INTEGRATED ODL ENVIRONMENTS WITH LABORATORIES

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Abstract *¾ A method and a system are presented that constitute an* Integrated Open Distant Learning (ODL) Environment. *Technologies that allow laboratory exercises to be performed between a team of two students where one is local and one is remote, through the Integrated ODL environment, are presented. A registration and position reservation system, for the limited laboratory sessions, for the local and remote students, is implemented with a* Scheduler. Hyperlinked Guided Environment *for executing a Laboratory exercise including steps such as* Design & Simulate, Experiment, Data Collection, *and* Results *are taking place. Conclusions are drawn on the effectiveness of the method and system.*

Index Terms ¾ Remote Laboratories, Integrated ODL Environment, Teleconferencing, Application Sharing.

INTRODUCTION

Open Distant Learning (ODL) methods can be applied for learning different subjects but it is not easy to be applied to teach laboratory classes remotely especially on technological subjects. Laboratory classes are meant for acquiring practical experience, so called “Hands On”, or “Learning by Doing”. The trainee should be physically located in the laboratory area to learn to use the equipment, make connections, and take measurements correctly. Technological advances though have reached the point that technical laboratories can be taught remotely.

An ODL system needs to have different organization and operation than that of conventional schools [4]. Different approaches have been followed to achieve remote control of different experiments in laboratories. A remote Measurement laboratory [11] provides remote access to instrumentation. An experimental environment for teaching, through the Internet, Advanced Control Techniques, is presented in [5]. Controlling remote systems on the Web are presented in [6]. A low cost Internet telerobotic system [12] gives access to remote experiments. In the Practical Experimentation by Accessible Remote Learning (PEARL) EU project, presented in [13], a system was designed and implemented with special features to also support people with disabilities. Timing and synchronization constrains are discussed at [10]. Distributed online laboratories, are presented in [7]. Different ideas and solutions for performing laboratory experiments over the Internet are presented at [9]. There exist also cases where the laboratory is virtual [8], where if designed well, it cannot be differentiated from actual laboratory, by a remote learner.

At the department of Electronics of the Technological Educational Institute (TEI) of Crete we follow a little different approach. We have performed the experiment of teaching technical laboratories to students who work in teams of two, where one student is physically located in the laboratory and the other is remote. This way, the remote student will not only be remotely controlling an experiment, but will also have human interaction with a partner located in the laboratory.

In the next section, a method and a system are presented that constitute an Integrated Open Distant Learning (ODL) Environment. The technologies that allow laboratory exercises to be performed between the team of two students are presented. In the following section, a registration and position reservation system, for the local and remote students, is implemented with a Scheduler. In the section after that, a Hyperlinked Guided Environment for executing a Laboratory exercise including steps such as Design & Simulate, Experiment, Data Collection, and Results is demonstrated. In the last section, conclusions are drawn on the effectiveness of the method and system.

AN INTEGRATED ODL ENVIRONMENT

Lately, there exist many organizations that produce educational material for teaching laboratories, with the use of a personal computer. The material consists of one or more experimental boards with one or more different experiments on it and they can interface with a PC. The Internet boom has brought the development of Internet assisted experimental environments as well as software tools for application sharing. In addition, there is the option of web conference, phone/camera connection, so the collaborator can be seen and heard.

The students work in teams of two where one student is physically located in the laboratory and the other is remote. The local student’s PC in the laboratory is

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connected to the experimental board and it's running the software for the experiment. Remote collaboration techniques were used. Figure 1 shows the setup required. The remote student can see the same screens as the student in the lab and can interact with keyboard and mouse controls. Commercial products such as PC Remote [1], PC Anywhere [2] and NetMeeting work that way and can be used to share the applications running at the local PC, to the remote PC.

The local student sets up the experimental board, and makes all the necessary connections. These connections are also shown on a diagram on the remote student's screen as they happen. A camera still picture can clarify things for the remote student. The public Internet, with its high traffic, is still unable to transfer real time moving picture between the members of the team. The voice also transfers with small noise but the team can communicate properly. The students can also exchange ideas by sending files and writing memos through "talk".

