Trajectory Tracking Control of Robotic Jaw Actuators via Galil Motion System

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Abstract

A mechatronic chewing robot of 6-DOF mechanism which consists mainly of the skull, six crank actuators, end effector and motion control system has been designed and is required to simulate human chewing behaviours while the chewed food properties are evaluated. The robotic mechanism is proposed and its kinematic parameters are defined according to the biomechanical findings and measurements of the human masticatory system.

This thesis is concerned with the design and implementation of trajectory tracking control for robotic jaw actuators via Galil motion controller. The aim of this project is to simulate the dynamics behaviour and force-motion control of the robot, and to quantitatively assess food texture changes during chewing. A control system based Galil motion control card has been formed to achieve the motion of simulated human mastication. Some real human mastication motion have been tracked and used as targeted trajectories for the robot to reproduce.

Several experiments have been executed to measure the jaw movements and chewing forces. To reduce the vibration of the actuators and protect sensitive linkage part of the robot, the traditional PID control and some advanced control theories were implemented to achieve most effective efforts. A mathematical model was also designed at the first stage when a test actuator powered by brushless motor was formed; however, it is finally proven not well controlled in either mechanical and control ways. Major features of the built robot including the motion control system are presented and tested. Experimental results including free chewing, soft-food and hard-food chewing are given where the foods are simulated by foam and hard objects. Also the joint actuations and driving torques required are compared for the chewing of different foods.

In conclusion, tracking motion control has been attempted on the physical robot and a solution to the trajectory control has been developed.

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Abbreviations and Acronyms

DOF	Degree of freedom
AI	Artificial Intelligence
SCSI	Small Computer System Interface
MI	Maximum Intercuspation
CC	Cascade control
RSS	Revolute joint, Spherical joint
WJ	Waseda Jaw
TMJ	Temporomandibular Joint