論　文　要　旨
Thesis Abstract

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※報告番号	第　　号	氏　名 (Name)	馮　晨 （FENG　CHEN）

主論文題名　（Title）

The Evaluation and Application of Bio-emotion Estimation Methods
(生体感情推定手法の検証と応用)

内容の要旨　（Abstract）

People have been putting a tremendous amount of time into electronic devices in daily life due to the COVID-19 pandemic. Consequently, social media has been increasingly used. As more and more people turn to it, some problems are caused by its growing clout, among which negative content, especially misinformation, is the major influence. However, exposure to the negative content may also result in users' negative emotions. Furthermore, they tend to spread or reply with negative content in a negative mood. To avoid this, we propose detecting the users' emotion stats and informing them of the results to help them regulate emotions while they use social media.

First, an appropriate emotion estimation method is required to detect users' negative emotions. The increasingly important emotion estimation based on different features has been studied in the affective computing field in recent years. Among previous studies, Ikeda's bio-emotion estimation method integrates physiological signals related to emotion with the psychological model, which allows people to estimate emotion objectively with simplified sensors. Such benefits make this method available for daily usage. However, the evaluation of this method is not enough. To apply this method to our proposal above, evaluating Ikeda's bio-emotion estimation method is the first step of the research. We conduct aromas to evoke specific emotions to evaluate this method since the aroma is wildly applied to therapies. We compared the estimated result with the classic subjective emotion evaluation self-assessment manikin (SAM) result to evaluate the bio-emotion estimation result. Through the experiment, we found that among four of five types of aromas, the bio-emotion estimation result is matched to the SAM result, except for one negative aroma, which caused an increase in heart rate. In this case, the bio-emotion estimation method result is the opposite of the SAM result. This experiment demonstrates the validity of Ikeda's bio-emotion estimation method in daily emotion-evoking situations.

After evaluating the bio-emotion estimation method, we aim at the second proposal to inform users of their emotion state. Since the evaluation of Ikeda's bio-emotion estimation method turned out well, we combined the bio-emotion estimation method with the closed-loop biofeedback method to inform users of the results. To this end, the second study was conducted to evaluate the subjective opinion of users with a questionnaire, which is to figure out whether the feedback of bio-emotion is acceptable for users. We also designed a prototype system to conduct the second experiment based on the proposal. According to the questionnaire and an interview-based survey in this experiment, most respondents

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who experienced the system have positive attitudes toward it. Therefore, we improved this system and compared the physiological signal changes of the users before and after the feedback.

Under the positive emotion condition, we found a significant difference between the rest and post-feedback procedures on pNN50. However, this result might be caused by the continuity of positive emotions and the short duration of the feedback. The user's negative emotions are deepened when their subjective emotion state is inconsistent with the estimated emotion state, which we believe is due to their different emotional intelligence and traits. In addition, given the fragmented usage scenario of social media, we turned the time-period bio-emotion feedback into real-time emotion feedback. On this basis, the fact that different users hold opposite opinions about bio-emotion feedback is due to the different emotion intelligence of users. Through the real-time bio-emotion feedback system, we noticed two problems. Firstly, the bio-emotion feedback based on the time period does not fit the social media scenario. Secondly, users have varying needs for bio-emotion feedback due to the differences in their trait emotional intelligence questionnaire (TEIQue). To address these problems, we redesigned the system. First up, we translated the time-based bio-emotion feedback into real-time emotional feedback. Next, actual negative content from social media was used as emotion evocation material. Finally, the questionnaire we conducted covers two aspects, the TEIQue and the user experience questionnaire (UEQ). Based on the result of the TEIQue, we classify the participants into different groups. We found a significant difference between the low self-control and high self-control groups. The comparison between these groups revealed that the group with low self-control was more relaxed than the group with high self-control. We also carried out a case analysis on a representative sample. The case analysis result demonstrated that bio-emotion feedback unconsciously changed the users' emotional states in many cases. Based on the result of UEQ, we show the perspicuity of our system.

In conclusion, real-time bio-emotion feedback impacts users' emotional states. The application of bio-emotion feedback in social media can be expected. Meanwhile, in this study, biosensors were applied under laboratory conditions. Therefore, we consider applying a wearable device to provide feedback on specific negative emotion states of users during social media usage. Meantime, since the bio-emotion feedback regulates the user's emotional state unconsciously, we believe it can also significantly contribute to mediating the user's emotional state and improving mental health.

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