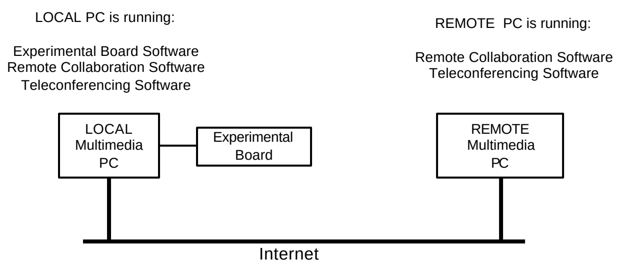


FIGURE 1
METHODOLOGY – LOCAL AND REMOTE.

Sometimes remote collaboration techniques can experience critical communication delays (since they transmit the pictures) and for time sensitive experiments that are performed interactively can be proved to be catastrophic. Remote control techniques of computer hardware interfaces developed at Boston University [3] could be applied, and solve the problem.

Access to the integrated learning environment is achieved through the University Network. The library can be considered to be the learning center of such a system. Currently at TEI of Crete we are working on implementing the infrastructure of such a learning environment. The proposed system is shown in figure 2.

Access for the remote users is provided through the Internet. There exists a Gateway to the Integrated ODL Environment. Through the Gateway, (a) educators can place or update the material, (b) system operators can supervise the operation of the system and (c) learners can access the environment and the material. The library's Web Server can give information and links about the Integrated ODL Environment.

A Scheduler is responsible for the registration of learners to the offered ODL courses. It keeps track of the size of each available section and the openings available at any moment. Its existence is very important for the successful application of the Integrated ODL environment and especially for teaching laboratories. The laboratories require interaction of the remote learner, the local learner (who together constitute one laboratory team) and the educator, where good coordination is needed.

