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Prototyping wearable devices for boosting entrepreneurial spirit

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With the advances in technology and more applications becoming real-time and embedded, teaching the mechatronics course only theoretically becomes insufficient. Consequently, project-based learning becomes one of the most effective approaches in teaching mechatronics subjects. The main objective of this paper is to present an innovative approach in project-based learning within a mechatronics course for teaching undergraduate students. The project based learning is presented through student projects inspired by wearable electronics as new trending fields in mechatronics. In this paper, a novel methodology for implementing the project based learning process was described. The course structure, organization and evaluation are explained. The students' feedback, results and the benefits from the course are also discussed. Conclusions about the project based learning and its effects in teaching mechatronics among undergraduate students are pointed out.

Keywords

Engineering Education, Entrepreneurial Spirit, Mechatronics, Project Based Learning, Wearable Electronics

1. Introduction

Mechatronics as one of the most innovative engineering field has not only introduced a synergic integration of disciplines such as mechanics, electronics and computer science, but has also turned the engineering education into a design philosophy [1]. Mechatronic systems comprise a basic system (mechanical, electro-mechanical, hydraulic or pneumatic), sensors, actuators and information processing. In general, a mechatronic system consists of three types of flow: material flow, energy flow and information flow. An overall scheme of a mechatronic system is given in Figure 1.

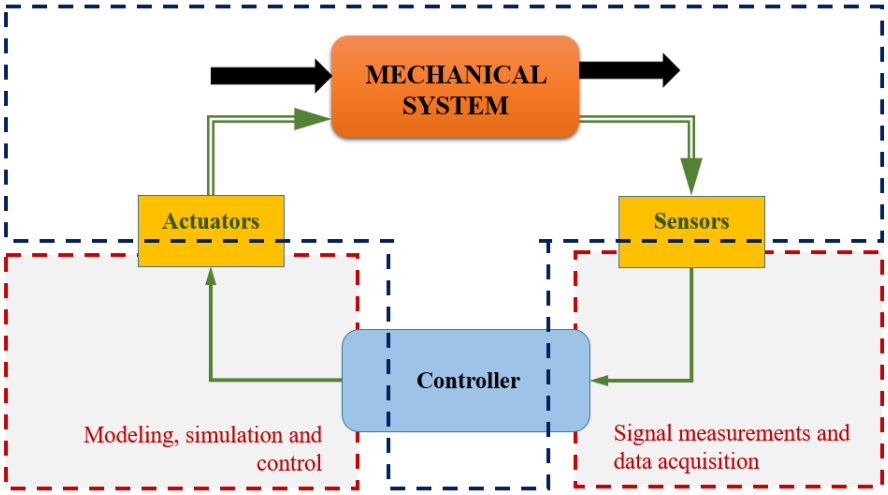


Figure 1. Overall mechatronic system scheme

Mechatronic curricula is a challenging process because it requires creative and critical thinking and also team-oriented skills. There are various methodologies and definitions that have been created to define the mechatronic system design, such as the industrial guideline VDI 2206. This standard gives a definition about the process of developing a mechatronic system: “The development of mechatronic systems presupposes the fully inclusive consideration of the systems, an interdisciplinary way of thinking, a common accompanying language among the developers and usually the use of computer-aided tools.” Because of the complexity and heterogeneity affecting most mechatronic systems, a systematic procedure is essential. Also, VDI 2206 presents the “V-model” as macro-cycle which is a graphical construct used to connect the model-based learning design and the development methodology, as shown on Figure 2.

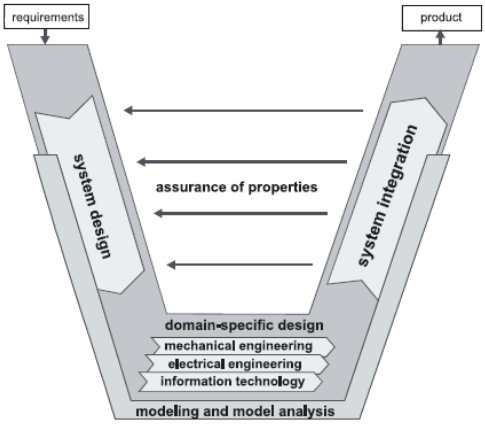


Figure 2: ”V-cycle” according to VDI 2206 [2]

