Developing New Technologies in Final Term Projects: An Industrial Approach.

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Abstract: One of the most challenging problems that the engineering educators face today, is how to prepare the future engineer for a ever-growing High Tech, Information Based market, where the development of new technological applications is a basic need. The solution adopted at Faculdade de Engenharia Industrial is to make partnerships with leading companies and industries, which enable students to work with state of the art technologies and give enterprises the possibilities to develop projects at low cost. Another aim of the industry is to foster the formation of new entrepreneurs in technological businesses.
Partnerships have given good results in applied research and final course projects. Two of these have been selected to illustrate these results. One of them, the "Pager Based Email Service" aims the development of a system that enables a notebook user to receive emails without the need to connect to the Internet. This is achieved with a pager connected to the computer. Another project is the "Estimation of Object Volumes based on Computer Vision", developed with the aim of introducing new technologies in industrial automation applications. Its goal was to estimate the volume of objects on an automatic production line.
Partnership in final course projects has permitted that students obtain practical results and good training, for their future and demanding high-tech career, and that private enterprise get new technological applications.

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

1. Introduction

One of the most challenging problems that engineering educators face today is how to prepare the future engineer for the ever-moving high-tech and information-based market, where the development of new technological applications is a basic need.

An alternative adopted at FEI - Faculdade de Engenharia Industrial, was to establish partnerships with leading companies and industries for the development of new technological solutions [1 - 3]. This strategy means better and cheaper formation of qualified engineers, ready to enter the labor market, and new applications at lower costs. It also allows that both teachers and students keep up with the state of the art in technology and quickly respond to the needs of a fast changing society with technological solutions. Another important aim, which is corresponded by industry, as stated by Motorola in the "Mission XXI Project" - a Latin American competition open to students from the 11 best Brazilian Universities - is to foster the formation of new entrepreneurs in the technological business.

Mission XXI [4] is a technical-economical challenge in the area of telecommunications, microelectronics and their applications, which brings private Enterprise and University together, spurring the imagination, initiative and creativity of students in a world wide economy. It is a competition that, at the climax of the current technological evolution, points at concrete actions, which permits that technology and business, with practical objectives, be brought together, joining imagination and realism. This opportunity intends to stimulate the breeding of "labs of

ideas", which requires a participation of multidisciplinary, agile and creative teams proposing business, products and services in the immediate future, in Latin America emerging and promising markets [5].

Partnerships have given good results in applied research and final course projects. Among more than 20 projects developed in the last year, two have been selected to illustrate these results.

2. Impager - Pager Based Email Service

One of the term projects is the "Impager - Pager Based Email Service" [6]. The goal is to develop a system that enables a notebook user to receive emails without the need to connect to the Internet. This is achieved with a pager connected to the computer. In this way, the Internet user can move in a region covered by a paging service and receive his emails, connecting with his Internet Provider only to reply to the messages.

Paging receivers or pagers have not changed drastically in terms of their functions in the last decade although their size was reduced and are now much more appealing than they used to be. They use advanced technology and are microprocessor-controlled and powered by a single disposable AA or AAA battery. A modern pager typically consists of the following modules:

- Receiver: Receives and modulates the paging signals;
- Decoder: Decodes binary information;
- Display: Displays message and other information;
- Controls: Allows user to access information and set parameters;
- Battery.

Paging base stations, which are responsible for sending the paging signals, are usually remotely controlled. A centralized controller offers many operational advantages, especially in the case of simulcasting, where several parameters of the base stations can be controlled automatically from a single location.

The developed system is composed of several parts: the email server, which is connected to the internet and receives the incoming mails; a packet software, that splits the email in several packets that can be transmitted using the pager protocol; the paging base station, which broadcast the packets; the paging receiver, connected to the notebook through a serial port, which receives the message and transfers it to the computer; and finally, the rebuilder, a program that merges the packets, reconstructing the original message and placing it in a directory from where the user can read it with the email program he desires.

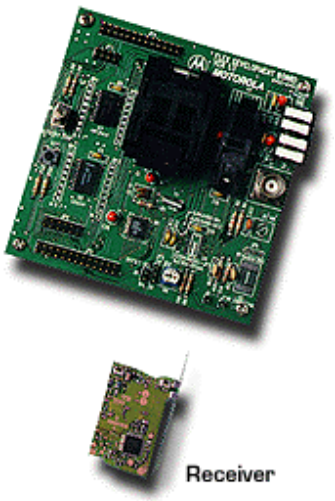

Fig. 1. The FLEX MC68175FDB Development Board.

