ESTING PLATFORM FOR ELECTRIC RELUCTANT MOTORS USING LabVIEW ENVIRONMENT

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Abstract: The paper presents the development of a virtual laboratory accessed via Internet, by combining the existence of a real test-bench with the Internet facilities. The idea of remote control devices is quite new in electrical engineering. Present paper deals with a particular aspect related to a virtual laboratory, with the purpose of initiating in research of reluctant motors the researchers wishing to approach modern equipments at which they have no physical access. It allows not only distance learning for the beginners, but also the achieving of a stable electronic link between researchers and producers of reluctant motors. To benefit of such virtual laboratory one need knowledge in various fields such as: electro-mechanics, electrical machines and drives, digital control, instrumentation, Internet.

Keywords: electric reluctant motors, electrical engineering

1. INTRODUCTION

Distance learning has been introduced at university level because it can provide more flexibility in university education. But, in the engineering field, the student need to work in real laboratory, to see and feel the equipment, and this may be a problem in distance learning. In the last years, the development of the faster processor, advanced graphical software and Internet capabilities allowed the implementation of virtual laboratory. This type of laboratory has some advantages compared to real laboratory, such as [1]:
a) It is not limited in time, as students can exercise at any hour;
b) If a university have one expensive equipment only it could share it with other universities and so students can practice on different equipment;
c) Students can review the laboratory session that has been made earlier as many time they want and in a relaxed environment;
d) Virtual laboratory can be a good alternative in distance learning system because it can fill the absence of practical session.
But also some disadvantages may be considered, such as:
a) The real equipment is at distance, so students can't feel it and for them all the equipment is just an image on computer display;
b) Students don't have the direct support of a laboratory assistant or a technician;
c) Only a limited number of experiments can be made, depending of preconfigured option.
The purpose of implementing such a virtual laboratory is not limited to distance learning, but also to achieve a stable electronic link between researcher and producer of reluctant motors, in the benefit of all producers and users involved. Like in case of other IT applications, the proposed virtual laboratory may be considered as a step to integration of scientific research into world global economy.

Figure 1 depicts the block diagram of a whole virtual laboratory, consisting of a real laboratory connected to the Internet by a Server.

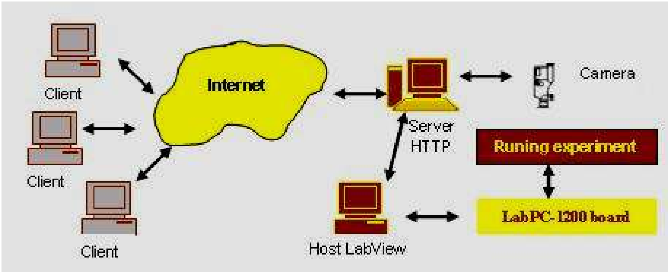

Fig. 1. Principle of virtual laboratory.

The Server is connected to a host PC, which contains a LabPC-1200 board made by National Instruments [2] to allow control of reluctant motor testing platform.

2. REAL LABORATORY

The real laboratory as reluctant motor testing platform represents the hardware support of this application. The real laboratory connected to a PC-accessed network consists in the concept of virtual laboratory. Figure 2 shows the structure of testing platform.

It contains a reluctant motor coupled to an electromagnetic powder brake and is supplied by a PWM inverter. A block of transducers ensures electric connexion of the power block to the host PC, by using a labVIEW 5 card to perform not only virtual instrumentation, but also main control signals to and from motor/inverter system.

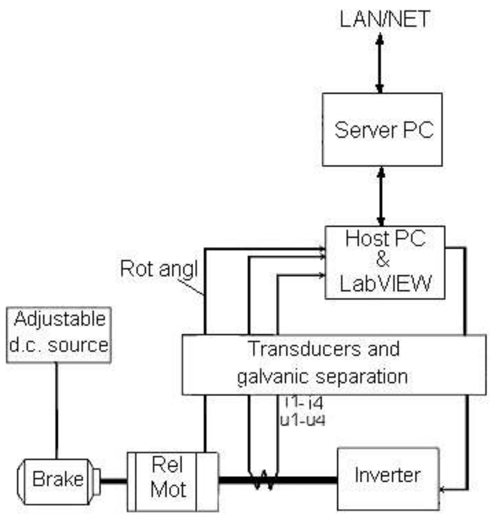

Fig.2. Structure of the testing platform.