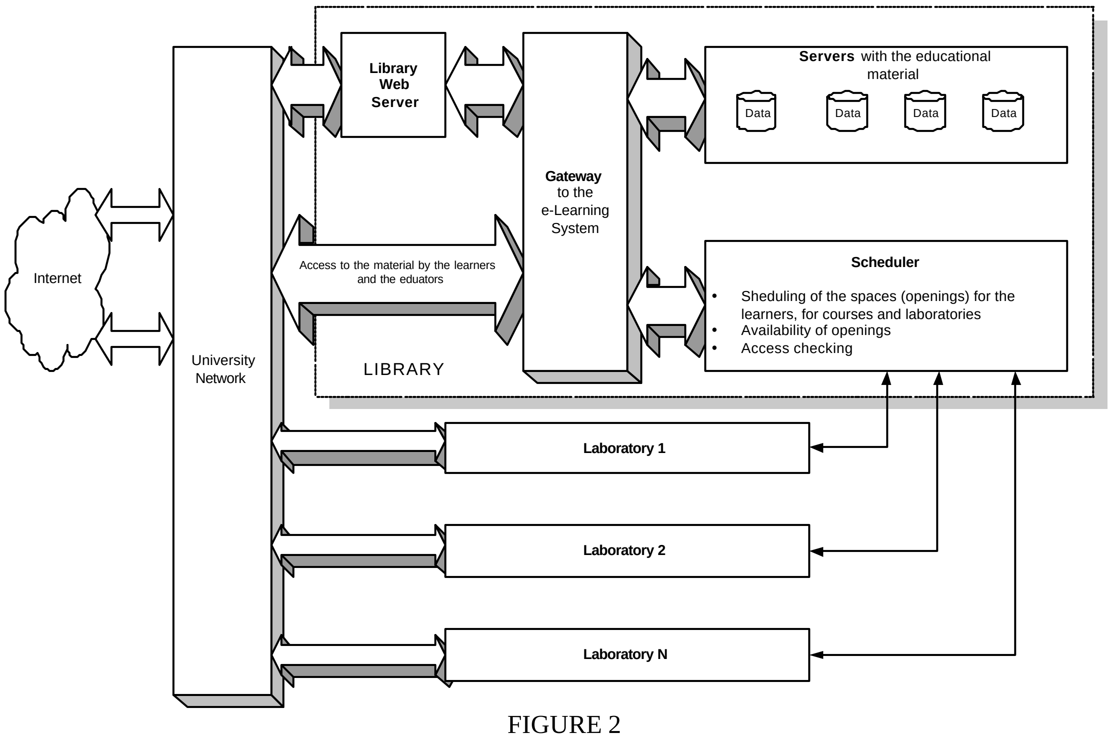


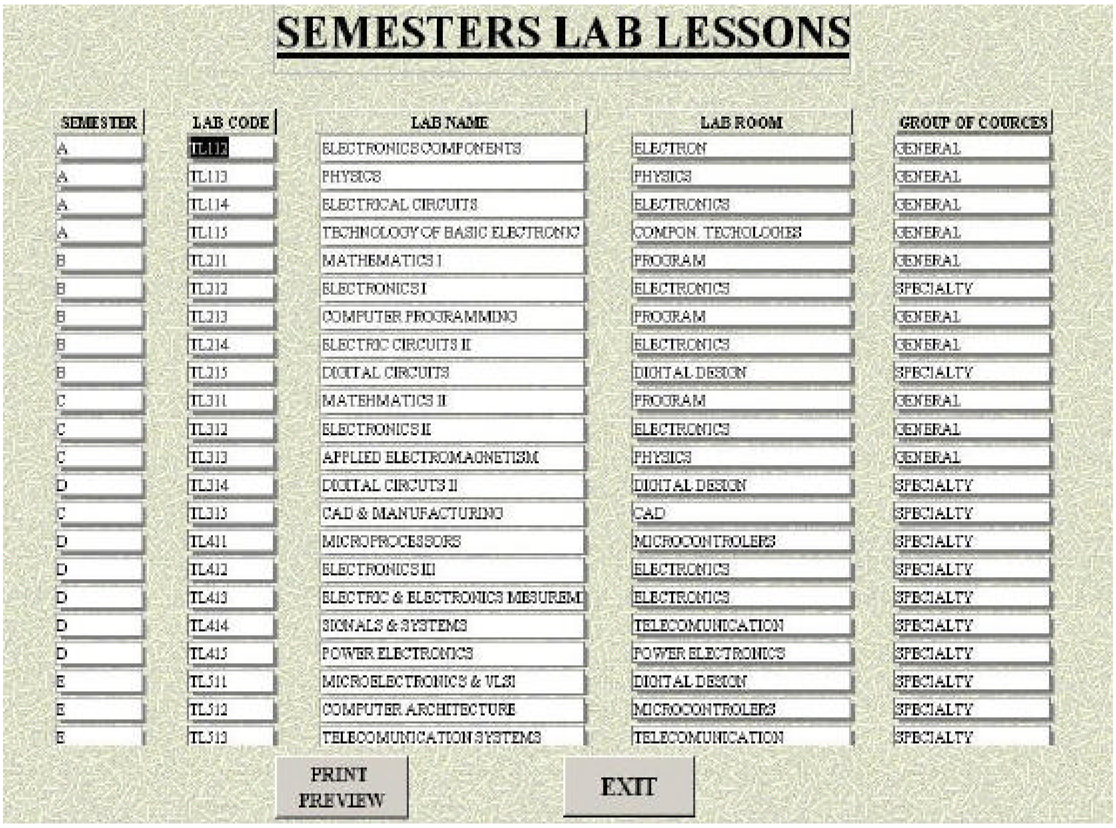
FIGURE 2
INTEGRATED ODL ENVIRONMENT.

Laboratories are equipped with special application boards that have interface with the PC. The local and remote users are operating the board. If the software accompanying the boards, has incorporated the remote control of computer hardware interfaces technique, then the remote user can also operate the board without high bandwidth communication requirements.

Various platforms were used for performing laboratories remotely on different subjects in order to validate the method. *COM3LAB* by Leybold Didactic (www.leybold-didactic.com) was used for Electronics Components, Digital Technology, Power Electronics and Transmitting/Receiving Technology. *S90NT* by Didacta Italia (www.didacta.it) was used for Analog and Digital Electronics. *ROBOLAB* by Lego (www.lego.com/dacta/robolab) was used for teaching entry level Robotics Laboratory. *IDE* (Integrated Development Environment) and *ICS In Circuit Simulator)* by P&E Microcomputer Systems (www.pemicro.com) were used for Microprocessors. *LabVIEW* and *LabVIEW RT* by National Instruments (www.natinst.com/labviewrt) was used for Real Time Data Acquisition and Control. *Edibon Teaching Equipment* (edibon@retemail.es) was used for Analog and Digital Communications as well as for Energy Systems. *MSK 2100, Mechatronical System Concept* by SL-Automatisierungstechnik (www.slhome.com) was used for mechatronics.

