Robotics without teacher

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Abstract:
The modernization of the formation within a university program obliges us to implement instruments, which contribute to the methods of teaching and preparing the student to be impregnated with an effective teaching, which facilitates the acquisition of the elementary techniques of robotics and to assimilate the concepts relating to the discipline.
The bulk of material dealing with robot theory, design, and applications has been widely scattered in numerous technical journals, conference proceedings, and some textbooks that either focus attention on some specialized area of robotics. Consequently, it is a rather difficult task, particularly for a newcomer, to learn the range of principles underlying this subject matter.
The primary idea of this article is to give for a newcomer the basic analytical techniques and fundamental principles of robotics, and to organize them under instrument in a unified and coherent manner.
To this end, the introduction of new methods of training for the courses, TD and TP (Simulation) is essential, from where the idea to design a didactic tools.
In this article, we chose a presentation of a teaching tool in the field of robotics judging essential to any student of the specialty, and we enriched this didactic course by complements allowing better seize the range of the put tools and to stress the importance of the ideas developed in this work. These complements present original applications in the field of robotics. This tool is designed under environment MAPLE, with the use of the MAPLETS for the design of the interfaces.

Key words: Didactic tool, Education, Formation, Training, Robotics, Maple, Maplets.

1. Introduction

The modernization of the formation within a university program obliges us to implement instruments, which contribute to the methods of teaching and preparing the student to be impregnated with an effective teaching, which facilitates the acquisition of the elementary techniques of robotics and to assimilate the concepts relating to the discipline.
The reform of the university education is an organizational change which is based on major purposes which guide the actions. It is of primary importance to wonder about teaching bases which must underlie it. It is significant to build the instruments of which will come to form part all the activities of this new system.
To place at the disposal of the student and the professional in search of an additional training, all the panoply of equipment and didactic tools necessary to study the robotics is inevitable way to satisfying this reform.
The number of hours of study is never sufficient for the students to have a good formation, which they oblige them to make an effort to acquire a better formation. This tool was conceived to provide to students involved in robotics and automation with a comprehensive of the basic principles underlying the design, analysis, and synthesis of robotic system.
We are interested, in this work, on the integration of tools and instruments, to be adapt at this organizational change. These are the reflections which will finally lead us to work out a didactic model being able to serve as basis with the university education that we undertake today, and on which the emergent countries melt legitimate hopes.

2. Robot Arm Kinematics and Dynamics

The bulk of material dealing with robot theory, design, and applications has been widely scattered in numerous technical journals, conference proceedings, and some textbooks that either focus attention on some specialized area of robotics.
Robot arm kinematics deals with the analytical study of the geometry of motion of robot arm with respect to a fixed reference coordinate system without regard to the forces/moments that cause the motion. Thus, kinematics deals with the analytical description of the spatial displacement of the robot as a function of time, in particular the relation between the joint-variable space and the position and orientation of the end-effectors of a robot arm [7].
Robot arm dynamics, on the other hand, deals with the mathematical formulation of the equations of robot arm motion. The dynamic equations of motion of a manipulator are a set of mathematical equations describing the dynamic behavior of the manipulator.

The notation of Denavit and Hartenberg is introduced and applied consistently throughout the tool. Jacobian matrices, workspaces and singularities studied in this instrument. This instrument introduces the dynamic of robotics manipulator of the serial type while discussing extensively the recursive Newton – Euler algorithm.

3. The Didactic tool

The aim of the tool is to serve as an instrument in robotics courses; another aim is to serve as a reference to the newcomer and student, in order to facilitate the integration of the teaching relations in the university higher education. This tool covers extensively the kinematics and dynamics of robotic manipulators of the serial type.

To design a didactic tool, it is to think on the contents and the way of supporting the discovery, the application or the synthesis of a concept by handling.

The teacher is certainly in first a pedagogue. The teaching act uses the three kinds of teaching relations: relations of teaching between the didactic professor and student, relations between the professor and the subject of study, the relations of trainings between the student and the subject of study (development of the student competences).

To create a tool, it is first of all necessary to wonder about the needs for the students, and the difficulties of raising and the means necessary to lead to this finality. The tool must be a "facilitator" its answers a fixed goal and corresponds to a category of student's aimed. This tool is usable in autonomy offering keys of comprehension.

To model, it is artificially to create one or more variables, resulting from a theoretical step aiming at replacing invisible complex phenomena by simplified and visible phenomena. It is the association between the support and the step which concretizes the tool. The support remains only one means with the service of the step or the educational strategy.

