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COORDINATION OF HUMAN UPPER ARM AND FOREARM MOTION IN RAPID EXTENSIONS

Mahmood Nahvi
California Polytechnic State University
San Luis Obispo, California

In many movements of the upper limb such as reaching, positioning, and diplacing the objects, the hand moves smoothly along a uni-directional planar trajectory with a bell-shaped speed profile.

Because of variability of the load, gravitational and velocity interaction forces between its segments, the dynamics of the arm during the motion is very complex. Motion of the upper arm and the forearm are coordinated to produce smooth movements despite such complex dynamics. This coordination constitutes an important organizational feature of arm movement. The present paper describes some experimental results related to the above and interprets their role in producing smooth motion of the hand.

Trajectories of the right upper limb in vertical plane and the simultaneous muscles' EMG activities were recorded for extensions of various amplitudes under four loads. The forearm trajectories are smooth with bell-shaped speed profiles. The upper arm trajectories may have bimodal speed profiles and three segments, resembling an inverted "Z." Segmentation is sharper for the points near the shoulder joint, and is accentuated by load. As one moves from the central points near the shoulder joint to the peripheral points near the hand, the three segments merge and result in smooth curves with single-peaked speed profiles. The three segments have a coherent time course and can be identified rather accurately and non-ambiguously.

The observed trajectories and the EMG patterns reveal an effective coordination strategy which utilizes the structure and the dynamics of the moving arm to produce smooth movement.