UNIVERSITÀ DEGLI STUDI
DI GENOVA

Biomedical Robotics

Assignment 3 - Group 9

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1 Introduction

The purpose of this project is to implement and design a control to move a cursor on a screen and reach some target. A virtual world containing the cursor and the targets is given in the file «$8\_palline\_color.wrl$ ». Using a smartphone as a sensor, let's design a control in order to reach the targets easily.

2 Starting choices

First, we starting by choosing a signal considering the sensors of our smartphone. Although a gyroscope could have been appropriate too, we decide to use an accelerometer. This one gives as outputs the value of the linear acceleration along the x, y and z-axes in m/s^2. It is totally appropriate for this project as we need to move a point toward different targets.
Moreover, we choose a sample time for the accelerometer equals to 0.01s.

3 Control design

3.1 Test without control

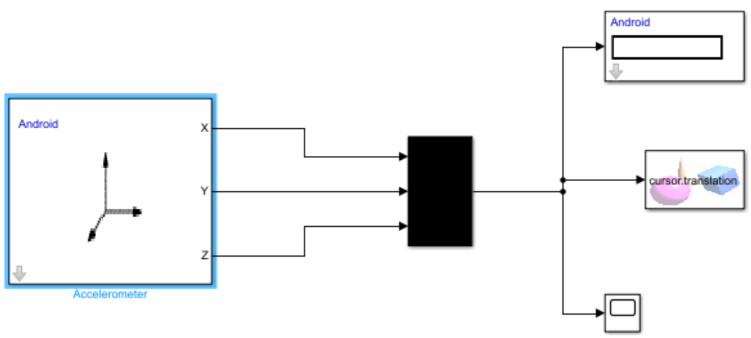

Figure 1 – First Simulink scheme

The first step using Simulink is to understand how can we display the virtual word and what is the behaviour of each output signal. Note that we decide to use a **MUX** in order to obtain a vector containing the three components as an input of the **VR Sink** used to display the virtual world.
After this first step, the cursor is totally uncontrollable and it is impossible the reach a target because it is too sensitive and too noisy. So it is clear that we have to design and implement a control.

3.2 Change in sensitivity

The idea is to use a gain block in order to change the sensitivity of the x and y-axes. We try with a gain for the both equals to 0.1, 0.01 and 0.001. The best value in term of sensitivity is 0.01 which is a good trade-off between rapidity of the cursor and sensitivity. Note that finally we choose G=-0.02 in order to keep the trade-off but slightly improve the rapidity of cursor displacement and the minus sign simply to turn by 180° the signals and use the smartphone in its usual position for starting. Then, we choose a gain equals to 0 for the z-axis. Indeed, we have a 2D virtual world so it is useless to keep it.

3.3 Noise reduction

In a same time, we need to use low pass filter block for the x and y-axes in order to remove the noise containing in the input signals. We design the both in the same way, the parameter values are shown below:

Passband edge frequency	3 Hz
Stopband edge frequency	6 Hz
Maximum passband ripple	0.1 dB
Minimum stopband attenuation	80 dB

Note that we need to set the input sample rate at 100 Hz as we have chosen a sample time for the accelerometer equals to 0.01s

