Image Technology based Students' Feedbacks Analyzing System using Deep Learning

Cho Nilar Phyo, Thi Thi Zin, *Member, IAENG* and Hiroshi Kamada, Takashi Toriu

***Abstract*— In these days, the integration of technology in teaching-learning process has become a central role in order to redesign a quality education system especially for the development of interactive education. In this concern, technology based analysis on the interaction between students and teacher and the feedback of the students play key roles. Thus, in this paper, we proposed the automatic students' feedbacks analyzing system for the purpose of speeding up the communication between students and teacher in the classroom by using the image processing and deep learning technology. In the proposed system, the students can use the five kind of color cards for answering the questions or for describing their feedbacks. Then the automatic students' feedback analyzing system will analyze the color cards objects by using the camera and describe the analyzed result to the teacher. In this way, the interaction between students and teacher can be faster and can give a lot of benefit for the education system. In order to implement this system, firstly, the color objects segmentation is performed over the input image using the predefined color thresholds. Then, the noise objects are removed by using the predefined maximum size and minimum size thresholds. Finally, the Deep Convolutional Neural Network (DCNN) is applied in order to classify the five color cards objects and non-card color objects. The experiments are performed on the image that have been taken in the large classroom under the different illumination condition. According to the experimental results, the proposed system can robustly analyze the color cards objects with the accuracy of 97.02% on the training data and 94.38% for the testing data. The proposed system can give the ubiquitous (anytime, anywhere) analyzing of the students' feedback in the classroom.**

***Index Terms*—students' feedback, e-learning, automatic analyzing, deep learning**

I. Introduction

THE interaction between students and teacher in the class room is the important part of the education system. The teacher usually has to communicate with many students in the classroom, especially in the large classroom. So, the interaction between all students and teacher become burden task for the teacher because of the many-to-one relationship (many students and one teacher). This process also takes much of the lecture time and sometime the interaction time is longer than the teaching time. In case of asking some questions to the student, the answer of each students can be different and the analyzing of the students' feedback or answer in large classroom become a little difficult and time consuming task for the teacher. This system aims to solve the problem of analyzing the students' feedback in large classroom using the color cards information. In the students and teacher interaction, the most frequently ask conversion are 'Yes' or 'No' and the secondary frequent question is multiple type questions such as 'A' or 'B' or 'C'. But in case of the questions with two or three alternative answers, the students will select the correct answer with 50% probability and at least 33 % probability without understanding the questions [1]. Therefore, the five kind of color cards (Blue, Green, Pink, Red and Yellow) are selected for the implementation of Automatic Students' Feedback Analyzing System in order to get the accurate answers with well understanding the questions.

The structure of this paper is as follow. In session 2, some related works of the e-learning system and the color and shape based image processing applications are presented. The detail about the proposed system is explained in session 3. In session 4, the experimental results and the sample output of the proposed system are described followed by the conclusion in session 5.

II. Some Related Works

In this session, some related research work of interactive e-learning has been presented. The Smart Remote Classroom project for real-time interactive distance learning system has been proposed [2]. In this system, the teacher can instruct the students like face-to-face interaction in the conventional classroom by using the augmented reality technology. In [3], the design, implementation, and initial results of the virtual classroom extension for effective distance education system have been described. The remote student can be integrated into the virtual classroom by projecting onto the back wall of the classroom. So that the student can feel real-campus life.

The authors in [4] described that the accuracy of the model for the user meta-cognition in intelligent learning environment can improve by applying the eye-tracking data. The method is very useful for the assessment of user exploration and self-explanation behavior. For identifying the student presence and assessing the student's interest, the authors in [5] applied the gaze direction which are estimated using student's face and hair information.

Manuscript received January 8, 2018; revised February 11, 2018. This work was supported by JSPS KAKENHI under Grant Number 15K01041.

