software and drivers for the USB connections.

Download the ZIP file MicroTrack v.3.zip that contains the setup, the link to the program is

<https://gubox.box.com/s/qq1vxff340qh0j9ohbvabb31eg3vh2ht>

Extract the files and open the folder MicroTrack v.3. In this folder there is another .zip file CDM21228_Setup.zip, this contains the drivers for the USB units in the two basestations, extract this and run the setup

When this is finished go to the microTrackControllerApp folder and run setup, this will setup the program and create a desktop icon for starting the sampling program

The viewer program is located in the microTrack-Viewer folder but there are no installation file, just open the folder and double click on the file microTrack-Viewer file which starts the application

It should not be necessary but it is recommended that you restart your computer after the installation

Sensor information and attachment

The sensors used are Bosch BNO055, that contain a triaxial 16bit gyroscope, a triaxial 14bit accelerometer and a geomagnetic sensor (https://www.bosch-sensortec.com/bst/products/all_products/bno055)

The sensors are attached to the forefinger, thumb and back of the hand by either surgical tape or the supplied sticky gel pads. If (when) the gel pads lost the stickiness, peel them of the sensor and wash them in warm water, dry them using a lint free cloth or left them air dry then reattach them to the sensors. There are a couple of extra gel pads for the forefinger and thumb sensors in the box. The gel pads should stick to both bare skin and surgical gloves, do not use ordinary examination gloves since they do not fit tight enough to secure the sensors on.

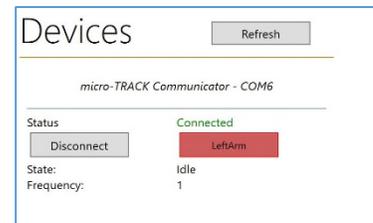
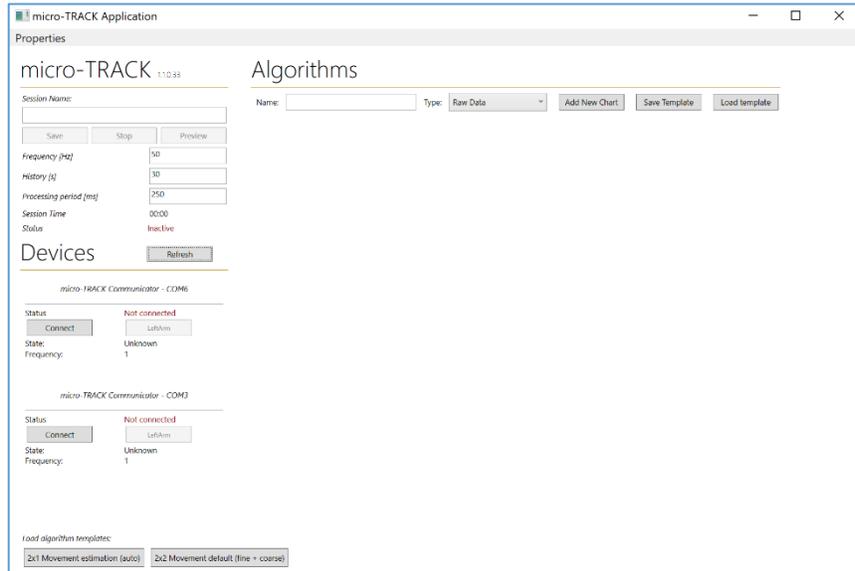
Setting up for recording

Start by plugging in the USB connectors for each base unit into the computer, and also plug in the USB camera if you want to record simultaneous video

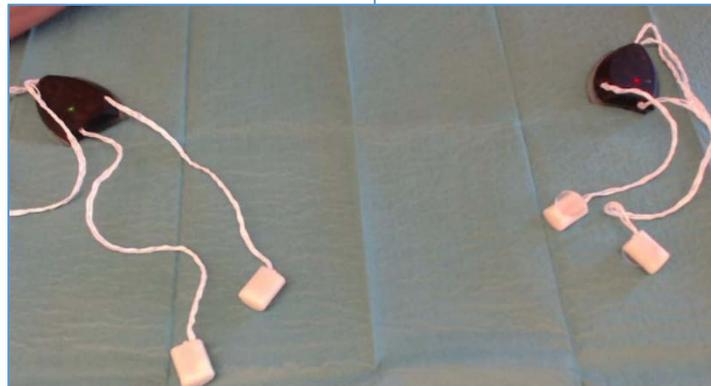
Then start the microTRACK controller program using the desktop shortcut that was created during installation.

