IMPLEMENTATION AND THE CONSIDERATION OF THE GLOBAL ENGINEERING EDUCATION

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Abstract

In the field of engineering education, Toyohashi University of Technology (TUT), Nagaoka University of Technology (NUT), and National Institute of Technology (NIT) have conducted the construction of the global educational environment (Tri-Institutional Collaborative/Cooperative Educational Reform Project), since 2014. As one of the global activities, TUT has provided Global Faculty Development (GFD) project since 2013 including the preparation. In GFD project, teachers from TUT, NUT, and NIT joined to develop and brush up the teaching skill to conduct lectures and practical workshops, for the global engineering education. The project has been carried out in three places: TUT Head Quarter, City University of New York Queens College (CUNY QC), and TUT Penang Campus in Malaysia. The acquisition of teaching and learning skill in the area of multi-cultural and multi-ethnic society was very effective and meaningful to step up the international skill of teaching. After the training in New York, actual lectures have been carried out in polytechnics and a university in Malaysia, to complete the outcome of the project. The technical subjects based on engineering field such as mechanical, electrical, chemical, architecture, civil engineering have been lectured in Politeknik Tuanku Sultanah Bahiyah (PTSB), Politeknik Seberang Perai (PSP), and Universiti Sains Malaysia (USM). The author made lectures of image processing technology for production engineering. In order to lead the students for the introductory learning of the industry field, basic and fundamental topics were lectured and explained. To encourage the comprehension of the learning contents, simple but useful concepts of image processing theory and practical examples were provided. In this paper, the detail of the trial of the technical subject lecturing, the evaluation, and considerations are described.

Keywords: image processing, quality control, production engineering, industry 4.0, engineering education, faculty development of teaching, international activities

1. Introduction

As the growth of global economy and industry, ethnic diversity has been spread and developed in many regions of the world. It has also given rise to the needs of globalization of education, especially in the fields of science, technology and engineering (e.g., Banks, J.A. (2007) and Downey, G.L. (2010)). In a part of conventional and traditional style of higher education, teaching and instruction had been done to the native students as the majority, and to the foreign students as the minority in the native language. However, as the worldwide movement of ethnic diversity spreads, the new trials of education have been needed to respond to the globalization of education (e.g., Ness and et al. (2017) and Moore C.B. and et al. (1997)). In order to fulfill the needs, teachers and instructors have to have the teaching skill in common language such as English even in Japan, and the sense of mutual understanding in international circumstances (e.g. Hoff, E. (2009)).

As described in the abstract, the author joined the GFD project in 2017. It was one-year project, and the trainees including the author have developed and reinforced the teaching skill under the international educational environment. In order to complete the project, and as the final stage of training of the project, the trainees had an opportunity to make lectures in three educational institutes in Malaysia. They were conducted mainly in mechanical, electric, electronic, and computer science classes. The contents which the author lectured are oriented to learn the fundamental and basics of image processing for industries, so that the students can easily start the study, and be interested to learn the technology.

This paper describes the details of conducting the lecture. It consists of main three parts, the preparation, the implementation, and the feedback & assessment. In the section 2, the concept and the topics of the lecture are described as the preparation. In the section 3, the implementation of the lecture is described. In the section, the contents of the lecture, the class going, and the communication with the students are described. In the section 4, as the results and the discussion, the survey of the lecture by the students and the results are described. In the section 5, overview and the consideration are described as the conclusion.
2. The preparation of the lecture

2.1 Structure and the flow of the class

When we make lectures, especially in the case of the students’ backgrounds are academically and ethnically varied, such as internationally circumstanced class, the teacher/lecturer needs to design the lecture contents more cautiously and properly than domestic and conventional case. To avoid the situation of misconception and/or low comprehension of the learning contents, it has to be carried out with organized and consistent flow (e.g., Caspi and et al. (2005) and Ambrose and et al. (2010)). In order to realize the organized lecture, the flow should be consisted mainly three parts: introduction, main part (subject matter), and conclusion. In the part of introduction, warming up and ice break talk should be included as the start up. After showing the contents list and outline of the lecture, the back ground and the objective of the subject are explained sufficiently, to clarify the purpose of learning the subject. At the end of the introduction part, small quiz and Q&A are also useful to simply check the comprehension and the reaction.

Next to the introduction, as a first step into the subject matter, a fundamental theory of the main theme is explained, and an example is given to understand the theory easily. To encourage the students’ interest, the example should be easy and/or familiar to imagine and figure out the problems. Using the first example of the subject, a basic and easy question is given to the students. To solve the question, the topic can be discussed with the group. If they seem difficult to figure out, giving hints is also effective. By the interactive communication with the students, finally reach the correct answer and the essential part of the theory. After the small comprehension check with Q&A and short discussion, proceed to the next level of the subject. At the second step, to accelerate and to deepen the comprehension of the subject matter’s concept, middle level (or advanced) question is provided. Using the concepts and the skill which are obtained in the first question, students try to solve an advanced problem. In this step, the combination with the former question and the concept to learn, new concept, and the related skill are given to the students. Through the communication of the comments and questions from the students, the teacher should overview and recognize the level of students’ comprehension and the interests of the subject matter. As the third part of the subject matter, advanced level of the contents are explained and displayed to make students to have wider knowledge and skill of the subject. Where needed, another quiz or assignment could be provided to step up the higher level.

