Final Term Projects in Electrical Engineering: Partnership with Industry to Prepare Future Engineers.

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Abstract*: One of the main problems faced by engineering schools nowadays is how to prepare an engineer for a fast changing market. To transform the students into versatile, competitive and qualified professionals, the distance between School and Enterprise must be shortened, and partnership with industry is a successful way that can be used for this. Based on FEI's tradition of partnerships with leading companies and industries, several new contracts are established every year and others are renewed.*
As a practical result of the partnerships, several joint projects, with private enterprise, were developed in the 1998 academic year. Among these are final term projects, developed by teams of students working in a real industry problem. This paper describes some of this projects, which includes: a Virtual Robotics Laboratory, supported by Microsoft and Bay Networks; an Intranet/Internet based Supervisory Control and Data Acquisition System, that employs software and equipment provided by GE-Fanuc; and an Access Control System for the university campus, which relies on a partnership with Oracle Corporation. The last project described is the Automatic Car License Recognition System, done with support from Microsoft and local companies, a good example of academic knowledge applied in an industrial problem.
Final term projects in partnership with, or sponsored by, private enterprise have greatly benefited both students and industry in reaching their goals.

Keywords: *university-industry joint programs, practice-based engineering education, final-term projects.*

1 Introduction

One of the main problems faced by engineering schools nowadays is how to prepare an engineer for a fast changing market. To transform the students into versatile, competitive and qualified professionals, the distance between School and Enterprise must be shortened, and partnership with industry is a successful way that can be used for this.

Based on FEI's tradition of partnerships with leading companies and industry [1], several new contracts are established every year and others are renewed. Among these: Motorola, Altera, Microsoft, Bay Networks, Novell, Oracle and HP companies could be mentioned.

As a practical result of the partnerships, several joint projects, with private enterprise, were developed in the 1998 academic year. Among these are final term projects, developed by teams of students working in a real industry problem.

More than 30 final-term projects were developed in the 1998 academic year. The great majority was done in collaboration with local industries or with the support of large corporations. Of these projects, some were of outstanding quality, and are described in the next sections.

2 A Virtual Robotics Lab

The World Wide Web allows students from remote areas to interact with teachers, other students and experimental instrumentation anywhere in the world, enlarging educational frontiers.

The main goal of this project is to allow students to work with a robotic manipulator from a remote site, enabling members of distant communities to access remote equipment to perform real experiments. To achieve this target, a communication and control system that use the World Wide Web as an interface was developed.

The system is based on two computers, one acting as a web server (receiving the requests from the student, translating the messages to commands that can be executed by the robot and controlling the robot execution) and a second one, equipped with a video conference system, enabling the student to see what is being executed by the robot, in real time, and exchanging information with an instructor at school. This way, the student can receive the whole course through the WWW, without loosing interaction capability, such as asking questions and getting an expert assistance to solve problems.

The project was developed under a partnership with Microsoft, which allows free access to the software tools needed, such as Microsoft Internet Information Server as its Web Server and Visual C++ to build CGI Scripts and servlets that receives students data and controls the robot. The video conference system was developed in Java, to allow students, with common Internet access but without videoconference equipment, to access the site. The site pages were developed with FrontPage 98 HTML editor.

After the final tests will be concluded, the project will be used at FEI not only in distance learning activities, but also in videoconference, streaming, voice- mail and remote control applications.

3. Internet Based Supervisory System

This project developed an Intranet/Internet based Supervisory Control and Data Acquisition System employing software and equipment provided by GE-Fanuc and Microsoft. The main goal was to integrate a Supervisory Control System with an Internet/Intranet based network, enabling the control of automated processes in real time using a WWW Browser.

The main advantages of this integration are the low cost of LAN based networks, the easy system upgrade and expansion, possibility of remote diagnosis and a friendly user interface.

The system has three basic modules: a Supervisory Server, based on GE-Fanuc “Cimplicity” software; a WWW server running Microsoft Windows NT and Internet Information Server, where the HTML interface to the "Cimplicity" System is located; and a CLP that is controlled. All computers and the CLP are connected using an Ethernet LAN.

4. Access Control System

Because of the recent increase in violence in large metropolitan centers, most industries and commercial centers are implementing security measures. The goal of this project was to implement an access control system at FEI campus, to protect students, staff and facilities.

Based on a Client-Server model, the system is composed of one server station where an information database is located, and several client stations, to be placed at the campus main access points. All stations will be connected through the institution local area network.