An association of formulas, definitions and simulations, so speaking are such, not constituting a didactic tool only as from the moment when it forms part of a step. This association has a cognitive purpose. It borrows for that ergonomics of coherent interface having menus, the explanatory buttons, legends, texts, questioning, animation, organization sets of themes …

A well designed didactic tool, directs the reasoning of the student towards a rational reflection, facilitates the construction of the concepts by graduated activities, and establishes a cognitive interaction between the student and the discipline taught by generating new knowledge.

These tools can be useful like logistical teaching support for the teachers, and can also take part in the capitalization of the knowledge within the universities.

4. The Maple software like support for this didactic tool

The Maple software is a system of symbolic calculation system [5, 6], it makes it possible to make advanced mathematical calculations. Several bookshops of functions and mathematical operations are already implemented. The software offers an environment of work easy to use and allows a great speed of development, thus evoking its capacity to handle the data of symbolic manner system or algebraic. This symbolic capacity system makes it possible for Maple to calculate exact analytical solutions with many mathematical problems including systems of equations, integrals, differential equations and problems of linear algebra.

We chose the Maple software like environment of this didactic tool, to exploit its system of calculation symbolic system and the interactivity of the software with its learning.

Moreover, Maple has a package Maplets [2, 3], which offers to the tool an ergonomics in the application, this package allows us possibility to create windows, buttons, limp of dialogue and other visual interfaces which interact with the student. The package of Maplets is one in the effective ways to develop the applications of GUI (Graphic User Interface). Maple is more favorable for the mathematical resolution of the problems in robotics than JAVA or the language C [1], especially for the representations in 3d.

We used Maple as a support for the creation of the didactic tool, to allow to the students the means to assimilate well the concepts of robotics; it would offer them a favorable framework to the training of the discipline.

5. The interface of the didactic tool proposed

This work concentrates on the use of a whole of Maplets instructions, for the graphic modeling of the tool, which interrogates with the mathematical core of Maple, offering an effective educational tool for the students and teachers.

The principal interface of the tool comprises a menu treating on a hierarchical basis the contents of the robotics courses [7], starting with general information on Robotics, passing by the various concepts of the discipline, parameter setting of Dinavet-Hartenberg, the homogeneous matrices of passage, the Jacobian, products of the matrices of passage, dynamics until simulation moving. The tool comprises also windows, buttons, edit zone, and zone for simulation (figure 1). The tool treats in particular the robotics of the manipulator arms.

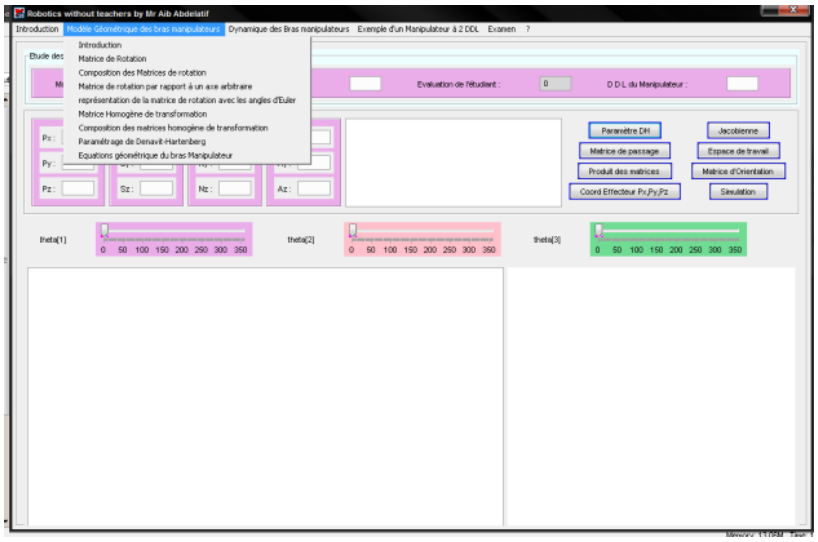

Figure 1: Interface principal menu

For example if we activate the "Généralité" title in the menu, we can consult part of the course [7] (figure 2), we chose this step, to facilitate with the learner the visual acquisition of information, even the division of the various menus is made with an aim of specifying the contents of the module to study.