THE SCHEDULER

The Scheduler is currently implemented on Microsoft Access Database keeping all information on availability of courses and laboratory sections. After the student logs on to the system, the list of courses can be viewed as well as the laboratory courses. Figure 3 shows the Laboratory classes offered. The *Lab Name*, the *Lab Code*, the *Semester*, and the *Group of Courses* (type of course) that the course belongs to, as well as the *Lab Room* can viewed, to help the student decide which classes will he register for the coming semester. Then the student can register and reserve sitting for one laboratory class. All the laboratory groups for each laboratory class can be viewed and the student can reserve a sitting (place), specified by the lab pc name, that the student will work on. As it was mention above, each lab workgroup (team) consists of two students, one local and one remote.



SEMESTERS LAB LESSONS

SEMESTER	LAB CODE	LAB NAME	LAB ROOM	GROUP OF COURCES
A	TL112	ELECTRONICS COMPONENTS	ELECTRON	GENERAL
A	TL113	PHYSICS	PHYSICS	GENERAL
A	TL114	ELECTRICAL CIRCUITS	ELECTRONICS	GENERAL
A	TL115	TECHNOLOGY OF BASIC ELECTRONIC	COMPON. TECHOLOGIES	GENERAL
B	TL211	MATHEMATICS I	PROGRAM	GENERAL
B	TL212	ELECTRONICS I	ELECTRONICS	SPECIALTY
B	TL213	COMPUTER PROGRAMMING	PROGRAM	GENERAL
B	TL214	ELECTRIC CIRCUITS II	ELECTRONICS	GENERAL
B	TL215	DIGITAL CIRCUITS	DIGITAL DESIGN	SPECIALTY
C	TL311	MATEHMATICS II	PROGRAM	GENERAL
C	TL312	ELECTRONICS II	ELECTRONICS	GENERAL
C	TL313	APPLIED ELECTROMAGNETISM	PHYSICS	GENERAL
D	TL314	DIGITAL CIRCUITS II	DIGITAL DESIGN	SPECIALTY
C	TL315	CAD & MANUFACTURING	CAD	SPECIALTY
D	TL411	MICROPROCESSORS	MICROCONTROLERS	SPECIALTY
D	TL412	ELECTRONICS III	ELECTRONICS	SPECIALTY
D	TL413	ELECTRIC & ELECTRONICS MESUREM	ELECTRONICS	SPECIALTY
D	TL414	SIGNALS & SYSTEMS	TELECOMMUNICATION	SPECIALTY
D	TL415	POWER ELECTRONICS	POWER ELECTRONICS	SPECIALTY
E	TL511	MICROELECTRONICS & VLSI	DIGITAL DESIGN	SPECIALTY
E	TL512	COMPUTER ARCHITECTURE	MICROCONTROLERS	SPECIALTY
E	TL513	TELECOMUNICATION SYSTEMS	TELECOMUNICATION	SPECIALTY

PRINT PREVIEW | EXIT

FIGURE 3
VIEW THE LABORATORY COURSES OFFERED THROUGH THE SCHEDULER.

This way a student can choose his distant partner. Figure 4, has four windows that show information about the laboratory class and room, the different groups (sections) and the respective times that somebody could attend, the sitting places and the names of the students already registered. As the student fills in the bottom right window, the information on the other 3 windows changes accordingly.

The student can view the list of the all exercises included in the laboratory class that has to perform during the semester. The Laboratory number and name, a short description, and the date to be performed can be viewed, while there are hyperlinks that lead to the full description and way of execution of the exercise, which is downloadable. Figure 5 shows the exercise list screen.

