제진장치의 제어기 설계와 실험에 관한 연구

레당카잉+· 남택근[1]· 노영오[2]

A Study On The Design Of Control Algorithm For Vibration Isolator And its Experiments

Le Dang Khanh+, Taek-Kun Nam[1] · Young-Oh Roh[2]

Abstract

In this paper the construction of vibration isolator using induction motor and its experiments are introduced. The vibration isolator is composed by plate, crank, electric motor and laser sensor to measure the displacement of plate. A control scheme to isolate the vibration signals due to the load variance and disturbance is designed with pole-placement and Routh-Huritz method. Experiments are also applied to confirm the effectiveness of the proposed control scheme.

1. System overview

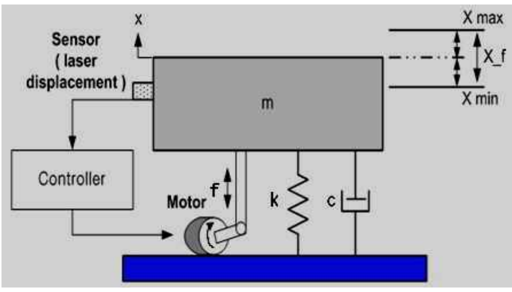

Fig.1 control object

Isolation system in this study consists of following components

- Passive isolation stage: Springs, Dampers, Mass
- Actuator: Electric motor Mitsubishi HCKF73. This motor generates a torque on its shaft then generated torque is converted to control force through crank mechanism.
- Sensor: SUNX Micro laser sensor LM10 ARN1251 with resolution of 10 micro-meters.
- Controller: NI cRIO 9022. NI Analog output 9263 and NI Analog input 9205 are mounted on the Controller.

2. Controller

Controller of the system is a PID Controller with selected gains based on Routh-Huritz and Pole-placement method.

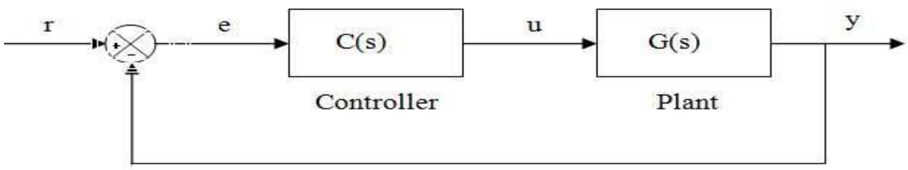

Fig.2 Control Scheme

where, $C(s)=\dfrac{K_d s^2+K_p s+K_i}{s}$, $G(s)=\dfrac{1}{ms^2+cs+k}$

Then feedback loop transfer function will be obtained as follows.

$$T(s)=\frac{C(s)G(s)}{1+C(s)G(s)}=\frac{K_d s^2+K_p s+K_i}{ms^3+(c+K_d)s+(K_p+k)s+K_i} \qquad (1)$$

Controller gains apply with Routh-Huritz and pole-placement technique are as follows

+ 레당카잉(목포해양대학교 대학원),E-mail:ledangkhanhmtb@gmail.com, Tel: 061)240-7225
1 남택근 (목포해양대학교 기관시스템공학부)
2 노영오 (목포해양대학교 기관시스템공학부)

Routh-Huritz method: $K_i > 0,\ K_d > -c, K_p > \dfrac{m(K_i - k)}{D + K_d}$ (2)

pole-placement technique: $\begin{cases} K_i = -m\alpha_1\alpha_2\alpha_3 \\ K_d = -m(\alpha_1 + \alpha_2 + \alpha_3) - c \\ K_p = m(\alpha_1\alpha_2 + \alpha_2\alpha_3 + \alpha_3\alpha_1) - K \end{cases}$ (3)

where, $\alpha_1, \alpha_2, \alpha_3$ are desired roots of the transfer function of Eq.(1)

3. Experiment results

Experiment result is as shown in Fig.3. Feedback control was applied around 6.5 sec after constant control input. The set-point of plate displacement was 6 mm and -2mm and we can see that desired control performance was achieved with proposed control scheme.

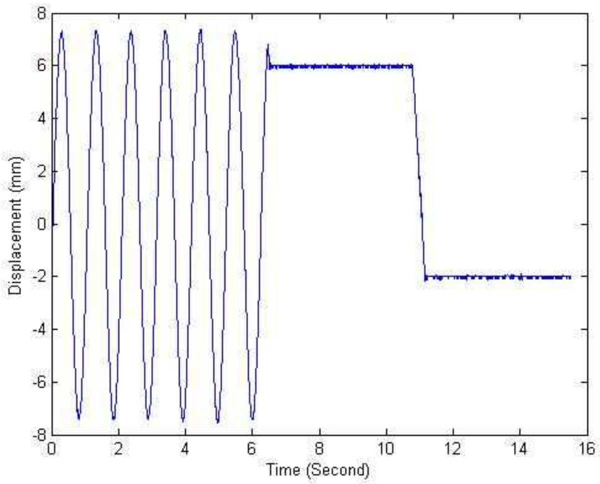

Fig.3. experimental result

This research is supported by 2010 Honam Sea grant college program and Green marine equipment research center(RIS B0012286).

References

[1] Garry W. Johnson, Rechard Jennings, Labview Graphical Programming, Fourth edition, McGraw-Hill, 2006

[2] Ashish Tewari, Modern control design with Matlab and simulink. John Wiley. England,2002.

[3] Richard C. Dorf, Robert H. Bishop, "Modern control systems", eleventh edition, Prentice Hall, 2008.

[4] D.Y.Kwak, LabView Express, Ohm, 2009.