The Design of Mechatronics Simulator for Improving the Quality of Student Learning Course in Mechatronics

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Abstract. Learning course on mechatronics specifically the Department of Electrical Engineering Education FPTK UPI still using simulation-aided instructional materials and software. It is still not maximizing students' competencies in mechatronics courses required to skilfully manipulate the real will are implemented both in industry and in educational institutions. The purpose of this study is to submit a design of mechatronic simulator to improve student learning outcomes at the course mechatronics viewed aspects of cognitive and psychomotor. Learning innovation products resulting from this study is expected to be a reference and a key pillar for all academic units at UPI in implementing the learning environment. The method used in this research is quantitative method with the approach of Research and Development (R and D). Steps being taken in this study includes a preliminary study, design and testing of the design of mechatronic simulator that will be used in the course of mechatronics in DPTE FPTK UPI. Results of mechatronic design simulator which has been in testing using simulation modules and is expected to motivate students to improve the quality of learning good study results in the course of mechatronic expected to be realized.

1. Introduction

Learning is the process of developing the expertise possessed by each student. Students are required to actively build knowledge and competencies that students have with professors who acts as a facilitator. With this method, students can acquire the knowledge and competence improvement well. The effectiveness of the learning process is influenced by factors of learning methods and media used. Both are intertwined, where the selection of a particular method will affect the type of media that will be used in the learning process, therefore there should be conformity between them to achieve learning objectives. Use of media in learning can generate interest and new talent and stimulate student motivation in the learning process.

In improving student learning and understanding necessary to have a media that can be used as an alternative in implementing the learning process in the classroom. Mechatronic simulator instructional media is an important tool to improve the learning outcomes of students in the subject of mechatronics, because the media is a form of student competency development. In the mechatronics engineering competency standards that are taught in the students of the Department of Electrical Engineering Education FPTK UPI, learning activities carried out by using a medium of learning that is dynamic with simulation methods. Obstacles encountered during the learning engineering is the only student can manipulate visually instead of the original object, so that students learn only through visual analyzes.

The modern advances in information technology and decision making, as well as the synergetic integration of different fundamental engineering domains caused the engineering problems to get harder,
broader and deeper [1]. Problems are multidisciplinary and to solve them require a multidisciplinary engineering systems approach, such modern multidisciplinary systems are called mechatronics systems [2-3].

Mechatronics engineer is expected to design products with synergy and integration toward constrains like higher performance, speed, precision, efficiency, lower costs and functionality, also in order to evaluate such concepts and others generated during the design process, without building and testing each one, Mechatronics engineer must be skilled in the modeling, simulation, analysis and control of dynamic systems and understand the key issues in hardware implementation [4].

The design of mechatronic simulator to be tested can be used a variety of engineering systems mektronika, including purely pneumatic systems, systems and pneumatic systems programmed [5]. With the design of mechatronic simulator is expected mastery of the course material can be increased so that the quality of student learning outcomes for the better. The designer of mechatronic has the freedom to modify these values, increase the number of inputs/outputs used and include non-linearities in the subsequent design iterations [6].

2. Literature Review

2.1. Mechatronics

In the narrow sense of mechatronic lead to numerical control technology is a technology using an actuator control mechanism to achieve a certain goal by monitoring the condition of motion of the machine using a sensor and enter that information into the microprocessor. Thus, mechatronics is a combination of basic disciplines such as, mechanics, electrical engineering, and informatics to design, produce, operate, or maintain the system and optimize the product to achieve the desired goal. Figure 1 shows a simple diagram of the science establishment mechatronic.

![Diagram of formation mechatronic science.](image)

The key element in success of a Mechatronics engineering program, and correspondingly Mechatronics engineering graduates, is directly related to the applied structural design methodology. A guidelines for structural design methodology and tools for the development process of Mechatronic products, that can support educators and help students in solving Mechatronics design integrated tasks with their specific properties and can be applied in educational process is highly required, such guidelines for structural design methodology are proposed in [2-8].
Some of the benefits of applying mechatronics [7], among others:

2.1.1. Increase flexibility. Mechatronics can be applied to improve the flexibility of a piece of equipment, such as industrial robot arm that can perform various kinds of work by changing the software program on a microprocessor as well as a human arm. This is a major factor allowing for the production of diverse type is the relatively small quantities.

