Universität Hamburg
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Biped Locomotion using Central Pattern Generators

Seminar Paper

Independent Study

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Abstract

Contents

1 Introduction

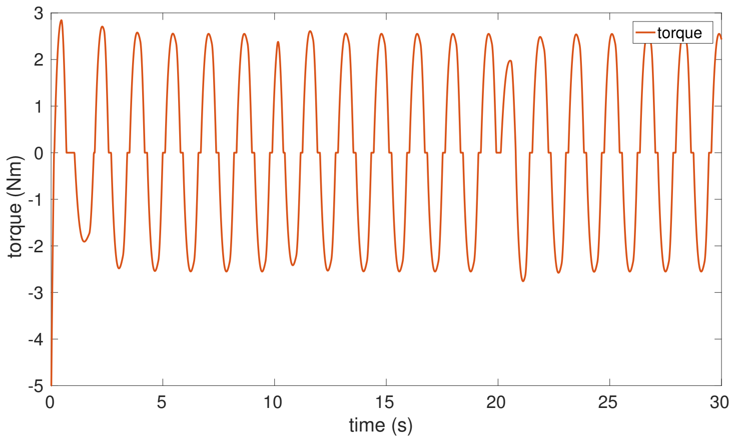
2 Section 2

2.1 Section 2.1

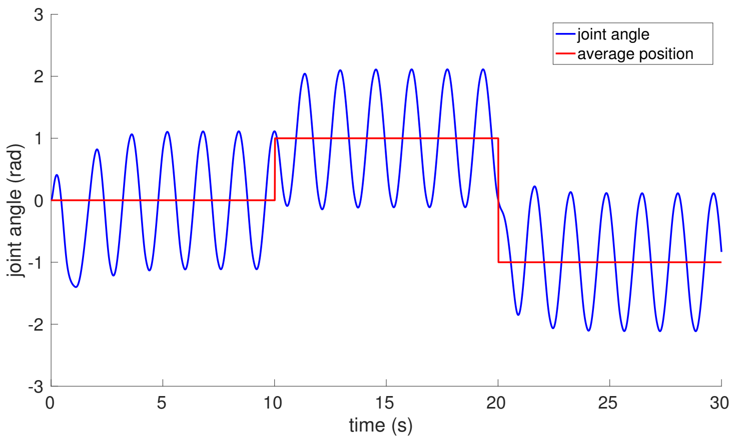
3 Properties of the Matsuoka oscillator

3.1 Using proprioceptive feedback to control the mean position

On its own, the Matsuoka oscillator produces oscillations about an arbitrary position, and the system itself is dynamically unstable. However, with the introduction of a feedback term, the mean position of oscillations can be controlled [3]. This is shown in figure 1.



(a) Torque output of the oscillator



(b) Joint position and average joint position

Figure 1: Changing the average position of oscillation

3.2 Controlling the amplitude of the joint angle oscillations

The tonic input to the oscillator is linearly related to the amplitude of the torque output and also approximately linearly to the amplitude of the position oscillations. Here the tonic input was linearly increased from 1.0 to 4.0 over 30 seconds, and as shown in figure 2, the amplitude of both the oscillations increases in a linear manner.

3.3 Controlling the frequency of the joint angle oscillations

By varying the time constants of the oscillator the frequency of the torque and joint angle oscillations can be varied. In figure 3, the time constant t_1 was set to 0.3 for the first 20 seconds, 0.6 for the next 20 seconds and to 0.9 for the last 20 seconds. The constant t_2 was set as $t_2 = 2.5 \times t_1$ as in [3]. As expected the frequency of both the torque and the joint angle oscillations decreases. However for the joint angles, the amplitude also increases as the frequency decreases. Throughout the 60 seconds, the tonic input u_t was set to 1.

4 Conclusion

[3, 4, 2, 1]

