

Biomedical Robotics Assignment 1 - Exercise 2 Answers

Group 10

Question 4:

Can you think about a different way to map the muscles and be able to reach all 8 targets with the activation of these muscles? Explore an alternative mapping approach between muscles and cursor movement that enables reaching all 8 targets. Identify any potential drawbacks associated with this alternative mapping method.

Answer:

In this case we implemented a mode switch logic, meaning that the program switches between controlling the cardinal directions and the diagonal ones (obtained applying a rotation matrix to the x and y control signals) based on some trigger event. In particular, one viable option would be to use the co-contraction of the trapezius muscles (therefore requesting that both muscles' activations exceed a set threshold) to trigger this switch.

Regarding the implementation, since the provided data did not contain any clear and distinct co-contraction events, we included a manual trigger halfway through the simulation to demonstrate the functional switch between the two modes. In a real-time scenario with live EMG acquisition, the co-contraction detection code would operate autonomously to manage these transitions.

Regarding the potential drawbacks, this approach implies discontinuous control and an increased cognitive load, as the user must pause to perform a specific gesture while mentally tracking the current modality. Furthermore, the reliance on frequent co-contractions to toggle modes can lead to muscle fatigue more rapidly.

Question 5:

Can you think of a different way to map the EMG activity to control of the cursor? There is no need for implementation, just answer the question, motivating your answer.

Answer:

An alternative mapping for the problem could be obtained by using polar coordinates (r, θ) . For example one could think of controlling the distance of the cursor from the center and an angle.

In particular, the first part of the preprocessing and normalization would be exactly the same as we did in the previous questions, but instead of mapping the muscles to x and y directions we could perform the following mapping:

- **Trapezius muscles:** we could use the maximum (or the average) of the two trapezius muscles to drive the cursor in the radial direction (r), away from the center. If the biceps are relaxed the cursor will simply move in the vertical direction, corresponding to an angle θ of 0° .
- **Biceps muscles:** we could map these instead to angular coordinates (θ), for example the right bicep could control the range $[0^\circ, 180^\circ]$ and the left one the range $[0^\circ, -180^\circ]$

In this way the user would be able to reach all the balls on the circle.