GOOGOLTECH

MAGNETIC LEVITATION SYSTEM

-- A new design with integrated laser sensor

Overview

Magnetic levitation is a classical technology in mechatronics. It combines electromagnetism and electronics technology, control technology, signal processing, mechanics, and dynamics. The technology is widely used in many industry fields such as magnetic levitation train, magnetic suspension bearing, miniature transmission equipment, measuring instrument, robotic wrist, magnetic levitation educational system, etc.

The Magnetic Levitation System (Model: GML2001) from Googoltech provides an ideal experiment platform for research and tutorial for undergraduate and graduate students studying classical control theory and modern control theory. Apart from its modern designed appearance, laser sensor is also applied as feedback signal to measure moving distance of the floating ball accurately.

In addition, the Magnetic Levitation body (Model: GML2001A) can be provided as a standalone experimental device for any third party or self-designed controller.

GML2001A

System Features

Students can thoroughly comprehend PID tuning, root locus tuning, frequency domain method tuning, status feedback control method with Matlab software platform experiment course.

Via optional analog control system, by observing and comprehending the structure of control system and the characteristic of driving module, students can construct embedded magnetic levitation controller by combining the analog control system with DSP, ARM, MCU, etc. The embedded discrete control algorithm can be perfected by comparing control results.

Students can select components such as photoelectric, ultrasonic, infra-red distance detecting sensor to build up the magnetic levitation body; and construct complete magnetic levitation system with self-designed embedded controller.

Laser sensor is used as feedback signal. Through the experiments, the non-linearity of the system can be directly viewed by the distribution of the electromagnetic field.

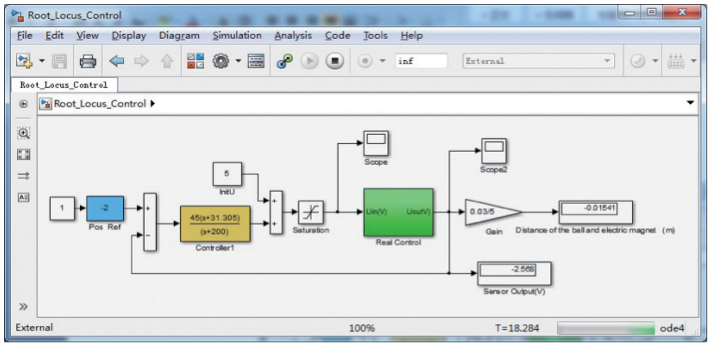
Control Principle

When the ball moves up and down vertically under the electromagnet, the laser sensor right below the ball detects the distance between the apex of the ball and the lowest part of the electromagnet. It converts the voltage signal to the controller. The controller calculates the output current level of the electromagnet coils. The emerged magnetic force can levitate the ball under the electromagnetic stably in any arbitrary position within the range.

Due to the characteristic of the mathematical modeling of the device that the composed unit is unstable without the controller, a corresponding controller must be designed to stabilize the system. As the linearization has to be carried out around a non-zero operating point, it is therefore very challenging.

Matlab Control Interface

Use Root Locus Control as an example (support Matlab version 2012b or above):



Experiment contents

Based on Matlab platform:

※ System modeling experiment and analysis;
※ PID tuning & PID controller design;
※ Root locus tuning, frequency domain method tuning, and status feedback.

Based on analog control system:

※ PID tuning & analog control experiments.

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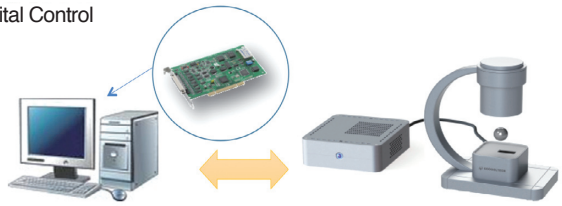
Control Configurations

(I) Digital Control

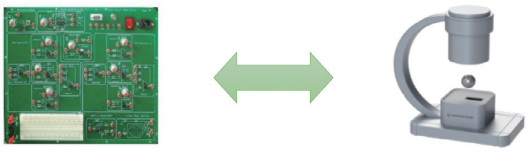


PC + Data acquisition card

GML2001

The standard model (GML2001) uses PCI Data acquisition card to communicate with the Magnetic levitation system drive.

(II) Analog Control



Analog Control Box

GML2001A

1. The analog control box model GAES1001 directly uses amplifier to control the system by two control schemes: current control and voltage control.
2. Self developed controller.

Specifications

Items	Specifications	Items	Specifications
Body Dimensions	210 x 150 x 280 mm (L x W x H)	Core Size	Φ=20 mm , H=94mm
Control Box	220 x 200 x 75 mm (L x W x H)	Control Distance	1-30 mm (steel ball = 94g , Φ = 45mm)
Coil Resistance	13.8 Ω	Laser Sensor	Class 2 Red Semiconductor Laser, 655nm, 1mW max
Turns	2,450	Power Supply	220 VAC
Coil Inductance	135 mH	System Weight	< 8 Kg

Specifications

Model	Description	Items	
GML2001	Magnetic Levitation System	AML-MB-2001	Magnetic Levitation Body
		AML-EB-2001	Control box with connecting cable
		A-DA-1711	Data Acquisition Card PCI
		S-UP-MAT	Googol Simulink experiments platform
		GAES1001	Optional Analog Control Module
GML2001A	Magnetic Levitation System (Body only)	AML-MB-2001	Magnetic Levitation Body
		AML-MB-2001B	Connecting Cable (loose end)
		GAES1001	Optional Analog Control Module or Self Developed Controller

Magnetic Levitation

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