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CURRENT LOOPS IN A MAGNETIC LEVITATION SYSTEM

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Abstract. *Since long time ago current loops are used in practice to render negligible the electric dynamics in magnetic levitation systems. However, this strategy has been justified until now only by means of intuitive ideas. In this note we present, for the first time, a formal stability analysis, which takes into account the electric dynamics, justifying use of such a control strategy.*

Keywords: Magnetic levitation system, Current loops, Position control, Lyapunov stability

1. Introduction.

Magnetic levitation systems are common benchmarks for control theory. This can be seen from the large amount of works published on the subject (see [1], [2] Ch. 8, [3], [4], [5], [6], [7] and references there in). There are two approaches for control design of magnetic levitation systems: *i*) voltage is the control input [2], [3], [1], [5], *ii*) electric current is the control input [4], [6], [1]. The second approach is very attractive because it allows to neglect the electrical subsystem and, hence, control design is simplified because it is done on the basis of a reduced model, i.e. the mechanical subsystem. This approach is rendered possible in practice by introducing an inner current loop driven by a proportional current controller [8] pp.76, [9], [2] pp.383, [6], as in most electromechanical systems. If the proportional gain of this controller is large then the electrical subsystem dynamics can be neglected. However, this is justified by using intuitive arguments and any formal analysis supporting these ideas does not exist until now. The main contribution of this note is to present, for the first time, a formal study which provides a justification for such an approach. We describe how to design two controllers for the magnetic levitation system by assuming that electric current is the input signal, i.e. using a current loop with a large proportional gain to neglect the electric dynamics. We show that both of these controllers can be designed by taking into account the electric dynamics through a Lyapunov stability analysis, i.e. by using voltage as the input signal. These results formally explain why strategy *ii*) works well in practice: a current loop with a large proportional gain allows to dominate terms neglected by strategy *ii*). This is another contribution of the present note.

This note is organized as follows. In Section 2, we present the dynamic model of a magnetic levitation system. Section 3 is devoted to present our main results. Some