As the final part of the lecture, the conclusion of the class is explained. In this part, the important and effective points of the contents should be listed to summarize the subject matter. This is also an important part to deliver the useful, practical, and essential part of the lecture. To set up these process for the lecture’s preparation, the teacher has to be aware of international sense of communication with the students, supposing the students are consisted of multi-national background. To share the concepts of the subject with the students, the delivered message should be constructed with the global mind set.

2.2 Build-up of the contents of the lectures

In order to conduct the lectures for the students of three institutes in Malaysia (PTSB, PSP, and USM), fundamental theory and basic skills of image processing have been applied. At the step of the preparation, the students’ academic profile, such as the learning background of mathematics, physics, and engineering was previously informed. The target students belong to mechanical engineering, electric/electronic engineering, and computer science departments. Addition to that, the age-group and the students’ attitude (e.g. quite positive and/or shy), are also useful as a prior information, to make a good matching with the contents and the students. The contents is mainly based the software part of the technology, and specially oriented to apply the field of production engineering such as plants and factories. To keep the good quality of the product which are assembled on the production line, quality control is crucial and essential. As one of the solutions to realize the quality control, image processing technology is very practical to detect the defects and problems of the products on the production line. On the other hand, the demands of the engineer who has the skills of image processing are rapidly growing, especially in the field of factory and logistics engineering (e.g. Industry 4.0). As we know, East and Southeast Asia regions have big potential as markets and manufacturing bases. To respond the potential also, the learning the basic of image processing for the industry is quite effective and useful.

To start the introductory learning for the image processing technology, the color image structure, the color decomposition, threshold process, and size-selection are introduced. As one of the color structure of digital imaging technology, RGB (Red Green Blue) is widely known and used. The conceptual scheme is shown in Figure 1.

![Figure 1: Color decomposition and three primary colors](image)

Each color component’s intensity is numerically digitized in the range of 0 to 255, from darkest to brightest i.e. 256 levels. A color which is displayed in digital imaging, are combined with the three color-components. The combination number is numerically calculated as shown below:

\[
256(R) \times 256(G) \times 256(B) = 16,777,216
\]

That is to say, digital imaging color is able to theoretically display 16,777,216 colors.
As the next step, one example is given. That is supposing we are the engineers to manage the quality control of a production line of a factory. The products are toys, so that the students can tackle the problems in familiar way. The mission of the engineer is to check the quality of the products from the image of the product inspection. The concept of the production line is shown in Figure 2.

![Figure 2: The concept image of the production line](image)

As shown in the figure, a camera for the products inspection is installed above the belt conveyer. The aim of the lecture is to learn the function and the algorithm to detect a standard and/or defective item in the image for the product inspection. To correspond with the three primary colors components, products are designed, as shown in Figure 3. They are Red Robot, Green Car, and Blue Submarine.

![Figure 3: The reference objects’ image](image)

These three objects are the standard products, and these are the reference images to compare with objective images. Each product has each color, shape and size. These factors (color, shape, and size) are the key to differentiate with other standard and/or defective items. The concept is the precondition for the introductory learning of fundamental and basic of learning image processing. The next section describes the implementation and the related matter of the lecture.

### 3. Implementation of the lecture

After the preparation as described in the previous sections, the implementation of the lectures is carried out. In the part of introduction, the industrial needs, importance of image processing were explained, as the background, and the direction of the lecture which is introductory learning of image processing. As the next step, the basic concept of the lecture which is described in the section 2.2 was presented in detail. In order to display the process of color-decomposition which is shown in Figure 1, an example image is decomposed in each color. Using the image processing software, the color-decomposition process is demonstrated in front of the students. The reference image (Figure 3) is decomposed as shown in Figure 4.

![Figure 4: Color-decomposition of the reference image](image)

(R) Red-component image,  
(G) Green-component image, and  
(B) Blue-component image

As shown in the Figure, Red Robot is brightest in the Red-component (R), Green Car is brightest in the Green-component (G), and Blue Submarine is brightest in the Blue-component (B) image. It tells us the relationship between each reference product’s color and the color-decomposition result. As a common rule, “brightest part is the target” to detect the standard object (reference image) in an image area. In other words, to detect the red object, red-component image should be chosen, to detect the green object, green-component image should be chosen, and to detect the blue object, blue-component image should be chosen.

### 3.1 The first step for the basic problem solving

As the next step, a basic question is given in the class. The image of the question is shown in Figure 5. The question is as follows:

![Figure 5: The image of first question](image)

“To detect the standard item, which color-component would you choose, red, green or blue?”

