Experiences of Robotics students in Machine Vision course being taught in a foreign language: comprehension, self-efficiency, and active learning strategies improvement

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Abstract

Crisis in Russia in 1990s significantly decreased engineering education quality. To catch up with developed countries, a novel 2-year master program in Intelligent Robotics was designed and implemented at Kazan Federal University based on world leading universities' experience. The program targets to educate competitive specialists with competences that are required by world labor market. To follow students' progress in core robotics courses we conducted surveys. The paper reports survey analysis that was conducted in Machine Vision course and covered such issues as English language comprehension, self-efficiency, and active learning strategies.

Keywords: Engineering education, robotics education, postgraduate studies, master program, Machine Vision, motivation.

1. Introduction

We are evidencing comprehensive digitalization and automation of all aspects of our daily life, including healthcare[1], economics[2], etc. Social and demographic challenges that developed countries are recently facing force us to develop technologies at accelerated pace in order to replace human labor with robotic systems (RS). Consequently, world demand for specialists in robotics is growing rapidly and creating new challenges for up-to-date engineering education.

According to Robotics Russian Association, robot density in 2014 was 66 RS per 10 000 workers while in developed countries the automation level is significantly higher, e.g., 478 RS in Korea, 314 RS in Japan, 292 RS in Germany, 164 RS in US[3]. To catch up with developed countries Russian government started long-term investments into engineering education and establish new higher education programs.

As a result of these efforts, a new master program in Intelligent Robotics was launched in September 2017 at Higher Institute of Information Technology and Intelligent Systems of Kazan Federal University, and its syllabus was designed to consider local employers' requirements[4]. After establishing the pilot program, we continue conducting student feedback surveys about our courses and to update the courses aiming for further effectiveness improvement. This paper presents analysis of Machine Vision course survey that was conducted in the (first) Fall semester of 2017-2018 academic year.

2. Postgraduate robotics studies

The master program targets to educate highly skilled experts in the field of Intelligent Robotics using modern set of robotic equipment that includes various types of robots and broad selection of sensors and cameras. Along with technical skills in robotics we provide

postgraduate students with such courses as Social Robotics and Communication Skills as serious robotics projects are always a team work and soft skills are a must in order to successfully implement a project.

Before opening the master program in Intelligent Robotics at KFU, we had started our surveys among bachelor students in order to understand motivation, evaluate environment of teaching in English and an opportunity to allow complicated material explanations in Russian considering the fact that all students were Russian native-speakers[4]. Further to have a regular update and improve our master program based on feedback from students we continued conducting surveys with students that are enrolled in Intelligent Robotics master program on the core courses of our syllabus such as Introduction to Robotics[8], Sensors and Sensing, Robot Operating System (ROS)[5] and Machine Vision.

3. Curriculum of Computer Vision Course

Machine Vision is one of the essential disciplines in the master program curriculum as visual feedback is very important for robots especially in industry where wide range of visual systems is applied[6]. In the last decade vision systems become more available due to technological improvements and progressively decreasing costs, which provided more facilities for developing new applications and using robots in production. In our curriculum we take into account that vision-assisted robots taking over a number of manufacturing jobs such as quality control, precision manufacturing and product sorting. Additionally, they also play a significant role human-robot collaboration and multi-agent robotics.

According to survey results no respondent studied Machine Vision subject before entering the program, either at educational organizations or by self-studying. Before launching the program, we anticipated this fact and designed Machine Vision curriculum assuming that students do not possess any knowledge in this field. Thus, the curriculum consisted of the following topics:

1. *Image formation*: optics, cameras, and representations.
2. *Image transformations*: sampling, color spaces, convolutions, linear filters, and histograms.
3. *Nonlinear filtering*: median filter, Fourier and Laplace transforms, frequency analysis, and transfer function.
4. *Feature Detectors*: feature points and matching, gradient, edge and corner detection, Harris detector, Canny and Sobel filters.
5. *Stereovision:* calibration, epipolar geometry, homography, stereo disparity, structure from motion, and optical flow.
6. *Recognition*: Machine learning in computer vision, neural networks, and image categorization.

By completing the course successfully, the participant was expected to possess the following skills:

- understand theoretical and practical aspects of image manipulation, formation, measurement, and analysis;
- implement methods of image matching and alignment;
- determine geometric relations between 2D images and the 3D environment;
- know and able to apply object and scene recognition, image categorization;
- design architecture of computer vision applications.

