Using Multimedia in Variable Speed Drive Teaching

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Abstract

The paper provides ideas and practical experiences using multimedia at the electrical engineering department in the field of electrical machines and variable speed drives. Using multimedia developments, it is possible to confront 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 different authoring systems are presented. A practical example, visualisation of phenomena and construction of a squirrel cage induction machine, is looked at in a closer way. The conclusion is that the undergraduates get more interested 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 and computers are very popular these days. The written word loses a lot of importance. In this world of pictures one can hear often the word multimedia as a key development for the future. The questions asked before starting this project were:

what is multimedia?
can multimedia be used to confront students in a more attractive and efficient way with several topics of the course of Electrical Machines and Drives?

This paper provides ideas and practical experiences using multimedia at the electrical engineering department in the field of electrical machines and variable speed drives. It should be stressed that the group aimed at is quite large: all electrical, electronic and mechanical engineering students taking the basic course on general electricity, electrical machines and variable speed drives in the third year of the curriculum, i.e. approximately 200 students per year.

Multimedia - the technology

What is multimedia?

Multimedia is a topic of high interest in the academic world. A clear definition is not always available. However, two generally accepted definitions are used and both agree to the point that multimedia is a technology and not a product.

To satisfy the first definition of a multimedia application, it should have an interaction with the user. This is a very broad definition 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 and movies, as the user determines himself what kind of pictures and sound he is offered.

The second definition is completely different: "Multimedia is every combination of text, pictures, sound, animation and video". This definition can be specified as follows: "First of all 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.

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 and the user can navigate or surf freely between them.

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 only. This council publishes and maintains MPC-specifications. Because MPC is a standard, not a computer it is possible to compose a configuration with components from different suppliers making the overall system to conform with the standard. The MPC-standard refers to the computer as well as to peripheral equipment. The most important requirements are shown in table I.

Multimedia authoring systems

A multimedia authoring system supplies a frame to the project. To this frame the different elements like audio, video, text, images or animations are linked. The authoring system supplies the communication of, the links between and the working together of the media in 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 functions of a project. They usually contain the program parts with specific ability to manipulate the media (create, record, reproduce, data input, ...).

Every multimedia project has its own structure and its own needs. It is the art to choose the system that satisfies the most.

Every medium has to be framed to be consistent with the rest. The authoring system should have as many editing tools as possible to

TABLE 1. Overview of the minimum specifications of the 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	1 serial and 1 parallel	1 serial and 1 parallel
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 sound 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

handle each medium. This prevents the user from buying extra specialised software and avoids communication problems from the authoring system to the extra specialised software when integrating the data.

Authoring systems make it possible to keep track of the program structure while programming contributes to simple subtasks. This characteristic is indispensable when developing a large multimedia application. Often it is even possible to visualise the interactive elements. There are two ways of programming: visual programming with keywords and icons, using a program language specific for the authoring system mentioned at the one hand, or classical programming at the other hand. The first method is more direct. Here 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 concise formulation may be realised.

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

On the basis of the organisation method, one can divide authoring systems in three groups: page-based, time-based and icon-based authoring systems.

In a page-based authoring system, the elements of a multimedia application are organised as pages of a book. Designers gather all the elements of the same size and place them in logical sequences as pages of a book. This is done for all media. A page can contain a small script where commands are placed that have to be executed when the concerning page is selected. A special file co-ordinates the work. These are object oriented systems: the pages contain objects (text, buttons, images, backgrounds,...) together with directives for the further course.

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 speed of the sequence can be adjusted by the designer and the later user. Powerful time-based packages permit interaction. 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 views it. This is called visual programming. The designer builds the program structure and afterwards a content is given to the constituting bricks, the icons. These icons 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 major differences are in the field of user-friendliness.

For the multimedia application developed within the electrical engineering department an icon-based authoring system is chosen: IconAuthor. It is used for the realisation of interactive multimedia applications that combine text, images, animation, video and audio. It is well equipped for computer supported education and interactive presentations. There are several reasons for this choice. First of all IconAuthor is integrated in a Windows environment and this means that already existing PC-platforms can be used for the implementation avoiding problems especially if the developed system has to be delivered to students working at their own place away from the laboratory. Secondly, IconAuthor is chosen after a thorough market survey because the programming technique is very easy. 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 components:

Authoring system providing the direction of the media; programming passes according to a fixed pattern; once the structure of the multimedia application is clear, it can be built up with icons that are selected from the iconlibrary; each icon has a particular function;
- Graphics Editor used to create coloured images that are static or used in an animation;
- SmartObject Editor providing the lay-out of the program and the implementation of text and graphics drawn within the Graphics Editor;

IAScope being a help utility, making it possible to debug during interim simulations;

in the animation module IconAnimate the shooting script of the animation is made;
- VideoEditor making it possible to handle and see video fragments.

RezSolution being a graphical help enabling to adjust the resolution of the bitmap pictures to the hardware configuration used;

Resource Manager performing 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 permitting to reproduce a designed multimedia application on any computer without installing the full IconAuthor program (student homework).

Multimedia – a practical example

Multimedia and student study programs

The basic course on general electricity, electrical machines and variable speed drives consists of lectures, theoretical exercises and laboratory sessions. Often students study very profoundly their textbooks on General Electricity, Electrical Machines and Drives, while still having some difficulties to visualise important phenomena and ideas. The laboratory sessions may clarify a lot, but they also have some shortcomings. 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 practice. It will be demonstrated how multimedia techniques can assist to overcome these problems.

Example at the Electrical Engineering Department

With the use of a multimedia development, it is possible to confront the students in an alternative way with some difficult and basic topics in 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;
- laboratory session.

