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Simulation of a Three-Link, Six-Muscle Musculoskeletal Arm Activated by Hill Muscle Model

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Abstract : The study of humanoid character is of great interest to researchers in the field of robotics and biomechanics. One might want to know the forces and torques required to move a limb from an initial position to the desired destination position. Inverse dynamics is a helpful method to compute the force and torques for an articulated body limb. It enables us to know the joint torques required to rotate a link between two positions. Our goal in this study was to control a human-like articulated manipulator for a specific task of path tracking. For this purpose, the human arm was modeled with a three-link planar manipulator activated by Hill muscle model. Applying a proportional controller, values of force and torques applied to the joints were calculated by inverse dynamics, and then joints and muscle forces trajectories were computed and presented. To be more accurate to say, the kinematics of the muscle-joint space was formulated by which we defined the relationship between the muscle lengths and the geometry of the links and joints. Secondary, the kinematic of the links was introduced to calculate the position of the end-effector in terms of geometry. Then, we considered the modeling of Hill muscle dynamics, and after calculation of joint torques, finally, we applied them to the dynamics of the three-link manipulator obtained from the inverse dynamics to calculate the joint states, find and control the location of manipulator's end-effector. The results show that the human arm model was successfully controlled to take the designated path of an ellipse precisely.

Keywords : arm manipulator, hill muscle model, six-muscle model, three-link lodel
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