Integrated System for the Support of Teaching, Design and Manufacturing of Antennas

Authors:
Olivier Vidémé Bossou, Swiss Institute of Technology, LEMA-EPFL-ELB Ecublens, CH-1015 Lausanne, Switzerland, Phone: +41-21-693-4625, Fax: +41-21-693-2673 olivier.videmebossou@epfl.ch
Juan R. Mosig, Swiss Institute of Technology, LEMA-EPFL-ELB Ecublens, CH-1015 Lausanne, Switzerland, Phone: +41-21-693-4628, Fax: +41-21-693-2673 juan.mosig@epfl.ch
Tonye Emmanuel, University of Yaoundé I, National Advanced School of Engineering, LETS-ENSP, B.P. 8390 Yaoundé, Cameroon, tonyee@hotmail.com

Abstract — The Laboratory of Electromagnetism and Acoustics of the Swiss Institute of Technology is developing a CD-ROM software package for the elaboration of algorithms and technologies devoted to adaptive antenna arrays, in collaboration with the Laboratory of Electronics and Signal Processing (Cameroon) and the Centre of Energy and Municipal Researches (Switzerland). The work in progress covers the development of a multimedia teaching-aid, within a client-server environment, for teaching, simulation, design and, finally, manufacturing of antennas. The software can also be used to remotely conduct tutorials through Intranet and Internet networks. This project aims to improve the teaching in the field of antennas, more particularly for students in Southern Countries, which lack the industrial environment in which the use of electronic equipment could be demonstrated. In this way, the chances for setting up in Southern Countries local manufactures of certain antenna types should be enhanced. The need for satellite communications is a vital stake in the economy of developing countries. The availability of satellites and the increasingly reliable communications protocols, in terms of transmission security, are first-order features of this technology. Once the means to use them become available, satellite communications are much easier to deploy than earth-bound communications. Nowadays the setting up of a transmitting and receiving station with a tracking antenna for radioamateur satellites is therefore essential. Within the scope of research on remote sensing carried out at the Laboratory of Electronics and Signal Processing, it will allow us to directly acquire satellite images, completing informations provided by commercial images. The majority of academic institutions related to the Cameroon State Universities could then have at their disposal, at some future time, earth stations to transmit and receive data through radioamateur satellites, setting up communications between institutions and centres distant from the headquarters of the universities involved. One of the advantages of the proposed setup resides in the low cost of its design and implementation. In addition, its exploitation would benefit from the solidarity of the world community of radioamateurs for the complimentary exchange of services.


INTRODUCTION

In many developing countries university infrastructures, equipments and number of teachers didn’t change since independance. Most of the equipments became obsolete and even out of usage. Lecture halls become more and more crowded. University staff can’t stand in front of the exponential increase of the number of students every year. Beside the increase of the number of students, the diminution of teacher’s salaries and the lack of didactic material decrease the teaching quality.

To solve this problem university chancellors are encouraging remote teaching in order to reduce the number of students and improve pedagogical aspects. But their budget can’t afford the prices of software available in the market. So they have to develop themselves their own software package. To achieve their goal, they’ll have to count first of all on themselves and after that on the collaboration of northern universities.

Our aim is to develop a multimedia teaching aid software to improve the formation of students and to design and manufacture locally some type of antennas using as far as possible local materials and artisanal equipments.

SOFTWARE PRESENTATION

The software we are developing is web based software and has four main parts : tutorial, laboratory, antennas synthesis and manufacturing.
Tutorial
It provides an illustrated antenna course with still and animated images (Figure 1, Figure 2, Figure 3), with many lessons. Each lesson is based on a specific item. At the end of every lesson, there are exercises to make sure that the student has understood notions developed in it. For items that seem to be complicated, such as the method of moments or adaptative antennas, there are directed works (Figure 4, Figure 5) to help the student to understand them as well as possible. This part will be developed with author software that is used to produce web based courses based in novel educative technology.

Laboratory
It simulates a real antenna measurement laboratory. The student will have on the screen a virtual laboratory where there are apparatus, antennas, cables, etc. Then he will connect them and carry on measurements and make a report at the end of the laboratory. The laboratory part which is not yet developed will benefit to developing countries which have neither industrial environment nor correctly developed laboratory infrastructure.

