

DISCOVERY LEARNING APPROACH TO CLASSIC ELECTRICAL MACHINES PRINCIPLES

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Index: Courseware development and delivery

Abstract: This paper aims at presenting the concept of Socratic interactions and discovery learning of classic electrical machines principles. The theories of electrical machines are by nature quite boring and abstract although there are a lot of experiments supported the theories. Traditional, students learnt the subject by drill and practice approach with standard textbooks. In the past two decades, computer is no doubt recognized to be the educational tool. The so-called “interactive” approach is applied to the learning process. Most of this approach applied to various subjects in different levels is mainly based on drill and practice. However, few packages are developed for electrical machine subject. In this paper, two different approaches “Rote Learning” and “Discovery Learning” applied to the interactive computer aided learning package of classic electric machine principles are discussed. Design of a discovery learning approach will also be presented.

INTRODUCTION

In the last decade, considerably researchers and academics in the world drew significant attentions and contributions in the development of computer aided learning packages in various subjects of different level of studies. Both individual research papers and multi-million dollar funded projects generally address computer effectiveness in a particular situation; they set out to prove that this approach is “expedient”. In accordance with the educational psychology, there are two approaches applied to the interactive computer aided learning package, namely Rote Learning and Discovery Learning. These two approaches based on different learning process hierarchies are suitable for different level of subject matters. In this paper, these approaches will be discussed. Moreover, the design of this discovery learning approach for electrical machine principles is also presented.

INTERACTIVE APPROACH

1. Rote Learning Approach

Rote learning approach is a logical approach based on a behavioristic modeling theory of learning. The subject material will be broken down into facts, the relationship among the individual facts or elements can be organized hierarchically. That means the subject material is composed of local knowledge: one fact leads to another fact that exists higher in the logical structure.

The teaching methodology of the rote approach involves presenting students with exercises and reinforcing their responses. This kind of drill and practice approach is able to let students learn the topic from easier level to harder level of exercises, each building on the previous experience of the learners and leading finally to knowing the specific topic of information.

This kind of learning package can act as a psychologist and collect empirical data on learners’ behavior. Predictive performance models can be developed and tested on actual data. This in turn can

lead the design of the package that can better individualize the instructional path.

This rote approach is also called “drill-practice” approach has great appeal to primary and junior school levels with large populations of students who are not performing at grade level and need remedy. This approach has been proven to be successful in mathematics, reading skills and language arts.

The rote learning approach to education has strong support in educational practice. It also plays on the popular hopes that the learning packages can teach skills with which teachers have been unsuccessful, to populations with which school systems have been unsuccessful. In the rote learning approach, the computers are treated as intelligent, sympathetic instructors.

2. Discovery Learning Approach

Discovery learning approach is another learning approach differing from the rote learning approach in some subjects in which rote learning styles of teaching were not conducive to real learning. Basically, discovery learning approach is a pragmatic rather than a logical prism, so the mechanism of learning is seen as discovery.

The feature of the discovery learning approach is to set out to embed the learning environment, change the traditional classroom atmosphere and the dominant teaching style. The new learning environment is called “Scenario”. A real environment would be simulated in the learning package to let learners explore by themselves. In case they need any help or computational tool, there are some guides and tools available for them. The learners best learn informally and through discovering for themselves. Psychologically, this theory received support from most of educational researchers in the world. This approach is able to understand the learners’ thinking and provided a context for apprehending their thinking models by artificial intelligence method. The cognitive sciences, using computational metaphors and techniques, have provided further insights into mathematical thinking and ways of talking about learners’ misconceptions. Electrical machines would be one of the subjects good for this learning approach. In this approach, graphics and visual representations play a great important role to stimulate the learner to discover and explore.

DESIGN OF DISCOVERY LEARNING APPROACH FOR ELECTRICAL MACHINES

A computer aided learning package has been developed to teach the subject of electrical machines for Higher Diploma level at Hong Kong Institute of Vocational Education. In the pilot stage, the three-phase induction motor would be taught by this package. This package is to support the normal classroom teaching and to let students learn by discovery of the real environments. The concept of the discovery learning approach is adopted in the package.