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III. PROPOSED SYSTEM

A. System's Concept

This system aims to provide the Automatics Students' Feedback Analyzing System in classroom. The illustration of the concept of the proposed system is shown in Fig. 1. The camera is setting in front of the classroom and the students can use five kind of color cards to reply to teacher's questions [1].

B. Card Design

In this system five kind of the color cards such as Blue, Green, Pink, Red and Yellow are used and each card is designed to easily handle by the students. The sample color cards images and the design of the card is shown in Fig. 2 and Fig. 3. For each color card, the width and height of card are 14.8 cm and 21 cm, respectively [1]. The color object is put at the center of the card and left the height of 3.7 cm from the top border of the card. At the bottom of the color object, the height of 3.7 cm followed by the region for handling the card with the height of 6.2 cm is left.

C. System Flow

The overall flow of the system is shown in Fig. 4. The proposed system is composed of four main process: color object segmentation, noise removing, object cropping and classification using Deep Convolutional Neural Network (DCNN).

Color Object Segmentation

The first process is the segmentation based on the color information of the input image. We transform the RGB color space of the input image into HSL (Hue, Saturation, Lightness) color space to be able to segment the color objects under various illumination changing condition. The RGB color space is device-dependent color model that means the color value can change depending on the input device (camera). HSL color space is widely used as the color picker systems because it is convenience for the color perception of human being. After transforming into HSL color space, we perform the segmentation of five color objects using the predefined color threshold value. In order to define the color threshold, we statistically analyze the maximum and minimum range value of HSL for each color on all collected classroom images including the bright and dark classrooms images by using the thresholding method in [7]. As a result, we get the mask which include the objects whose HSL value are within the predefined threshold of five colors. The result color mask of the segmentation process is as shown in Fig.5.

Noise Removing

The second process of the proposed system is noise removing process. This process is a simple process of removing noise object using the predefined size threshold. The segmented color object whose size are less than the minimum size threshold of 25 pixels and greater than the maximum threshold of 2025 pixels are regards as noise objects and remove. The result color mask after noise removing process is as shown in Fig. 6.

