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BEHAVIORAL RESEARCH BLOG - HUMAN BEHAVIOR RESEARCH - EMOTION



What is RPPG?

POSTED BY GUEST BLOGGER ON THU 17 OCT. 2019 - 5 MINUTE READ

This blog post is written by Mayuko Kanemura. During her internship at Noldus, she performed a validation study of the use of Remote PPG in FaceReader. She compared three heart rate measurements: RPPG, PPG, and the gold standard, ECG.

In this blog post, she explains what RPPG is and gives recommendations on how to best measure this.

Tools for **automated analysis of facial expressions** provide an objective assessment of a person's emotional expressions in consumer behavior and sensory research.

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FaceReader also offers other video-based functionalities that are useful for sensory and consumer research such as automated registration of the frequency and variability of heart rate.

Heart rate and heart rate variability

Heart rate (HR), the measure of how often the heart beats per minute, is influenced by the autonomic nervous system (ANS) which consists of two primary branches, the sympathetic and the parasympathetic nervous system.

The former is active when we are in an exciting situation (threat, fear, stress, and exercise) and increases heart rate. The latter is active when we are in a relaxed



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Measuring HR and HRV remotely

FaceReader can measure **heart rate and heart rate variability remotely** using remote photoplethysmography (RPPG), a tool to measure heart rate remotely without attaching sensors. It only requires video recording with a high-resolution camera. It can be beneficial in various kinds of physical, health and emotional monitoring, such as monitoring of drivers, consumers, the elderly, and infants [2].

Those kinds of monitoring are now available with less discomfort, using remote PPG. As part of my research, I looked at HR and HRV while participants consumed different kinds of foods, because I wanted to observe the physiological mechanism changes during food consumption.

PPG

The principles of PPG are the following: Using the example of a wearable, such as a heartrate-sensing watch, light emits to the skin from one sensor and a second sensor detects how much light is returned to the device. This forms the contrast between emitted light and reflected light. The amount of reflected light changes according to the blood volume, which is caused by capillary dilation and constriction, hence it can estimate the heart rate.

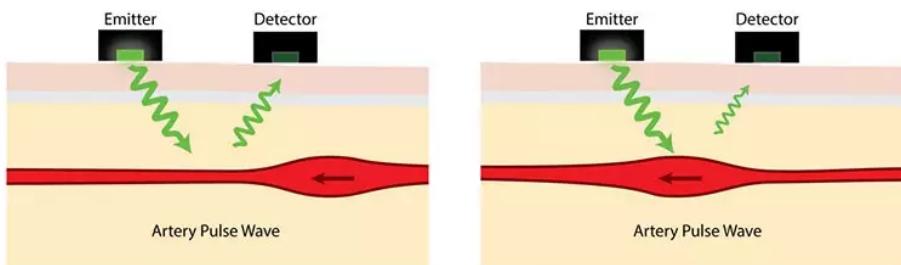

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Figure 1. Optical heart rate sensing. Left: lower pressure preceding the pulse wave means narrower arteries and less absorption (higher reflectivity) of the green light source. Right: a higher blood pressure pulse causes wider arteries and more light absorption (lower reflectivity) [3]. Credit: [The Conversation](#).

Remote PPG

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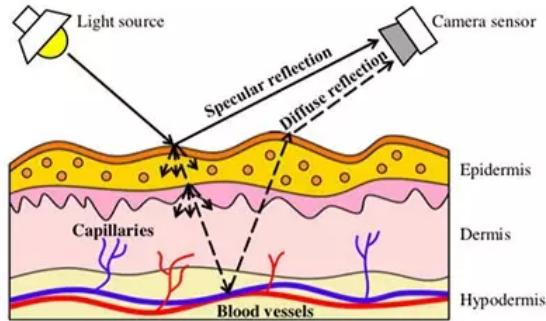
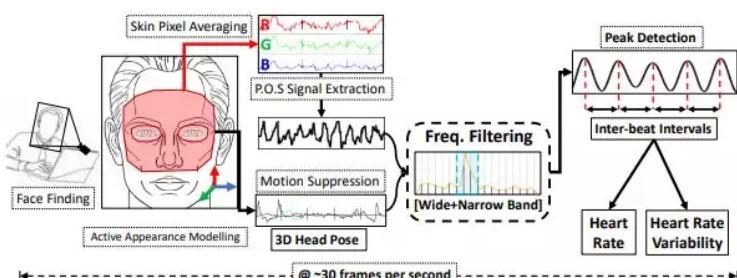