2.1.2. Improve reliability. Mechatronics can improve reliability, such as the use of electronic components to control the movement so that the components of the manual machine motion controllers can be reduced, as well as improving reliability.

2.1.3. Improve the precision and speed. The application of digital control and electronics technology, the level of precision machinery and machine motion speed can be increased even higher to a certain extent. This limit, for example is a machine rigidity that prevents higher speed because of the advent of vibration. The elements of mechatronics include: mechanical machines, sensors, controllers, drive circuit, actuators, and other sources of energy.

Mechatronics system as an overall system, and embedding the sensor, actuators, and microcomputers into the mechanical process, the microcomputers can be integrated with actuators, the process, or sensor or be arranged at several places. Integrated sensors and microcomputers lead to smart sensors, and integrated actuators and microcomputers developed into smart actuators. For large systems bus connections will replace the many cable. Hence, there are several possibilities to build up an integrated overall system by proper integration of the hardware [1].

2.2. Mechatronics system design
Mechatronic system design process addresses these challenges, it is a modern interdisciplinary design procedure, it is the concurrent selection, evaluation, integration, and optimization of the system and all its sub-systems and components as a whole and concurrently, all the design disciplines work in parallel and collaboratively throughout the design and development process to produce an overall optimal design– no after-thought add-ons allowed, this approach offers less constrains and shortened development, also allows the design engineers to provide feedback to each other about how their part of design is effect by others.

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3. Methods
The research method using a combination approach to Research and Development (R & D), where the methods of research conducted in this study required several stages of the preliminary studies, designing, manufacturing tools, product testing is limited to accept the proposed improvements of the user,. The next step is to decide the steps of the improvement of existing products and the improvement of products. After experiencing improvement, product more widely tested and used in the learning process and then analyzed the results of the learning process by using the media created.

Mechatronics design approach challenge conventional sequential design approach, by connecting machine design-test tools and creating a virtual machine prototype before designing the physical machine, to take all advantages that can result from an integrated design, this approach offers less
constrains and shortened development, also allows the design engineers to provide feedback to each other about how their part of design is effect by others [1,2,7].

4. Results and Discussion
Trainer trials carried out gradually, starting from testing of components, test wiring after component coupled to the stand, and then to test the overall ranging from logic module panel, module temperature control, and stepper motor modules. The following documentation of the results of their trial:

4.1. Logic module panel experiment

These trials involved testing the wiring, testing the connection between a laptop with logic panel, the testing process of downloading and uploading program. Wiring strung indicated on the module as in figure 3 below:

When the wiring has been completed and no error occurs in the device simulator, further programming HMI / Display using GP Editor software and programming ladder diagram using Smart Studio software.
In such testing all aspects of the device works fine ranging from components, software, up to the communication device. Not found problems or errors that cause interference with the performance of the device.

4.2. Control module temperature experiment
At the trial of this temperature control module includes the testing of components, wiring test whether it is appropriate or not, the test program, and test sensors. First performed in accordance with the scheme Coupling circuits contained in the module, and then conducted the experiment in accordance jobsheet. Here are some of the documentation of mechatronic simulator experiments.

At trial circuit temperature control all devices are working properly and smoothly and no significant error, this shows that the simulator devices are working properly and in accordance with the given jobsheet [9-11].
5. Conclusion

Based on the results of the design, testing, analysis tools as well as the discussion of the study, the authors came to the conclusion, among others:

a. Design and manufacture of mechatronic simulator that has been equipped with modules and usage guidelines are expected to assist students in learning and supporting subjects mechatronic system so that the quality of learning outcomes for the course is expected to improve both aspects of cognitive and psychomotor aspects.

b. Based on test results that have been carried out, ranging from logic testing panel, temperature control, and stepper motors can be concluded that the trainer designed mechatronic been able to work well without any errors or significant disruption.

c. Trainer mechatronics has been designed has several advantages including easy to use, because it has components that are portable and can be set in accordance with the position that we need and has a plug & play models are more efficient over time with furnished by guidebook or structured modules.

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