# On the optimization of a Capsubot with a Spring

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## ABSTRACT

A capsule robot (capsubot) is a type of compact mobile device which can explore fields inaccessible to humans. In recent years, such devices received intensive attraction mostly in connection with medical purposes: a tiny capsubot with camera can be swallowed by patient to diagnose diseases; another application is inspection of pipelines. A capsubot without external moving parts contains an internal mass, being put in motion by an actuator. As the internal mass changes its position relative to the capsule, the center of gravity shifts. An appropriate control strategy is needed to provide periodic motion of the capsubot in desired direction. Due to limited resources (size and mass of the robot, power supply, etc.), the optimization problem (in a sense) is of great practical importance.

First results on optimal vibratory displacement were obtained more than half a century ago [1-3]: the optimal acceleration profile is three-step. Formally speaking, this problem is similar to the basic model of capsubot with external friction [4], and the same optimal strategy can be used there. Note that in these papers the optimality is understood as maximal average velocity of the capsubot. Another criterion – minimal energy consumption - was considered in paper [5]. Further modifications of the capsubot include elastic springs: papers [6,7] are devoted to the computer modeling.

In this paper, a two-step control strategy is proposed in the cases of linear or non-linear spring. Optimality conditions are obtained and the comparison with no-spring case is made.

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