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Research & Innovation
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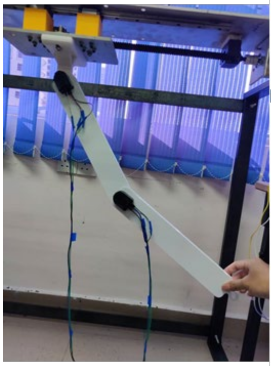
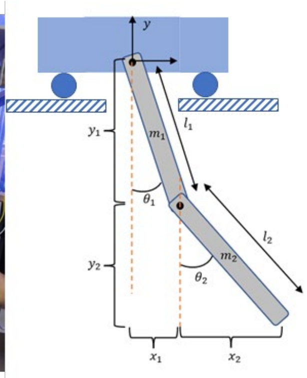
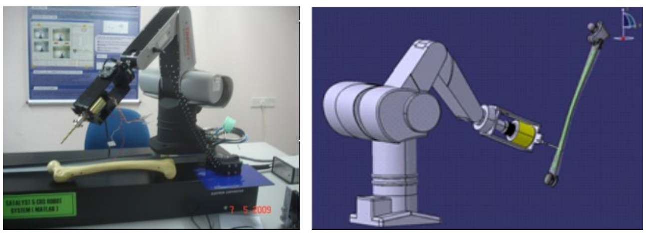
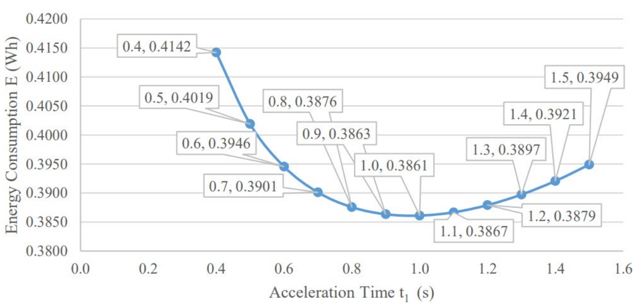
Intelligent Motion Control of Robotic Mechanism



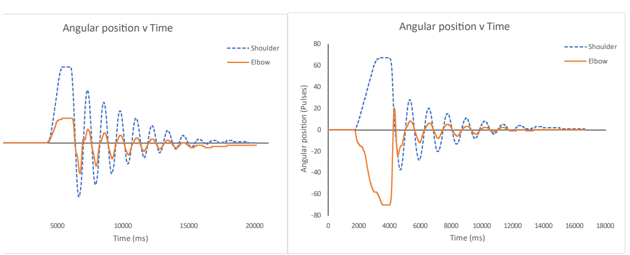




6-DOF Robotic Arm Manipulator



Optimization of Energy Usage



Vibration Suppression

Robotic mechanisms are increasingly used in various industries, including agriculture, automotive, aerospace, medical, and logistics, due to their controlled features. With the increasing demand for repetitive high-speed and high-precision operations, intelligent control coupled with adaptive motion strategy is crucial to address the issues of excessive vibration and energy usage. These are important for economic justification besides several motion constraint parameters such as end-effector travel distance, speed, and acceleration during the robot's operations. These parameters are important to avoid workpiece breakage, machine tool fatigue, excessive vibration, and energy usage for an extended period of repetitive operations.

This research study investigates models and methods for vibration suppression and energy optimisation of a DC motor-driven robotic mechanism. The prototypes used are six degrees of freedom (DOF) robotic arm manipulator and three degrees of freedom underactuated robotics crane with the developed computer algorithm. The under-actuated crane mechanism consists of a double link system where rotation motions consist of two parts, each belonging to respective links. Link 1 is a rotation motion due to the DC motor embedded with the encoder. Link 2 is the swing motion affected by link 1.

A robot dynamics model was developed as a function of natural frequencies and energy consumption. Based on this function, the linear segment with parabolic polynomial blend trajectory planning was utilised for vibration suppression and energy optimisation. Machine learning via gradient of the steepest descent algorithm is implemented to search for the parameter's adjustment and the self-tuning adaptive motion controller gains. The four parameters considered are total motion distance and time, maximum velocity and acceleration.

Experimental results show that this intelligent tuning approach is feasible and efficient, offering a starting point for achieving desired control performance. The settings can be adjusted and customised to suit the system's needs and goals, resulting in a customised and enhanced motion control experience.

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