References

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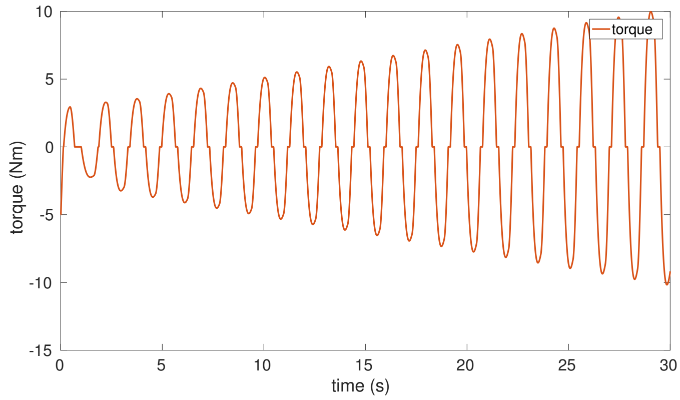
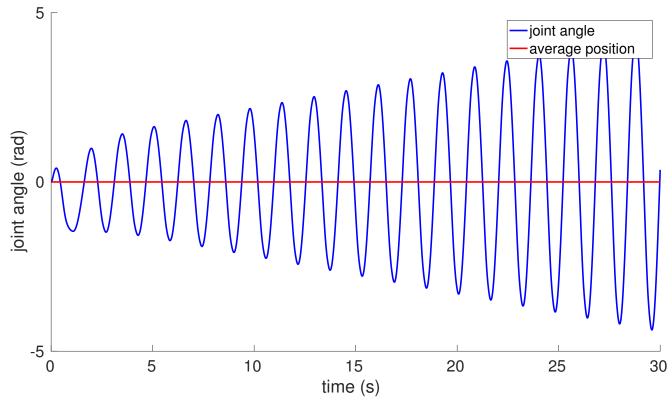
[2] Kiyotoshi Matsuoka. Mechanisms of frequency and pattern control in the neural rhythm generators. *Biological cybernetics*, 56(5-6):345–353, 1987.

[3] Renaud Ronsse, Dagmar Sternad, and Philippe Lefevre. A computational model for rhythmic and discrete movements in uni-and bimanual coordination. *Neural computation*, 21(5):1335–1370, 2009.

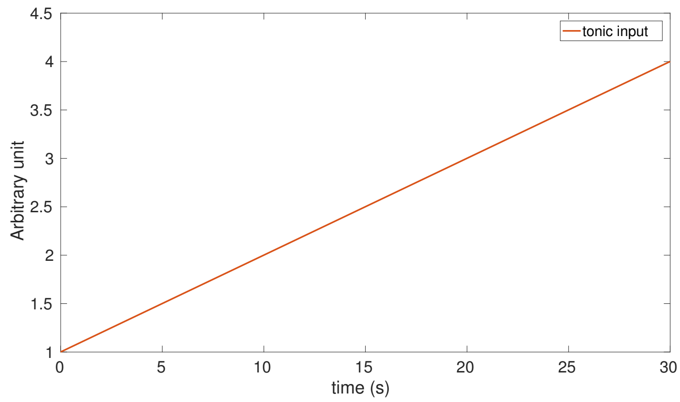
[4] Matthew M Williamson. Neural control of rhythmic arm movements. *Neural networks*, 11(7):1379–1394, 1998.



(a) Torque output of the oscillator

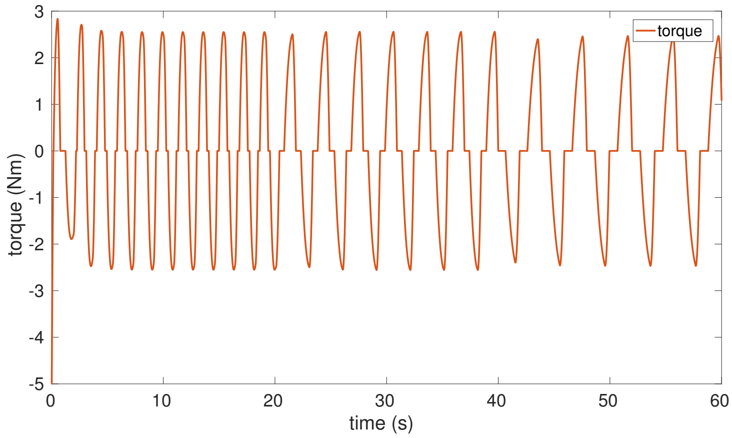


(b) Joint position and average joint position

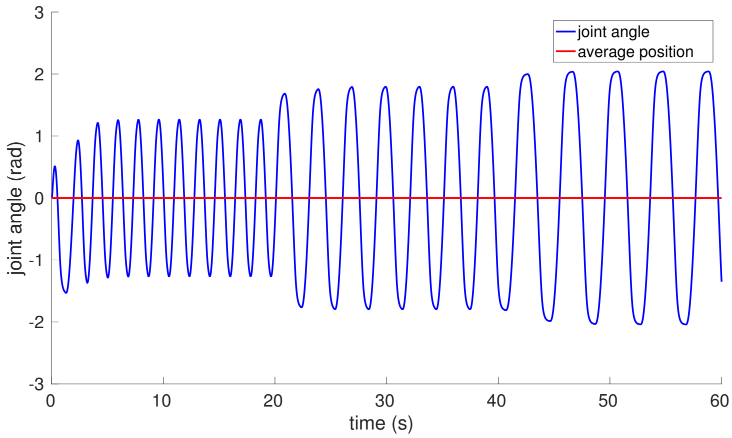


(c) Tonic input to the oscillator

Figure 2: Changing the amplitude of oscillations



(a) Torque output of the oscillator



(b) Joint position and average joint position

Figure 3: Changing the frequency of oscillation