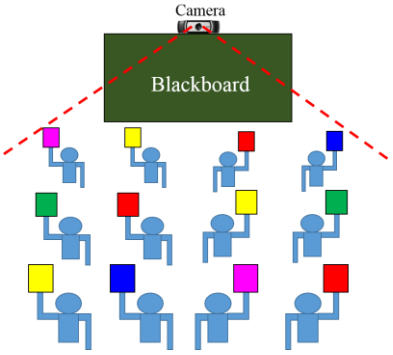


Fig. 1. Concept of the proposed system

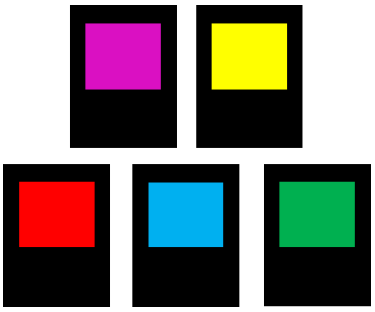


Fig. 2. Sample five color cards

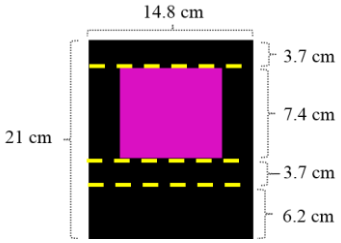


Fig. 3. Design of color card

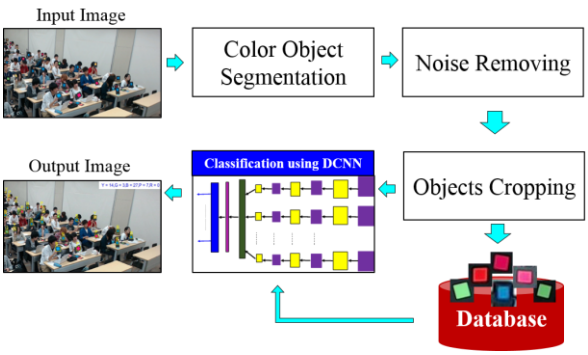
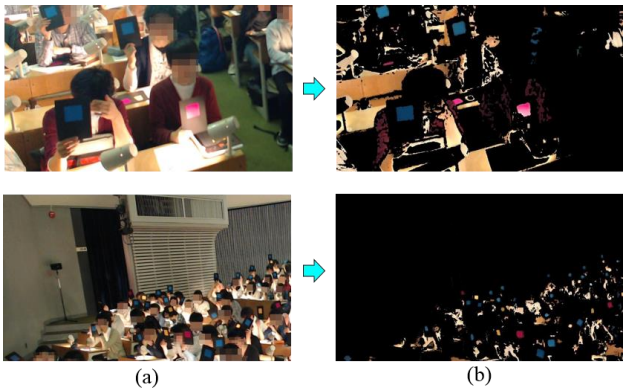


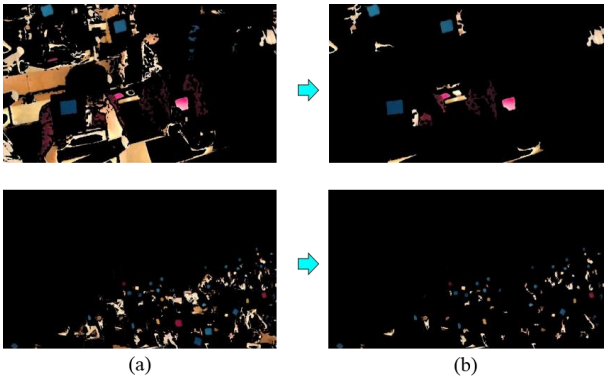
Fig. 4. Overall system flow of the proposed system



(a) (b)

Fig. 5. Color object segmentation results: (a) input Images, (b) result color mask

ISBN: 978-988-14047-8-7
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)



(a) (b)

Fig. 6. Noise removing results: (a) color based segmentation, (b) color mask after noise removing process

Object Cropping

After removing the too large and too small noise objects, we need to crop the remaining objects for preparing as the input for DCNN. The input size of DCNN is 32×32 RGB channel images. Therefore, we crop each objects on the RGB image using the result mask of noise removing process and then resize into 32×32. We also create the color card objects database in order to train and test the system for color card classification.

Classification Using DCNN

For the classification of the color card objects from the other non-card color object, the Deep Convolutional Neural Network is applied. The DCNN is the famous method for visual object recognition and classification system. The detail architecture of DCNN is shown in Fig. 7.

The input of DCNN architecture is 32×32×3 size. There consist of three hidden layers and each contains three functions: convolution, max pooling and activation. The filter of size 7×7, 5×5 and 3×3 are used for the convolution functions of each hidden layer. The pooling size of 2×2 is used the same for all hidden layers. The weight initialization of all layers are done by random initialization with normalized Gaussian distribution. The feature map of each hidden layers are 3, 10 and 15, respectively. The fully connected layer consists the weight vectors of size 100. In the output layer, there exist 6 output units and each is for each color card class of Blue, Green, Pink, Red, Yellow and Non-card color objects. Before the output layer, the soft-max function is applied for getting the probability of each possible color cards class. The network is trained by using the backpropagation algorithm with stochastic gradient descent method with iteration of 10000, learning rate of 0.0001 and momentum value of 0.9. The implementations are developed using the Caffe Deep Convolutional Neural Network framework [8].

