

## USING VIRTUAL INSTRUMENT IN D.C. MOTOR SIMULATION

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**Abstract:** This paper uses a state-space model of the D.C. motor build for constant flux. For the system's simulate is build a VI where the most important element is a Matlab script which contains the matrices A, B, C, D of the state-space model, the independent variable time and the Matlab simulation function *lsim*.

**Keywords:** d.c. motor, state space model, virtual instrument, Matlab script, simulation

### 1. Functionally equations of the D.C. motor

We'll be considered a direct current (D.C.) electric motor [1] with separate excitation, compensating winding and commutating pole. If the excitation flux is considering constant it can build the mathematical model in state-space form so that is possible to use it into Matlab program simulation. To build the state-space model brings in this mathematical model the input, state and output vectors [3] i.e. state vector  $x(t)$  with components supply current  $i_s(t)$ , angular displacement  $\alpha(t)$  and angular speed  $\omega(t)$ , input vector  $u(t)$  with supply voltage  $v_s(t)$  and load torque  $m_L(t)$  and output vector  $y(t)$  with components are the same with state vector components. Now we can use the function *lsim* ( $A, B, C, D, v, t$ ) [7]:

### 2. Build the VI to simulate D.C. motor in LabView

The control panel and bloc diagram of the VI used to simulate D.C. motor are presented in fig.1. The base element of the LabView program named **simmot.vi** whence is used to simulation D.C. motor working is the Matlab script node [4]. Through this, is

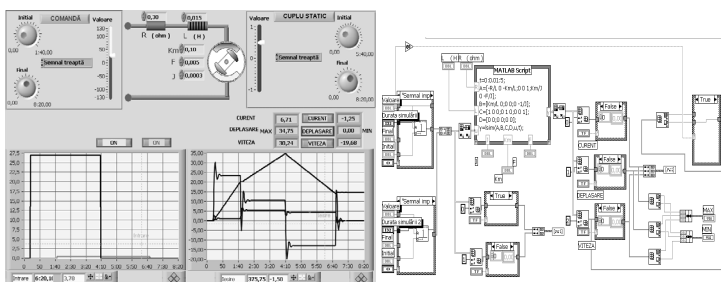


Fig.1. Front panel and bloc diagram of the **simmot.vi**

inserting into LabView program the matrix A, B, C, D of the motor state-space model. The motor constructive parameters  $R, L, K_m, F$  and  $J$  represent also the model parameters and these are sets by controls placed on front panel. Because the input vector has two components for generate the right signals are build two blokes on the front panel. These two blokes are represented in diagram bloc by CASE structure, each with three subdiagrams, which generates the standard signals. Subdiagrams contain respectively Impulse Pattern.vi, Pulse Pattern.vi and Ramp Pattern.vi and these and those parameters like amplitude, width or delay are shifting by corresponding controls from the control panel.

With the two arrays contain the input pattern using BUIL ARRAY node it can obtain a new array that has values arranged by rows form and represent for real system the input signals and for graphic representation of these it can use a graphic display WAVEFORM GRAPH type. Necessary form for input vector require a transpose array so that obtain a vector arranged by two columns and for realize that it can use TRANSPOSE 2D ARRAY node that rearranges the elements of 2D array such that 2D array [i, j] becomes transposed array [j, i]. Similarly the same node it using at output of the Matlab script node because the output vector of this node must row type and must have three columns that correspond to the three output signals. The input and the output terminals of the Matlab script node corresponding to the input and output signals must be Real Matrix type.

To display the inputs and the outputs signals is used the WAVEFORM GRAPH display and for selection of these signals is used INDEX ARRAY nodes on the input and on the output too by corresponding push button on front panel. To right course of the simulation program is necessary that number of samples of the vector  $t$  that represent simulation time in Matlab must be the same with the number of samples of the signal generation pattern. To do that, in Matlab script, the vector  $t$  that specifies the time samples for the simulation has  $5/0.01+1=501$  components and is necessary that the number of samples of the Ramp Pattern must be 501, too. The control panel include a dynamic animation of the motor axle spinning using 8 sequences corresponding to the 8 distinct position of the motor axel.

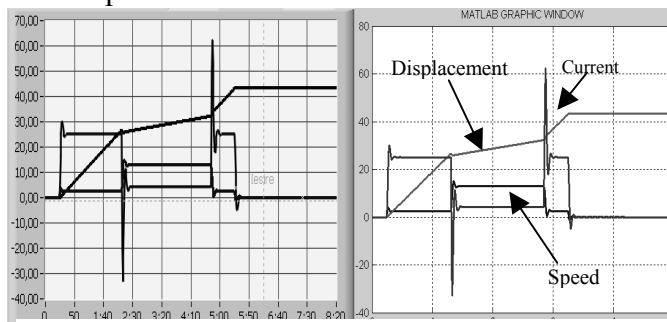


Fig.2 Data representation of output signals in LabView and Matlab

### 3. Conclusions

LabVIEW launches Matlab and if used the *plot(t,y)* instruction [2], [5] after *lsim* instruction into Matlab script, a new Matlab window appears. In fig. 2, the similarity between both LabView and Matlab results can be observed. Through the instrumentality of controls placed

on front panel of the VI it can settings the model parameters and the input signals parameters too. Also, because LabView is a data acquisition dominant program is possible to make comparison between data acquired from a real system and data obtained from mathematical model of this system.

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