MULTIMEDIA: A HELP IN TEACHING ELECTRICAL MACHINES AND DRIVES

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ABSTRACT: This paper provides ideas and practical experiences using multimedia at the electrical engineering department of the Katholieke Universiteit Leuven in the field of electrical machines and variable speed drives. By using multimedia developments, it is possible to confront undergraduate students in a more attractive and efficient way with electrical machines and drives. The paper approaches the term multimedia from different points of view. The definition of a multimedia computer is explained and the minimum requirements are mentioned. Different authoring systems available to program multimedia applications are presented in this paper. The authoring system IconAuthor^{TM} , used at the electrical engineering department, is dealt with thoroughly. In a practical example, the visualisation of phenomena and construction of a squirrel cage induction machine, is looked at in a closer way. The developed laboratory session module is also presented. The conclusions, after an evaluation by the students, are that the undergraduates get more interested in the subject and even recommend additional multimedia applications in other topics of electrical engineering education.

INTRODUCTION

During the last years, society changed to a world of images. Television, computers and interactive computer games are very popular these days. The written word loses a lot of importance. In this world of pictures and interactive motion one hears often the word multimedia as an important development for the future. The term multimedia stands for a mass of applications, investments in money and in time and a lot of expectations. Two general questions asked before starting the educational project were:

- What is multimedia?
- Is it possible to confront students in a more attractive and efficient way with several topics of the course of Electrical Machines and Drives by using a multimedia application? Can the transfer of knowledge be improved by this kind of presentation?

This paper gives some information concerning the term multimedia. The paper provides ideas and practical experiences using multimedia at the electrical engineering department of the Katholieke Universiteit Leuven in the field of electrical machines and variable speed drives. Because students are using this application, feedback is asked to them so they can give comments concerning the application to improve future releases of the program. It should be stressed that the group focused is quite large: all electrical, electronic and mechanical engineering students taking the basic course on electrical machines and variable speed drives in the third year of their curriculum, i.e. approximately 200 students every year.

MULTIMEDIA - THE TECHNOLOGY

What is Multimedia?

Multimedia is a topic of high interest even in the academic world. A straight forward definition is not always available, but it is clear that it concerns a collection of media like written texts, photos, tables, diagrams, sound, music, television, video, etc. Two definitions are generally accepted [1,6] and both agree on the point that multimedia is a technology and not a product.

The first definition of a multimedia application says that the application should have an interaction with the user. This means that the application reacts on pulses from the user and the user himself can take initiatives of his own. This definition is very broad and categorises a lot of modern programs into the multimedia range. However, it puts in perspective that working with multimedia is different from working with television or movies, as the user determines himself what kind of pictures and sound he is offered.

The second generally accepted definition is completely different. It states that: "Multimedia is every combination of text, pictures, sound, animation and video". This definition can be specified as follows: "One speaks of interactive multimedia if the user himself controls which information he wants to address and how detailed it has to be. That is why the user disposes over a number of buttons on the screen where he can click on".

The second definition is the most accepted one.

Table 1: *Overview of the minimum specifications of the multimedia PC (MPC)*

Part	MPC Minimum specification	Minimum recommendation
Computer		
Processor Type	80386 SX	80386 DX
Clock Frequency	16 MHz	33 MHz
RAM-Memory	2 MB	4 MB
Diskette station	3.5 inch; 1.44 MB	3.5 inch; 1.44 MB
Hard disk	30 MB	200 MB
External import possibilities	101-key keyboard; mouse	101-key keyboard; mouse
Input/Output-gate	1 serial and 1 parallel gate	1 serial and 1 parallel gate
Graphical reproduction	VGA, 640*480, 16 colours	256 colours (0.28 mm dot-pitch)
CD-ROM-player		
minimum data transfer velocity	150 kB per second, block size 15 kB	150 kB per second, block size 64 kB
maximum search time	1 second	350 ms
MTBF	10000 hours	10000 hours
Sound		
type of sampling	PCM	PCM
sampling resolution	8 bit-mono	16-bit (stereo)
sampling frequency ADC	11.025 kHz, microphone input	22.05 and 44.1 kHz
sampling frequency DAC	11.025 and 22.05 kHz	11.025; 22.05 and 44.1 kHz
external noise output	microphone	microphone and stereo-input
internal mixing	CD, synthesiser and DAC	CD, synthesiser and ADC
noise output	stereo	stereo
MIDI- in- and output	in, out; interrupt driven	in, out; interrupt driven

Sometimes instead of multimedia the term hypermedia is used. In a hypermedia application a structure is provided where it is possible to link the different media in a certain way. The user can navigate or surf freely between those different media. Sometimes hypermedia allows not only references within the same document but allows also references to other data-sources, that can be used on line, so the user can use very extensive data informations.