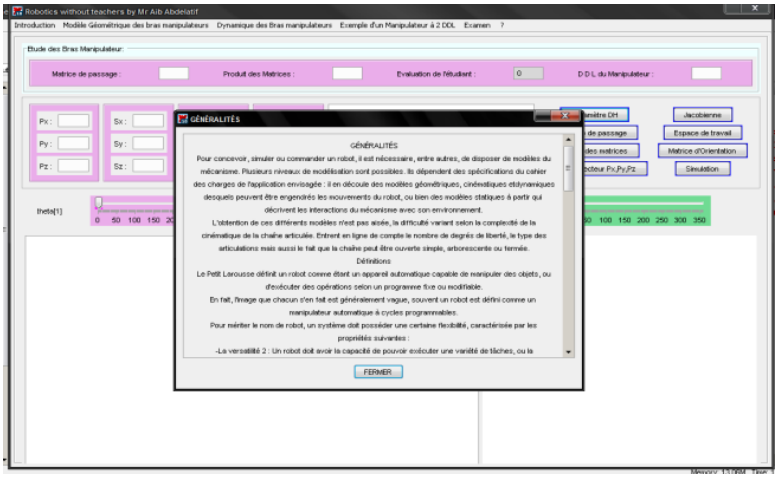

Figure 2: Activation of the title appearing in the menu

In order of enriching the contents of the tool, we equipped it with all the instruments which helps learning to well assimilating his course, these instruments are put in a step which allows the student a memorizing knowledge, by a visual acquisition of information, the comprehension and the application of the concepts of robotics are facilitated by the activation of the buttons [8]. To acquire the concepts by handling, the tool proposes to the learner the means of analyzing the facts and interpretations of simulations in order to help him to understand the concept, and it also offers an self-evaluation for learner by exercises and QCM [7].

Teaching does not consist in solving problems for the students, or their post solutions but requires much more profit-sharing and of training. The student needs to think on process of solution by himself.

In this context, the immediate reaction are very useful characteristics for the students, they find the advice and the step by step control of their answers, an effective method.

learners often find difficulties in employing the mathematical formulas, in their right place to solve a problem of robotics, one proposes through this tool, a means to raise this difficulty, the figure (3) and figure (4) can be used, at the time of a revision, as an example of comprehension, it directs learner in a process by explanatory comments, it progressively guides him by stages.

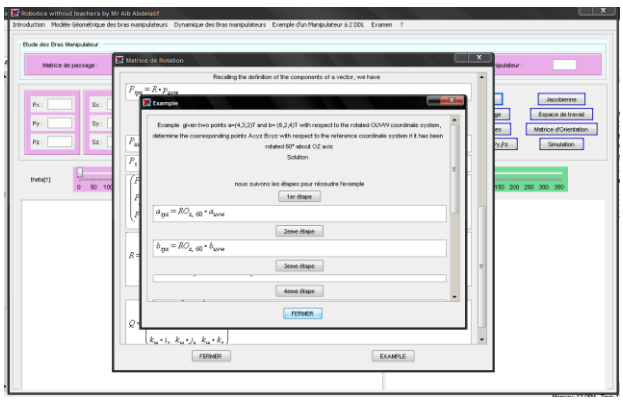

Figure 3: Example of resolution

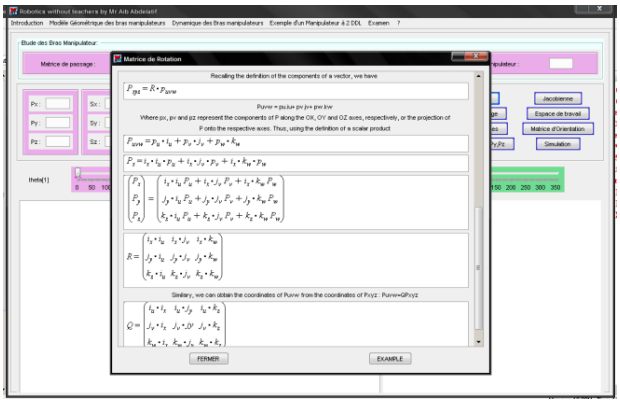

Figure 4: Stages to follow to solve the example

Some phenomena in robotics can be explained only by representations in 3d, even the teachers find difficulties to make them understood to the students, for this reason the support used in this tool combines text, graphics and animation. This support allows a new pedagogic approach with the use of more attractive method where the interactivity plays a role of assimilation, and with the possibility of an advantageous adaption to the process of training of learning. Figure (5) shows that when designing tool, we reserved the lower corner right to present the simulation of the manipulator arm.

