Neuro-Inspired Systems Engineering: Block 2, Tutorial 2.

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Task 7. Note that the goal position is two bytes in size, it can be set between 0 and 1023. Create a sinus wave on the motor goal position with 0.5 Hz and an amplitude of 600, oscillating around the goal position 500. Set the maximum motor torque to be full range first and then half range. In each test apply manually a resistance to the moving part of the motor and at the same time illustrate the resulting position through SerialPort. Use the provided code “changeID” [25% of the grade]

To achieve maximum motor torque, we set the value at the corresponding address to 1023. Figure 1 shows the motor position while applying manual resistance. We observe that the oscillatory pattern of the motor position is not significantly impacted by the manual resistance.

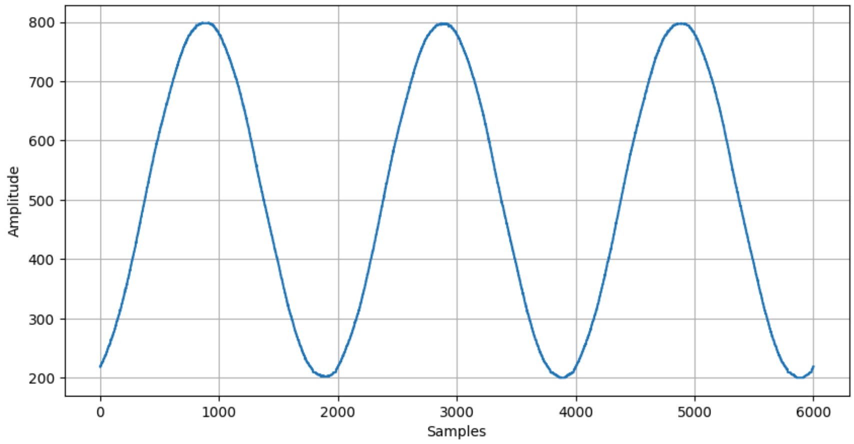

Figure 1. Oscillation of motor position at maximum torque with applied manual resistance. The plot demonstrates the motor's present position behaviour when subjected to manual resistance during operation at its full torque capacity.

Next, we set the value at the corresponding address to 512 to achieve half motor torque. Figure 2 shows the motor position while applying manual resistance. We observe that the oscillatory pattern of the motor position is still oscillatory. However, it is not as smooth as in the case of maximum torque (e.g. at around 2800 samples). Thus we can observe a minor impact of the manual resistance.

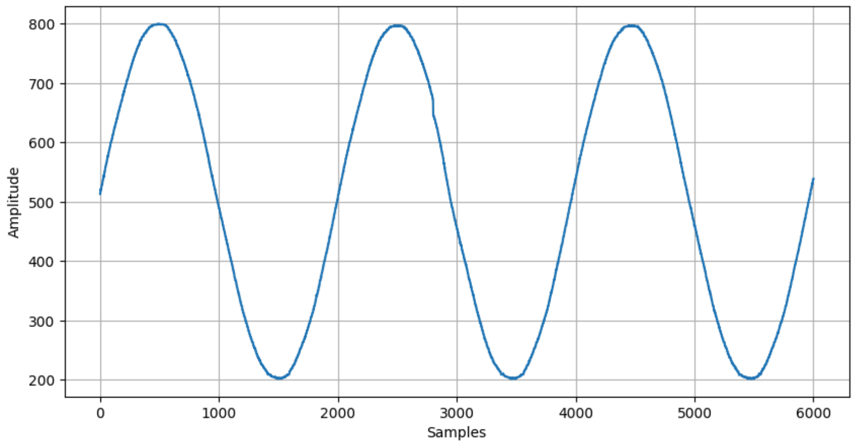

Figure 2. Oscillation of the motor position at half torque with applied manual resistance.The plot demonstrates the motor's present position behaviour when subjected to manual resistance during operation at its half torque capacity.

Task 8. Note that the goal position is two bytes in size, it can be set between 0 and 1023. Create a sinus wave on the motor goal position with 0.5 Hz and an amplitude of 600, oscillating around the goal position 500. Set the moving speed to be full range first and then half range. In each test illustrate the resulting position through SerialPort. Use the provided code “changeID” [25% of the grade].

We used maximum motor torque for the trials in this task. To achieve maximum and half moving speed, we set the value at the corresponding address to 1023 and 512, respectively. Figure 3 shows the motor position at maximum speed, Figure 4 the motor position at half range moving speed. In both cases, the motor position oscillates in the full range of the sine wave input (i.e. 200 to 800). In an additional trial, we set the moving speed to 100 and could observe that the amplitude of the oscillation decreased and the shape of the oscillation changed (see Figure 5). With this speed, the motor’s goal position gets updated faster than the actual motor movement, i.e., its present position cannot reach the goal position before the goal position gets updated again.

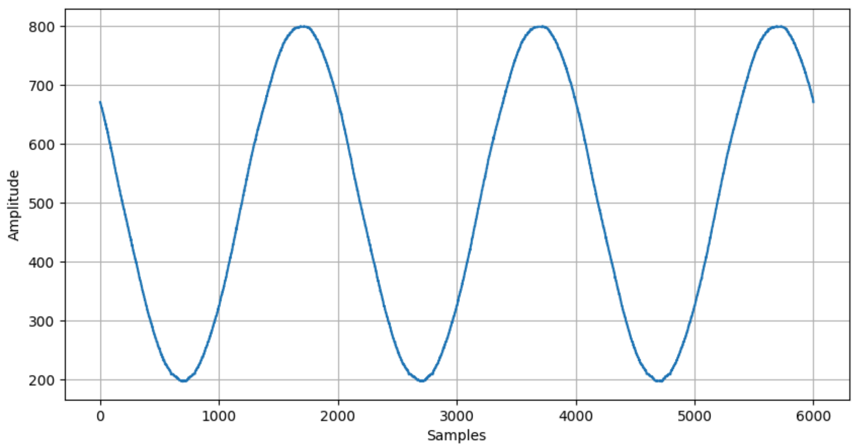

Figure 3. Oscillation of the motor position at maximum speed.