Multimedia-computer

The term multimedia-personal-computer (MPC), does not refer to electronic apparatus, but refers to a standard with some minimum requirements. MPC is a trade mark of the Multimedia PC Marketing Council and refers to IBM-compatible personal computers. This council publishes and maintains MPC-specifications. Because MPC is a standard and not a computer, it is possible to compose a configuration with components from different suppliers conforming with the standard. The MPC-standard refers to the computer as well as to peripheral equipment. The most important requirements are shown in table 1.

Multimedia Authoring Systems

A multimedia authoring system supplies a frame to a project. To this frame the different elements like audio, video, text, images or animations are linked. The authoring system supplies communication links and the working together of the media in different applications. The possibility to program the interactions between computer and user is also offered.
Authoring systems deliver the environment to connect the contents and the function of a project. They usually contain the program parts with specific ability to manipulate the different media (create, record, reproduce, data input, ...).

Every medium has to be framed in order to be consistent with the other media. A good authoring system should have as many editing tools as possible to handle each used medium. This prevents the user from buying extra specialised software and omits communication problems from the authoring system to the extra specialised software when integrating the software.

An authoring system makes it possible to keep an overview of the program structure while programming contributes to simple subtasks. There are two different ways of programming: visual programming with keywords and icons, using a program language specific of the authoring system mentioned at the one hand, or classical programming at the other hand. The first method is the most direct one. With this method, it is possible to stress the contents rather than the way of programming. If the classical method is used (programming language), the knowledge of the language is required but a more concisely formulation may be realised.

Two positive characteristics of an authoring system are the possibility to program interactions and the possibility of interim testing of the application.

On the basis of the organisation method of the authoring systems, one can distinguish them in three different groups: page-based, time-based and icon-based authoring systems.
In a page-based authoring system, the elements of a multimedia application are organised like the pages of a book. Designers gather all the elements of the same size and place them in logical sequences like pages of a book. This is done for all the different media. A page can contain a small script where commands are placed that have to be carried out when the concerning page is selected. A special file co-ordinates the work.

A time-based authoring system organises the events and elements of a presentation on a time axis with a resolution upto 1/30 seconds. These systems are useful when a sequence of images has to be shown from the beginning to the end. The velocity of the sequence can be adjusted by the designer and the latter user. Powerful time-based packages permit interaction from the user. During the program a time axis is visible on the monitor.

In icon-based authoring systems, the general structure of the multimedia application can be visualised in the way the designer sees it. This method is called visual programming. The designer builds the program structure and afterwards a content is given to the building bricks, the icons. These icons can contain text, graphics, animation, sound, ... During the development the designer keeps an overview of the program structure.

Authoring systems are indispensable in the realisation of a multimedia application. Depending on the purpose a well considered choice has to be made. The largest differences between different authoring systems are in the field of user-friendliness.

For the multimedia application developed within the electrical engineering department of the Katholieke Universiteit Leuven an icon-based authoring system is chosen: namely IconAuthor™. There are several reasons to justify this choice. First of all IconAuthor™ works integrated in a Windows™ environment and this means that already existing PC-platforms can be used for the implementation avoiding problems. Secondly, IconAuthor™ is chosen after a thorough market survey because the programming technique is very simple to use. Another reason to chose IconAuthor™ was the total approximation of multimedia by this authoring system. IconAuthor™ contains several modules and each of them are specifically suited for the implementation and manipulation of a certain medium.

IconAuthor™ consists of nine different components:

- An authoring system that provides the direction of the media.
- Graphics Editor used to create coloured images that are static or that are used in an animation.
- SmartObject Editor provides the lay-out of the program and the implementation of text and graphics drawn within the Graphics Editor.
- IAScope is a help utility with the possibility of debugging during interim simulation of the application.
- In the animation module, IconAnimate, the shooting script of the animation is made.
- VideoEditor makes it possible to handle and watch video fragments.
- RezSolution is a graphical help giving the ability to adjust the resolution of the bitmap pictures to the hardware configuration used, when showing the application.
- Resource Manager performs the book keeping during programming. This help program keeps track of all the fonts and all the files used in an application with a view to the distribution of the application.
- Presentation System permits to reproduce a designed multimedia application on any computer without installing the full IconAuthor™ program package.