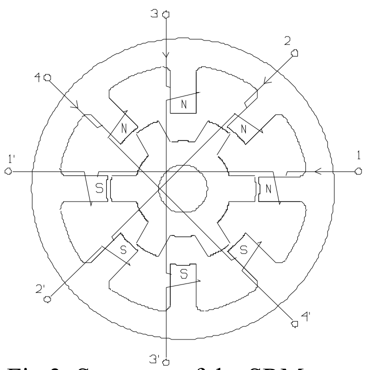

Fig.3. Structure of the SRM.

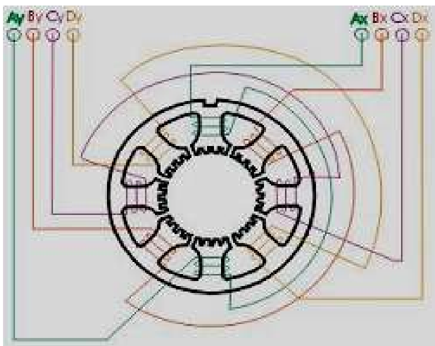

Fig. 4. Structure of the VRSM stator.

Fig. 5. VRSM picture.

Two types of reluctant motors are involved: a switched reluctance motor (SRM), and a variable reluctance stepping motor (VRSM). The SRM used is of 8/6 4 phase type and his electromagnetic structure is depicted in figure 3 [3].
The used SRM has the following characteristics:
Electromagnetic peak torque =4 Nm;
Phase current = 9 A;
Phase voltage = 200V;
Step angle = 15^0.
The VRSM taken for study is a common 8 pole, 4 phase motor [4], with the following main characteristics:
Electromagnetic peak torque = 2 Nm;
Phase current = 4 A;
Phase voltage = 60V;
Step angle = 2.65^0 (136 steps/rot).
Figure 4 shows the electromagnetic structure of its stator.
Each phase is built from two diametrically opposite poles windings, in such a manner that each phase has two ends, available for various connecting techniques in PWM inverters.
Figure 5 shows the picture of the whole motor, as it has been manufactured in authors' laboratory.
A unique PWM inverter has been designed to supply both VRSM and SRM. Usually reluctant motors are supplied by voltage sources (series resistance switches or dual voltage schemes) or by current sources (PWM schemes). PWM schemes are the most popular inverters in case of reluctant motors [5] due to their adaptability to various techniques based on voltage and current processing. In this case, OrCAD environment has been used in order to design and simulate the PWM inverter. Figure 6 shows the block diagram of the inverter as base for design in OrCAD Capture.
The PWM inverter provides excellent voltage and current waveforms in case of reluctant motors [6]. It is associated to VCC sources and additional electric devices into a Motor Driver, and represents the real laboratory as seens in figure 7.

3. HOST PC AND LABVIEW

The host PC is a 200Mhz PC, 32 MB Ram, with a Realteck RTL 8139/810x Ethernet board in order to provide connection to the Server. Also, a Lab-PC1200 board witch is a completely switchless and jumperless data acquisition board is used.
This allows DMA, interrupts, and base I/O addresses to be assigned into the system to avoid resource conflicts with other boards in the system. This board was designed for high-performance data acquisition and control for applications in laboratory testing, production testing, and industrial process monitoring and control. Lab-PC 1200 board has eight analogue input channels ACH0-ACH7, that can be configure as eight single-ended or four differential inputs, a 12-bit successive-approximation ADC, 24 lines of TTL-compatible digital I/O, and three 16-bit counter/timers for timing I/O.