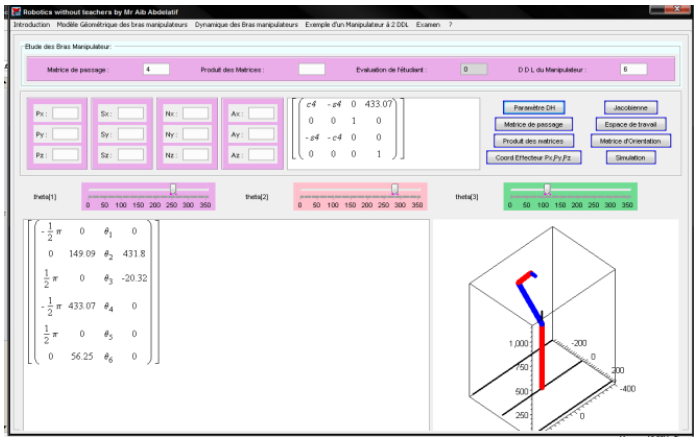

Figure 5: Appearance of the zone of simulation

In addition to animation, the learner needs other information allowing him acquiring the discipline, this is why we have associated other data like the rotates angles, the matrices of passage, the coordinates and orientation of the end - effecter [7].

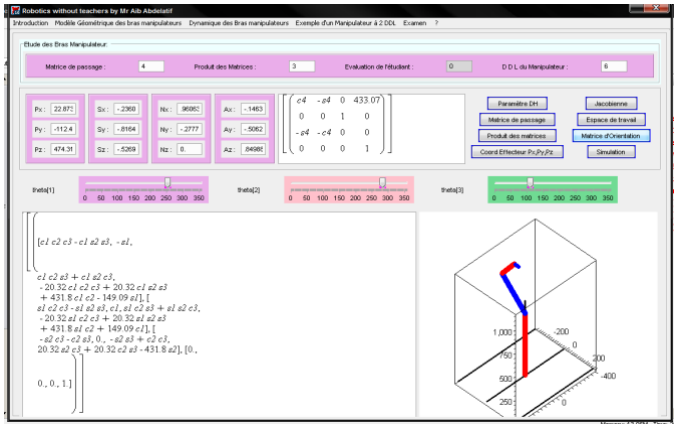

Figure 6: Product of the matrices of passage

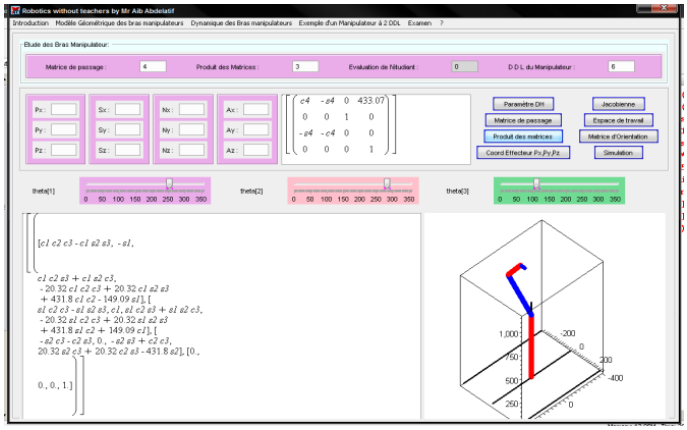

Figure 7: Coordinates of the effector and its orientation

6. Conclusion

The number of hours of study is never sufficient for the students to have a good formation, which they oblige them to make extra efforts to acquire a better formation, which carries out the students to be even dealt with by themselves.

The proposed teaching tool finally is only an attempt to describe a need imposed by the reform of university education. This model is a tool for managing changes caused by pedagogical innovation that is the modernization of the structure of teaching methods. It continues in the context, the acquisition of concepts through manipulation. But in order to make this work effective, it is still necessary that it is adapted to the group for which it is intended.

The originality of work arises out of didactic tool developed under the environment of the mathematical software, Maple, a support of teaching assistance for the assimilation of the module of robotics. This step will not be limited to the field of robotics; it will be spread out over other disciplines in order to raise other difficulties.

Need to give students a good education, uniform and customizable, obliges us to offer an approach that fits into a logical accumulation of knowledge, such knowledge has become an important aspect in modern scientific education.

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