

画像からの心拍数計測と表情認識を用いた感情状況の変動推定

Vision Based Emotion Estimation Using Heart Rate and Facial Expression

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[Purpose of Research]

The ability to read human emotion has many applications in human-computer interaction and affective computing. Reading facial expressions is a common approach in emotion expression recognition systems. However, there are times when people do not show obvious facial expressions (Fig. 1). There are also times when people may try to hide facial expressions. For example, if we asked people to participate in a pilot viewing of a new TV show, they may indicate it was enjoyable even if they did not

enjoy it because they were being polite. Thus it is important to use some other means of sensing emotion to supplement facial expressions.

Fortunately, psychophysiology [1] indicates emotions can also be recognized by measuring physiological responses like cardiac activity. Physiological responses due to emotions are also more difficult to hide. However, most proposed systems rely on specialized sensors that must be attached to the body. This limits the range of applications possible.

In our work, we propose using video-based photoplethysmography to read cardiac activity from RGB videos of the human face. Due to tiny color changes in the skin, reading cardiac activity from RGB is possible and we show its effectiveness in emotion detection/recognition on video content.

From our findings, it will then be possible to use cardiac-based emotion recognition to supplement facial expression recognition. A major upcoming application of our work is in detecting the emotional state of elderly patients in care facilities using our sensing system. We are currently investigating this application in cooperation with an elderly care facility.

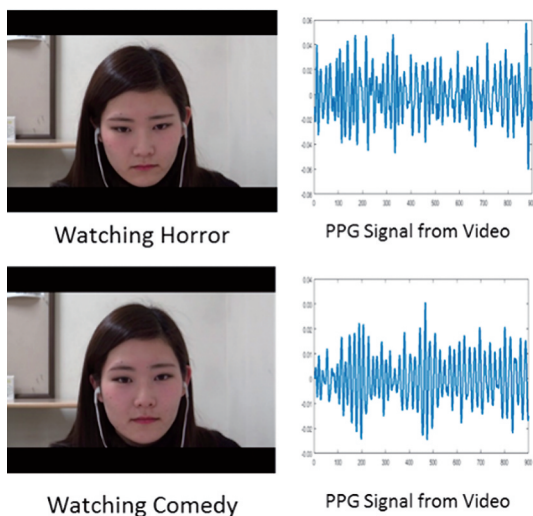


Fig.1 Human subject watching video clips. Facial expressions are similar. We recognize emotion by photoplethysmograms (PPGs).

[Contents and Results]

In the early phases of our work, we took our past “heart rate from video” algorithm [2] as a starting point and explored ways to improve robustness in more realistic settings such as motion and poor lighting (1, 2, 6). (Note that citations with parentheses refer to our “Publications and Achievements”).)

Later, we built a dataset of human subjects (40 university students) watching horror and comedy video clips and measured their heart rates (HR) from videos of their faces. (3) In this study, we verified that the emotional stimulation from videos cause a statistically significant increase in average HR compared to the subjects’ average resting HR. We also confirmed that our video PPG algorithm could accurately read HR compared against a FitBit sensor (correlation 0.9). The possibility of using video PPG to detect emotional changes in multiple people using a single camera was also investigated. (4)

Our next step was to explore reading cardiac activity from real world videos and see if it would be possible to detect emotional states. Specifically, we decided to use YouTube “reaction vlogs” as a testbed of real-world videos. “Reaction vlogs” are videos where vloggers record themselves watching things such as movie trailers. We can see their facial reactions and also try to estimate their cardiac activity using our video PPG algorithm.

We did a preliminary study in (5) on YouTube video analysis. To deal with the complex motions that could occur in real-world videos, we also introduced some major improvements to our algorithm (Fig. 2). This algorithm is similar to our past work [2]. However, we introduced Delaunay Triangu-

lation to track triangular regions on the face (instead of square patches) to address pose changes. We also used the RGB channel weighting scheme proposed in [3].

To confirm the feasibility of estimating HR from YouTube, we captured 18 videos with highly varied motion and uploaded them to YouTube. We then downloaded our videos from YouTube and estimated HR. We found that the uploaded YouTube videos had a mean absolute error (MAE) of 9.9 BPM. The original videos had a 6.9 BPM MAE but it shows HR estimation from YouTube should be possible. We then downloaded videos from seven vloggers that watched the Christmas Horror Movie, “Krampus” (Fig. 3).

From these videos, we estimated the average HR (over all the vloggers) at 30-second intervals and observed the changes in average HR. Fig. 4, shows, in the scariest parts of the trailer, the average HR had a significant increase (with a decrease in standard deviation). This suggests we can read accurate HR with detected emotional changes consistent with our past findings on our dataset from (3).

Despite the effectiveness of using HR to detect emotional changes, there is the limitation that HR does not give enough information to

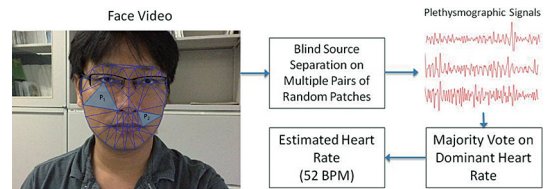


Fig. 2 Basic flow of the video PPG algorithm for estimating cardiac activity.