Project based learning (PBL) presents a methodology for applied engineering education which is created to allow students to develop projects which are applicable to the industry [3]. Apart from the classical teaching methods, project based learning provides the students a chance for a hands-on, real industry problems solving which will make them more competent and skillful for a further job in the dynamic and demanding engineering labor market [4]. The project based learning opens up new wider ways of creative thinking, develops their skills in decision making, time management and ultimately most important team working [5]. Project oriented education strengthens the development of the soft skills of the students in terms of making their own decisions and taking responsibility in the process of creating an original idea. At the end of the process, their motivation and self-esteem get drastically higher because they feel successful in designing real projects [6]. The final result of practical project implementation is the integration of applying basic knowledge, specific knowledge and acquirement of new theoretical knowledge, but most important in improving students' practical competences [7, 8].

Within the study program in Mechatronics in the Faculty of Mechanical Engineering in Skopje, students have been involving in project-based learning process in the past 10 years. The project based learning is implemented through organized projects where students work on predefined tasks that would lead to complete products. In 2010, a project consisting of Universities and EU industry partners has been developed in order to establish connection to the local industry needs [9]. One of the objectives of the project for the Faculty of Mechanical engineering was a development of an autonomous vehicles as a student project industry examples of project based learning which are presented in [10].

The main objective of this paper is to present an innovative approach in project-based learning within a mechatronics course for teaching undergraduate students on their 3rd year studying on the mechatronics study program. The course "Introduction of mechatronics" is the first mechatronics course that student have while their study. The purpose of this paper is to present a successful methodology for teaching mechatronic by developing goal-oriented student projects within this course in the Faculty of Mechanical Engineering in Skopje.

2. Teaching methodology

To define the mechatronics system design, a method composed of combined knowledge was applied to the mechatronics curricula. The course structure was compiled of 4 segments: theoretical study of the fundamental concepts, LabVIEW software programming, writing a research paper and developing prototype. The project based learning methodology allow the students to real develop real projects. The applied methods to this mechatronics curricula achieved effective and easier understanding of the overall design and concept of the mechatronics system.

The idea was to introduce project based teaching mechatronics to mechanical engineering students from Mechatronics study program. There were 30 students divided in 15 teams consisted of 2 people and each team had to deliver a project task until the end of the semester.

At the primary phase, the students were assigned to do a research within the given topic about wearable electronics and choose an interesting segment to further analyze. The goal

was each team to produce a prototype and to write a review paper about the subject they have chosen. This made the projects themes more global, challenging and more motivating. Through developing simple, but still attractive and very useful projects, the students have learned the work and implementation of the sensors, actuators and computer programming as a consisting parts of a mechatronic systems.

A period of one week was given to the students in order to explore and read about the topics and to choose an interesting specific problem observed in 5 relevant (not older than 5 years) scientific papers. The teaching assistant and the student assistant presented the students how to proceed the process of searching and exploring successfully in order to find relevant information. They introduced them to “Google scholar” as a searching machine to find important research and review papers. After the first week, the teams presented their ideas in front of the professor and the teaching assistant and explained their vision and plans on how the project will be realized. These ideas were discussed and approved or in some cases modified by the professor. Their resources were framed only in terms of limited time and money. They were allowed to use components only from the Mechatronics laboratory under the Faculty or to spend additional 10 Euros per student and were given a period of 10 weeks to complete the projects. During the working process they were monitored by the teaching assistants who asked for a weekly report about the progress of the work, but were also helping them with certain problems they were facing. They were also analyzing the students’ team work and the atmosphere among the team partners. In the meantime, the student assistant was teaching the students software programming in LabVIEW, as a part of the subject content. At the end, the total grade of the project teams in general, and of every student separately was evaluated by the following criteria, as shown on Figure 3.