There are four main parts of the package.

1. Basic knowledge of three-phase induction motor.
2. Experiments.
3. Assessment.
4. Analysis and Result.

The flowchart of the package is shown in Fig. 1.

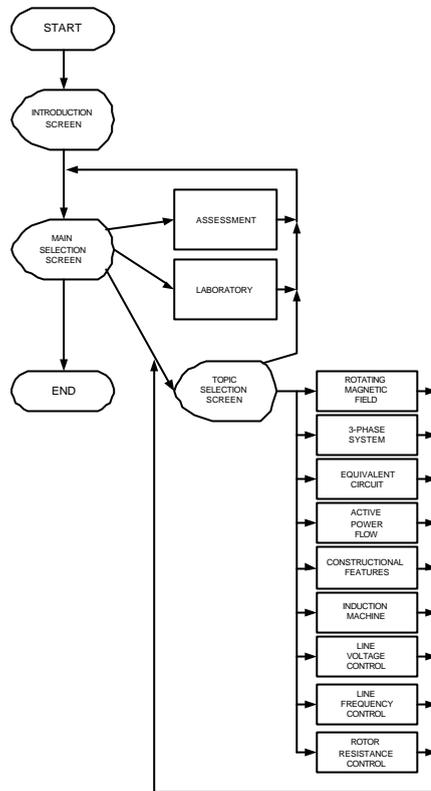


Fig. 1: Flowchart of the Package

This educational software has 9 sessions for the basic knowledge of three-phase induction motor. In this paper, focus will be mainly put on the topics which students found difficult to understand. There are:

- Rotating Magnetic Field
- Line Frequency, Voltage and Rotor Resistance Control
- Active Power Flow

Rotating Magnetic Field

The aim of this session is to let users know what the rotating magnetic field is and how to make the rotor to rotate.

In this session, it is divided in 2 parts.

The first part is for basic learning, the second part is for detail study. For the first part, a two-pole induction motor is used to demonstrate the relation between the rotor, stator and loading. Users can adjust the loads by pressing the “load” buttons to visualise the changes in slip and speed when different loading is applied.

Fig.2 shows the rotation of the rotor.



Fig. 2: Rotating Field

In the second part, it is to focus more detail information of the rotating magnetic field.

Fig.3 shows the sinusoidal waves and the vector diagram represent the relationship between the instantaneous three-phase currents and the magnetic flux as time varies. Observing the “moving ball” shows the idea through the animation by observing the “moving ball”.

In addition, users can view the movement of the rotating magnetic field that is shown in Fig.4.