Visualisation of the rotating field

In the part of the visualisation of the rotating field, it is possible to see the behaviour of the rotating field in the ideal case, where the current distribution is continuous along the stator surface. Fig. 1 shows an instantaneous view of the animation of the rotating field in a circular way. Fig. 2 shows the linear representation.

The realistic case, where the current flows through conductors embedded in stator slots, is also examined. Fig. 3 shows an instantaneous view of the animation of the rotating field in a linear way.

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

Other student interactions are the answers to multiple choice questions where a correct answer has to be given before he can proceed with the session. At last, to make the rotating field even more comprehensive a piece of a digitised videotape is implemented. This part of a video gives an alternative presentation of the rota-

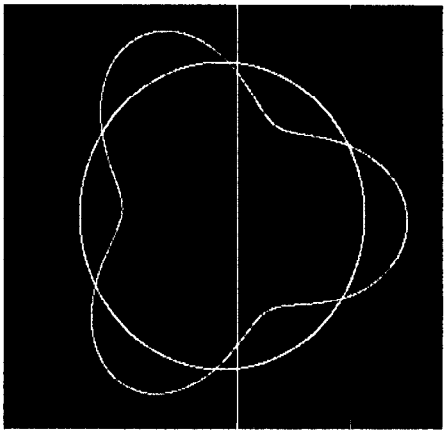

Fig. 1: Circular presentation of the animation of the rotating field with continuous current distribution at the stator surface. Number of pole pairs $p = 3$.

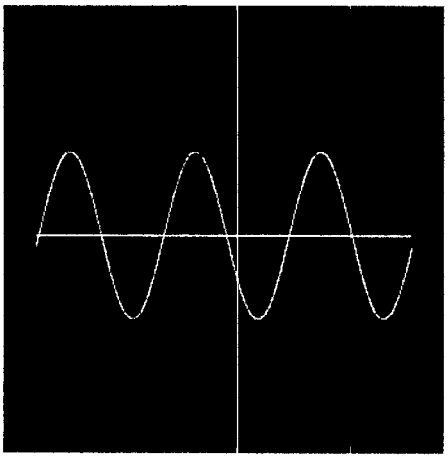

Fig. 2: Linear presentation of the animation of the rotating field with continuous current distribution at the stator surface. Number of pole pairs $p = 3$.

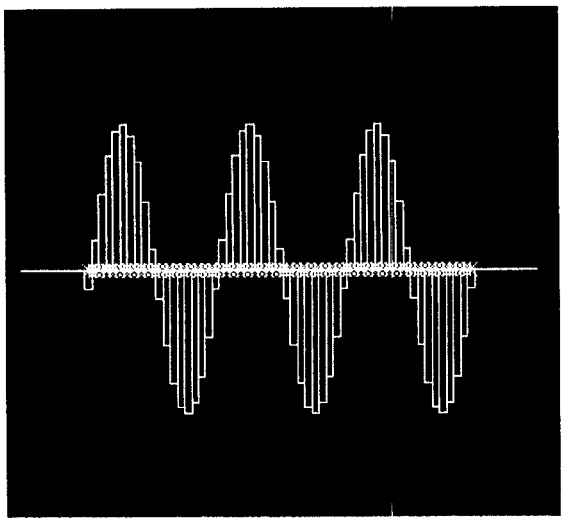

Fig. 3: Linear presentation of the animation of the rotating field with realistic current distribution in slots. Number of pole pairs $p = 3$, number of slots per pole and per phase, $q = 3$.

ting 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.

The same approach can 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 of 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 machine part. The student can even obtain 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 part inside the machine. Fig. 4 shows an example of a detailed view of the rotor of the squirrel cage induction machine

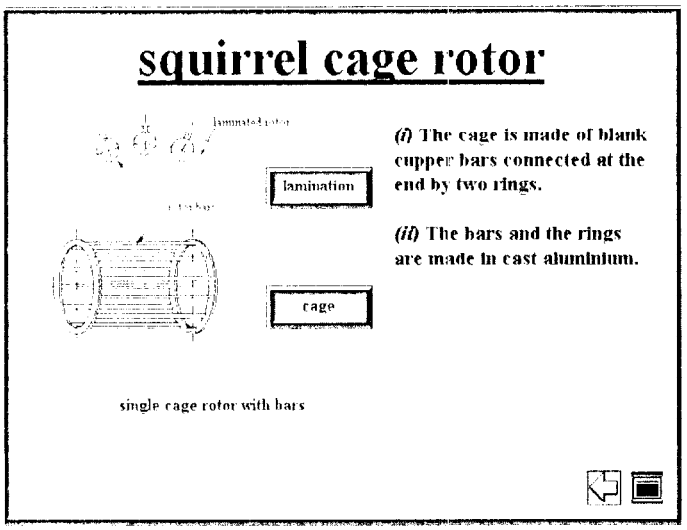

Fig. 4: Example of a detailed image used in the mechanical construction part

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

Laboratory sessions

The third part of the application deals with the laboratory sessions. By working with this part the student can prepare himself for the 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.

Experiences and feedback

The above mentioned application of a multimedia laboratory session at the Katholieke Universiteit Leuven is prepared for undergraduates in the third year of their engineering studies. Since almost one year and a half we successfully used this technique. 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.

Students have been asked to evaluate this project. In general the reactions were 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 and therefore it can be used any time and place is seen as an improvement in teaching. Furthermore, many students possess their own PC, so the executables, eventually excluding sound can be used after the working hours and during the preparation of the 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 in the field of 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. Additional multimedia applications in other topics of the electrical engineering education are strongly recommended by the undergraduates.

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