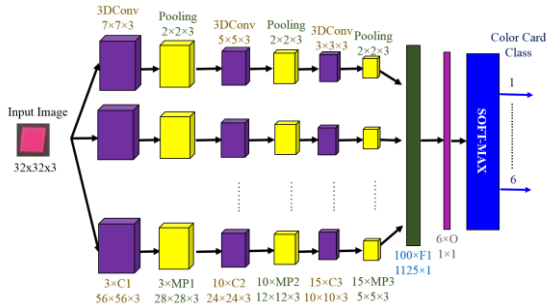
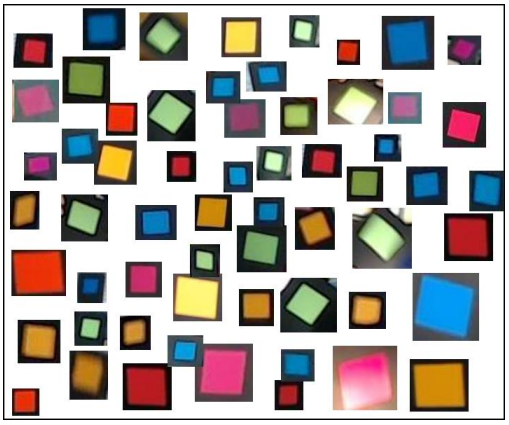


Fig. 7. Architecture of Deep Convolutional Neural Network

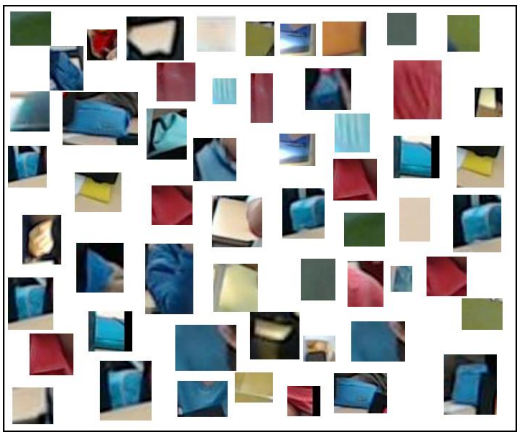
IV. EXPERIMENTAL RESULTS

The experiments are performed on the images of large classroom which include around 100 students in each room. For getting the image that cover the whole classroom area. The images are taken by using two cameras and then combine them before performing the analyzing. Therefore, each image is composed of two slides and the total classroom images is 47 images including both bright and dark classroom. After processing the color based segmentation and noise removing, we create the database which include the color card objects as positive class objects and non-color card object as negative class objects. The example of positive class objects and negative class objects are shown in Fig. 8(a) and Fig. 8(b), respectively. After creating the color cards database, we got the card objects of 1040 for blue color, 420 for green color, 550 pink color, 130 red color and 800 for yellow color and 2260 for non-color cards objects. Then we use two-thirds of both positive and negative class objects as the training data and the other objects as the testing data. Then we train the DCNN over the 3470 training data.

Some experimental results are shown in Fig. 9. We can see that the proposed system can correctly classify the color card and the other objects even though they are very similar color. We evaluate the performance of the proposed system on both training data and testing data. According to the experimental results, the proposed system got the accuracy of 97.02% for training data and 94.38% for testing data as shown in Fig. 10.



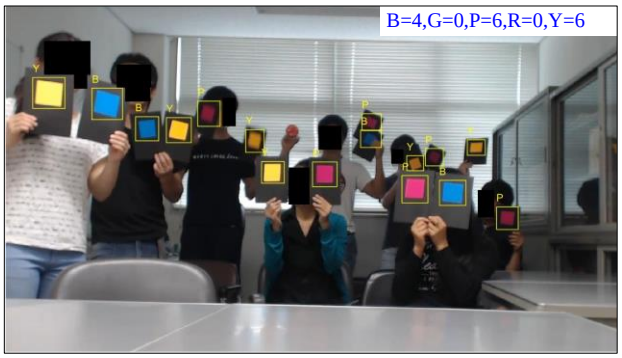
(a)



(b)

Fig. 8. Some example images of color card database: (a) positive class object and (b) negative class object