If the window is too large or too small (depending on the resolution of your screen) you can adjust the size by clicking on **Properties** in the top left corner, adjust the size using the **Application scaling** slider.

Next you should connect the hand units. Click on the **Connect** button for the first Device (micro-TRACK Communicator – COM6) and wait until the indicator to the right of the Connect button changes to green or red. Repeat this for the second unit (micro-TRACK Communicator – COM3). When correctly connected it should look like the figure to the right. You can switch left and right by clicking on the indicator.



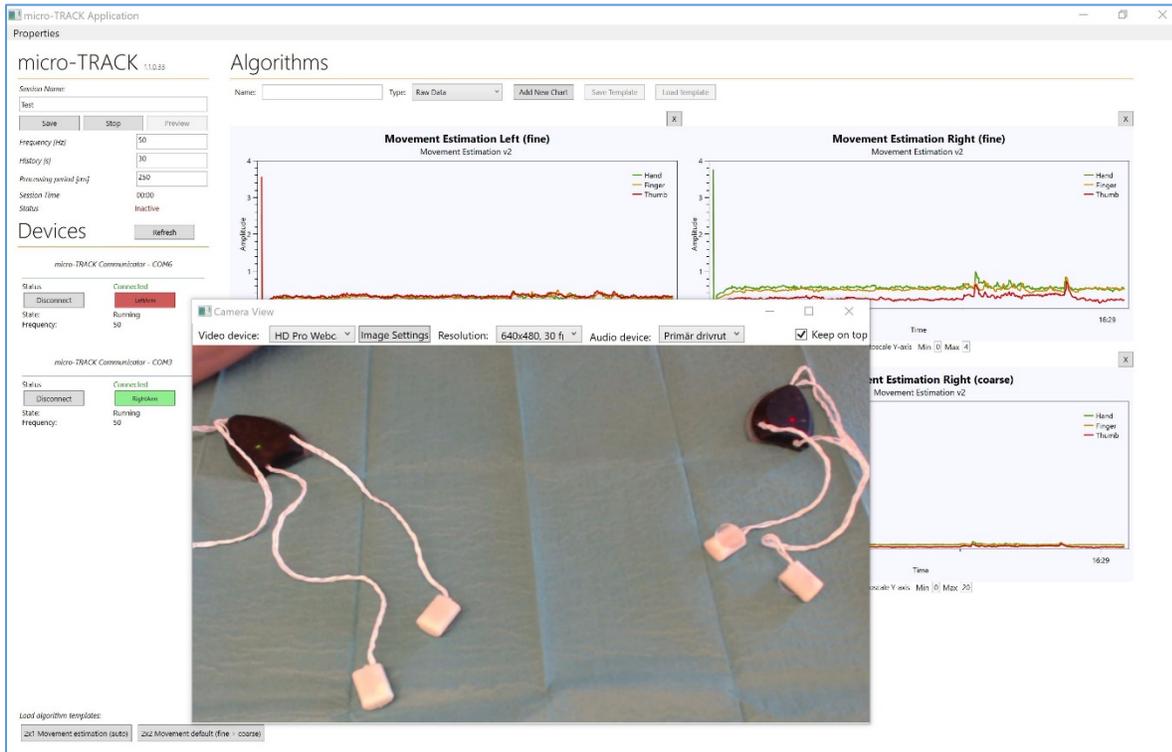
The two units are color coded both in the program (red or green indicator next to each Connect button) and on the sensors, the base units are marked left and right and when correctly connected the right side should show a green LED light in all the sensors for the right hand and a red LED light in all three sensors for the left side, see picture below (left and right view from the test person)



When the communication with both hand units are established, click on the **2x2 Movement default (fine and course)** button below the Load algorithm templates in the lower left part of the window, this will open four recording windows. This is a standard way of showing the movements with both fine and course movements for the three sensors for each hand. You can setup your own windows using the buttons under the Algorithms heading but **2x2 Movement default (fine and course)** works fine in most cases and do not affect the recorded variables.