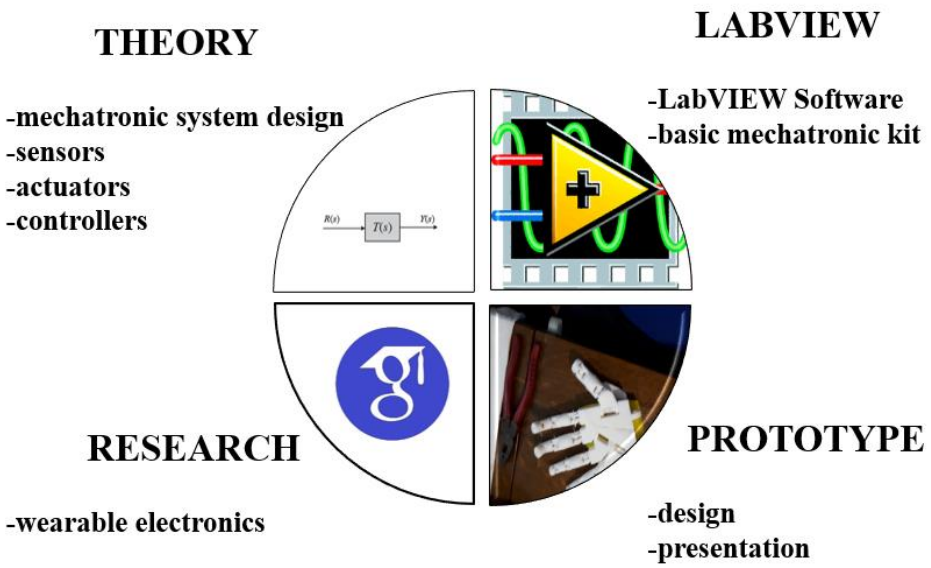


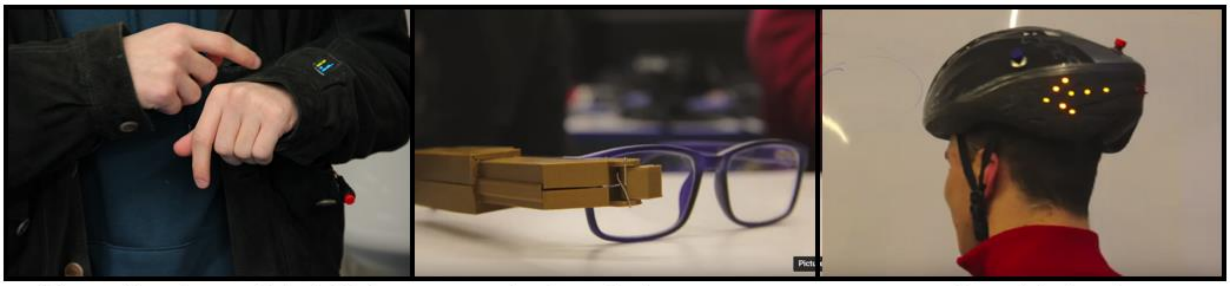
Figure 3. Course structure

In the 8th week of the semester, the students were tested over in theoretical concept. In the 14th week they had another test in form of LabVIEW exercises which contributed with another 25%. The rest 50% were given to the students according to the quality of the review paper they have written and the prototype that they were expected to make at the end of the semester. Every part of the subject was quantified equally with 25%. After the 15th week, the professor and the teaching assistant organized a class where all of the teams had to present their prototypes in front of all the rest. Each team was given 15 minutes to present a PowerPoint presentation about their work and to show their prototypes. After that, they were evaluated by the professor, the teaching assistant, lawyer for intellectual property and the students themselves. Each student was graded according to the percentages from the self-grading and percentages from the test.

Each of the segments of the course structure contributed to upgrading students' skills equally effective, but in different aspects. The theory that they have been taught and afterwards examined helped them in concepts understanding and improving their technical literacy in mechatronic field. They have learned the principles of work of components that one mechatronic system is built of and the physical and engineering processes happening meanwhile. The LabVIEW software provided the students with a hands-on experience in software analysis and interfacing and DAQ analysis which created a virtual image about a mechatronics system function. They were introduced to Google scholar as a way of searching which has never been mentioned or used during their studies. Also, in order to write their own research paper, they were introduced to the key-points of a paper structure and the methodology of writing a paper. When their papers were finished, they were taught how to check them for plagiarism online. On the other hand, apart from the technical knowledge they got through studying the theory and software, they also progressed in developing their soft-skills through their work on the prototype.

3. Case studies

The process of working on the projects resulted in upgrading not only the theoretical, but also practical education, but also their team spirit and soft skills were developed. Through working on a specific project for wearables, their motivation and inspiration for self-proving increased. Wearable devices or simply wearables, are devices that can be worn on different parts of the body that have integrated microcontrollers in order to achieve different functions. Easy to wear, constantly evolving and upgrading, wearable electronics are becoming the new trend. At the end of the course, they were feeling proud and appreciated because their projects were successful and their prototypes were properly working. The course resulted in different, very prosperous projects. In this paper are presented the inspiration, the idea and the final results from the best 3 of them, shown on Figure 4.



a. Wearables for assisted driving b. Smart glasses c. Smart helmet

Figure 4. Prototypes of the case studies (a. wearables for assisted driving; b. smart glasses; c. smart helmet)

3.1 Wearables for assisted driving

This project was inspired by the in-car usage of wearables is inevitable as many drivers bring their gadgets in the cabin space. With the tendency towards connected cars, investments in car-related technologies such as wearable devices and smartphone apps drastically increases. Also, many of the major automakers adopt the concept of wearable electronics in attempt to enhance the driving experience. This type of devices for in-car use can be exploited for many different purposes. The main one is the safety of the passengers achieved by detecting drowsiness, stress level of the driver, or even identifying theft of the automobile. Prototype of a jacket for assisted driving was constructed. The jacket has multiple functions provided by implemented sensors for breath analysing for toxicity level in the blood, sensor for seat-belt alert and the temperature and humidity in the air.

3.2 Smart glasses

Smart glasses are to glasses as smart watches are to watches—that is, they're a wearable device capable of presenting useful information to the user. The project develops smart glasses that give information about oncoming call, a text message, weather prognosis and GPS information while driving. The smart glasses are a very practical solution and cheap solution to a lot of modern problems. The model contains low-budget electronics such as: Arduino Mini, an OLED display, Bluetooth shield, Li-Po battery and a charging station. As for non-electronic parts, 3D printed plastic casing is used and a mirror to reflect the picture with a small glass screen on which the picture is projected. When fully assembled, the glasses connect with a smartphone using application that sends the information.

3.3 Smart helmet

The main inspiration behind this project is providing safety while driving bicycle using wearable electronics. A smart helmet is a helmet designed for improving the safety of those who use bicycles as a way of public transportation. Its integrated system is designed to provide effective travelling through public traffic and increase the awareness of the others

surrounding the bike. The prototype has been categorized as a wearable electronic and uses several smart components that define its functionality. The helmet's main functionality is to provide LED powered turn signalization. The LED lights are connected to an Arduino platform which contains a smart program code designed for this specific functions. On the sides of the helmet there are two touch buttons which are put in place as a way to activate the LED indicators. In between the left and right signal, there is a red STOP blinking LED signal which changes its blinking style depending on the use of the turn signals. This system is compact and easy to use, provides a modern solution to safer and cost effective public transportation.

4. Soft skills development

The project based learning conducted within the "Introduction to mechatronics" class is a process of inductive teaching and learning which focused on developing innovative thinking in students. For the students, it is not sufficient to only obtain technical skills and knowledge, but also to develop communication and team-based skills. This approach utilizes real problems, not hypothetical ones and teaches the students how to function in a systematic and progressive way. Besides the classic way of grading and questioning, the course included self-directed learning and learning from the peers. The students were divided in teams and were given limited time and money to construct their project prototype. This resulted in increased sense of responsibility and resource management. Given the task to create a project prototype on a subject they have never read about was very challenging for them and developed their research, problem-solving and critical thinking skills. The team-work upgraded their awareness of discipline and strive to achieve success in order to stand out and not disappoint their team members. They were motivated to deliver the given task in terms of creating the best technical solution, but they also had to pay attention of their relationship and communication with the rest of the students. As a new aspect, they were introduced to academic writing for the first time. Throughout the semester, they were constantly learning and comparing each other's work, which created a positive and healthy competition. The grading was separated in four equally valued parts (theory, software, review paper and prototyping) which tested their capabilities of strategic thinking in terms of organizing the work more effectively, efficiently and systematically. Essentially, at the end of the course the students' feedback was most important. They were feeling self-confident and stated that they feel like they have improved their knowledge, attitude, values and skills. They realized that engineering, especially mechatronics, is more than just facts and equations.

