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Recognizing Micro Expression Pattern Using Convolutional Neural Networks (CNN) Method DuringEmotion Regulation Training for Parents in The Pandemic Era

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Abstract. *During this pandemic, most of people's activities are carried out through digital media. Both learning and working processes are using the video-conference platform, a platform deemed effective to facilitate the needs of distance communication. One of the limitations of using video-conference lies in difficulty in understanding emotional conditions based on solely camera video. Hence, speakers generally do not know their interlocutors' feelings related to the materials being presented. Grounded on this issue, we examined a facial expressions-based emotion recognition tool. Micro expression is one of the micro-languages of communication. Machine learning model developed in this study was Deep Learning with Convolutional Neural Network (CNN). The library that was used was Keras, this was used to recognize micro expression pattern. Additionally, OpenCV was also used for the general face recognition process. Both libraries were operated using Python programming language. The result of the micro expression test involving thirty participants detected three types of facial expression, namely joy, sadness, and anger expression. However, face recognition applied in the present study still needed some improvements, especially for anger and sadness expression. With regard to joy expression, 89% of the expression were recognized. Based on the recorded data, it is necessary to improve the recordingscriteria to obtain a clearer expression.*

Keywords *emotion, expression, Convolutional Neural Networks*

1. INTRODUCTION

Understanding how individuals express emotion and its meaning is crucial in social interaction. Broadly speaking, individuals are interested in knowing their interlocutors' thoughts and feelings [1]. Through emotions, people can either create or break a relationship. While a relationship could exist due to individuals' similarities that lead to comfort, a relationship can also be broken due to situations that trigger negative feelings.

Emotional expression constitutes an individual's perceptions, which are verbally or nonverbally shown [2]. An emotional expression often emerges spontaneously and is difficult to be controlled or hidden. Ekman, Friesen & Ellsworth [3] argue that emotional expression includes four elements, namely physiological response, motor response, verbal response, and interactive consequence. The physiological response could be in the form of physical symptoms resulted from changes in body organ's work (e.g., heartbeat, oxygen level, and skin color changes). Meanwhile, the motor response may be shown through behavioral tendencies as a response to an emotional stimulus, such as aggressive behaviors. Facial expressions are categorized as one of the forms of motor response. The third element, verbal response, refers

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to an expression of words that reflect one's emotional state. Lastly, the interactive consequence could be defined as an event that happens to two or more individuals, where one's behavior is followed by certain responses from the others.

Despite debates on the definition of emotional expression, scholars agree that emotion itself is useful for an individual's life. Human basic emotions, i.e., joy, anger, fear, disgust, sadness, and surprise [4], allow individuals to prepare themselves to face various events without thinking about them first. Emotions do not only function to survive but also serve as an energizer [5]. Hence, in the field of psychology, emotion is viewed as closely associated with motivation. A feeling toward an object could make individuals do certain things to the object.

Facial expression is a part of emotional expressions, which is also known as micro expression. More specifically, micro expression helps individuals to communicate with one another. A micro expression is useful in communication, considering that verbal expression may potentially contradict one's feelings. For instance, when an individual is worried and anxious, he or she unconsciously conceals such feelings behind higher voice tones. By understanding micro expressions, we would be able to see a pulled muscle around the corner of the eyes and mouth, which indicate discomfort and panics [6].

The presence of emotions expressed by micro expressions plays important role in the parenting context since they can strengthen parents' message to their children. As [7] states, micro expression represents an individual's original emotion. As shown by the example above, parents' response to their children sometimes does not comply with their emotions. Parents tend to yell at their children when their actual feelings are anxiety and worry because their children go home late. Regarding this context, parents should be aware of their emotion and their proper expression.

An individual's awareness of his or her emotion and the way to properly expresses it is one of the indicators of emotion regulation. Emotion regulation is defined as how an individual regulates his or her emotion, when and how to show such emotions [8]. Parents with maladaptive emotion regulation (e.g., using punishment) may influence the children's emotion regulation [9]. When parents fail to regulate their emotion (emotion dysregulation), children face a higher risk of experiencing disruptive behaviors [10].

Accordingly, it is necessary to enhance parents' emotion regulation skills. In this regard, we conducted an emotion regulation training for parents of 2-6 years-old children. The participants were recruited based on the findings of the previous study showing that there is some violence against 2-6 years old children due to a lack of emotion regulation skills.

[11].

Conducting psychology-related training during a pandemic is challenging. To protect participants' safety and health from covid-19, the training was conducted online using Zoom meeting application. The participants performed a number of designed activities in their homes based on the trainer's instruction. One of the limitations of online training is the inclusion of all psychological aspects, particularly affective aspects. Differences in participants' conditions and situations influenced their involvement during the training. As a result, certain emotions that were expected to arise from the participants went beyond our control. In such a condition, facial expression emerges as the main indicator of participants' emotional state. However, the existing online platforms had not been equipped with micro expression detectors to identify the participants' emotions. The present study aimed to test the accuracy of a facial expression recognition tool using Convolutional Neural Networks (CNN). This tool is expected to serve as an additional plugin for online meeting platforms, thus allowing the training organizers to recognize their participants' emotional states shown by facial expressions.