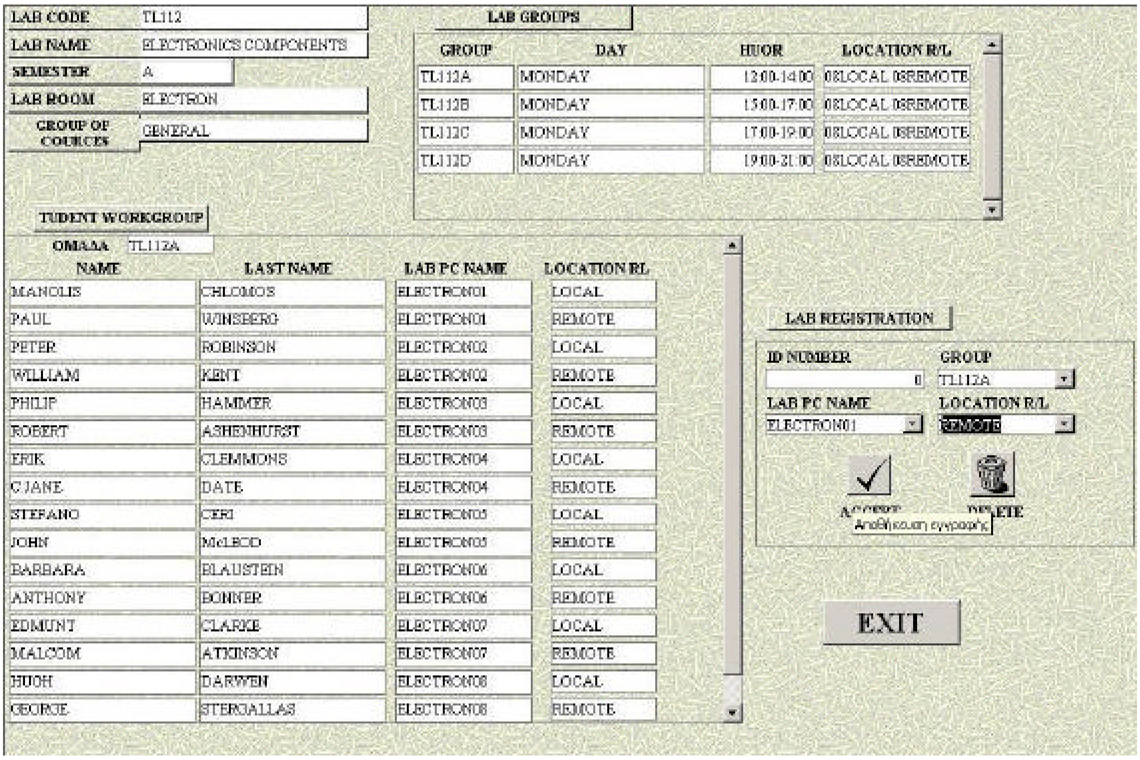


FIGURE 4
LAB GROUP (SECTION) REGISTRATION.

HYPERLINKED GUIDED ENVIRONMENT FOR EXECUTING A LABORATORY EXERCISE

To perform the exercise several parts need to take place. An Hyperlinked Guided Environment is created that helps guide the student through the different work parts. The hyperlinked environment is implemented around the Microsoft Power Point software. A screen precedes with the description of the experiment. Figure 6 shows a description for a diode experiment. Another screen, figure 7, shows all the work parts that will take place and the hyperlinks to the different software packages used for each part

The *Design* hyperlink on figure 7 will call the first program which is a CAD/CAM application called "PROTEL". With this program the schematic circuits in-use are already drawn, and it is very simple for the student to understand it and make some changes quickly. Simulations can take place on the design.

The *Experiment* hyperlink on figure 7 will call another program such as Labview from National Instruments. This program is accompanied by an interface card installed inthe Laboratory PC, and an external board where the electronic components will be connected. This way analog signals will be allowed to come into the PC. In this diode exercise, currents and voltages are measured. The experiment would have already been designed by the educators on the LabView tools. The local student will make the connections on the external board.

The *Data Collection* hyperlink on figure 7 will call the next program which is the Microsoft Excel Spreadsheet, the measurements are imported and some graphs can be drawn.

FIGURE 5
EXERCISE LIST FOR A LABORATORY CLASS.

The *Result* hyperlink on figure 7 will call the next program which will open the Datasheet of that diode component so the experimental results measured can be compared with the specifications from the manufacturer.

The *Help* hyperlink on figure 7 will call a MicroSoft Word Document that explains the usage of the different software packages.

EVALUATION OF THE METHOD

Evaluation of the above described educational method and system showed that the level of training of the remote student is almost as good as the level of training of the local student. The duration of the laboratory exercise though, needs to be a bit longer to counterpart for the physical separation of the team members and the extra time needed for communication. Some experimental boards' software could run in simulation mode without the presence of the experimental board. When the remote and local students were given the experimental board's software to run it at their home PCs in simulation mode, they were better prepared and the performance of the actual experiment took less time. This is true when the public Internet can offer a minimum Quality of Service (QoS above a minimum threshold, which may vary depending on the requirements.