MULTIMEDIA - A PRACTICAL EXAMPLE

The basic course on electrical machines and variable speed drives consists of lectures, theoretical exercises and laboratory sessions. Often students study very profoundly their abstract textbooks on Electrical Machines and Drives, but still have some difficulties to visualise important phenomena and ideas. The laboratory sessions may clarify a lot, but they also have some shortcomings.

Multimedia and Student study programs

First of all, the laboratory sessions are normally done just once per student group. Secondly, the sessions take place in groups of three or four students per experimental test set-up. Therefore it is not always enlightening for each student individually. Last but not least, the sessions in the laboratory do not have the aim to recapitulate the theory of the textbook, they are there to teach some of the practice. It will be demonstrated how multimedia techniques can assist to overcome the mentioned problems.

An example at Katholieke Universiteit Leuven

By using a multimedia application, it is possible to confront the students in an alternative way with some difficult and basic topics of the course of Electrical Machines and Drives. Initially it was intended to concentrate merely on the induction motor and more specifically on the behaviour of the rotating field when changing some machine design parameters. Later on, the program was extended and the developed application consists of three parts:

- visualisation of the rotating field,
- mechanical construction of the induction machine,
- laboratory session.

Visualisation of the rotating field

In the part concerning the visualisation of the rotating field, it is possible to see the behaviour of the rotating field in two different cases. First of all there is the ideal case, where the current distribution is continuous along the surface of the

stator. Figure 1 shows an instantaneous representation of the animation of the rotating field in a circular way. Figure 2 shows an instantaneous representation of the same rotating field but in a linear way. In both figures the number of pole pairs, p is equal to three.

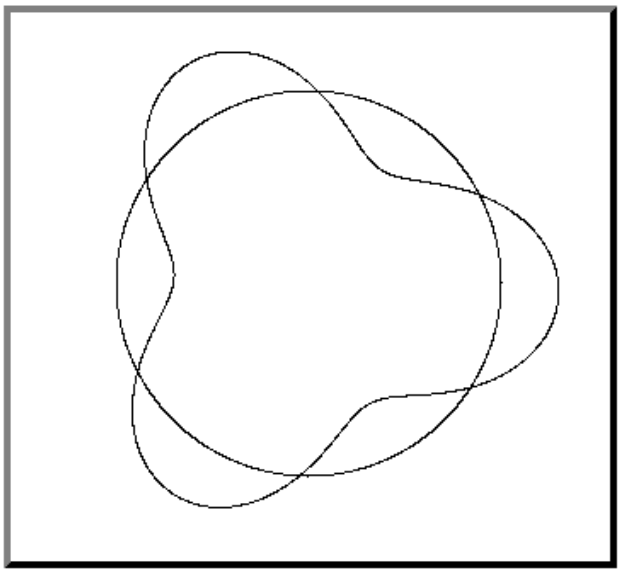

Fig. 1: *Circular presentation of the animation of the rotating field with continuous current distribution at the stator surface. Number of pole pairs p = 3.*

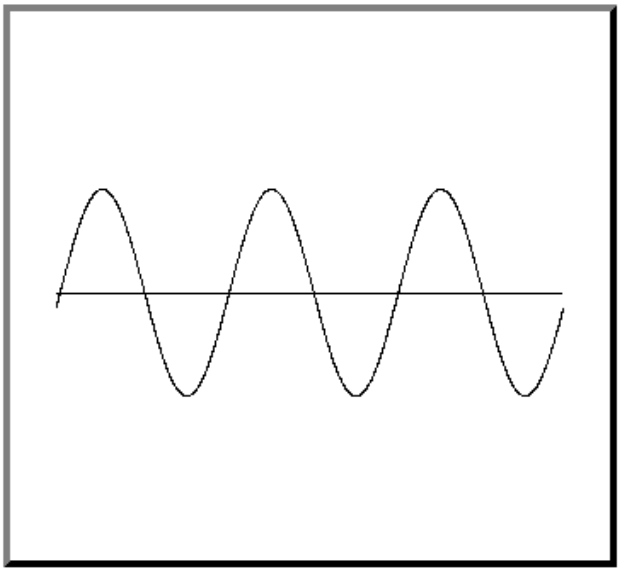

Fig. 2: *Linear presentation of the animation of the rotating field with continuous current distribution at the stator surface. Number of pole pairs p = 3.*

The second case is the realistic case, where the current flows through conductors embedded in the stator slots, is also examined. Figure 3 shows an instantaneous representation of an animation of the rotating field in a linear way with the realistic current distribution in the stator slots. In this representation the number of pole pairs, p and the number of slots per pole and per phase, q both are equal to three.