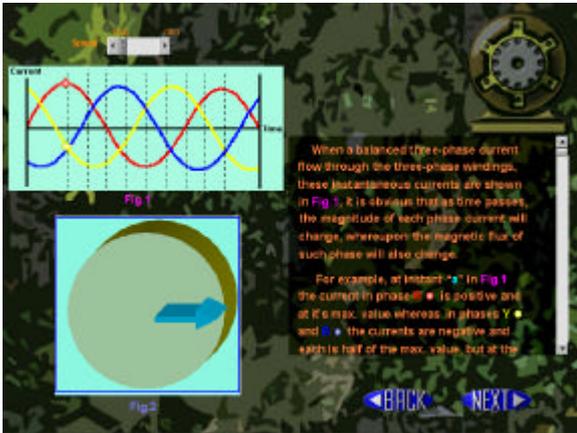


Fig. 3: Time and space movement

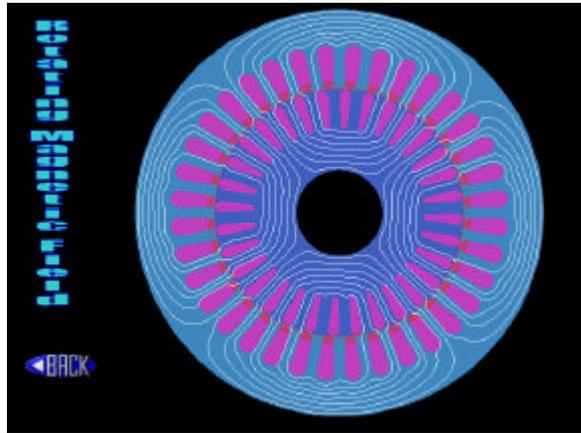


Fig. 4: Flux movement

Line Frequency, Voltage and Rotor Resistance Control

The aim of this topic is illustrate the effect of frequency change to torque-speed characteristics in changing frequency.

In Figs.5-7, diagrams with three buttons which are used to control the torque-speed characteristics when frequency is changed.

The frequency is input by the users.

“Calculate” button is used to plotted the torque-speed curve of the input frequency.

When the “Frequency Change” button is pressed, the movement of the torque-speed curve is shown in the diagram with increasing frequency that can let users understand the concept by this interactive learning software package.

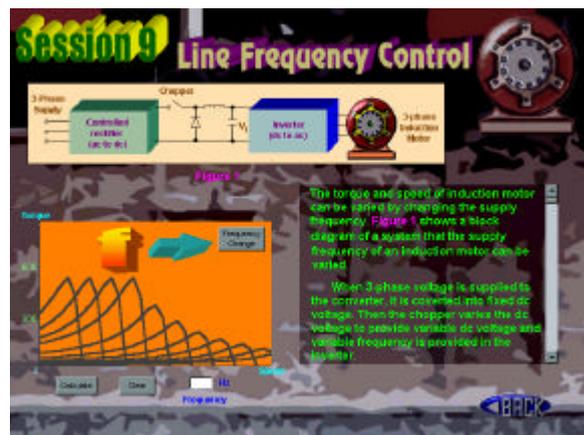


Fig.5: Line Frequency Control

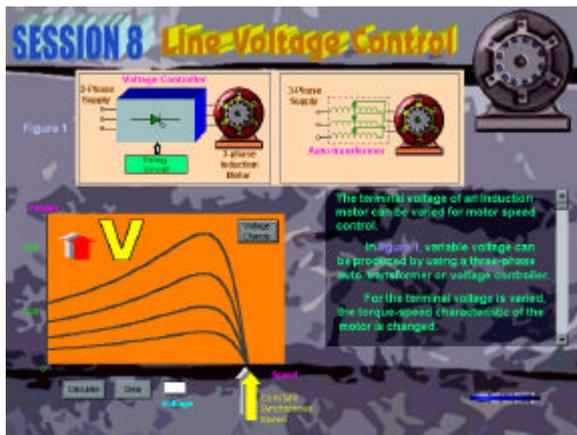


Fig.6: Line Voltage Control

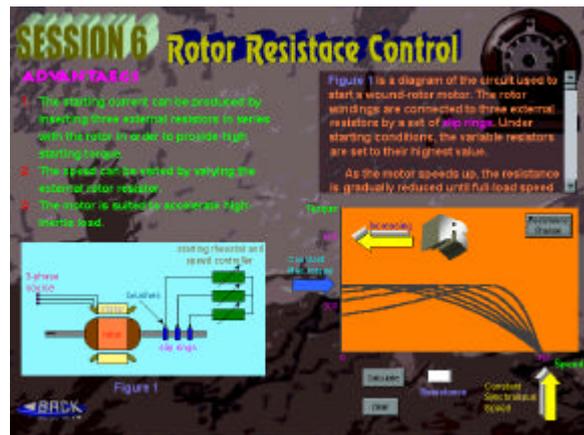


Fig.7: Rotor Resistance Control

Active Power Flow

The aim of this topic is to let users understand the power flow inside the motor when it is in normal operating condition.

In Fig.8, a switch button which is used to turn on the motor and when the motor is rotating, the arrows are shown gradually to represent the power flow inside the motor, including the iron, copper losses and frictional losses.