As shown in the figure, one item (green fruit) which is not a standard item (wrong object) is displayed. The aim
of the question is to choose the correct color-component image to detect the standard object i.e. Red Robot in this case. The selection of color-component of the image is important and practical for the detection of the target object in color. Thus the color-component selection is asked as the first question. After the question is given, the students had several minutes for the discussion among them. The color of the standard item (target object) is red, so the red part of the image has to be the highest intensity (brightest) in the component image. After the discussion, let them choose and raise their hand for the correct option, from red, green, or blue component images. And several students are asked why they chose the color-component image. The reaction and the comprehension of the lecture can be checked by the discussion. As previously described, the red object is brightest in red component image. After their choice, color-decomposition process is demonstrated in front of the students. The image of the result is shown in Figure 6.

As we see from the Figure, the red-component image has a brightest part at Red Robot. Therefore, the correct answer is (R) Red-component image. By the thresholding process to search and mark the brightest part in the image, the question which is searching the standard item in the image can be solved. The result of the software performance is shown in the Figure 7.

As shown in the figure, Red Robot part is bordered with light-blue line. By the detection of Red Robot in the image, the shape, size, and the location are also obtained as the numerical value. Through the solving the problem, students can learn the concept of color-decomposition of the image and thresholding process.

3.2 The second step for the further level problem

As the further step, another problem is given. The image of the question is shown in Figure 8. The question is as follows:

Figure 8: The image of second question

“To detect the defective item and wrong object, which color component would you choose, red, green or blue? (You can choose 2 components)”

To avoid confusions and misconceptions, the options are listed.

A) Green & Red
B) Red & Blue
C) Blue & Green

As shown in the figure, one item (reddish cake) which is not a standard item, is displayed as a wrong object. Addition to that, a broken submarine is seen in the left hand side. The aim of the question is to figure out how to choose the correct components combination to detect the cake as the wrong object, and the broken submarine as the defective item. To solve the problem, several steps are needed to find out the wrong object and the defective item. As we did in the first problem which is described in the previous section, the color-decomposition is done as the first step. The image is shown in Figure 9.

As we see in the figure, all of objects are not bright in the figure (G), and that suggests the Green-component image is not suitable for the detection of the target images which are red and blue objects. That is to say, the correct
answer of the question is the option B) red & blue. In order to find out the two targets (red cake and broken blue submarine), two steps of image processing are applied. At first, the red cake which is wrong object is detected by the thresholding process in the Red-component image (Figure 10).

Figure 10: The detection of target image (red cake) by thresholding process in the red-component image

As the second step, thresholding process is applied to the Blue-component image. As shown in Figure 11, both of broken and standard submarines are detected.

Figure 11: The detection of broken and standard submarines in the blue-component image

As the third step, size-selection processing is applied after the thresholding. Based on the size of reference object (the standard product), smaller size of the object is selected as the target object (defective product). The result of the processing is shown in Figure 12.

Figure 12: The detection of broken submarine by the size-selection processing

As the final step, combining the process results for the Red-component and the Blue-component images, the target objects are detected and displayed as shown in Figure 13.

Figure 13: The detection of defective product and wrong object

The step of solving the question was also demonstrated by the software’s performance, and the students could realize how the image processing works for the product inspection. After the Q&A and discussion, the practical concepts are explained as the summary. Through the lecture, students have learned practical image processing methods (color-decomposition, thresholding, and size-selection) for the production engineering.

4. Results and Discussions (The evaluation of the lectures)

At the end of the lecture, the survey of the class has been conducted, to evaluate the quality of the lecture and the class going. The contents of the survey is as follows: The evaluation of the lecture

(1) Organization
(2) Interest level of the topics
(3) Comprehension level
(4) Satisfaction

The lecturing skill

(5) English skill
(6) Attitude of the teacher (gesture, posture and eye contact)

Each item’s evaluation is ranged from 1 to 5. Higher number is, higher the evaluation is. Totally five lectures were carried out in three institutes, and every class is surveyed for the evaluation of the lecture. As one of the result, the evaluation which was surveyed in USM is shown as radar chart in Figure 14.

Figure 14: Evaluation of the lecture in USM
The class has 54 students, the ratio of boy and girl students was roughly 50% and 50%. They belong to Sixth semester (Third grade) of the Electric & Electronics Engineering Department. They were good attitude, positive behaviour, and well concentrated to the lecture. Their reaction and response to the questions were good, and the discussion with the students was also active. These students’ reaction, response, attitude, and the communicated class going between the students and the teacher are reflected to the results of evaluation which is displayed in Figure 14. To clarify the detail of the result above, the breakdown of each item is shown in Figure 15.

5. Conclusion

In order to realize the implementation of engineering lecture in the international circumstances, Global Faculty Development project has been carried out. The author has joined the project in 2017, teaching and communication skill in English has been reinforced in TUT and CUNY QC. For the implementation of actual and practical lecture of engineering, the introductory learning for the image processing of the production engineering is designed. It is oriented to teach to the students of engineering such as mechanical, electric & electronic, and computer science. The implementation of the lectures were evaluated by the participated students in three institutes in Malaysia. The evaluation results have been feed backed, and considered. And the further steps for the global engineering education will be carried on. To maintain the global connection and the network of engineering education, international exchange of teachers and students will be more important and should be more developed world wide. Trials as described in this paper may be a part of the realization of the movement. However, the activities are hoped to be more spread and developed in the educational institutes of the world.

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