Real-time PID Control for Magnetic Levitation System with Special Hall Effect Sensor

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***Abstract*—This paper describes the Magnetic Levitation System (MLS/maglev) focused on the design of a real time object-microcapsule-based in proportional-integral-differential (PID) control for levitated ferromagnetic objects. The maglev dynamic model including its equivalent circuit is first elaborated. The control objective is to design a real-time PID control methodology based on GoogolTech by feedback control method using a visual interface software to ensure stability. The effectiveness of the proposed PID control scheme for the magnetic levitation system is verified by numerical simulations and experimental results,**

Keywords: levitation, hall effect, electromagnet, Maglev, Magnetic levitation, PID Control.

I. INTRODUCTION

In recent years important advances have been made in different technologies using magnetic levitation systems (MLS) or Maglev, therefore, some of them are named and represent the main point of interest and departure with which the selection of levitation technology Magnetic

In the levitating system, a sphere of ferromagnetic material and mass is drawn upward by a magnetic force generated by an electromagnet; since the sphere has a weight, there is also a gravitational force that pulls it down. In this way, when a balance occurs between these two forces (magnetic force *Fm*, and gravitational force *Fg* are equal in magnitude) the levitated object in the air. Since the position of the sphere is never the same, as the system is easily destabilized, the magnetic force has to be controlled.

In Maglev technology, usually needs a mathematical model of the real system; once a good model is obtained and verified, thus a suitable control laws can be implemented to compensate the plant instability and improve performance.

Due to its nonlinear and unstable nature, the Maglev systems are very challenging projects. A PID feedback control is used to control magnetic field that levitates the objects to stabilize it in the platform. Linear system model only works well over a small region of operating point [1].

II. PLANT DESCRIPTION

The maglev device consists the electromagnet, the object position sensors, the levitating object, and the controller-computer interface board and drivers, real time control toolbox, see Fig. 1 and Fig. 2

Otherwise, Maglev is a nonlinear, open-loop unstable and time varying dynamic system. The basic principle of MLS operation is to apply the voltage to an electromagnet to keep a ferromagnetic object levitated. The object position is determined by two types of sensors (Hall Effect and distance), in other hand, the coil current is measured to identify and multi-loop or nonlinear strategies and to levitate the object a real-time controller it becomes necessary. The sensing stage is where a continuous monitoring of the position of the sphere is carried out and the information is transmitted to the control stage; in this system stage, the object position is adjusted through the control of algorithms, which tries to approximate to the set-point position with the real position, this determines the action that the electronic actuator must execute. The power stage receives the signal generated by the controller and interacts with the electromagnet. The PID controller proved to be effective for set point regulation and for tracking a changing input [2].

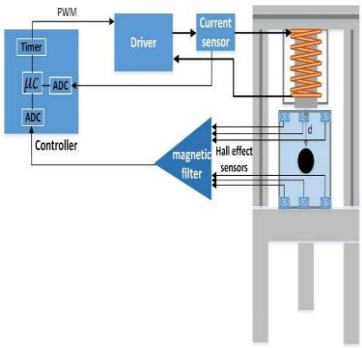

Fig. 1. A schematic representation of the plant model of the maglev system.

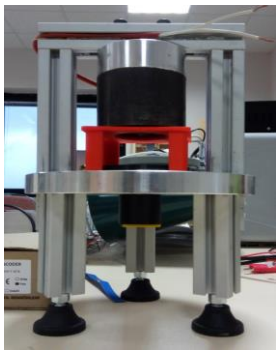

Fig. 2. Prototype Magnetic Levitation System

Furthermore, changes of the parameters of the plant, such as change of mass and suspension of the variations of resistance and inductance their magnetic susceptibility decreased with increasing temperature [3], must also be taken into account, thus the magnetic levitation system includes: