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Control of miniature linear actuator using sensorless measurement of position of a DC driving micromotor

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Abstract

The presented research was aimed at creating and testing a control system of a spooler for winding miniature induction coils. The discussed analysis was realized in order to verify a possibility of synchronizing the speed of the spindle drive (stepping motor) with the speed of the wire feed unit (miniature linear actuator based on a DC micromotor). A method of a sensorless measurement of rotor displacement of a DC micromotor was applied to control position of the actuator. The method is based on analysis of the current signal and its pulsation corresponding to the shaft rotation. An ATmega8 microcontroller communicating with PC was used to implement various control algorithms. Using a prototype of the controller, there were performed tests of the drive system, proving that synchronization between drives of a different type by means of the proposed method of analyzing current signal in a DC micromotor is possible

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Keywords: sensorless angle measurement; DC micromotor; stepping motor; control system, linear actuator;

1. Introduction

The presented works were connected with elaboration of a control system for an automatic spooler of miniature coils, whose kinematic diagram is presented in Fig. 1 [1]. The system of the spooler comprises two drives – one for spindle rotation and one linear in the wire supply unit. The first drive is a stepping motor, which through a synchronous belt drive drives the spindle shaft, onto which the core of the winded coil is fixed. The motor ensures a

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rotary motion of the spindle and at the same time a possibility of rotational motion of the core. Coil wire is supplied from a magazine to the core. The linear module, built on the basis of a DC micromotor, is the element ensuring wire feeding along the coil axis. From the point of view of a correct operation of the device, a significant issue that must be solved while building the control system is to ensure synchronization of both drives.

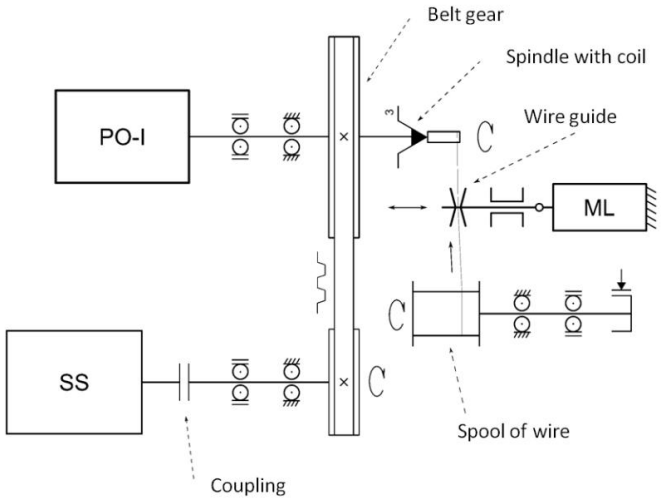

Fig. 1. Kinematic diagram of the spooler for miniature coils [1]
PO-I – encoder, ML – linear module, SS – stepping motor.

As the linear module, a small actuator based on a DC micromotor was used; it was developed at the Institute of Micromechanics and Photonics, Warsaw University of Technology (IM&Ph WUT) to play a role of a driving member of a section of a modular snake-like robot [2]. View of the drive are presented in Fig. 2.

Fig. 2. Miniature linear module.

Because of a compact structure of the linear drive module, it was decided not to develop its structure by attaching an additional transducer of linear or angular velocity. Instead, it was proposed to use as a source of the signal of angular velocity of the drive a novel method of a contactless measurement of the position of micromotor rotor based on processing current fluctuation of the mechanical commutator – minutely discussed in [3].

2. Sensorless system for measuring displacements of the linear drive

At the IM&Ph WUT, there was carried out a study related to using a phenomenon for measuring purposes. The phenomenon consists in generation of pulsation of the armature current while operating a DC motor. The pulsation is associated with mechanical commutation and is a derivative of the structure of such motor. The brushes supplying