The server station was developed using Microsoft Windows NT and Oracle database tools. It is responsible for maintaining the access information of all the users and granting (or denying) accesses authorization.

At the client side of the project are several IBM-PC stations with barcode readers. In this stations the user identification card is scanned and an authorization is requested to the server. At this moment, a message is sent to the server, which consult its database to check the user information. If the ID card is valid and the user has access to the requested area, a message is sent to the client approving the user requisition to enter the campus.

The students developed a testbed using Microsoft Visual Basic and Visual C++ tools and its implementation on the campus is currently under discussion at administrative level.

5. Security System Based on Signature Recognition

Another security related project is the Security System Based on Signature Recognition, which is being developed with the help of Microsoft and Microsoft Resellers. This software is responsible for access authorization on a Windows NT 4.0 network, relying on *on-line* signature recognition technology to check if the user, trying to log, on is registered. The software, called “Alcatraz”, adds security to the netlogon procedure used by Microsoft NT, which is based on simple password check. As the system analyzes the user’s signature, it can detect non-authorized login attempts of any person who has found a user’s password, but cannot reproduce the user’s signature.

The signatures are obtained through a mouse tablet [2] (figure 1), a device that consists of a pressures sensitive surface, which grabs data as pressure and position of a pen at dynamically and is connected to the computer using a serial port. Due to the simple installation process and the low cost of the equipment, the project is being analyzed as having a strong market potentiality.

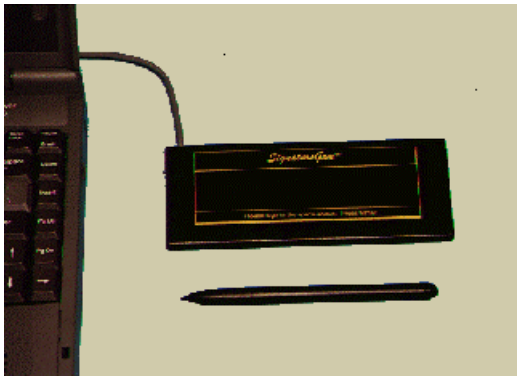

Figure 1: The Mouse tablet used.

6. The Automatic Car License Recognition System

The fast and constant evolution of the technology has been generating new possibilities of use of the techniques of Artificial Intelligence in several sections of the society. Particularly, in the area of Pattern Recognition, new applications appeared in several fields. The last project is the Automatic Car License Recognition System, which based on a single car image to determine its license number. It is being developed in partnership with a large shopping mall administration in São Paulo. The goal of the project is to generate a database with the number of the licenses of all the cars that enter a large commercial building, for security reasons. The software, however, can also be used for automatic ticket entrance and fine, automatic tooling and other similar applications.

The system is based on Computer Vision algorithms to find the car license in an image and on Optical Character Recognition (OCR) techniques to determine the letters and numbers of a car license, from images captured by a frame grabber board for a PC computer.

The system has 6 basic modules (figure 2):

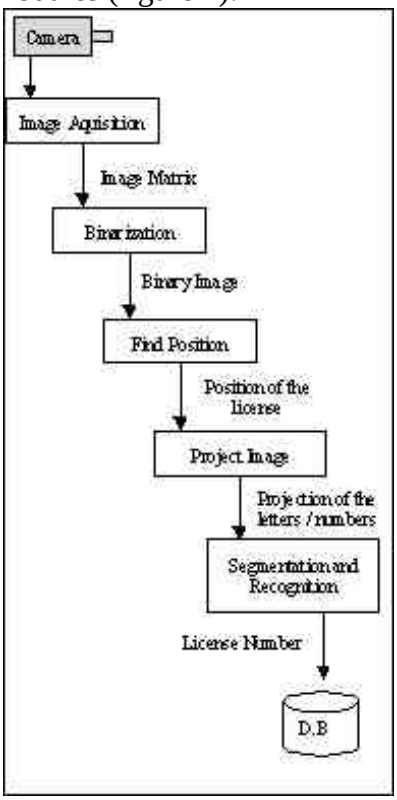

Figure 2: basic outline of the system.

The image acquisition is done with a camera fixed in a position where it focus on the front part of the car, where the license is. The program can captures the images continuously or takes snapshots. The camera can be a common VCR one, a surveillance camera or a digital camera.

