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A MOTIVATING PEDAGOGICAL APPROACH: "LEARNING BY PROJECT"WITH AN ELECTRONIC DESIGN EXAMPLE OF ULTRASONIC TRACKING RADAR

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Abstract : This paper first shows the complexity of the relation between the new student generation and the teacher. We describe some major changes in student's behaviour and the consequences on the quality and efficiency of traditional pedagogy. Thus, we explain that the classical teaching method does not match anymore with the student's needs and we try to show an other way of teaching. Far from the theoretical and difficult traditional courses, "learning by project" can be an interesting alternating practical approach. The example of a small ultrasonic radar design project is used to describe this strategy..

Key words : "learning by project ", system approach, motivation, ultrasonic radar.

1. Introduction

1.1 ENSEIRB learning overview

1.1.1 Classical teaching methodology

Since a few years, we observe a kind of increasing gap between the student's needs and what we gave to them. A global disaffection for all theoretical lessons appeared and our traditional pedagogical reached its limits.
These tendencies we noticed in our school are confirmed by French national statistics: there is a global demotivation for the scientific curriculum. Economical, commercial studies seem to be now more attractive for this new generation of students.

A Global Quality program has then been engaged in our school inducing a deep pedagogical reform as well on the bottom as on the form. All the scientific, electronic, and other engineering fields of the ENSEIRB program will have to be reformatted. As we can not change the students, we must change ourselves to be more efficient and attractive for the future students.

1.1.2 The students

We have attended for a few years, a change of behaviour students. The teachers are in front of a new kind of public and do not know how to manage behaviours which are not familiar. Among the major evolutions, we can extract the most important one's:

- The international origin and the diversity of social origin of our students increase the difficulties of teaching: level dispersion and cultural diversity is not anymore compatible with traditional lessons in full classroom.
- Most of the students have a lot of extra scholar activities such as sport, internet electronic games, and other leisure's. They are interesting from a personal development point of view, but they also generate a too big mental energy dispersion which is not favourable to a rigorous school work.
- A reduction of capacity of attention (inherent in human being and normally about 45 min with 1 hour) has also been observed. Thus, the efficiency of a traditional theoretical course of 1 hour is now poor, due to a progressive unhooking of the audience faster than before.
- At least, our students act now like consumers more than students : this "zapping" phenomenon is destabilizing for the teachers.

1.1.3 Supply and demand

According to this situation, it appears that supply and demand as regards teaching, need to be given in phase. As the previous teaching methods doesn't match anymore with these students of today, we have to test other teaching methods to restore effectiveness and quality.
We must now considerer the relation teachers/ students like a client/supplier relationship, in term of business. The client satisfaction must become

one of our priority. And we have to adapt our pedagogical strategy to these new deals.

2. Learning by project

2.1 Introduction

If this concept is obviously not new, its introduction in scientific school is quite recent. The aim of this approach is to optimize the motivation and to develop the curiosity of the students by a practical approach and a "bottom up" teaching strategy.
Such approach avoids the abrupt and difficult theoretical courses and training which are nowadays rejected by the students and makes the student more confident and responsible of himself.
A funny project is also an opportunity for the student to develop his team work spirit and his management ability.

2.2 Application

The design of simplified ultrasonic radar has been chosen to experiment this learning approach in second year study of our engineer school.

3. Description of the project

3.1 General description

The aim of this project is to design, to wire and to build a simplified ultrasonic radar for a target localisation and distance measurement in a half horizontal plane. The target distance is between 1 to 5 meters.

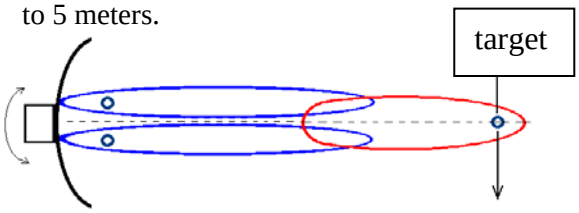

Fig 1 : detection synoptic

The final design consist of :

- An ultrasonic emitter (40 kHz) simulating a target to detect,
- A radar with two ultrasonic receivers located at the hearth of the parabola.
- A step motor for the horizontal plane rotation of the parabola.
- Two magnetic switches for a half plan limitation of the radar displacement.
- An electronic board computing the distance and the target angular position
- An electronic power driver board for the step motor which allows the tracking of the target.

