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Statistics Causality Analysis of Emotions Evoked by Self-Feedback and Facial Features Based on Feature Maps

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Abstract: Previous studies have demonstrated that emotional arousal is evoked by visual feedback of a selfie. This selfie was subjectively evaluated as having a good face and a good psychological state. However, the causality between emotional arousal due to feedback from a selfie and facial features recognized by the human eye was not revealed. The objective of the present study was factor clarification of the emotional arousal. The study evaluates the kind of facial information the human eye recognizes when the human distinguishes the type of selfie. For this, a model was developed using machine learning to automatically classify if a photographed selfie can favorably affect the emotional state. As a result, the type of selfie was distinguished at 83.3% correctness, and it was suggested that the whole face was recognized when the human eye evaluated a selfie as a selfie that can have a favorable effect on the emotional state. In other words, when evaluating the face, it was suggested that evaluating the whole, not the part, would be a cause of emotional arousal.

Keywords: Emotion, Emotional Arousal, Machine Learning, Selfie

I. INTRODUCTION

There has been a growing interest in finding solutions to motivate young people who are socially withdrawn, and interest in education, employment or training. Their characteristics are projecting poor self-images of the past onto self-images of the present and a decreasing desire for self-approval [1]. Humans who cannot feel self-approval elicit a decrease in self-esteem when the following processes occur: 1: desire approval from other people, 2: cannot accept oneself, 3: decrease of self-esteem [1] [2]. The decrease of self-esteem relates to the decrease of intrinsic motivation [3]. Therefore, humans who have decreased self-esteem eventually become aimless people. The improved of self-esteem has the effect of encouraging the growth of a human [4]. This problem is solved through daily positive motivation by emotional arousal [3] [4].

We have previously investigated that the selfie was considered a useful tool for emotional arousal, and the effect of a selfie on the emotional state was studied [5]. As a result of the previous study, positive emotion significantly increased when providing feedback of a selfie that was subjectively evaluated as having a good face or a good psychological state. It is possible to apply these indicators without bias from gender or age because selfies used for feedback reflect the psychological state of the evaluator, and it is an extremely important approach that emotional arousal is evoked by providing feedback based on a selfie.

It is desirable that emotional arousal by feedback from a selfie was obtained on a routine basis and easily. It is considered that a system automatically changes the photographed selfie into a selfie that can favorably affect the emotional state is useful. For the development of this system, it is necessary that the causality between emotional arousal by feedback from a selfie and the facial features recognized by the human eye has been demonstrated, however, this causality has not been demonstrated yet. The objective of the present study was to do factor clarification of the emotional arousal. The study evaluates the kind of facial information the human eye recognizes when the human distinguishes the type of selfie. For this, a model was developed using machine learning to automatically classify if a photographed selfie can favorably affect the emotional state. Bag-of-Features (BoF) and Convolutional Neural Network (CNN), which is a method of machine learning, and to evaluate the kind of facial information the human eye can recognize to distinguish the type of selfie.

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II. METHODOLOGY

A. Development of model

The model was developed using machine learning to automatically classify if a photographed selfie can favorably affect the emotional state, because to do factor clarification of the emotional arousal. BoF and CNN were used as a method of machine learning. The selfies were classified as the Positive-selfie and the Negative-selfie based on the previous study [5]. The selfies that can favorably affect the emotional state were denoted as the Positive-selfie, the other selfies were denoted as the Negative-selfie.

B. Input Data

The input data applied to BoF and CNN were 212 facial images of 22 men and women aged 21 to 54 years. The size of the input data was 100×100 pixels. The input data were expanded by three times by random rotation. The input data were classified evenly as Positive-selfie and Negative-selfie. The input data were the selfies used for the feedback for evoking emotion [5]. These selfies were taken and evaluated using the original application shown in Fig.1. This application was implemented on an Android phone. The subjects took the selfies and evaluated their impressions of the images using the application. The conditions were as follows: each subject took a selfie in the morning and at night, for a total number of the 30 selfies; all selfies were evaluated immediately. The evaluation of the impression of selfies was performed using a visual analogue scale (VAS: 0 - 100 %) by operating the SeekBar. The left end of the SeekBar was the lowest VAS score (VAS = 0 %); the right end was the highest VAS score (VAS = 100 %). A high VAS score indicated a good condition; a low VAS score indicated a worse condition. The indices of the measured impression evaluations were as following: Face satisfaction (Satisfaction), Face likes and dislikes (Like), Skin condition (Skin), Hair condition (Hair), and Eyes and brow condition (Eyes) as an evaluation of face condition, Comfort, Vigor, Aggressiveness, and Optimistic as an evaluation psychological state when taking a selfie.