4. Research Method and Analysis

The surveys assist us to analyze attitude, motivation, and challenges that students faced during Machine Vision course in the first semester of the master program, which lasted 1.5 astronomical hours, and was run 18 weeks. We conducted initial survey after the first class and a final survey in the end of the course before a final test. The initial survey included 49 questions that referred to students' expectations from the course and previous experience, while the final survey included 39 questions and questioned about new in-class experience. A number of identical questions in both surveys allowed observing dynamics of English language and motivation. The surveys were conducted in Russian via on-line Google forms. The questions contained statements, open-ended and multiply choice questions. Each statement was presented on a 5-point scale with optional answers: strongly disagree (SD), disagree (D), no opinion (NO), agree (A) and strongly agree (SA), which appear along X-axis in Fig. 1-6. Y-axis of Fig. 1-6 indicate percentage of the respondents that selected the corresponding options. We applied the same research method that we had used in our previous papers[4,5,7,8]. For the analysis we selected 9 respondents with technical background who participated in both initial and final surveys.

4.1. *English language comprehension*

Machine Vision classes were taught in English to Russian native speakers considering that students had some history of studying English language at school and university. English language comprehension was assumed the main milestone for effective teaching, however, the students did not meet significant difficulties with receiving information in English[4,5]. As Fig.1 demonstrates, the tendency of using English with less anxiety was positively progressive by the end of the course. A special language environment was created for the students to feel comfortable and perceive material more effectively. Figure 2 depicts a reflection on the opportunity to ask for explanations in Russian if a student could not understand the material in English, and the tendency was positive toward the course end.

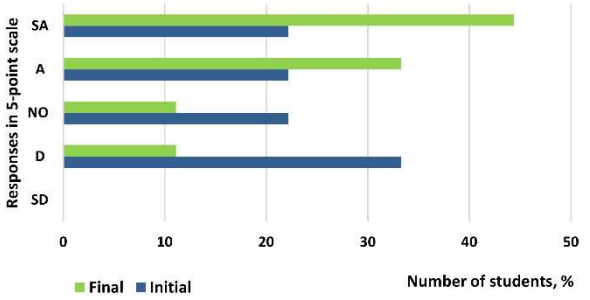

Fig. 1 I do not worry if I make mistakes while speaking English during classes.

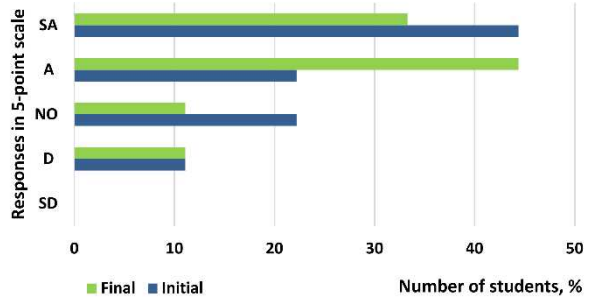

Fig. 2 I am not afraid if I do not understand when the teacher speaks English, because I can ask for explanations in Russian.

4.2. *Self-efficiency*

In the end of the course majority of students (11,1% SA and 44,4% A vs. 44,4% NO) considered the course was the most difficult for them in comparison with other courses. Even though 55,5% of the students considered it to be the most difficult one in both initial and final surveys, 88,8% of them disagreed with the statement "I think, I will not be able to learn the subject no matter how much efforts I put". Moreover, responding "If a lecture content is difficult I would avoid learning the material" statement, the students replied 66,6% SD and 33,3% D in the beginning of the course and 77% SD, 11,1% NO, 11,1% A by the end of the course, which supports the conclusion that despite difficulty of the course more students shifted to be more self-efficient while learning the material. Figure 3 shows that during the course 77,7% of the students thought that they will pass the final examinations successfully.

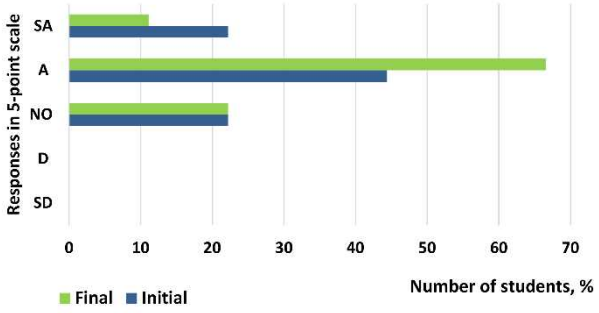

Fig. 3 I am sure I will successfully pass Machine Vision course.

4.3. *Active learning strategies*

During the course the students not only passively digested the material but also actively learned it using extra sources (Fig. 4). One of the motivation components to study the subject could be related to students' plans after graduation as it is shown in Fig. 5: 100% of the students (66,6% SA, 33,3%A) realized the importance of studying the subject since they believed that they are going to use this knowledge in a future job.

Moreover, 6 out of 9 respondents would like to connect their future with robotics, while 3 did not decide yet. However, even with that high motivation the course was not an easy one for the respondents as 77,7% (66,6% SD and 11,1% D) disagreed with the statement that they would study the course independently rather than participate in the classes (Fig. 6), which adds credits to self-efficiency where students considered the subject the most difficult among other courses.