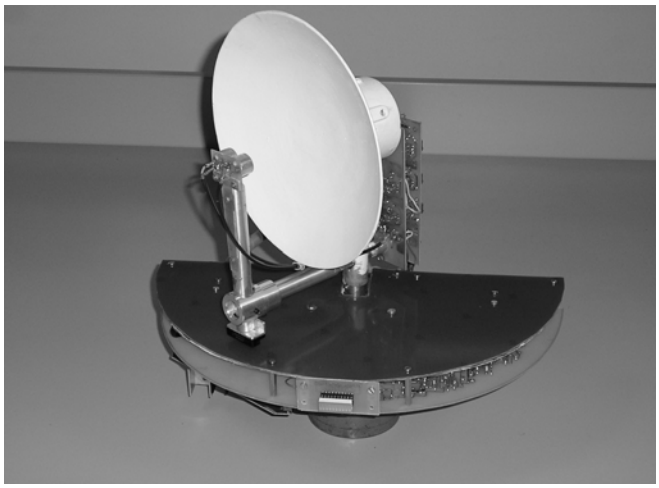

Fig. 2 : view of the radar

3.2 Angle measurement and target tracking

The radar works like human eyes based on stereoscopic vision : the two receivers receive the emitted signal from the target. The intersection between the emission and reception lobes defines the energy level received by each receiver.
If the target perfectly aligned with the parabola axis, the received level on each sensor will be identical. If not, one receiver will receive more than the other one. Then, a correction signal will trig the rotation of the radar to track the target in the good direction.
Counting the number of step allows knowing the angular position of the radar.

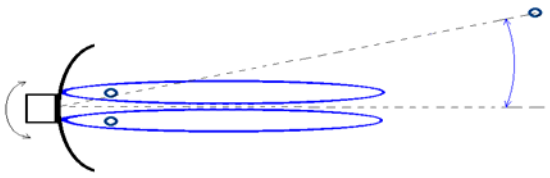

Fig 3 : target non aligned

When the emitter is turned off or not visible, the radar makes some "way and returns" in the half plane until to discover the target. All the rotations of the motor are managed by a microcontroller [5].

3.3 Distance measurement

The used principle is the one we find in air plane radio altimeter… but very simplified.

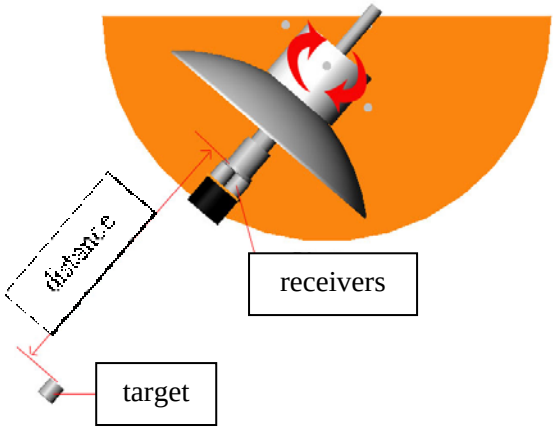

Fig 4 : distance measurement

A frequency saw tooth sweep is done on the emitted signal (40 to 50kHz). The received signal is delayed due the propagation time. The time delay **ΔT** is proportional to the distance, **d** covered in the free air at the ultrasonic wave velocity **c** (m/ s)

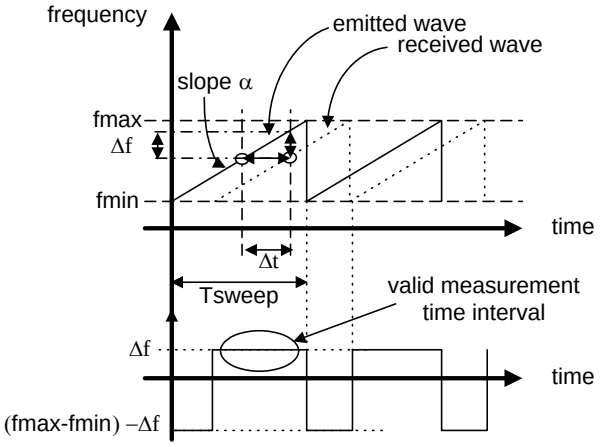

Fig 5: radio altimeter principle

By measuring the frequency gap between the emitted frequency and received frequency, we can compute ΔT and then the distance.

An image of the measured distance is displayed used a simple LED bar graph.
Of course, some simplifications are done to "forget" some hard problems of a true radio altimeter.