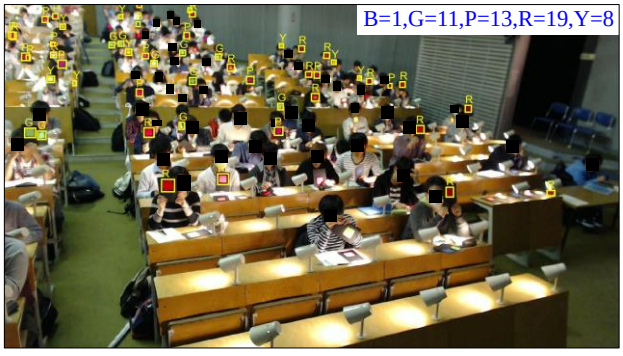
ISBN: 978-988-14047-8-7
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)



(a)

(b)

(c)



(d)

Fig. 9. Some experimental results: (a) small classroom image, (b) medium number of color cards in classroom, (c) larger number of color cards in bright classroom, (d) larger number of color cards in classroom

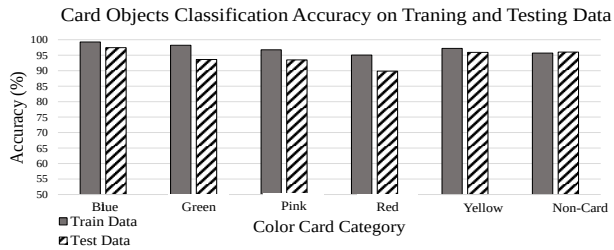


Fig. 10. Color card classification accuracy of each color on both training and testing data

V. CONCLUSION

In this paper, we proposed the Image Technology based Automatic Students' Feedback Analyzing System using color cards. According to the experimental result, the proposed system can robustly analyze the students' feedback under the different illumination changing condition such as the bright classroom and dark classroom. Because of using the deep learning technology, the robustness of the system is increased that lead to the ubiquitous analyzing system.

REFERENCES

[1] Kamada, H., Yamada, K. and Yoshikawa, K., "Automatic Response Analyzer in Classroom using Image Processing and Cards", *ICIC express letters. Part B, Applications: an international journal of research and surveys*, vol. 7, no. 8, pp.1719-1725, 2016.

[2] Shi, Y., Xie, W. and Xu, G., Smart Remote Classroom: Creating a Revolutionary Real-time Interactive Distance Learning System, *Proceeding of International Conference on Web-Based Learning*, pp. 130-141, August, 2002.

[3] Dondera, R., Jia, C., Popescu, V., Nita-Rotaru, C., Dark, M. and York, C.S., Virtual Classroom Extension for Effective Distance Education, I*EEE Computer Graphics and Applications*, no.28, vol.1, 2008.

[4] Merten, C. and Conati, C., "Eye-Tracking to Model and Adapt to User Meta-Cognition in Intelligent Learning Environments", *In Proc. of the 11th International Conference on Intelligent User Interfaces*, pp. 39-46, January, 2006.

[5] Ugurlu, Y., "Human Interactive E-learning Systems Using Head Posture Images" *In Proc. of World Academy of Science, Engineering and Technology*, vol.65, pp.1107-1110, 2012.

[6] Lee, S.H., Choi, J. and Park, J.I., "Interactive E-Learning System using Pattern Recognition and Augmented Reality", *IEEE Transactions on Consumer Electronics*, no. 5, vol. 2, 2009.

[7] Cho Nilar Phyo, Thi Thi Zin, Kamada, H. and Toriu, T., "Color and Shape based Method for Detecting and Classifying Card Images", *In Proc. of 2017 International Conference on Artificial ALife and Robotics (ICAROB)*, p.307-310, 2017.

[8] Jia, Y., Shelhamer, E., Donahue, J., Karayev, S., Long, J., Girshick, R., Guadarrama, S. and Darrell, T., "Caffe: Convolutional Architecture for Fast Feature Embedding", *In Proceedings of the 22nd ACM international conference on Multimedia*, pp. 675-678, November, 2014.

ISBN: 978-988-14047-8-7
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