Next type a name for you session in the **Session Name**: this will create a subdirectory in Documents/microTRACK on the computer with the date as name (yyyy-mm-dd) and then create a subfolder within this sub directory with the session name you just typed in.

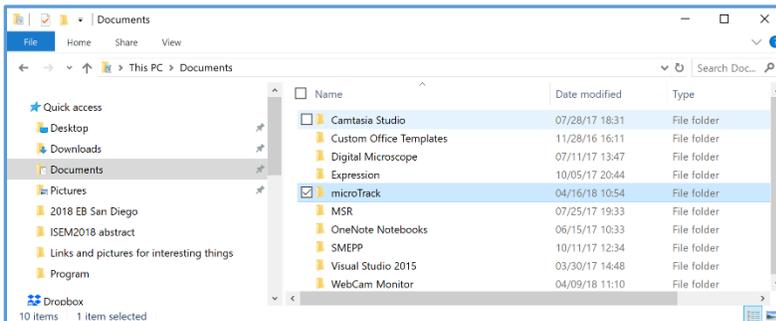
Then click **Preview**, this will open the video window and start showing the sensor data. You can now adjust the position of the video window and the resolution of the video and make sure that the sensor data works. Once everything is ready you start recording by clicking on the **Save** button, data and video will now be saved. If you want to pause the recording just click the **Pause** button and when you want to resume click **Save** again. When finished click on the **Stop** button. At the end of the session a window will appear showing a summary of the movements during the session, this data is saved in the



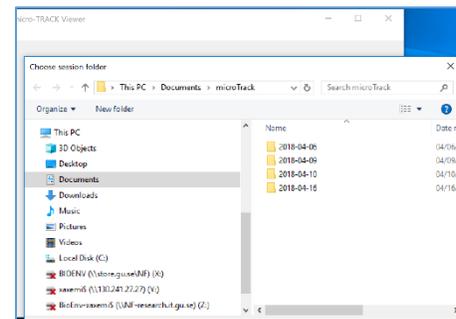
SummaryValues.txt files. The picture above shows how it looks when the Preview is on and the sensors are active and ready to be attached.

Recorded data

All microTRACK files are stored in Documents /microTRACK, when you start a new session all files are stored in a subdirectory with the date as name (yyyy-mm-dd) and within this sub directory a subfolder with the session name. All files related to this session will be save in this directory (a Chart data sub directory, Raw.txt data file,



SummaryValues.txt data file, audio and video files).



The Chart data sub directory contains the information that was shown at the end of the session, there are four .txt files, two for the right and left fine movements and two for the right and left course movements.

The Raw.txt file contains all data in raw data format saved at the frequency that you set during the session (default 50Hz)

The table below show all the variables that are recorded and stored in the Raw.txt file

