Robust speed control of belt-driven two-inertial systems against belt tension variation

12303386 Yuya Goi Super visor: Yasuhide Kobayashi

1. Background

General purpose servo motors are widely used in industrial equipment.

PID controller is implemented with auto tuning mechanism.

PID controller

- good point : simple structures
- bad point : poor performance for low-stiffness and/or high-inertia

Robust control

complex structures but better performance ; plant variation can be also considered

About belt-tension

Tension of flat belt should be set as given value, because belt-tension influences belt-driven system.

Adjustable device for belt-tension setting is necessary in order to examine control system for belt-tension variation.

2.Experimental apparatus

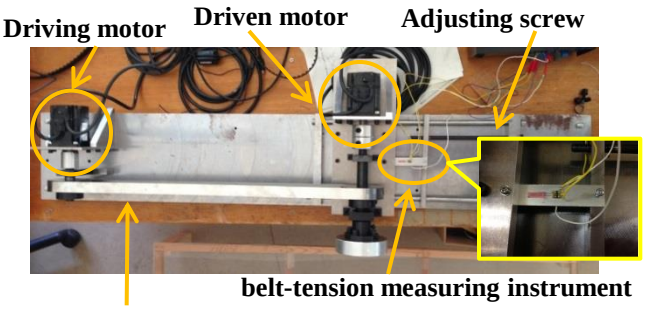

Fig.1 Experimental apparatus

Belt-tension measuring instrument

Theoretical formula of output voltage

$$\Delta V = \frac{V}{4} K \frac{F}{AE}$$

Calibrated equation

$$\Delta V = 0.175F$$

ΔV:Output voltage , V:Input voltage(5V), K:Gauge factor(1.9), A: Cross-sectional area , E:Young'smodulus , F:Load

3. Robust speed control experiment

Frequency response experiments

Frequency response experiments are performed with three belt-tensions : 30,40 and 50[N]

- Input signal : torque of driving motor
- Output signal : speed of driving motor

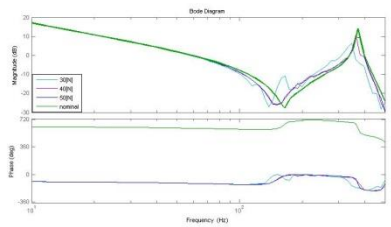

Fig.2 Frequency response experiments measurement

- Nominal plant is made by belt-tensions of 50[N]
- Shape of a belt-tension of 50[N] is similar with belt-tension of 40[N] and 30[N], but 50[N] line is smoother than 40[N] and 30[N] line.
- Resonance peaks change by belt-tensions.

Weighting function

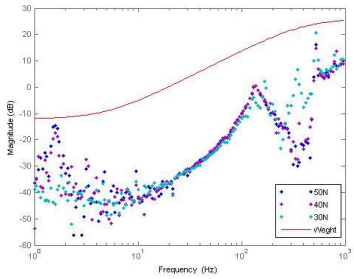

Fig.3 Weighting function

Weighting function is designed to cover nominal error of belt-tensions : 30, 40 and 50[N]

Robust speed control experiments

Robust speed control experimental condition

- Reference speeds are 5[rad/s] during 0-1[s], 5-8[s] and 10[rad/s] during 1-5 [s].
- Disturbance of 30% of rating torque is added to driven motor during 2-4[S].

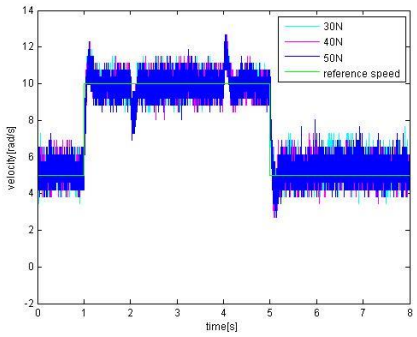

Fig.4 Time responses of driven motor's speed

- Overshoot is shown when reference speeds change after driven motor's speed follow reference speed.
- Reference speed is changed when disturbance torque is added, after driven motor's speed follow reference speed.
- The similar performance has been achieved for three cases.

4.Conclusion

- Belt-tension measuring instrument has been installed using strain gauges.
- We experiment robust speed control. The similar performance has been achieved by robust control against belt-tension variation.