Position-Velocity Control for the CMU Modular Snake Robot

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Motivation

To make the Modsnake have a smooth and more graceful motion , i.e. to have a real snake motion, a velocity controller should be added in addition to the existing position control which is responsible for the locomotion of snake.

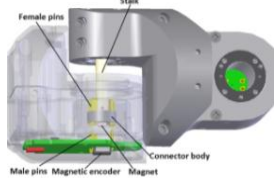Fig. 1 Snake following a helical trajectory when climbing poles

Fig. 2 Two modules connected showing relative joint angle

Existing Control System

- Modular robot: 16 modules
- Between each 2 modules: **one d.o.f. joint angle** (fig. 2)
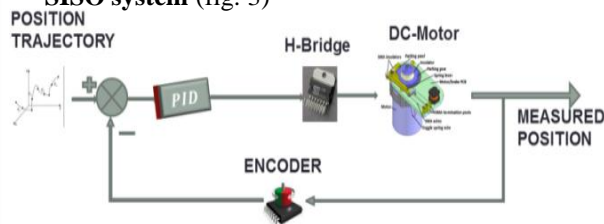- Produces jerky motion
- **SISO system** (fig. 3)

Fig. 3 Control system currently implemented on joint angle

New Control System

- Addition of angular velocity control
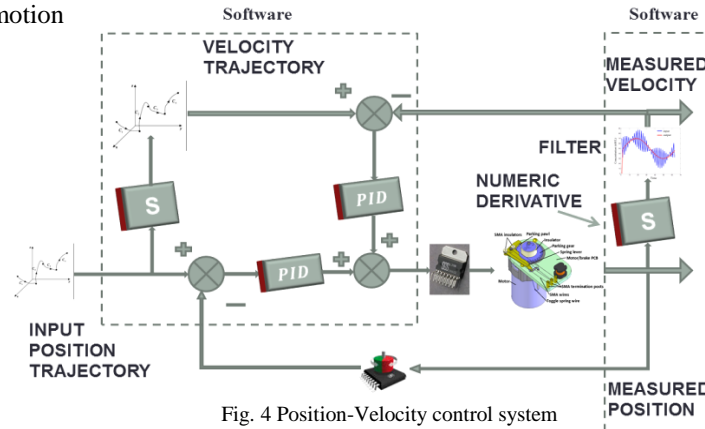- **MIMO System**
- The applied system architecture is shown in fig. 4

Fig. 4 Position-Velocity control system

Features of the New System

- Velocity is derived from the magnetic encoder:
  o Encoder reads the output hub
  o Problematic for deriving velocity because there are very few ticks per time step

- The Filter achieves two goals:
  o Reduces real time noise
  o Trades minor lag for **increase velocity resolution**

New System Accomplishments

- Command joint angle positions and **velocities**
- Enhance locomotion gaits performance
- Knowledge of additional states of the joint angles (velocity)
- *Energy Efficient*

Results

Figures 5 and 6 show the improvement when implementing a velocity control:

- The position trajectory followed is now **smoother**
- **No sudden stops** and **sudden starts** during motion (**reduces vibration and chatter**)
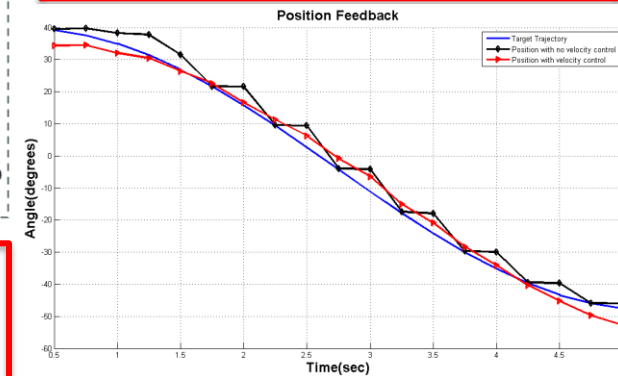- Less error in tracking desired velocity
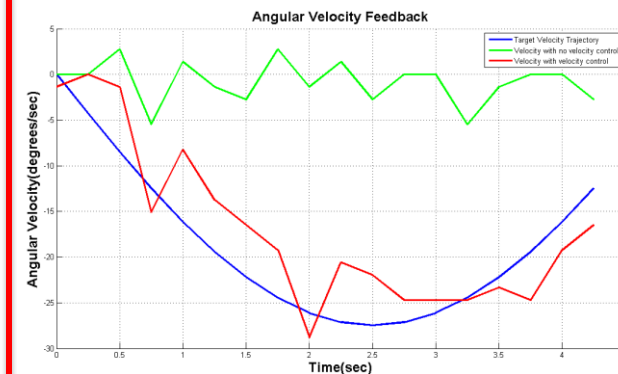

Fig. 5 Position Plots

Fig. 6 Velocity Plots