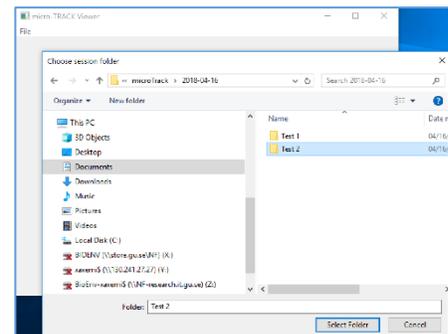
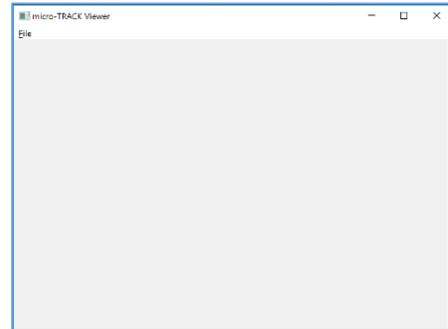
Right and left hand HAND	Right and left hand FINGER	Right and left hand TUMB
Hand Acceleration-X	Finger Acceleration-X	Thumb Acceleration-X
Hand Acceleration-Y	Finger Acceleration-Y	Thumb Acceleration-Y
Hand Acceleration-Z	Finger Acceleration-Z	Thumb Acceleration-Z
Hand Heading	Finger Heading	Thumb Heading
Hand Roll	Finger Roll	Thumb Roll
Hand Pitch	Finger Pitch	Thumb Pitch

Viewer program

To replay a session use the Viewer program go to the sub directory were you unpacked the microTRACK viewer.zip file to and double click on the microTrack Viewer.exe file. This will open a window with just one option **File** (see image tomthe right).

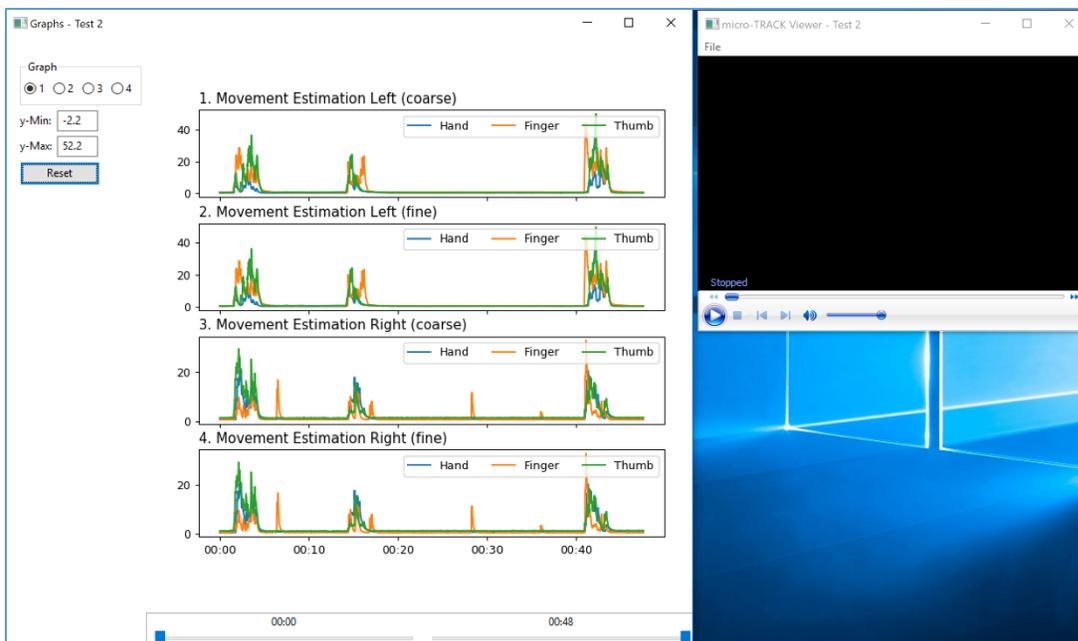
Click on File, this will open the Documents/microTRACK subdirectory on your computer, select the folder with the date that when you recorded the data and then select the session name you created for that recording session.

Two windows will open, one for the recorded data and one for the video recorded during the session. The recorded data will be shown in the 2x2 Movement default (fine and course) format and you can adjust the y-axis scale on each channel by selecting the channel number (Graph) and the set the scale (y-min and y-max). You can also change the x-axis scale by using the sliders at the bottom of the window. The left slider shifts the data along the x-axis and the right slider expands the time axis for a more detailed view.