3.4 Final Simulink scheme

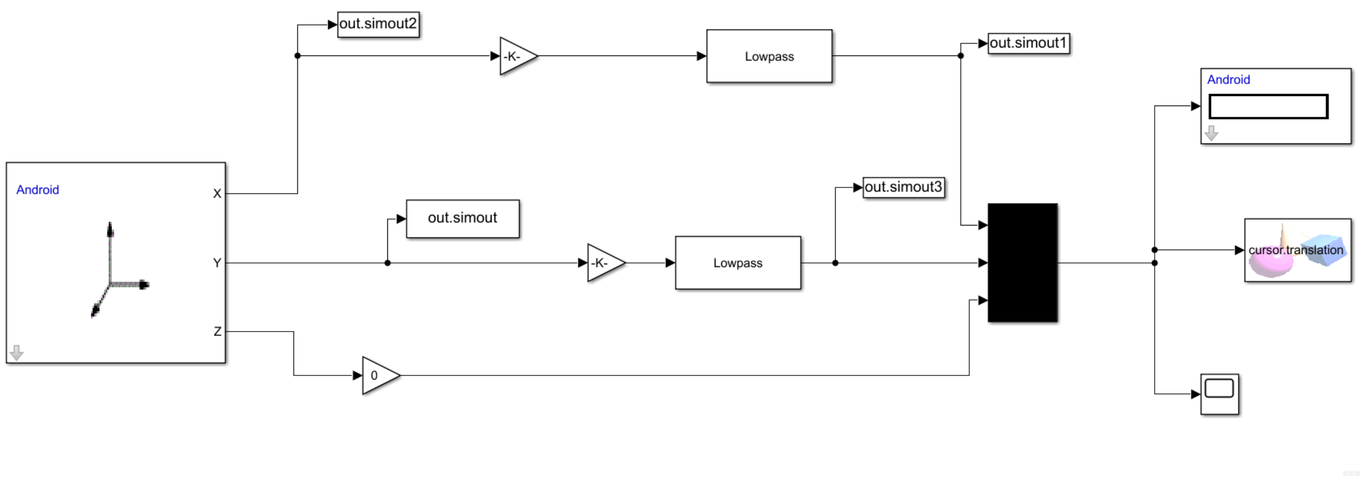

Figure 2 – Final Simulink scheme

In order to save the input and control signals with their time stamp in a file and be able to show the results of the experiment, we use 4 "To workspace" blocks, 2 before the control for each axis and 2 at the end. The results are shown in the next section.

4 Results

In this section, we show the performances of the user, practicing in the control, and the difference between beginning and end of training while performing center-out reaching movements. For that, one group member try three times the experiment holding the smartphone in the right hand and by moving it to reach the 8 targets starting from the center point. The result obtained for each test is shown below (a video is also added in the folder in order to understand how the experiment has been realised) :