The project was based on the FLEX Development Board MC68175FDB (Fig. 1): a flexible platform for developing FLEX paging devices using the MC68175 FLEX chip decoder in conjunction with the Motorola FLEX 2-bit Analog-to-Digital (A/D) converter. This two-chip solution simplifies the implementation of a FLEX paging device by accepting four-level audio signals from a wide range of readily-available paging receiver devices, and communicating via the Serial Peripheral Interface (SPI) port with a wide range of standard microcontrollers and microprocessors.

This project was developed on Microsoft Windows and Red Hat Linux platforms, and took part in Motorola's Mission XXI Project.

3. Estimation of Object Volumes based on Computer Vision

On another front, several systems were developed with the aim of introducing new technologies into industrial automation applications. One project that deals with this problem is the "Estimation of Object Volumes based on Computer Vision" [7], which goal was to discover the volume of objects on an automatic production line based on Pepperl+Fuchs sensors (Fig. 2).

The analysis process starts with the image capture, which happens when the P+F sensor detects that an object is arriving on a conveyor belt. In this application, the P+F sensor acts as a detector and as a product tag, allowing information about the product to be stored with it.

Fig. 2. Pepperl+Fuchs sensors

The system is based on Computer Vision techniques [8] to determine the height, width and depth of the object, from images captured by a frame grabber board for a PC computer. This information is recorded in the sensor tags on the objects and can be retrieved at any point of the line: the object has all information that is needed for any production decision about it. The frame grabber used (fig. 3) is a Brooktree 848 image acquisition board, based on the Video for Windows standard, which allows programs to process and display 24 bit color images in real time. The camera used is a small size, high definition, Phillips digital camera.

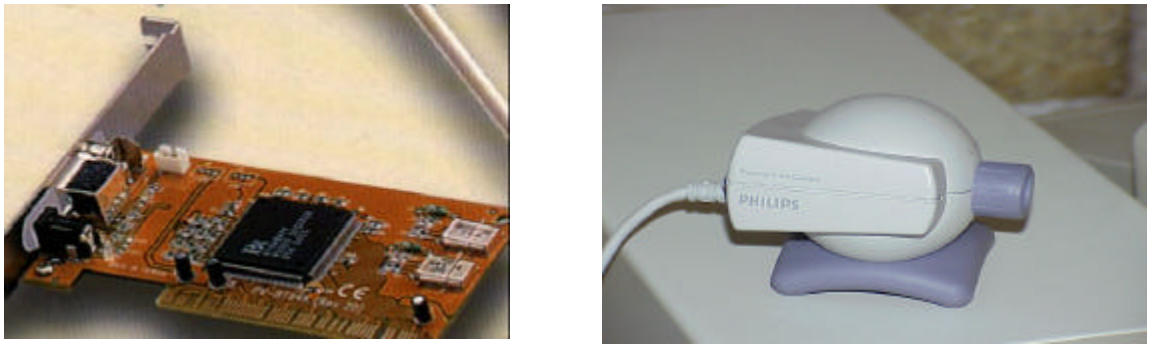

Fig. 3. Bt848 Frame grabber board and camera for a PC computer

In the experimental setup (Fig. 4) the camera is installed over a conveyor belt, with focus on the object from a top viewpoint. Also, a mirror is installed at the side of the conveyor belt, so that in the same image there is the top

view and the side view. This allows the system to calculate the area and height (and the volume which is area times height) of the object from the same frame.

The Computer Vision algorithms used are based on the Sobel edge detector [9]. It first applies a threshold filter on the image, transforming it in a binary image. From this black and white image, it extracts the edges of the object and then finds the corresponding area and height. Fig. 5 presents an image and the results of the Sobel edge detection algorithm. The object and its mirror image are easily seen on the left figure.

