Centre for Artificial Intelligence and Robotics – DRDO

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Weekly Report

Week 20-24 (1st January 22 to 31st January 21)

*Objective*

To study position and torque control for single joint and literature surveys of

*Literature Survey*

* Warburtin *et al*., 2017 [1] used Mirrored Movement Therapy to perform upper arm rehabilitation with focus on shoulder, in people with stroke problems to validate its kinematics. They utilized an upper body exoskeleton named Harmony to mirror movement in the healthy arm to the arm with stroke. For the experiment evaluation shoulder abduction/adduction, flexion/extension and scaption were conducted, and the difference between left and right acromion were taken as refence point to measure error. Root Mean Squared error for shoulder abduction/adduction, flexion/extension and scaption were 6.5 mm, 10.6 mm and 7.1mm respectively.
* To reduce jitters in the knee joint during squatting process a weight assistive exoskeleton Xiao *et al*., 2021 [2] developed a pneumatic model in AMESim software. Model consist of a single acting cylinder placed at knee joint to control irregularities in the assistance and motion of the knee joint. Control was achieved in the return flow of the cylinder. They simulated presented model in AMESim and carried out experimental verifications. To optimize the control author used PID controller where error was determined by the difference in desired and actual angles of knee joints. The knee joint jitters were found to be within 1.8 % for the stand – squat – hold - squat process.
* Wang *et al*., 2020 [3] used multi-domain system-level modelling software Maplesim to simulate and determine dynamic centre of the gravity on upper body exoskeleton.
* Winder *et al*., 2008 [4] proposed an upper body exoskeleton control based on the control of lower body exoskeleton named Berkeley Lower Extremity Exoskeleton (BLEEX) to stabilize the weapon held in hand and to reject disturbance in the system. To model the system author used Lagrange’s method and SimMechanics package from MATLAB/Simulink. The derived equation of motion is shown below,

Where is the input torque, is the Mass component, is the velocity vector, is the gravity component and is the angular position of a joint. These values have been provided in [4]. In simulation stage, elbow joint angle was within the range of -0.4 rad + 0.4 rad while for shoulder joint it stayed within -0.6 rad and +0.6 rad.

* Fei *et al*., 2017 [5] modelled and designed a upper body exoskeleton to control it using robust time delay estimation based Intelligent PID (TDE-iPID) control and compared its performance with PID control. The designed exoskeleton was 6 DoF link with 3-joints on Shoulder, 1 on elbow, 1 for pronation/supination and 1 at wrist joint. Its inverse kinematic model was extracted using DH parameters. The performance of PID and TDE-iPID was similar but easy to control parameters of TDE-iPID than PID.
* Jonas *et al*., 2019 [6] presents a modified double parallelogram linkage (DPL) mechanism, which allows active assistance to flexion/extension in sagittal plane of the shoulder joint and also providing 2 passive joints to allow user to move arm in other two planes. It uses a cable driven mechanism to provide torque at shoulder joint from the motor placed in the lower back of the user. The cable between two pullies were modified reduce slacking and losing tension in the cable when two pullies move with respect to each other.
* Quispe *et al*., 2020 [7] compared the performance of the PD and PID controller using a 3 DoF upper body exoskeleton by analysing arm trajectory during rehabilitation task modelled with image recognition. The design includes 2 DoF at shoulder and 1 at elbow. The dynamic model was designed in Simulink. It was found that in shoulder joints PD control performed better than PID by 12.84 % and 24.91 % in abduction/adduction and flexion/extension while in elbow flexion/extension PID was better than PD by 8.38 %.

*Work*

*Future Work*

More.

*Reference*

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