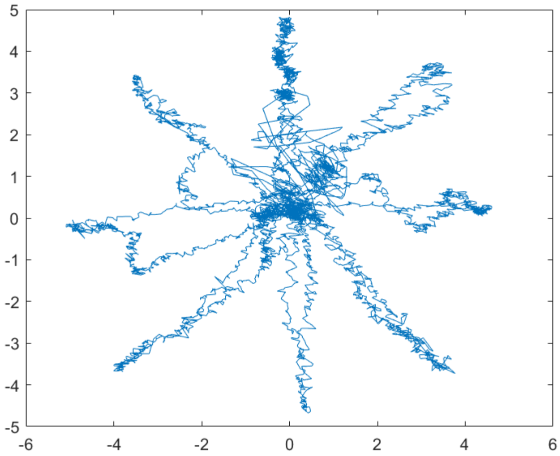

Figure 3 – Step 1 : Input signals

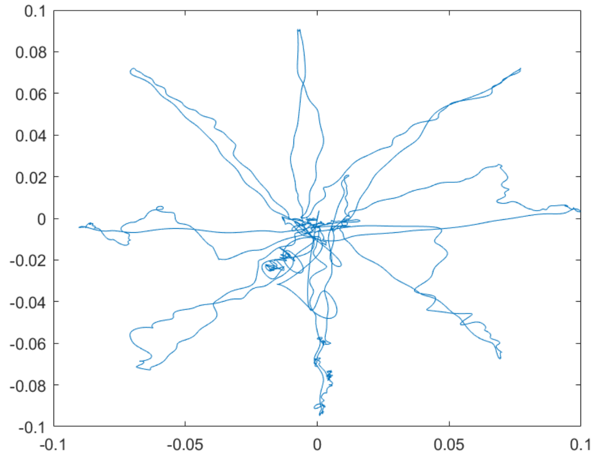

Figure 4 – Step 1 : Controlled signals

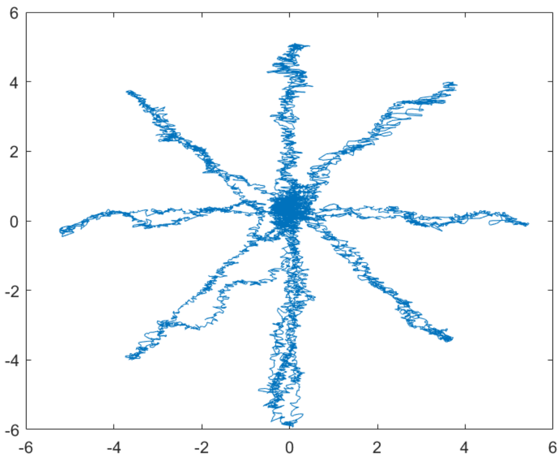

Figure 5 – Step 2 : Input signals

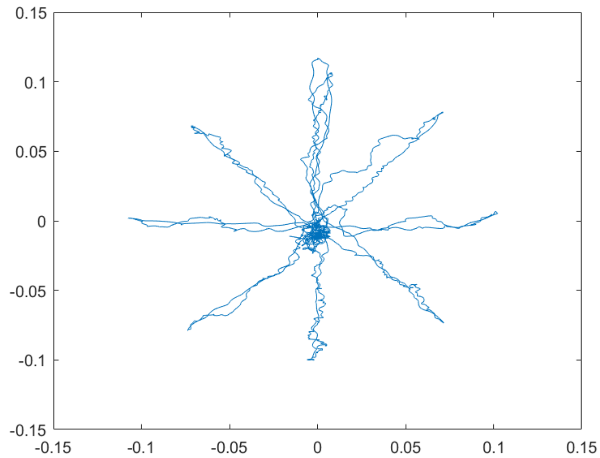

Figure 6 – Step 2 : Controlled signals

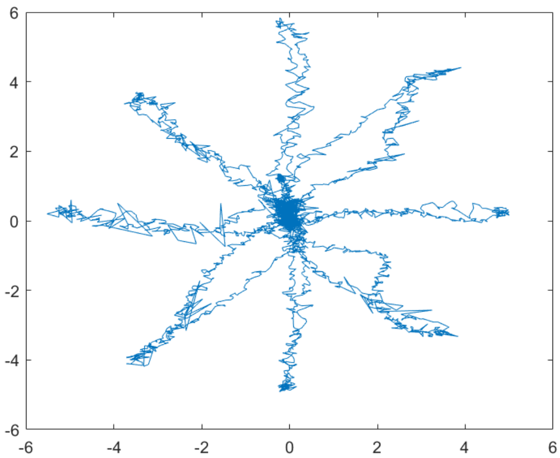

Figure 7 – Step 3 : Input signals

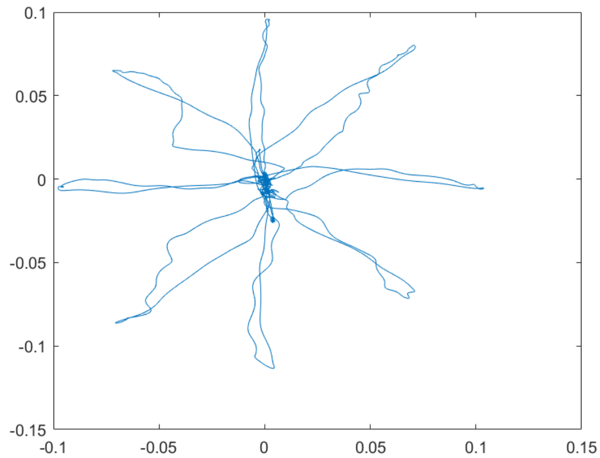

Figure 8 – Step 3 : Controlled signals

Then, in order to show an other way to use the sensor, we have done the experiment placing the smartphone on the head (fixing horizontally by the two hands) and the purpose is now to move the upper trunk to reach the targets. (A video is also added to the folder to understand exactly the movement). The result of the controlled signals is shown below:

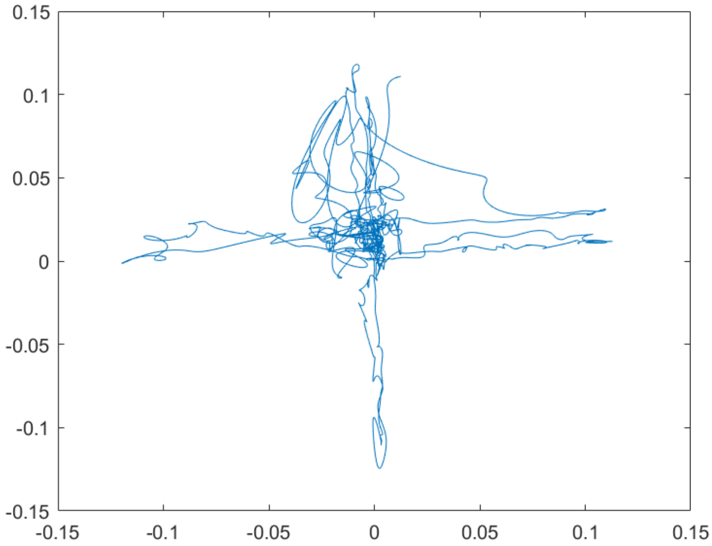

Figure 9 – Moving of the upper trunk

5 Conclusion

To conclude, as shown by the result figures, the control is performing. Indeed, all targets can be reached one after one as expected without difficulties, the noise is removed and the trajectory is more precise and smoother.