Fig.8: Active Power Flow

Laboratory

There are three major laboratories to let users explore the safety, wire connection and trouble shooting concepts.

In the first laboratory, a set of guides is ready for users to complete the laboratory. For example, when the users connect the Ammeter and the Voltmeter to the circuit, they have to make sure that the meters are connected in the proper connection, otherwise users will be warned by a “beep” sound. Besides, interchange of wires is not allowed.

After the circuit is connected, users can switch on the power supply, which in turn energize the motor, and hence they can adjust the resistance of the rotor starter and the slip value of the motor. Moreover, when we want to connect the wire, we should double click the terminal, at which we want to start the wiring, and then move the pointer to the other terminal, which is proposed to be the end of the wiring, and click it once.

In addition, the users cannot switch the power supply on, before the circuit is connected since this is

very dangerous in real case. On the other hand, removal of any wires from the circuit is prohibited, while the switch is ON.

The torque-speed and current-speed characteristics can be visualized when the switch is on. The curves will be changed simultaneously when the loading or external resistance is adjusted.

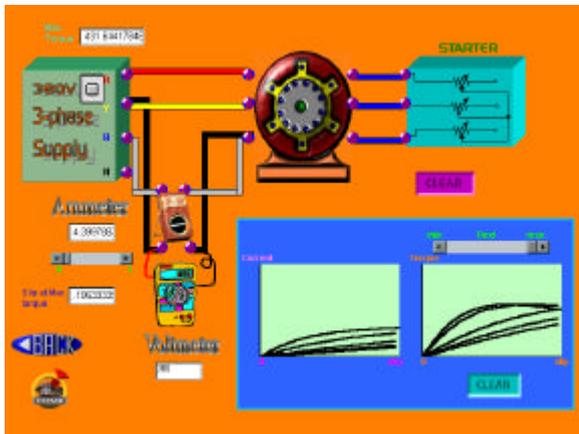


Fig 9: Laboratory 1

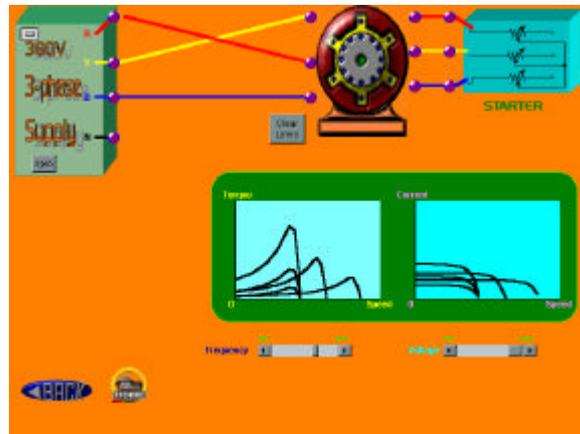


Fig 10: Laboratory 2

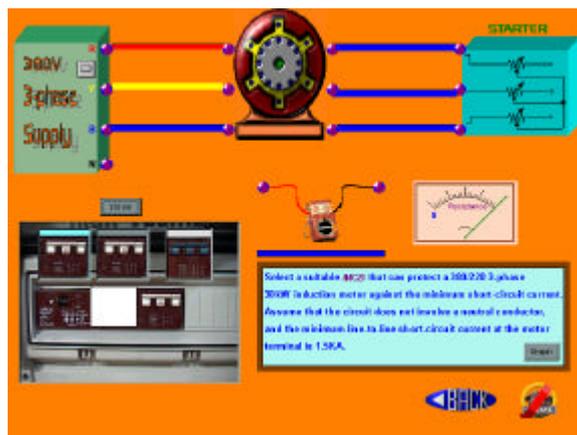


Fig. 11: Laboratory 3

CONCLUSION

With the discovery learning approach, the package has demonstrated the teaching of some classic theory in an interactive and discovery ways. A real environment would be simulated in the learning package to let the learners explore by themselves. In this approach, graphics, and visual representation play a great important role to stimulate the learner to discover and explore. It package is in use in the teaching of electrical machines in the Higher Diploma courses.

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