Figure 2. The skin reflection model that contains specular and diffuse reflections, where only the diffuse reflection contains pulsatile information [4]. Credit: Wang et al. (2017).
Algorithmic principles of remote-PPG. IEEE Transactions on Biomedical Engineering, 64(7), 1479–1491. DOI: 10.1109/TBME.2016.2609282

The approach to remote detection is the following:

- [Skin pixel selection] The face in the captured webcam image is detected and modeled in order to determine facial landmarks and head orientation. Subsequently, approximately the top two-thirds of the face, where most of the blood vessels are concentrated, is selected as the region of interest.
- [Signal extraction] The average of each pixel colors (red, green, blue) of the region is measured over time (both specular + diffuse reflections).
- [Signal filtering] The noise from the head motions is detected by fitting the facial model and then noise-free heart rate is produced.
- [Output calculations] By detecting peaks, inter-beat intervals are measured and then the heart rates and heart rate variability are estimated.

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FaceReader validation study

In the validation study, 25 participants were asked to watch a video (still condition) and to consume different food stimuli, ranging from liquid to solids (water, yoghurt, chicken, sausage), and the other way around. To validate the RPPG by FaceReader, BIOPAC ECG and BIOPAC PPG were used.

Within the still condition, the measurement of RPPG was successful. However, during food consumption, the differences between measurements from RPPG and ECG were bigger during consumption, indicating that RPPG underestimated higher heart rates. The movement of the face during food consumption disturbed the RPPG measurement. On the other hand, BIOPAC ECG and PPG showed high agreements.



FREE WHITE PAPER: FaceReader methodology

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Recommended conditions

As a result of my research, the following conditions are recommended for FaceReader RPPG:

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~~Wearable RPPG measurement is sensitive to motion of the head. It is recommended to use a setting where participants are sitting and not moving too much. A high correlation between the gold standard and RPPG in these situations has been observed in many studies.~~~~to use a setting where participants are sitting and not moving too much. A high~~~~correlation between the gold standard and RPPG in these situations has been~~~~observed in many studies.~~

Because of the increasing attention to remote PPG, these drawbacks are expected to be solved, at least partly, with the improvement of algorithms in the near future.

References

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The influence of ad-evoked emotions on brand attitudes

Can brand authenticity generate positive emotions among consumers and turn into a positive brand attitude?



The emotions of people who think they're nice

What does 'nice' actually mean in relation to psychological variables? And does it positively correlate with self-reported levels of health, happiness, and wellbeing?



Comparing machine emotion recognition with a human benchmark

Our emotions come across clear in our facial expressions. Due to this, facial expressions can be used in a wide variety of studies.

Main applications

Human behavior research

- AV recording & evaluation
- Data integration & visualization
- Eye tracking & physiology
- Spatial behavior
- Emotion analysis
- UX research
- Behavioral coding & analysis
- Lab set-ups

Animal behavior research

- Zebrafish video tracking
- Rodent video tracking
- Home cage & Welfare
- Anxiety, fear & depression
- Rodent gait analysis
- Animal behavior & observation
- Cognition & memory
- Animal behavior, welfare & health tracking
- Open field test

Main products

Human behavior research

- Viso
- The Observer XT
- FaceReader
- TrackLab
- Labs
- Data acquisition systems
- Eye tracking

Animal behavior research

- EthoVision XT
- The Observer XT
- TrackLab
- CatWalk XT
- ErasmusLadder
- DanioVision
- DanioScope
- PhenoTyper
- Mazes

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