Fig. 1 The evaluation of the impression of a selfie. It is possible to evaluate a selfie by operating the SeekBar at the bottom of the image.

C. Bag-of-Features

BoF [6] is a method of object recognition that applied Bag-of-Words which is a method of natural language processing. BoF that can input arbitrary feature amounts was used for this study because facial recognition is conducted based on facial local feature in general.

The algorithm of BoF used in this study is shown in Fig.2. The procedure for obtaining BoF from the images was as follows: 1) The feature amounts were calculated from the all input data, feature amounts of Accelerated-KAZE (AKAZE) [7], KAZE [8], and Oriented FAST and Rotated BRIEF (ORB) [9] were used in this study; 2) the calculated feature amounts were evaluated using k-means clustering, the center of cluster was defined as a Visual Word, and the number of clusters were found to be eight in this study; 3) Visual Word dimension histogram was calculated from feature amounts of the all input images. All the input images were classified into Positive-selfie and Negative-selfie by k-means clustering based on the histogram created.

D. Convolutional Neural Network Construction

CNN is a method of Deep Learning, and can automatically get feature amounts like the human empirically understand [10]. Construction of CNN is divided into the convolution layer and the pooling layer, and the layer can get better internal expression as the layer deep. Moreover, it is possible to evaluate the kind of facial information the human eye can recognize by evaluating the feature map of CNN. Therefore, CNN was used for this study.

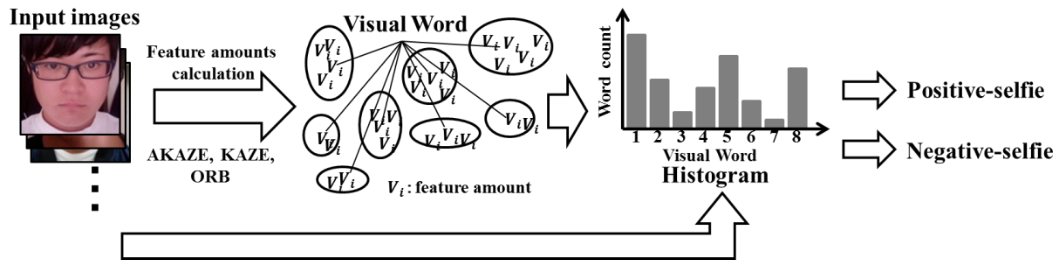

Fig. 4 Algorithm of BoF. Visual Word was calculated by k-means clustering. The number of clusters was eight.

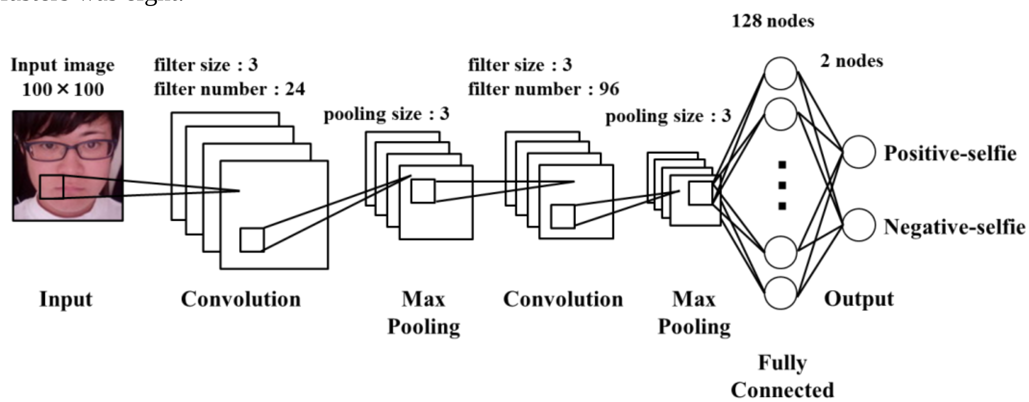

Fig. 3 Construction of CNN

The input images were divided into testing data of 60 images and training data for 576 images. The performance of the discrimination model of selfie, made using the training data, was evaluated using the testing data. The discrimination model was made using the selfies as input data and two types of selfies (Positive-selfie and Negative-selfie) as the objective variables. The construction of CNN is shown in Fig.3. The CNN consisted of two convolutional layers, two pooling layers, and one fully connected layer. The ideal parameters of the CNN were established during examination. The learning rate was 0.001. The learning algorithmic rule was back-propagation. The activation function of the output layer was a Rectified Linear Unit function (ReLU). The error function was cross-entropy. The learnings were stopped when the error between the outputs of the training data and the objective variables was unimproved 50 consecutive iterations.