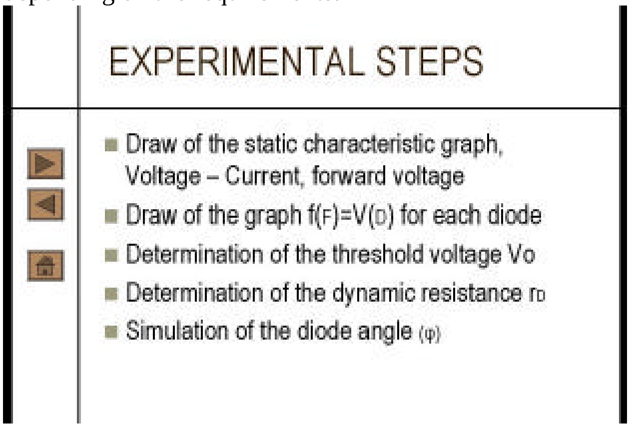


FIGURE 6
DESCRIPTION OF THE EXPERIMENT.

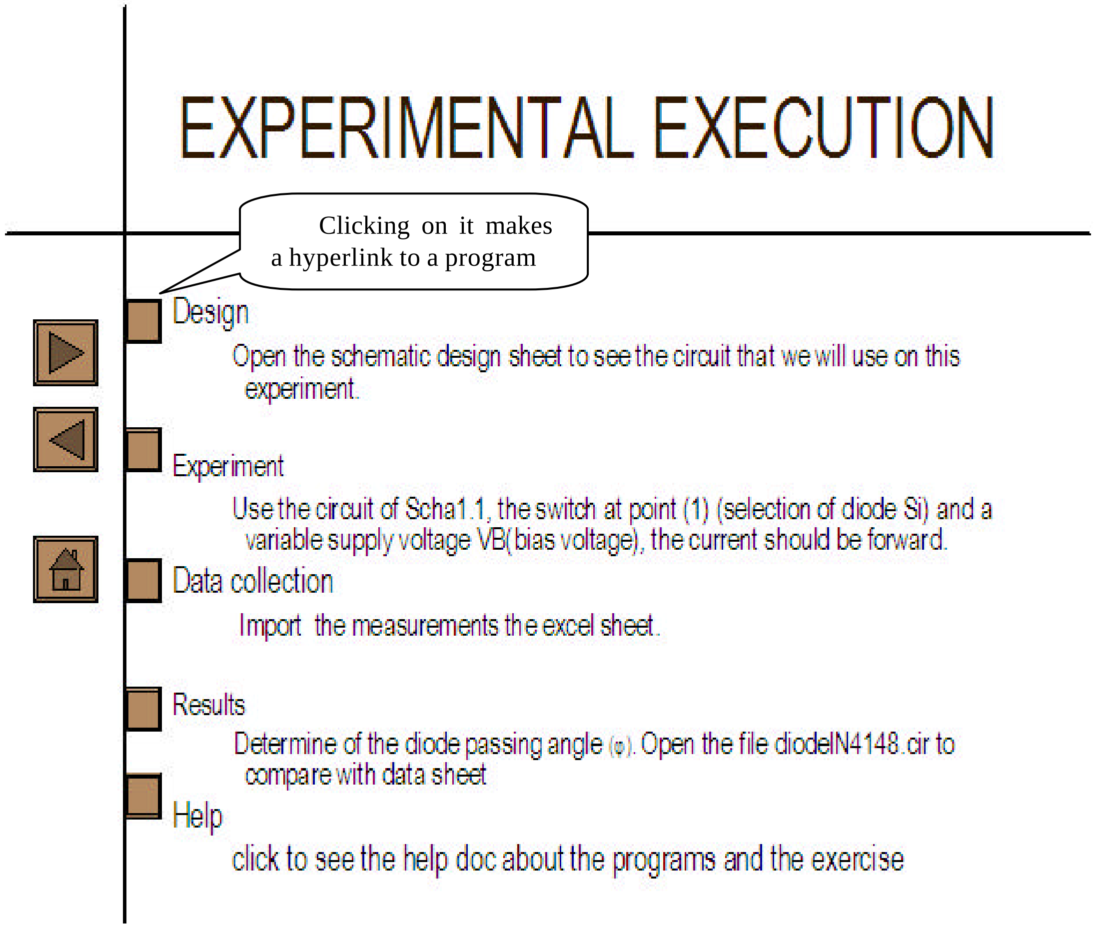


FIGURE 7
EXPERIMENT WORK PARTS

Otherwise the remote student cannot follow, gets frustrated and is unable to perform the experiment. When the Internet Connection was 128 Kbps which could be achieved by Basic Rate ISDN (BRI) lines the QoS was more than satisfactory.

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