The recorded data and the video are synched and you can navigate through the dataset or video in two ways. You need to start by starting the video and then you can either

1. Click on an interesting point in the dataset and the video will jump to that place or
2. Move to an interesting part in the video recording and the market in the recorded data will jump to the same time in the dataset



Supplementary information

Calculations 2x2 Movement default (fine and course)

If you use the 2x2 Movement default (fine and course) setting for viewing during a session there will be three traces for each sensor (finger, thumb and hand) shown in each windows for the left and right hand.

The algorithm used for calculating the values for each sensor is:

$$\text{accSumW} = \sqrt{(\text{sensorW}.\text{accX}^2 + \text{sensorW}.\text{accY}^2 + \text{sensorW}.\text{accZ}^2)}$$

$$\text{accLP} = (\text{accLP} * \text{filterFactor}) + (\text{accSumW} * (1 - \text{filterFactor}))$$

$$\text{accHP} = \text{accSumW} - \text{accLP}$$

$$\text{accRes} = \text{accHP} * \text{accelerationFactor}$$

$$\text{rot} = ((\text{oldWPitch} - \text{sensorW}.\text{Pitch}) + (\text{oldWRoll} - \text{sensorW}.\text{Roll}) + (\text{oldWYaw} - \text{sensorW}.\text{Yaw}))^2$$

$$\text{oldWPitch} = \text{sensorW}.\text{Pitch}$$

$$\text{oldWRoll} = \text{sensorW}.\text{Roll}$$

$$\text{oldWYaw} = \text{sensorW}.\text{Yaw}$$

$$\text{rotres} = \text{rot} * \text{rotationFactor}$$

$$\mathbf{resW} = \text{accRes} + \text{rotres}$$

fs is the sampling frequency, accelerationFactor, rotationFactor and filterFactor are the values you set when you set up the graphs (automatic for the present windows for instance 2x2 Movement default (fine and course)). **resW** is the result that is plotted for each incoming sample

Calculation of the summary windows

In the summary window that appear after the session the following algorithm is used

For each sensor sensor W:

$$\text{averagesW} = \text{resW} / \text{fs}$$

$$\text{totalAverage} = (\text{averagesS0} + \text{averagesS1} + \text{averagesS2}) / \text{fs}$$

The average values is then divided with the total number of seconds in the session

Converting the .NET time used to date and time in Excel

The first column in the Raw.txt file is time in .NET time format. In order to work with the time information in Excel it must be converted to Excel time.

Insert three new columns to the right of the .NET time (B, C and D) and use the formula below in column B

$$=(A4 /POWER(10;7) / 60 / 60 / 24) – 693593$$

The example above is for the row A4 in the Raw.txt file

This will give you Excel time in B4

To convert this to Date and Time you copy the result from B to the C and D column then format the columns as follows

For Date in C4, right click on C4 and select Format cell, in the Format cells window select Date and select a type you what.

For Time in D4, right click on D4 and select Format cell, in the Format cells window select Custom and type tt:mm:ss,000

The copy the cells B4-D4 down to cover all the rows in the file

It should look something like this

1	Raw Measurement Data, logging started on den 11 juli 2017 11:50:23			
2	Time			
3	.NET time	EXCEL time	Date	Time
4	6,36353706E+17	42927,49	2017-07-11	11:50:23,827
5	6,36353706E+17	42927,49	2017-07-11	11:50:23,827
6	6,36353706E+17	42927,49	2017-07-11	11:50:23,851
7	6,36353706E+17	42927,49	2017-07-11	11:50:23,851
8	6,36353706E+17	42927,49	2017-07-11	11:50:23,879
9	6,36353706E+17	42927,49	2017-07-11	11:50:23,879
10	6,36353706E+17	42927,49	2017-07-11	11:50:23,899
11	6,36353706E+17	42927,49	2017-07-11	11:50:23,899
12	6,36353706E+17	42927,49	2017-07-11	11:50:23,927
13	6.36353706E+17	42927.49	2017-07-11	11:50:23.927