Magnetic Levitation System

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GOOGOL TECHNOLOGY

The Magnetic Levitation System (MLS) is composed of an LED light source, an electromagnet, an optoelectronic sensor, amplifier module, an analogue control module, data acquisition card, and a steel ball, etc. Its structure is simple, yet the control effect is very intuitionistic and interesting. One can easily levitate one or more steel balls in a steady-state position and keep them floating. This system synthesizes main experimental contents in control area and satisfies many experiment requirements such as automatic control, control theory, and feedback system, etc, which are suitable for UG or PG course designs and algorithm research as well.

Control Principle

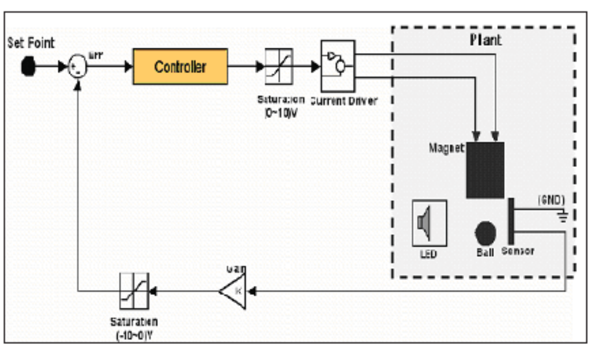
The MLS is a typical non-linear open-loop unstable system. By passing a certain amount of electric current through the electromagnetic winding, it will generate an electromagnetic force. By regulating the electric current in the circuit, the electromagnetic force can be adjusted to be equal to the weight of the steel ball, thus the ball will levitate in equilibrium state. However, this state is an open-loop unstable equilibrium; it is because the electromagnetic force between the electromagnet and the steel ball is inverse proportional to the square of the distance between them. Once the equilibrium state is slightly interfered (for instance, pulsation of the voltage across the electromagnet winding, or vibration around the system, etc), the ball will drop or be gripped by the electromagnetic winding, so the system has to be a closed-loop control system.

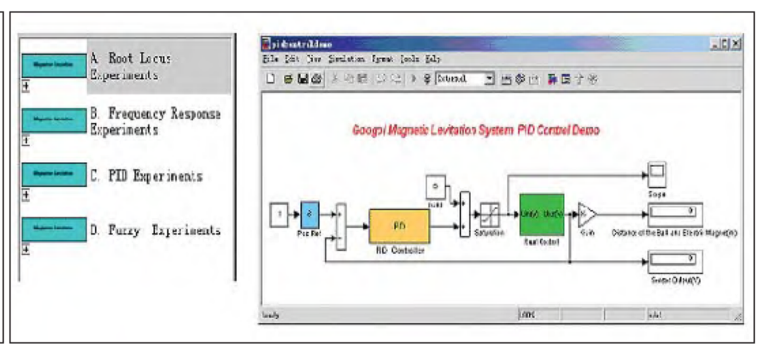
The measuring equipment is composed of an LED light source and a sensor which can detect the variation of the distance between the steel ball and the electromagnetic winding. When the ball is dropping due to interference, the distance will increase. The sensor detects the variation of light intensity and generates a related signal. After the adjusting process by the controller and the magnifying process by the amplifier, the control electric current through the electromagnetic will increase, the steel ball will be attracted back to the equilibrium position.

System Characteristics

- Open architecture structure
- Real time and on-line parameters adjustment
- Simple operation, easy manipulation and safe to use
- Compatible with MATLAB/Simulink control software
- Interesting experiments and intuitionistic control effect.
- Covering the knowledge in the area of Electromagnetic, Sensor Technology, Analogue Circuit and Computer Control, etc

Control Diagram and Software Interface (MATLAB)





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Solutions 4U Sdn Bhd (706527-A) 36-1, Plaza Puchong, Jalan Puchong Mesra 1, 58200 Kuala Lumpur, Malaysia Tel: +603-8071 1300 Fax: +603-8071 1400
Solutions 4U Pte Ltd (200713296Z) 259 Onan Road, Singapore 424651 Tel: +65 6468 3325 Fax: +65 6764 5646 www.solutions4u-asia.com enquiry@solutions4u-asia.com

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Technical Specifications

L x W x H	350mm x 178mm x 376mm
Winding Resistance	13.8 Ω
Control Precision	0.1mm
Winding Turns	2450
Winding Inductance	135mH
Winding Dimension	Φ = 20mm, H=94mm
LED Light Source	+12V, 1W
Sampling Frequency (AD)	30KHz
Power Input	AC220V 50HZ 3A (AC110V Optional)
Weight	< 10Kg
Control Range	1—20mm (m=22g, Φ = 55mm) 1– 15mm (steel ball m = 120g, Φ = 55mm)
Maximum Loading	200g (Control Range will be very small)
Data Acquisition Card	• 16 double-ended analogue input channels, 2 single-ended analogue output channels • 16 digital input/output channels • 12-bit A/D converter, sampling rate up to 100KS/s • 1K sampling FIFO buffer on-board • Each input channel gain programmable • Automatic channel/gain scan • Analogue sampling channel voltage range selectable (± 10V, ± 5V, ± 2.5V, ± 1.25V, ± 0.625V)

Suggested Experiments:

- System modeling experiment and analysis
- System open-loop response analysis
- PID controller design
- Root locus controller design
- Frequency response controller design
- Analogue control experiment (Analogue control module required)
- User defined control algorithms

Ordering Guide

Model Number	Model Name	Package
GML 1001	Magnetic Levitation System	• MLS main body • Data acquisition card • Googol Simulink software experiment platform • Analogue control module (optional)

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