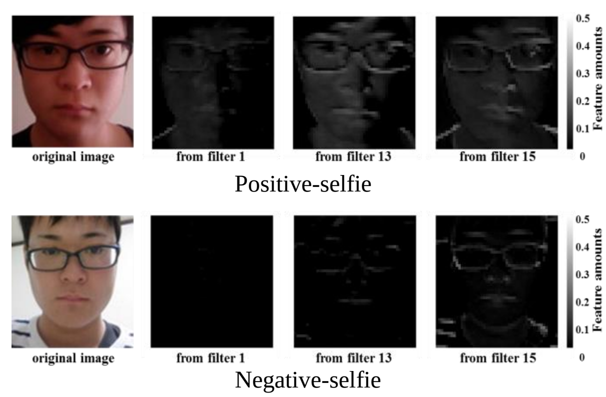

Fig. 2 The original image and the example of 3 feature maps that were output randomly from 24 weighting filters in the first pooling layer. The dark colors signify weakly and the light colors signify strong feature quantities.

III. RESULTS AND DISCUSSION

The discrimination rates of AKAZE, KAZE, and ORB of BoF were 57.3%, 51.9%, and 52.1% respectively. The discrimination rates of BoF were considered to be low because BoF depends on the algorithm for detecting feature amounts and the positional relation of feature amounts is not considered. On the other hand, the discrimination rate of CNN was 83.3%, and it was higher than all feature amounts of BoF. Therefore, the causality between emotional arousal by feedback from a selfie and facial features recognized by the human eye was evaluated based on the feature map of CNN.

The original image and the three feature maps showing the sample that were output randomly from 24 weighting filters in the first pooling layer is shown in Fig.4. The feature amounts of Positive-selfie appeared to the whole face. On the other hand, the feature amounts of Negative-selfie appeared to the boundary areas such as eye, mouth, nose, and eyebrow. It was suggested that the boundary areas of face were recognized when the human eye evaluated a selfie as Negative-selfie and the whole face was recognized when the human eye evaluated a selfie as Positive-selfie. Additionally, principal component analysis (PCA) was applied to 24 weighting filters in the first pooling layer that was output from the same Positive-selfie as in Fig.4 because of analyzing in more detail the causality between the facial features recognized by humans and the emotional arousal. As a result of PCA, the proportion of the first principal component was 37.7%, the proportion of the second principal component was 28.1%. The factor loading of the first principal component is shown in Fig.5. Focus on the facial area, the features amounts appeared to the whole face by the same taken. That is, it was considered that evaluating the whole face, not the part, would be a cause of emotional arousal. This study developed a generic model, but it is also necessary to develop an individual model to distinguish selfies, which based on the facial information differ for each human.

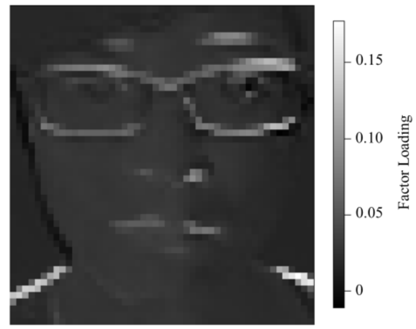

Fig. 5 The factor loading of the first principal component.

IV. CONCLUSION

The objective of the study was to distinguish a Positive-selfie from a Negative-selfie using Bag-of-Features and Convolutional Neural Network, and to do factor clarification of the emotional arousal. The discrimination rate of CNN was found to be higher than the discrimination rate of BoF, and this discrimination rate using CNN was 83.3%. By evaluating feature maps, it was found that when a human eye evaluates a selfie, its evaluation is determined by its ability to recognize the whole face or the boundary areas. That is, it was considered that when the Positive-selfie was visually feedback, evaluating the whole face instead of the part, would be a cause of emotional arousal. We plan to conduct to develop an individual model that considers personal characteristics such as human personality.

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