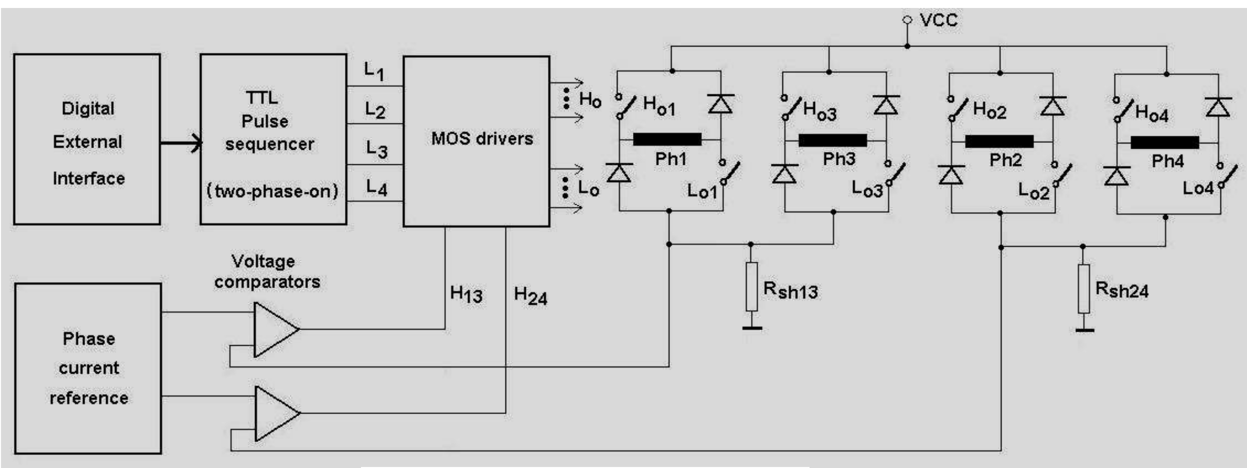

Fig. 6. Block diagram of the inverter

Current transducer (LEM LA 55-P) and voltage transducer (LEM LV 25-P) are used for each of the four phases of the motors, in order to have a galvanic separation between the power module and measure module (the LabPC board).
Also, in order to protect the digital part against the disturbances that could appear, it is decided to make a galvanic separation. The electrical scheme of this separation circuit for one channel is presented in figure 8.

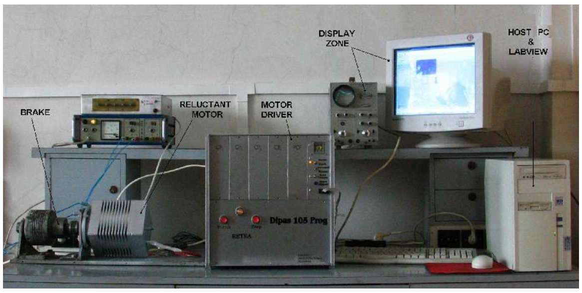

Fig. 7. Picture of real laboratory.

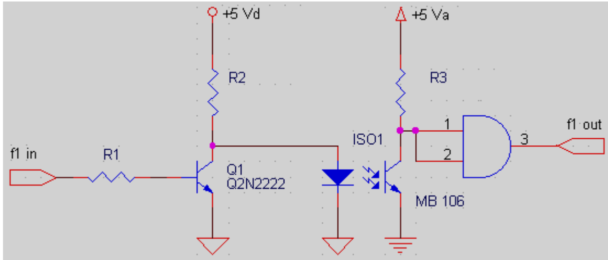

Fig. 8. Separation module.

4. I/O INTERFACE

The Host PC is connected to each equipment described previously through the LabPC board and is also connected to a HTTP Server.
The HTTP Server hosts the web page created for this laboratory. In figure 9 one can see the home page of WWW Server, with all menus and with possibility to be read in Romanian or in English.
The page also have another menu that can be useful to the client, like a “download” button, where the client could download LV RunTime Engine, a software provided by National Instrument and necessary for experiments visualization, a “useful links” button, where client will find links to the most important sites related to the virtual laboratory subject and a “contact” button, where clients can post any suggestions and question they may have. The “Real Laboratory” link will display an image of the testing platform from laboratory (figure 7). Each equipment has a text box with links to pdf. documents with respective technical characteristics and other useful data.
The “Virtual laboratory” link will take the client to a test page where he must answer to a general question about virtual labs, in order to have access to the page with available remote experiments.

5. VIRTUAL LABORATORY

5.1. Front panel

When the client accesses the HTML page containing one of the example (in this particular case a signal generation and processing), the LabVIEW is automatically granted the control of the virtual instrumentation (VI), and a message box is appearing “Control granted”. In the same time a message box is appearing on Server announcing that the client has control “Control transferred to name of client” (figure 10). The client will have full access to the running application and the Server could only monitor the process.
The client could release at any time the control of the application to Server by right clicking on the running application and selecting “Release control of VI”. In this case, a message box will appear announcing that the Server has control of the VI and the client could only visualize the running application on Server without any control.

Fig. 9. Web page of laboratory.

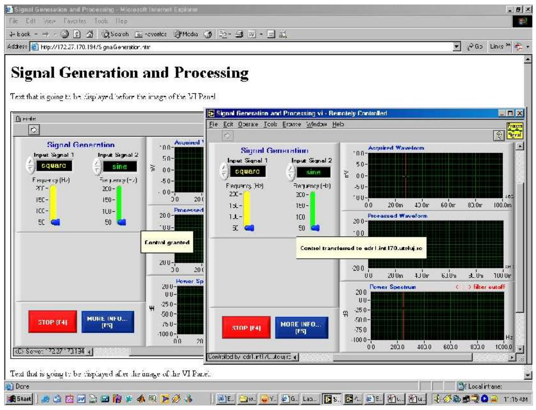

Fig. 10. Taking control of VI.