The student can interact with the program by choosing all the important machine parameters like the number of pole pairs, p and the number of slots per pole and per phase, q. Each choice of parameters gives a different representation. The animations are generated using MATLAB™ and are imported into the multimedia program.

Other possible interactions by the students are the answers to multiple choice questions where the student has to answer correctly before he can proceed with the multimedia session. At the end, to make the rotating field even more comprehensive, a part of a digitised videotape is implemented. This part of a video gives an alternative presentation of the rotational field. A travelling wave is shown. The analogy between the physical principle of the rotating field and the visualisation with up and down going bars is demonstrated very clearly.

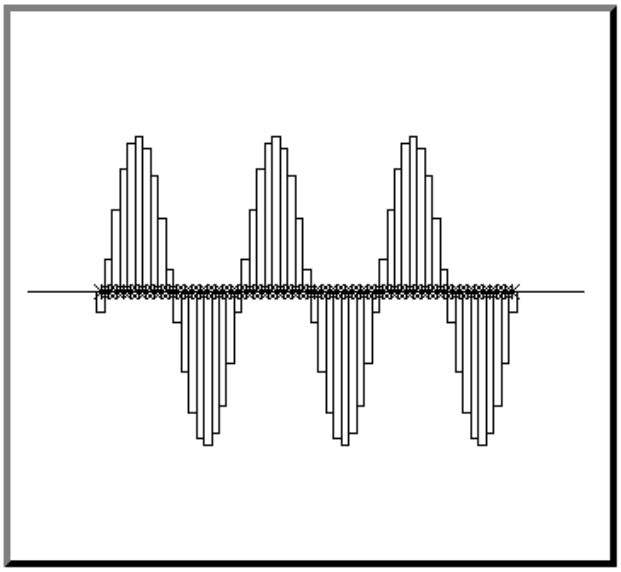

Fig. 3: *Linear presentation of the animation of the rotating field with realistic current distribution in slots. Number of pole pairs p = 3, number of slots per pole and per phase, q = 3.*

The same approach could be used to study the influence of the time harmonics in the voltage and current supplied by a frequency inverter.

Mechanical construction of the induction machine

In the part dealing with the mechanical construction of the induction machine, the student gets an overall view of the squirrel cage induction motor. Clicking on the different parts of the machine the student gets the name and the function of the chosen part of the machine. The student can even get a more detailed picture. It is also possible to go to a list of machine parts and click on one of the names. In this way the student learns more about the function and about the location of the specific parts inside the machine. Figure 4 shows an example of a detailed view of the rotor of the squirrel cage induction machine.

Most of the images shown in this part of the student session are photos put on a photo-CD and then imported into the multimedia program after being digitised by using specific software.

Laboratory sessions

The third part of the application deals with the laboratory sessions. By working with this part of the application the student can prepare himself for the practical laboratories. All the experiments and calculations the student has to perform during the sessions, are explained, and all the required measuring equipment and their connections are also shown in detail. Figure 5 shows an example of a test the students have to perform during the corresponding laboratory sessions.

