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50. Internationales Wissenschaftliches Kolloquium
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A. Ahranovich / D.Azentani / J.Zentner

The Linear Step Motor Mathematical Model Design and Verification Using Identification Toolbox Method as a Mean for Improving the Motor's Performance

ABSTRACT

A variety of mathematical models for linear step motors can not give the exact and definite description of motor behavior. The work describes an approach to mathematical model constructing and, basing on experimental investigation of linear step motor behavior, the verification of model is carried out. The model which with sufficient accuracy describes linear step motor is based on model building of physical processes which take place in linear step motor. Mathematical model presented is used for computer simulation of control system with different regulators which are to improve motor’s dynamics, and, as the result, hardware performance and precision.

MATHEMATICAL MODEL OF LINEAR STEP MOTOR

The mathematical model presented is based on description of physical processes in linear step motor (LSM). Such approach allows take into consideration most non-linear energy transformation in the motor. The model of LSM consists of three parts: electrical, magnetic, and mechanical. Such division of LSM model helps simplify the investigation of model adequacy, besides usage of such approach is supposed to make the model "transparent", e.g. it will help to estimate the contribution of this or that variable into dynamics of LSM.

MATHEMATICAL MODEL VERIFICATION

The main goal of working out a model is to create an adequate model, as only adequacy can guarantee the motor’s behavior prediction. To verify worked out model, Identification Toolbox of MATLAB was used. This tool helps verify mathematical model with high accuracy. During experiments, the model of motor LSM-211.HS produced by RuchServoMotor was verified.

Identification Toolbox needs some input and output data which represent control signals and system response. Basing on these data, the transfer function of the system is built, and, using one of identification techniques, the model transfer function is constructed. The signals used for model verification are divided into two groups: simulation results and experimental data. It’s obvious, that both groups must incorporate the same signals of two (one virtual –model; another one real- linear step motor with controller) systems. The signals acquired for model verification are shown on fig. 1.

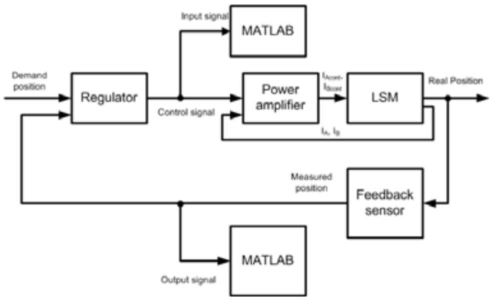

Fig. 1. Signal acquired for model verification

The experimental data is analyzed in three stages. The first stage incorporates building transfer function of the system on the whole interval of acquired experimental data. The second stage presupposes building two transfer $W_1(s)$ $W_2(s)$ functions of system basing on two different data scopes acquired during the first half time of experiment and during the second one. Having built these three transfer functions, their comparison is carried out. If these transfer functions are similar, the average transfer function $W_{exp}(s)$ is build. In case when these three functions vary greatly, our method of verification can not be applied, as the model changes in time. The data acquired during computer simulation is also used to build the transfer function of LSM model $W_{mod}(s)$. At last, the comparison of these two transfer functions is done and the conclusion is made.

VERIFICATION RESULTS

Basing on experimental data and data acquired during computer simulation, the adequacy of worked-out model with accuracy up to 92%. That means that the worked out mathematical model can be used afterwards for computer simulation with different regulators, which increase the motor's dynamic characteristics.

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Autorenangaben:

Post-graduate student Aliaksandr Ahranovich
Post-graduate student Daw Azentani
Belarusian State University of Informatics and Radioelectronics
P.Brovki Str. 6, Minsk 220027 Belarus
Tel.: +375 (17) 239-88-30
E-mail: mmts@bsuir.unibel.by

Dipl.-Ing. Johannes Zentner
Technical University Ilmenau
D-98684 Ilmenau
Tel.: +49 (36 77) 69 39 27
Fax: +49 (36 77) 46 90 63
E-mail: johannes.zentner@tu-ilmenau.de