Asymmetry of temporal patterns of control effects maintaining the sequence of stable and unstable oscillations of the human body center of mass.

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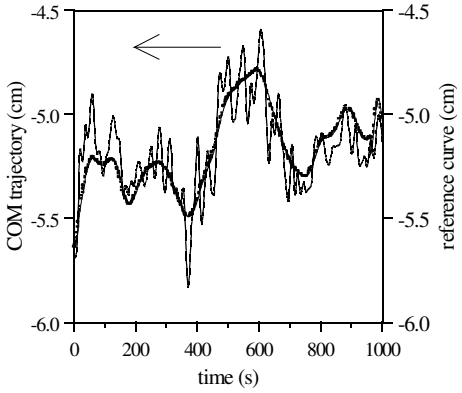
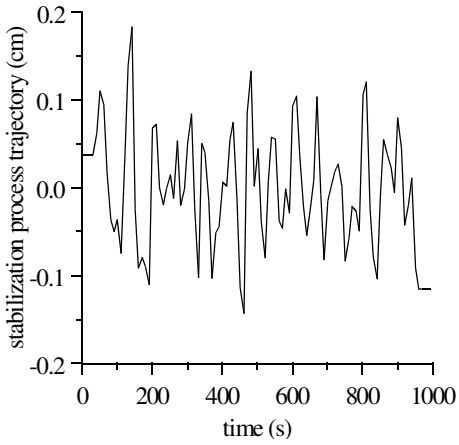
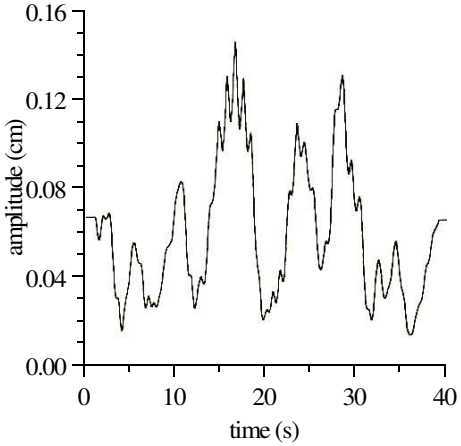
We consider the stabilization of the position of the human body center of mass (COM) with respect to the reference point (the point relatively which the postural balance is maintained) during quiet standing. The problem of analysis of temporal patterns of control effects realizing maintenance of the human posture is examined.

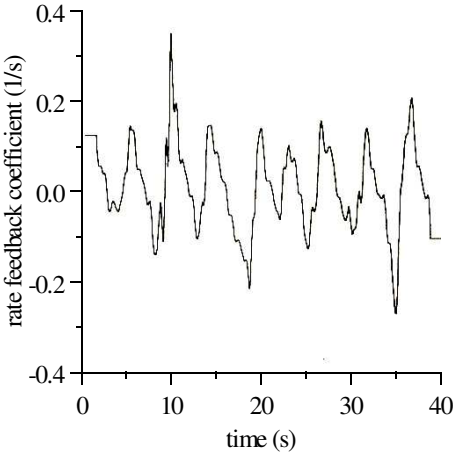
To solve the problem we isolate by first the component corresponding to the stabilization process from the trajectory of the COM oscillations. The method for solving the problem consists in identifying control effects and getting temporal patterns of amplitudes of their oscillations. The feedback of the system realizing the stabilization acts as control effects. The COM position feedback and the COM transition rate feedback are shown to be nonstationary. The coefficient of the position feedback remains negative and the coefficient of the rate feedback changes the sign. As a result, the trajectory of the stabilization process is a sequence of alternating stable (damping) and unstable (increasing) oscillations. The amplitude of these oscillations changes from the maximum down to minimal value approaching to zero.

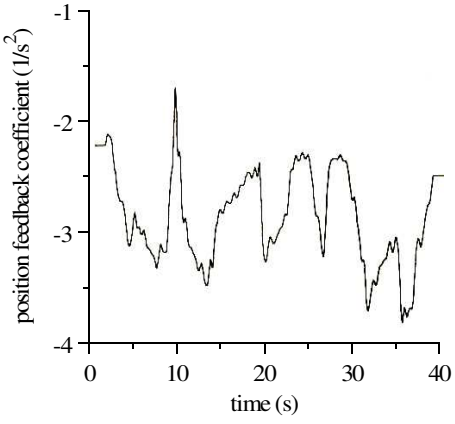
From the data obtained it follows that the considered system solves alternately two different problems. First, it generates bursts of oscillations of the COM trajectory. Second, it controls oscillation damping and approximating to the current position of the reference point. Asymmetry of the stabilization and destabilization processes is that the stabilization time far exceeds the destabilization time. One might expect that alternation of the stabilization and destabilization is a reflection of the process of coding of control effects by neurons of the central nervous system.




stabilization process trajectory (cm)
0.2
0.1
0.0
-0.1
-0.2
0
200
400
600
800
1000
time (s)


amplitude (cm)
0.16
0.12
0.08
0.04
0.00
0
10
20
30
40
time (s)


rate feedback coefficient (1/s)
0.4
0.2
0.0
-0.2
-0.4
0
10
20
30
40
time (s)


position feedback coefficient (1/s2)
-1
-2
-3
-4
0
10
20
30
40
time (s)