In this paper, data of participants' facial expressions are discussed based on theories of emotion and facial expressions.

Discussions from an electrical engineering perspective are presented in another paper.

2. MATERIAL AND METHODS

Method

Data of the present study were collected through online training using Zoom meeting application. Thirty participants were involved, they were parents of children aged 2-6 years old. Their ages ranged from 20-40 years old and have various occupations.

Technical matters and materials of the training were designed based on Emotion Regulation Training in parenting as discussed in the previous study. Due to Covid-19 pandemic, some adjustments were made, including the duration of training, materials, and model of the training.

The training and data collection was done in two days. Lasting for 3 hours per day with two sessions/day, the training was conducted online. The participants were required to always set the video mode on, stay in a well-lit room, and be active during the training.

In conducting the training, we collaborated with an experienced, professional trainer. The materials of the training included "recognizing emotion in parenting, effective communication with children, Positive thinking and Relaxation technique, and Emotion

Regulation in Parenting. In addition to providing psychoeducation, trainer also invited participants to discuss in order to create a two-way communication. Ice-breaking activities i.e., games showing certain emotional expressions when bringing up their children were also done. These activities aimed to show participants' various emotional expressions. These facial expressions were used as the data of the study and analyzed.

Materials

The model developed in the present study was deep machine learning with Convolutional Neural Network (CNN) using Keras library (with Tensorflow backend) to recognize emotions and Opencv for general face recognition. Concerning the programming language, python was used. The device used in this study was SBC Jetson AGX Xavier and Jetpack operating system (Linux Distro for Jetson devices), as shown in Figure 1.

Emotion recognition processes consisted of two stages, namely data training and data testing.

1. Data Training

The parameter used in this stage is shown in Table 1.

Table 1 Data parameter

Batch size per training	**32**
Epoch/ iteration	50
Resolution (length, width, no. of channels).	48, 48, 1
Ratio between training data and validation	8 : 2
Types of Emotion	7 emotion

The data used in the present study were open-source fer2013 data, consisting of 28710 face data, and 1000 face data obtained from zoom recordings. Thus, the total was 29710 data. The result of training data showed 66% accuracy and was saved as an hdf5 file to be read by python language.

2. Data testing

In data testing stage, the result of data training was tested. The test consisted of two types, namely the test based on emotion category and the test based on facial expression identified by the system.

a. Emotion category-based test

In this test, only three out of seven types of emotions were tested, namely joy, anger, and sadness. The flow of datatesting for emotion recognition is shown in Figure 1.

Figure 1 Flow of data testing for emotion recognition

In this test, the program cut a part of video recording into a section to be processed, i.e., participants' facial expression. The cut section was identified, the result of the identification was in the form of percentage of seven types of emotions (i.e., anger, disgust, fear, sadness, surprise, joy, and normal) throughout the recordings. The video sample that was taken from zoom recording was 1 minute-long.

b. Test based on facial expression identified by the system.

This test was conducted to find out the system's ability in recognizing facial expression from zoom recordings. The test was conducted based on ratio between number of participants and number of faces detected by the system.

3. RESULTS AND DISCUSSION

The reading process identified three facial expression, namely joy, anger, and sadness. These three expressions, according to Paul Ekman, are human's basic expression [4]. Ekman argues that human basic emotions include anger, disgust, fear, joy, sadness, and surprise. These emotions are produced by neural networks and area in brain, including amygdala, which is located near hippocampus. Along with other parts of the brain, amygdala produces emotion based onthe stimulus [12].

Basically, emotion does not only belong to human, however, human is able to express various emotions through his/her face. Each emotional expression holds their own attribute. In the present study, recognition of such characteristics was done by artificial intelligence, allowing the program to identify the participants' facial expressions based on the samples of expression that had been input.

a. Joy

Joy is indicated by the rise of lip corners. More specifically, genuine smile (Duchenne smile) is shown by the rise of cheek and wrinkles on the outer corners of the eyes [13]. Such an expression shows an enjoyment from the senses (visual, auditory, tactile, etc.) [14]. Our program was able to identify joy although some expressions did not show characteristics of joy as stated above. Figure 2 below shows a sample of expression that was accurately

recognized based on theoretical characteristics.

Figure 2. Expression of joy

Participants' facial expression is in accordance with the characteristic of joy as described by Paul Ekman in Figure 3. Ekman states that joy is indicated by narrowed eyes and wrinkles on the corner of the eyes, raised cheek, pulled-back lips followed by teeth show when smiling. This is in line with Bartlett et al. [15] who argue that a genuine and fake joy expression could be differentiated from the wrinkle on orbicularis oculi, the muscle that surrounds the eyes. This micro movement may be pulled up.