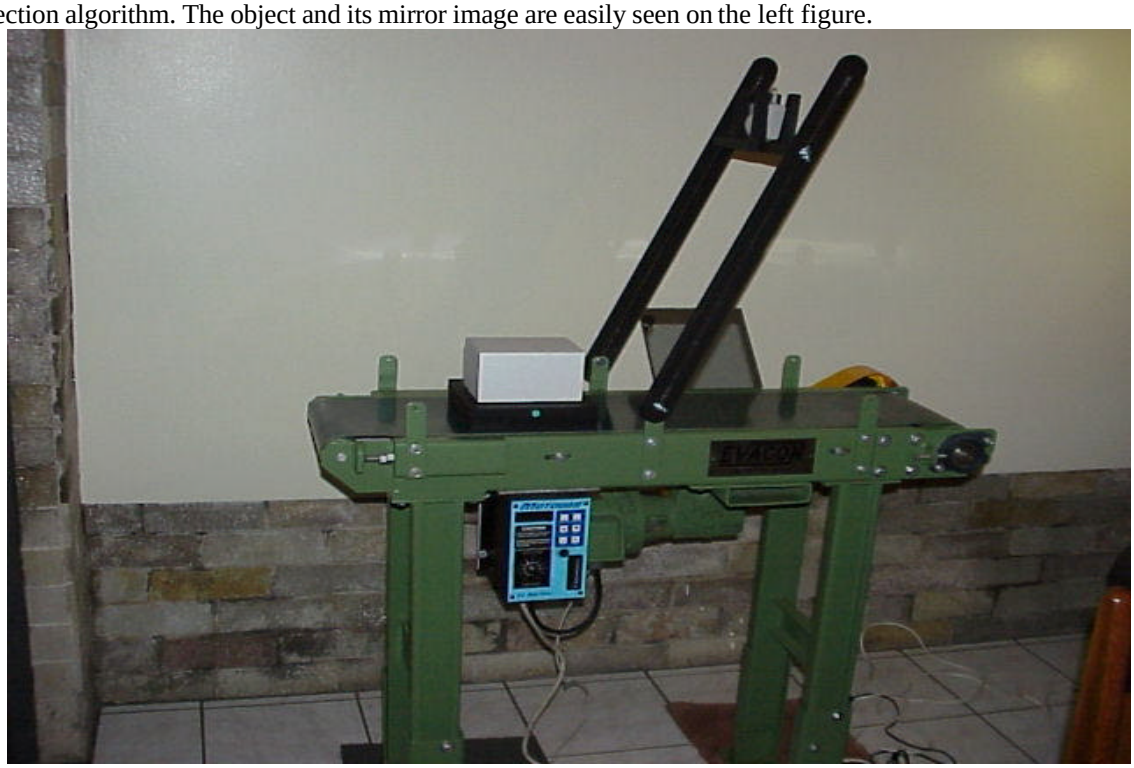

Fig. 4. The experimental setup, showing conveyor belt, camera, mirror and object.

Fig. 6 presents the system user interface, which shows the image of an object on the conveyor belt, the values for the object dimensions (height, area and volume) and the system conditions. It includes modules for the control of operation conditions of the system, as adjusting camera options and belt speed. Also, it allows several visualization modes, enabling the user to see different parts of the Computer Vision process.

Fig. 5. An image from the camera and the corresponding edges.

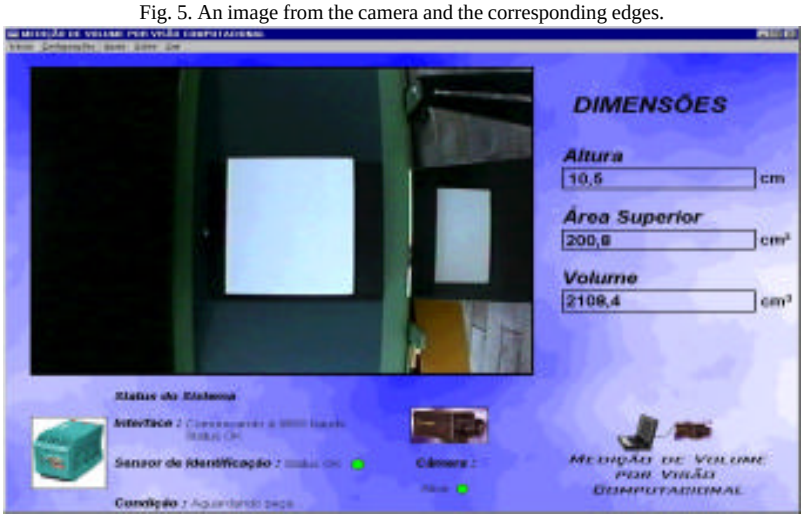

Fig. 6. System' s user interface.

Finally, the system showed good measurement results, with less than 5% errors in the estimation of volume. It was developed using Microsoft Visual Basic and Visual C++.

Other developed projects include a Voice Control System for Vehicles based on Artificial Neural Networks, supported by Microsoft, a cardiac monitoring system that employs software and equipment provided by Altera Corp., and several telecommunication and computer based systems which relies on a partnership with companies such as Nortel / Bay Networks, Novell, Oracle and HP.

4. Conclusion

Partnership with industry has proved to be very effective for both parties, in developing new high-tech projects at low costs through final course projects and applied research, and preparing students for a new and demanding information based market. They are not only being trained to work with the most advanced technologies, but they also develop a new attitude and a way of thinking about their possibilities and potentiality. Due to this they start looking at their professional future in the view of a dynamic young entrepreneur, and not only as a future competent but dependent employee of a company.

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