3. Conclusions

In this paper an innovative methodology to mechatronics course was presented. The main aim of these projects was to implement the project based learning in the "Introduction of mechatronics" class held in the Faculty of Mechanical Engineering in Skopje. The project based realization of the subject resulted in being very successful.

Based on implementing the project based learning experiences, it can be concluded that the main benefits of project oriented education are acquiring basic and specific knowledge and application of the acquired knowledge unlike the traditional education approach. As an overall

conclusion from this process is that both teachers and students have to show bigger commitment and responsibility in the process of teaching and learning. The project based learning have shown to be the most adequate methodology for teaching mechatronics in specific, but engineering in general, because it represents a link between the education and the industry. This way of learning provides the students competences that drastically increases their chances of success in the modern world.

Based on implementing the project based learning experiences, it can be concluded that the main benefits of project oriented education are acquiring basic and specific knowledge and application of the acquired knowledge unlike the traditional education approach, developing soft skills, entrepreneurship and serious approach on solving a real problem. As an overall conclusion from this process is that both teachers and students have to show bigger commitment and responsibility in the process of teaching and learning.

The work of the team led by the assistant professor, as well as videos from the projects that were constructed at the end of the semester within this class can be followed on http://ms3lab.com/.

References

1 Shetty, D., and A. C. Giriyapur. "A new approach in mechatronics education through project based learning by international collaboration." In *em 120th ASEE Annual Conference & Exposition, Frankly*. 2013.

2 VDI 2206

3 Avilés, Oscar F., Ruben D. Hernández, And Jaime Duran García. "Project Based Learning Applied To Teaching Mechatronics." *International Journal Of Applied Engineering Research* 13, No. 22 (2018): 15574-15579.

4 Wang, Yu, Ying Yu, Hans Wiedmann, Nan Xie, Chun Xie, Weizhi Jiang, And Xiao Feng. "Project Based Learning In Mechatronics Education In Close Collaboration With Industrial: Methodologies, Examples And Experiences." *Mechatronics* 22, No. 6 (2012): 862-869.

5 Putra, Andi Sudjana, Jun Jie Ng, Kok Kiong Tan, Hwee Choo Liaw, Kok Zuea Tang, Sunan Huang, And Tong Heng Lee. "Enhancing Student Participation In A Design-Centric Mechatronics Class." *Mechatronics* 23, No. 8 (2013): 918-925.

6 Davidovitch, L., Avi Parush, And A. Shtub. "Simulation-Based Learning In Engineering Education: Performance And Transfer In Learning Project Management." *Journal Of Engineering Education* 95, No. 4 (2006): 289-299.

7 Pinter, Robert, And Sanja Maravic Cisar. "Measuring Team Member Performance In Project Based Learning." *Journal Of Applied Technical And Educational Sciences* 8, No. 4 (2018): 22-34.

8 De Los Rios, Ignacio, Adolfo Cazorla, José M. Díaz-Puente, And José L. Yagüe. "Project–Based Learning In Engineering Higher Education: Two Decades Of Teaching Competences In Real Environments." *Procedia-Social And Behavioral Sciences*2, No. 2 (2010): 1368-1378.

9 Gavriloski, Viktor, Jovana Jovanova, And Klaus Peter Kaemper. "Project-Oriented Approach In Mechatronic Education In Macedonia, Kosovo And Montenegro." In *Mechatronics (Mecatronics), 2012 9th France-Japan & 7th Europe-Asia Congress On And Research And Education In Mechatronics (Rem), 2012 13th Int'l Workshop On*, Pp. 231-236. Ieee, 2012.

10 Fürstner, Igor, And Zoran Anišić, Eds. "Proceedings Of The 2nd Regional Conference Mechatronics In Practice And Education–Mechedu 2013." (2013).