Fig. 3 Sample “YouTube Reaction” Videos

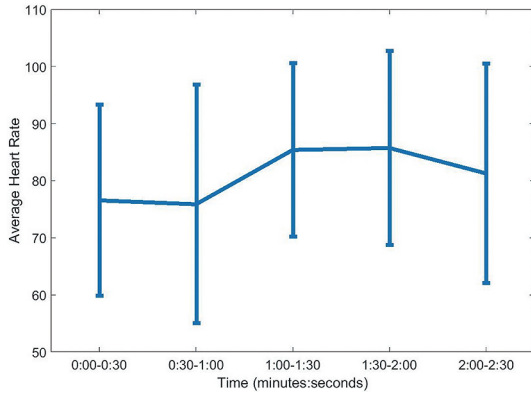


Fig. 4 Average HR (BPM) of the vloggers from watching the movie trailer. Standard deviation bars are shown.

classify the type of emotion a person experiences. For example, we may want to know if someone is experiencing fear or joy. Thus in (7), we decided to estimate the PPG signal (cardiac pulse signal and not just HR, see Fig. 1) and then attempt to classify emotions.

In (7), we were able to estimate the PPG signal (not just the HR). Our algorithm (Fig. 2) provides multiple independent hypotheses of the PPG signal. We found that by taking the normalized average PPG signals (with the same dominant HR), we could get a single robust estimate of the PPG signal. The PPG signals in Fig. 1 are examples of actual estimates from video.

We then applied this approach to estimate the PPG signals on our dataset of university student reactions to watching horror and comedy video clips. We then tested using SVMs to classify the PPG signals into either “horror” or “comedy”. (Being able to classify PPG signals by the type of video the subject watched would be an indication of effective emotion classification.) Table 1 shows classification results using PPG signals estimated from our algorithm and compares to using the average intensities of 17 facial action units. Facial expressions gave better results than our PPG-based method but this is because we did

Table 1 Leave One Out Cross-Validation results using linear SVMs in all cases. PCA denotes PCA preprocessing of the data.

Feature Type	LOOCV Acc.
Video PPG	65.4 %
Video PPG (PCA)	67.3 %
Facial Action Units	76.9 %
Facial Action Units (PCA)	78.8 %

not ask the subjects to hide their facial expressions. Our method is still able to read emotion relatively well without relying on facial expressions, which can be easily hidden.

[Future Work]

We are working with a care facility to explore applications in elderly care monitoring. We will also work towards improving video PPG-based emotion sensing and how it can be effectively combined with facial expression recognition.

[Publications and Achievements]

- 1) A. Lam, Y. Kuno, “Towards Estimating Heart Rates from Video Under Low Light”, In 12th Intl. Symp. on Visual Computing, Springer, 2016.
- 2) 大津耕陽, 倉橋知己, K. Das, 福田悠人, A. Lam, 小林貴訓, 久野義徳, “環境変化に頑健なビデオ映像による心拍数計測手法”, In 23rd Symp. on Sensing via Image Information, 2017. (最優秀学術論文)
- 3) K. Das, S. Ali, K. Otsu, H. Fukuda, A. Lam, Y. Kobayashi, Y. Kuno, “Detecting Inner Emotions from Video Based Heart Rate Sensing”, In Intl. Conf. on Intelligent Computing, Springer, 2017.
- 4) K. Das, K. Otsu, A. Lam, Y. Kobayashi, Y. Kuno, “Towards Detecting the Inner Emotions of Multiple People”, 第99回パターン計測部会研究会, 2017.
- 5) A. Lam, K. Otsu, K. Das, Y. Kuno, “Towards Taking Pulses Over YouTube to Determine Interest in Video Content.” In Intl. Workshop on Frontiers of Computer Vision, 2018.
- 6) K. Otsu, K. Das, H. Fukuda, A. Lam, Y. Kobayashi, Y. Kuno, “映像解析に基づく頑健・高速な心拍数計測手法”, In 24th Symp. on Sensing via Image Infor-

mation, 2018.

- 7) K. Das, A. Lam, H. Fukuda, Y. Kobayashi, Y. Kuno, "Classification of Emotions from Video Based Cardiac Pulse Estimation", In Intl. Conf. on Intelligent Computing, Springer, 2018.

[References]

- [1] J.A. Stern, "Toward a Definition of Psychophysiology", Psychophysiology. Jul, 1 : 90-1, 1964.
- [2] A. Lam, Y. Kuno, "Robust Heart Rate Measurement from Video Using Select Random Patches", In Intl. Conf. on Computer Vision, 2015.
- [3] G. de Haan and V. Jeanne, "Robust Pulse Rate from Chrominance-Based rPPG", IEEE Trans. on Biomedical Engineering, vol. 60, no. 10, pp. 2878-2886, Oct. 2013.