6. EXPERIMENTAL RESULTS

There were implemented some VI's like signal generation, an already made VI from LabVIEW examples, who can generate and analyse two different signal waveforms, an Addition VI (figure 11). The Addition VI is a simple VI made for testing the communication with client, who could made first the difference between two numbers (Nr1. and Nr.2) and display the result, and after that, the addition between Int.1 and Int.2.

Another VI is the oscilloscope VI who allow the acquisition of the pulse signals for 2 phases of the motor (figure 12).

With the last VI, named Acquisition and Analyze, it is possible to acquire the waveform for phase voltage and current waveforms when motor is running (figure 13), and to display the phase current and flux variation (figure 14). Flux variation is obtained by processing the current and voltage.

7. CONCLUSIONS

A very promising tool for investigating reluctant motors has been proposed by combining the experience on reluctant motor drives with IT facilities provided by Internet and labVIEW environment. In this purpose a real laboratory is connected through a labVIEW board in a host computer to the Internet, using a second computer as Server. A web page is built both for visiting and remote for operating with reluctant motors. The virtual laboratory as proposed is only a beginning, but it can be improved provided future users and producers will visit its web page. Technical improvements of real laboratory are also expected as well as a rising interest for such scientific dialogue. The web page as described may be accessed immediately after public presentation of this paper.

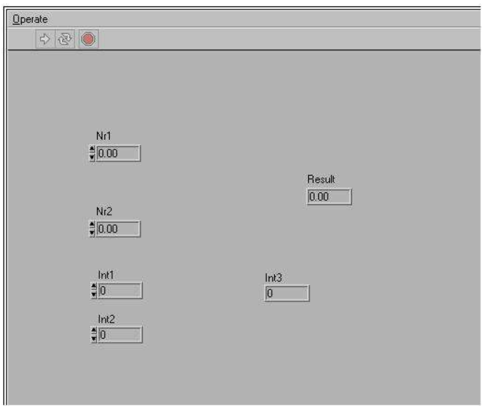

Fig. 11. Addition VI.

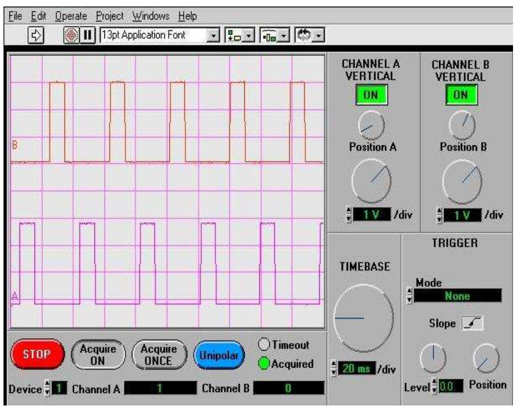

Fig. 12. Oscilloscope VI.

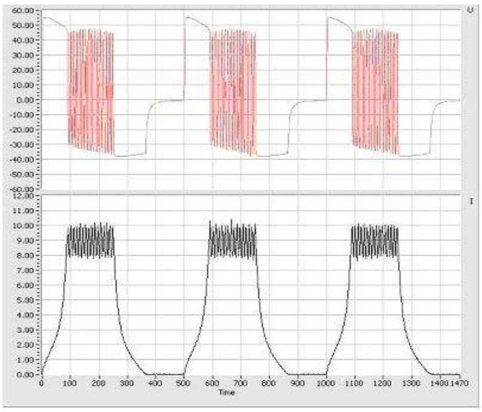

Fig. 13. Phase current and voltage.

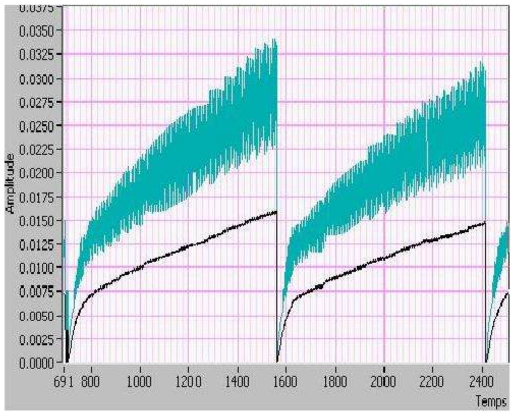

Fig. 14. Phase flux variation and current.

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