Antennas synthesis
Antenna synthesis structure is represented in Figure 19. First of all the user must choose a frequency range, then a frequency band (Figure 6). After that he has four possibilities:
1. A list of antennas which operate within this frequency band is proposed to the user. He will make a choice and then introduce some input parameters (Figure 7). The software will give him the antenna dimensions (Figure 8), its characteristics, the maximum value of the radiated electrical field and the radiated power pattern in two and three dimensions cartesian coordinates, in polar and spherical coordinates (Figure 9 - Figure 12);
2. The user chooses an antenna, modifies the proposed parameters (Figure 13) and evaluates the influence of these modifications on the antenna characteristics;
3. The user chooses a radiated pattern and he will be proposed an appropriate type of antenna;
4. The user will construct himself his antenna by choosing radiated elements and introducing their parameters. The software will give him the antenna characteristics and the radiated power pattern.
This part is developed in Java language. With regard to the narrow bandwidth of local area networks and the amount of information involved, we choose to use servlet in order to execute the application on the server. Each function calculates the characteristics and the dimension of the antenna involved.

Manufacturing
This part presents the practical calculations, the material and equipment used to manufacture antennas. It also describes all the manufacturing steps and a video is provide for every step (Figure 14 - Figure 17).

TRANSMITTER–RECEIVER RADIOAMATEUR SATELLITE EARTH STATION
After designing and manufacturing the adaptative antenna, we can now build our earth station which has five parts (Figure 18): one computer, one modem, one transceiver, one electronic drive unit and the adaptative antenna.
The computer will have three types of software:
• A linux operating system: the licence is free;
• A satellite software which gives the satellite position with respect to the station and communicates the azimuthal and elevation coordinates to the transceiver: It can be downloaded from the net;
• The modem software which is used to receive and transmit data from and toward the satellite.
The role of the modem is to code and decode the PACSAT protocol. Its available on the market.
The transceiver sends and collects signals towards and from the satellite. It also provides an output to monitor the antenna mechanical positioning system. This output signal will be connected to the electronic drive unit for electronic monitoring. It is available on the market.
The electronic drive unit will be designed, manufactured and used to command the adaptative antenna switches.

CONCLUSION
The system described in this paper constitutes a viable solution to the scientific dissemination problems encountered in southern countries. Many of the components of the system have already been designed and tested, at least as software beta version and it is hoped that the final result will be soon available.
REFERENCES


[9] TIRKAS, P., A., Private communication, Arizona State University (from [4]).


FIGURES AND TABLES

FIGURE 1
VERTICAL QUATER. WAVE ANTENNA

FIGURE 2
FERRITE ANTENNA
FIGURE. 3
MOMENT METHODS ILLUSTRATION

FIGURE. 4
MOMENT METHODS DIRECTED WORK.

FIGURE. 5
RADIATED PATTERN.

FIGURE. 6
FREQUENCY BAND AND ANTENNA SELECTION.

FIGURE. 7
ENTRANCE OF INPUT PARAMETERS.

FIGURE. 8
SELECTED ANTENNA DIMENSIONS.

FIGURE. 9
SELECTED ANTENNA RADIATION PATTERN: 2D CARTESIAN COORDINATES.

FIGURE. 10
SELECTED ANTENNA RADIATION PATTERN: POLAR COORDINATES.
FIGURE. 11
SELECTED ANTENNA RADIATION PATTERN: 3D CARTESIAN COORDINATES.

FIGURE. 12
SELECTED ANTENNA RADIATION PATTERN: SPHERICAL COORDINATES.

FIGURE. 13
ANTENNA PARAMETERS MODIFICATION.

FIGURE. 14
BENDING STATION.

FIGURE. 15
ASSEMBLING STATION.

FIGURE. 16
RIVETING STATION.

FIGURE. 17
COMPLETION STATION.

FIGURE. 18
TRANSMITTER-RECEIVER RADIOAMATEUR SATELLITE EARTH STATION.
FIGURE 19
ANTENNA SYNTHESIS STRUCTURE.