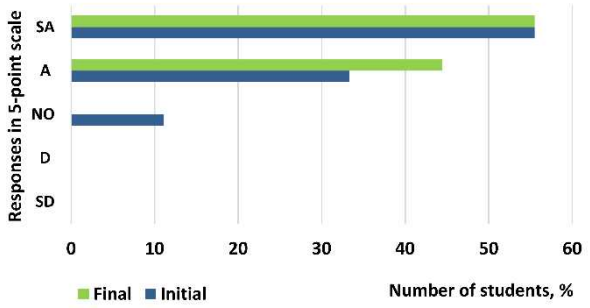

Fig. 4 If I do not understand new material of Machine Vision course, I shall try to find extra sources myself to understand it.

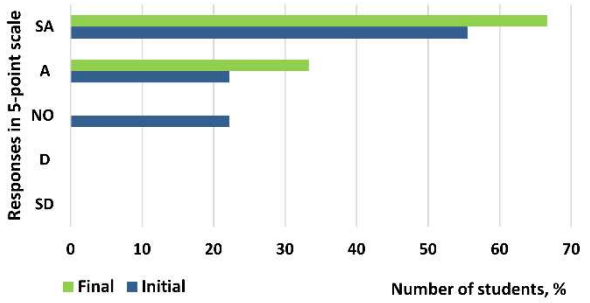

Fig. 5 I think that studying Machine Vision course is important, because I shall use this knowledge in my future job

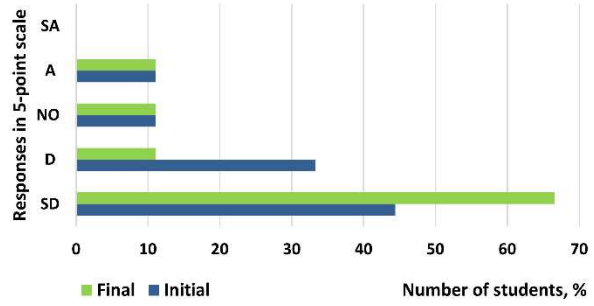

Fig. 6 If I had an opportunity not to take Machine Vision class I would have better learned it by myself.

5. Conclusions

Analysis of surveys among postgraduate students of Machine Vision course showed positive results in the course material comprehension in English while having an opportunity to ask for additional explanations in Russian. Despite the fact that the course was evaluated as the most difficult one among others, the students applied significant self-efficiency to learn the subject and used active learning strategies while possessing high motivation to study the course because the vast majority of the respondents associated their future career with robotics. Next we plan to develop new surveys in order to evaluate master program in Intelligent Robotics courses content comprehension along with conducting continuous surveys to track students' needs and to follow the robotics area global market employers' requirements.

Acknowledgements

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References

1. A. J. Aljaaf, C. Mallucci, D. Al-Jumeily, A. Hussain, M. Alloghani, J. Mustafina. A Study of Data Classification and Selection Techniques to Diagnose. *Applications of Big Data Analytics: Trends, Issues, and Challenges*, Springer (2018), p 121-134.
2. R. C. Brown. Made in China 2025: Implications of Robotization and Digitalization on MNC Labor Supply Chains and Workers' Labor Rights in China. *Tsinghua China L. Rev.* (2016), 9, 186.
3. Russian National Association of Robotics Market Participants. Analytical Research: World Market of Robotics (January, 2016). http://www.robotunion.ru/ru/
4. T. Tsoy, L. Sabirova, & E. Magid, (2017). Towards Effective Interactive Teaching and Learning Strategies in Robotics Education. *IEEE Int. Conf. on Developments in eSystems Engineering* (2017), pp. 267-272.
5. T. Tsoy, L. Sabirova, & E. Magid. Effective robotics education: Surveying Master Program Students Experiences in Robot Operating System Course. *IEEE Int. Conf. on Developments in eSystems Engineering* (2018).
6. L. Pérez, Í. Rodríguez, Í., N. Rodríguez, R. Usamentiaga, R., & D. García, D. (2016). Robot guidance using machine vision techniques in industrial environments: A comparative review. *Sensors*, 16(3), 335.
7. T. Tsoy, L. Sabirova, M. Abramsky, E. Magid. Establishing Effective "Teaching for Robotics: a comparison study of Bachelor students participated in Introduction to Robotics course". *Int. Conf. on Artificial ALife and Robotics*, pp. 212-215, 2018.
8. T. Tsoy, L. Sabirova, E. Magid. "Effective robotics education: Surveying Master Program Students Experiences in Introduction to Robotics Course", *Int. Conf. on Mechanical, System and Control Engineering*, vol. 220, 2018.