3.4 Block diagram

The final block diagram is given in figure 8.

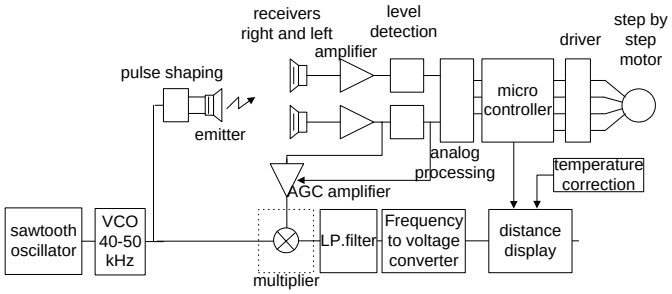

Figure 8

4. Pedagogical flowchart

The project proceeds by group of 6 students. It is distributed over one six-month period with 10 practical lessons of 4 hours. The miles stones of the project are :

- Student group constitution: Initiation with the team work. During this first step, the individual Herman profile [2] of each student is done. According to the individual profiles [3] , the team is then made up. The team profile [4] is then identified (open, close synchronous, random). For each team type, the methodology, and the human organisation, (task management, leadership…) is then describe for a first student sensitizing to team management,
- Practical demonstration: Existing finished radar is shown to the students. They are invited to experiment it and to think about different possible block diagram..
- Specifications definitions: The specifications are defined all together into a frame given by the teacher.
- Project management initiation: Once the specification and block diagram are defined, the job of each member of the team must be defined. By a short seminar on project management, we help the students to make task repartition, project manager designation.
- Bibliography: Showing the necessity of collecting information before starting the design, we encourage the student to find documents, books, and articles. Despite the internet facilities, we suggest to the students to find them rather in the library. This process is often more efficient and quick.
- Electronic design: a few lessons are dedicated to the design. Each member of the team must study its sub module in respect with the specifications. The whole electrical schematic diagram is then established by the team manager.

- Electronic design report: At the end of the design step, a written report is generated by the student. The technical and financial choices as well as the micro controller program must be explained and justified
- Manufacturing: electronic board are wired and mechanical elements are assembled by the students
- Manufacturing report: in this report, the students must clearly describe the soldering, wiring and assembly process, to make their prototype reproducible.
- Sub module and global test : once the whole system is correctly manufactured, each part is tested individually. Finally, the global performances are validated.
- Test report: in this report, the students must indicate the results and performances they obtain, in comparison with the nominal specifications.
- Final report : All the intermediate reports are collected to make the final report.
- Oral report : each group must orally expose the covered subject during the last meeting.

5. Advantages of "learning by project"

- The ludic aspect of the project (the radar is rotating, the LED are flashing!) is a source of motivation. It is also an opportunity to teach some difficult fields of electronic as simply as possible.
- Despite a frame worked project, some freedom into the design gives the impression to the students to be actor and creator. It acts like a creativity amplifier.
- Our « system » approach allows to mix different fields of electronic.(analogue, digital, sensors, micro programming, power motor driving) It ensures a better comprehension, a better connection between them, and causes a global interest for the lessons.
- The complexity of the electronic design is better received by the students through a practical approach.
- This project is the opportunity of a self encouragement to the student to deepen himself his knowledge (by necessity and not obligation).
- The project is also a time for a human experience, a pleasant team work, and management Each student can discover his own preferences, profile, and personal interest.
- At least, a positive emulation inter group is developed, in a good environment of work.

6. Results

Even if it is always difficult to "measure" the impact of a teaching strategy, this one seems to be more attractive than before, looking at the results of the "student annual debriefing report": The last one show that the satisfaction rate raised from 45% up to 65%. Even if there no spectacular increasing of the technical level, there is rather a improvement in motivation, interest, physical and mental presence of ours students.
The students point out the funny aspect of the project, and also the system approach which allows mixing their different acquired technical knowledge.

7. Conclusion

We showed in this paper that the traditional teaching methods do not match anymore with the actual pedagogical needs for environmental, individual, and society evolution reasons. As we can not change the students, we only thing we can do, is adapt our pedagogical approach to them: "Learning by project" seems to be a good way (among others) to improve the efficiency and the quality of our teaching. Through a serious, complex but funny design project, we showed that it was possible to improve the behaviour, the motivation and the curiosity, of our students. Permanent adjustments and adaptation between student's needs and teaching strategy is probably the best way to make our scientific curriculum more attractive in the future.

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