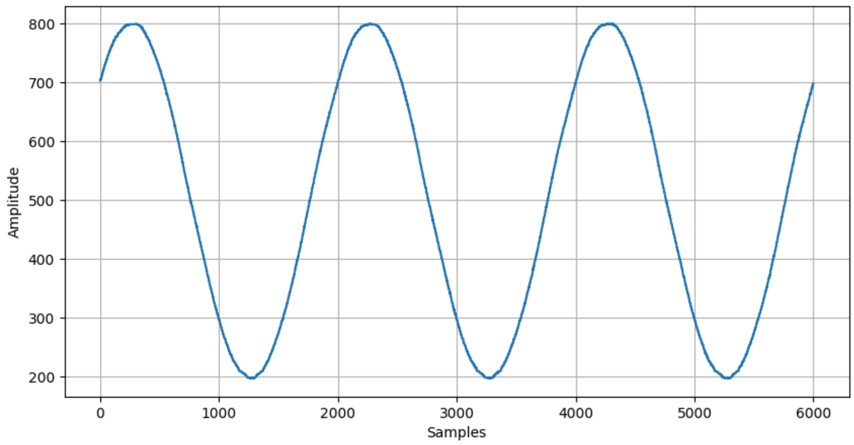

Figure 4. Oscillation of the motor position at half speed.

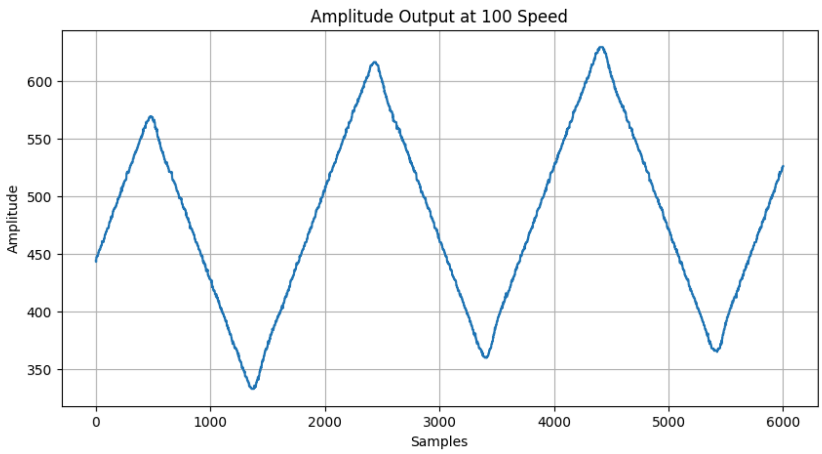

Figure 5. Oscillation of the motor position at speed = 100.

Task 9. Now, use the CPG code (RS_neuron.ino or Matsouka oscillator) from tutorial 1 to generate an oscillatory movement at the motor [50% of the grade].

We used the full range for motor torque and moving speed for this task. We achieved an oscillatory pattern using two mutually inhibiting Matsuoka neurons. Analogously to the previous task, we aimed for an oscillation of the goal position around 500. We achieved the oscillatory pattern by subtracting the output of neuron 2 (y_2) from the output of neuron 1 (y_1), and scaled the result by a factor of 1000 in order to see a meaningful pattern. For the oscillation around 500, we added an offset of 500:

$$goal\_position = 1000 * (y\_1 - y\_2) + 500$$

Additionally, we tuned the parameters of the Matsuoka model in order to stay within the position range of the motor. For the final trial, we used the following parameter values:
s_i = 1, b = 3.5, T = 12, a = 1.3.
The resulting oscillatory pattern is displayed in Figure 6.

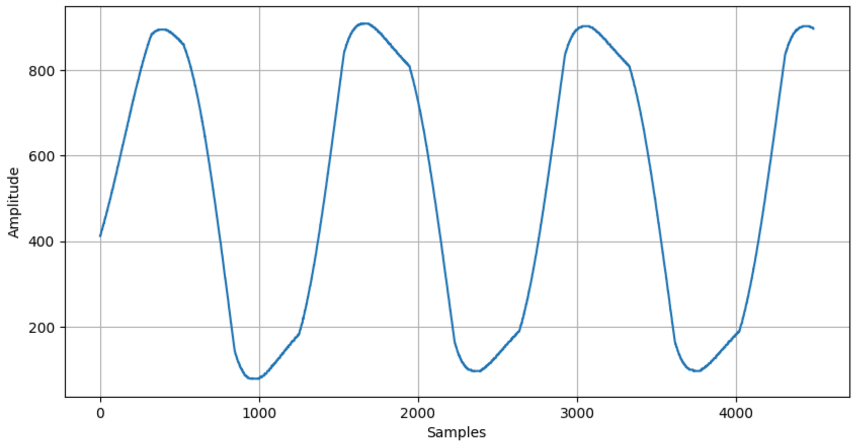

Figure 6. Oscillatory motor output using two mutually inhibiting Matsouka neurons.