After the image is captured, it is binarized. The binarization process consists of the transformation of colored images in monochrome ones. Because the letters in the images have

a high contrast level, the binarization simplifies the image processing without loss of important information. Figure 3 shows an original license and its binarized image.

Figure 3: Image Binarization of a license.

Once the image is binarized, the system tries to find the license in the image. This module is based on chain code [3] algorithms and it searches for a closed square area with the estimated size of the license. This module is the most complex and the one subject to the largest number of errors. At the moment, it is still in development and the system has been working with an operator indicating the position of the license. Figure 4 exhibition a typical image and the expected result of a search.

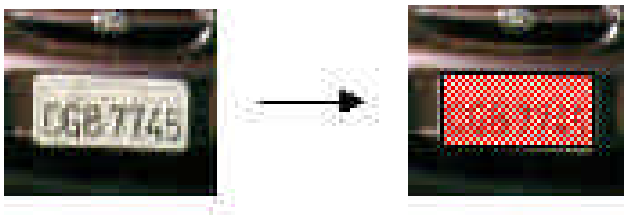

Figure 4: Seeking the license in the image.

Among the several existent character recognition algorithms the most common are the ones that accomplish a vertical projection of the points of the image and then analyze the histogram generated.

Based on the position of the license in the image, them system performs a horizontal and vertical projection of the letters in the license [4]. This projection consists in counting the number of pixels in a certain line or column and making a histogram. The result of the horizontal and vertical projection of a license is shown in figure 5.

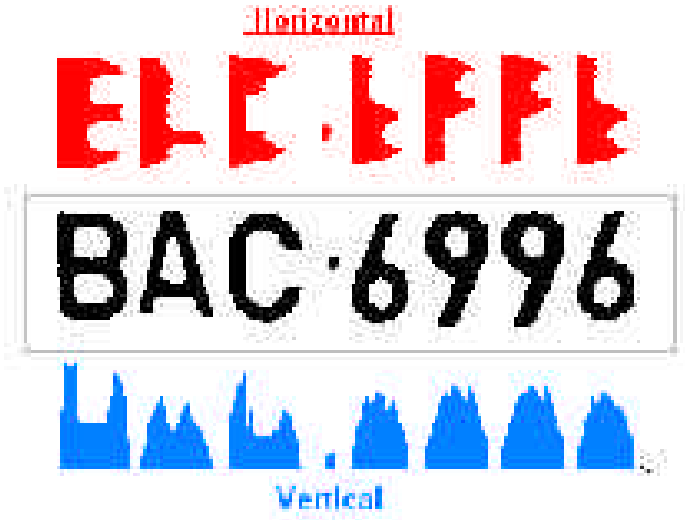

Figure 5: horizontal and vertical projections.

The system accomplishes a horizontal projection besides the vertical one for 2 reasons. First, the horizontal projection allows the determination of the initial and final position of the letters is in the axis y; second, it enables the identification of characters that have similar vertical projections.

After computing the projections, the characters must be segmented before they can be identified. The segmentation process makes a vertical scanning of the projection to locate the beginning and the end of the characters it must recognize and then finds the white spaces between the characters. Figure 6 shows the result of segmentation.

Figure 6: character segmentation.

After the segmentation the characters must be identified. This identification is done through the comparison the horizontal and vertical projection of each character with a pattern previously classified. With these projections characters are easily identified. The patterns used in the development of the project are the Brazilian official ones for licenses with 3 letter and 4 digits in black, with gray background.

The results presented by the system were satisfactory. With relation to the recognition of the numbers, the system had a great success percentage: all the licenses that could be read by an operator were also correctly recognized. The letters presented a greater misclassification percentage, but this happened mostly in not clearly readable licenses.
The performance of the system was satisfactory: a recognition can be made in less than one second, what enables implantation of the system in places where the vehicles circulate in low speed.

Finally, the project was developed on a standard IBM-PC Pentium computer with Windows NT. The system was developed in Visual C++ 4.0 and Visual Basic 5.0.

7. Conclusion

Final term projects in partnership with, or sponsored by, private enterprise have greatly benefited both students and industry in reaching their goals.

This work presented several projects developed in cooperation of Brazilian industry
- Virtual Robotics Laboratory - Microsoft and Bay Networks
- Intranet/Internet based Supervisory Control and Data Acquisition System – GE-Fanuc
- Access Control System - Oracle Corporation
- Security System Based on Signature Recognition - Microsoft
- Automatic Car License Recognition System - Microsoft

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