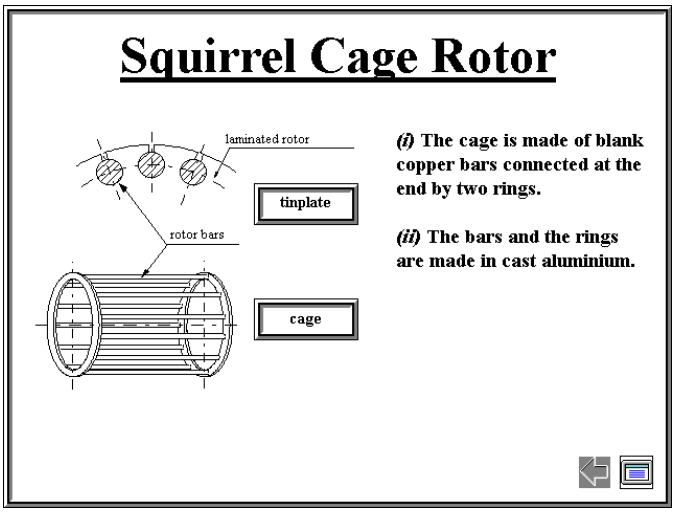

Fig. 4: *Example of a detailed image used in the mechanical construction part*

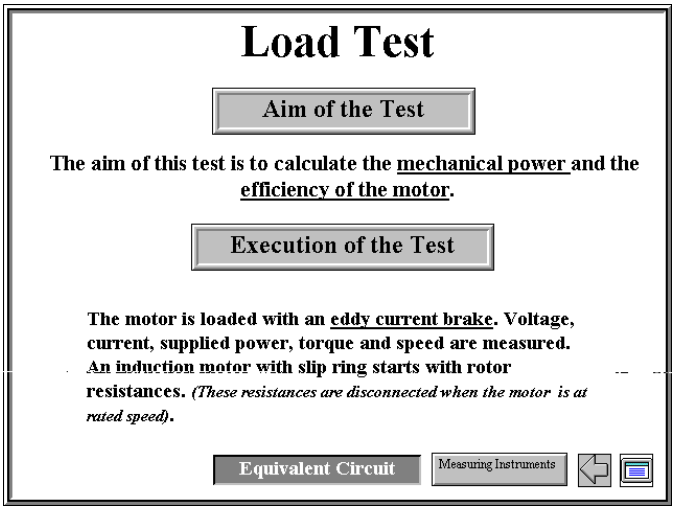

Fig. 5: *Example of a test the students have to perform*

Experiences and feedback

The above mentioned application of a multimedia session at the Katholieke Universiteit Leuven is prepared for undergraduates in the third year of their engineering studies. Since almost two years and a half we successfully used this technique in the education. It can be stated that multimedia in combination with conventional lectures gets the undergraduates more interested in the subject and improves the transfer of knowledge and the understanding of the phenomena. It is seen as a help in studying the course of electrical machines and variable speed drives.

Students have been asked to evaluate this project. In general the reactions were very positive. The students judged the application as very user-friendly. The animation's concerning the rotating field are found extremely enlightening. The fact that the application is available on the computers inside the laboratory. The application is also available on disks and therefore it can be used any time and place. This is seen as an improvement in teaching. Furthermore, many students posses their own PC, so the executables, eventually excluding sound can be used after the working hours and during the preparation of their examinations.

The vast interest of the students resulted in a schedule to develop additional applications in the field of power electronic drives, transformers and dc-machines.

CONCLUSIONS

In this paper an alternative and more efficient way to confront students with topics out of the field of the electrical machines and variable speed drives is described. To get the undergraduates more interested, a multimedia session has been developed to visualise phenomena in the squirrel cage induction machine. Also the complex mechanical construction of this type of machine is introduced to the students during the multimedia sessions. The possibility is given to prepare the laboratory session on induction machines in a more profound way by exploring the multimedia application. Additional multimedia applications in other topics of the electrical engineering education are strongly recommended by the undergraduates.

REFERENCES

1. Vaughan T., *Multimedia: making it work*. Berkeley: Osborne McGraw-Hill (1993).

2. Jennings R., *Werken met Windows 3.1 Multimedia.* Schoonhoven: Academies Service (1992).

3. The Math works Inc., *The Students Edition of MATLAB*. Englewood Cliffs: Prentice Hall (1992).

4. *IconAuthor User Manual for Windows.* Nashua: Aimtech Corporation (November 1992).

5. *IconAuthor Reference Manual for Windows*. Nashua: Aimtech Corporation (November 1992).

6. Matthijs K., *Gebruik van multimedia ter ondersteuning van de cursus inductiemachines*. Master Thesis at the Katholieke Universiteit of Leuven (1994).

7. Henning Edward, *Multimedia - animating your PC with sound and vision*. PC Magazine, 303-308 (October 1992).

8. Malfait A., Matthijs K., Reekmans R., Hameyer K., Belmans R*., Using multimedia in the field of electrical machines* Using Hypermedia for education in electricity utilisation-UIE & CBEE Leuven, België (27-28.04.95).

9. Olivié H., *Multimedia: meer dan een trend; een inleiding tot de studiedag* Van Cauterenleerstoel, Leuven, België (30-11-1994).