As shown in figure 2, participants' cheeks were pulled up. Besides, their lips were pulled back and formed a smile. However, only two participants showed their teeth when smiling.

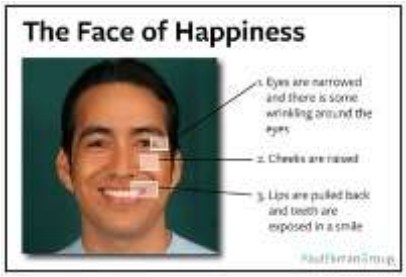

Figure 3 Joy expression according to Paul Ekman (source: paulekman.com)

However, we also found some expressions without such characteristics were detected as joy. These expressionsare shown in Figure 4.

Figure 4 Participants' normal expression that was detected as joy

As stated above, we input 29710 face data to the computer. A computer can only process what has been introduced and to do so, it requires a pattern as the main reference and comparison [12]. The expression shown in figure 4 was detected as a joy expression based on the data recognized by the computer. In addition, micro expressions are difficult to detect because of their low intensity and only last for about 0.5 second [7]. Normal facial expression could be detected differently by the computer based on the data that are input to the computer.

b. Anger expression

Anger is an individual's reaction to frustration that is usually followed by the intention to harm individuals who offend him/her. When anger presents, an individual's expressions indicate that he or she is ready to harm others/ Some characteristics of anger expression include tense arm and neck muscles. In addition

, an angry person tends to press his/her lips tightly and clench his/her teeth [1]. Anger expression may also be indicated by forehead frown, tightly pressed lips, and tense facial muscle [13]. Anger expression, according to Gary
J. Collier, could be described as shown in figure 5.

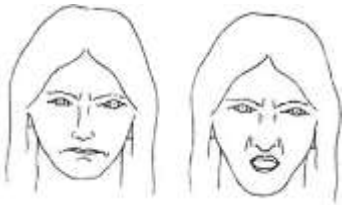

Figure 5 Anger expression, according to Gary J. Collier

Paul Ekman explains that the characteristics of anger include lowered eyebrows, glaring eyes, and tightly pressed lips. The difference between Ekman's and Collier's description of anger is the teeth showing. Paul Ekman's description of anger characteristics is shown in figure 6.

Figure 6 Anger expression according to Paul Ekman(source: paulekman.com)

During the training, there was a session where participants faced stimulus that was

expected to trigger their anger expression. It was a 1-minute video showing a parent's abuse of their children. The test result showed that during the emotion detection process with anger stimulus, no participants showed anger expression. The two most frequently detected expressions were normal and joy, which contradicts anger. As shown in Figure 7, the expressions that were shown were normal and joy expressions, in other words, the system still failed to recognize anger.

Figure 7 Facial expression when given anger stimulus yet detected as different expression.

Based on the collected data, there was an expression that was detected as anger (figure 8). However, that expression is not visually in compliance with Paul Ekman's or Collier's characteristics of anger.

Figure 8 Participant's expression that was detected as anger.

c. Sadness expression

Sadness expression also holds some characteristics, such as lowered eyebrows and lowered lip corners [13].

Characteristics of sad facial expression are shown in figure 9.

Figure 9 Sadness expression according to Paul Ekman (source: paulekman.com)

Based on data we have collected, there was an expression recognized as sadness, as

shown in figure 10. However, there was no characteristic of sadness found in this participant. Meanwhile, in figure 11, characteristic of sadness as described by Paul Ekman was found, yet the expression was recognized as a normal expression.

Figure 10 Participant's expression that was detected as sadness.

Figure 11 Participants' sad expression that was detected as normal

Based on the collected data, it was found that facial expressions shown in zoom recordings had not been properly recognized by the system. Technically, it was caused by participants' face position, lack of lighting, and poor image quality. Besides, some participants turned off their camera during the training.

From psychological perspective, disconformity between participants' emotional expression and system recognition result was possibly caused by the stimulus that failed to lead to the expected expression. In addition, participants' environmental factors can also influence their affective involvement. Although we had asked participants to focus and condition their surroundings, environmental factors were still uncontrolled. This was shown by participants who joined the training while holding their children. Moreover, since the participants joined the training from their home, some of them did other activities during the training.

4. CONCLUSION

Face recognition model implemented in the present study needs several improvements, especially for anger and sadness expression. With regard to joy expression, 89% of the expression were recognized with a ratio of 3:1 of the data. Based on the recorded data, it is necessary to improve the recording criteria to obtain clearer expression. It is also necessary to improve participants condition during the training in order to psychologically enhance their

involvements.

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