Affective Mirror

Automated Emotion Detection Through Photoplethysmography &Facial Expression Analysis

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1 Overview

Facial expressions are powerful channels of nonverbal human communication. Although determining how a person is feeling based on their expressions is trivial for us, it is quite challenging for computers. Current research has proposed various techniques such as machine learning to address this issue. However, computers are capable of analysing other forms of signals such as heartbeat rate. The goal of this project is to develop a system that can detect emotions, satisfying the following requirements:

- Non-invasive
- Non-contact
- Non-wearable

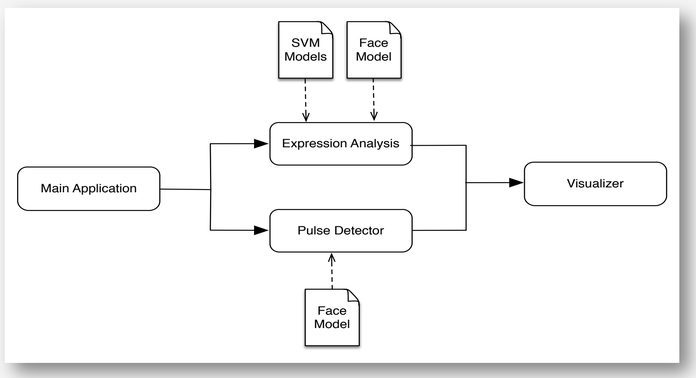
Implementation

The high-level design of the system consists of three distinct components.

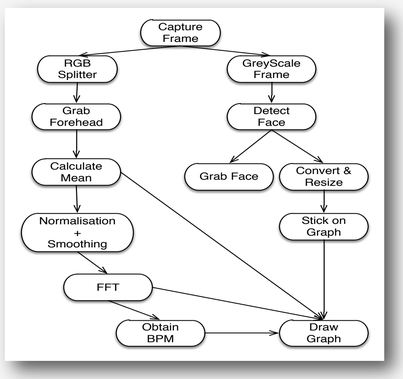
- Facial Expression Analysis
- Pulse Detection
- Visualisation

Video frames from the camera are fed to the Expression Analysis and Pulse Detector components. The Expression Analyser uses $GTSVM_2$ (GPU-Tailored Approach for Training Kernelised $SVMs_3$) which enables GPU processing for the SVM_3 algorithms used. $OpenCV_1$ is used for face detection.

a Component architecture including classier models



b BPM computation process

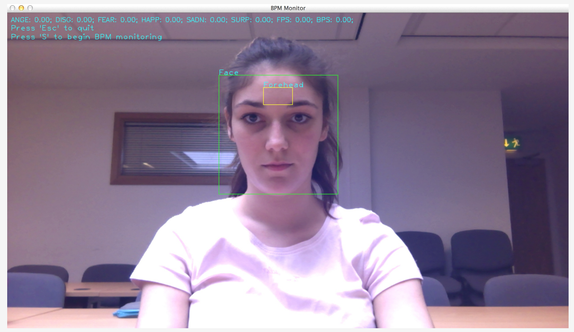


The Pulse Detector employs ***Photoplethysmography***$_4$ (PPG), a novel video-based methodology for non-contact, automated detection of cardiac pulses. This is a simple webcam-based optical technique that measures blood volume changes to sense cardiovascular pulse. This technique uses normal ambient light as a source of illumination for acquisition of PPG signals. This method relies on volumetric changes in the facial blood vessels during the cardiac cycle. The colour sensors of the webcam pick up a mixture of the reflected plethysmographic signal. Since the hemoglobin absorptivity differs across the visible and near-infrared spectral range, each colour sensor records a mixture of the original source signals with slightly different weights.

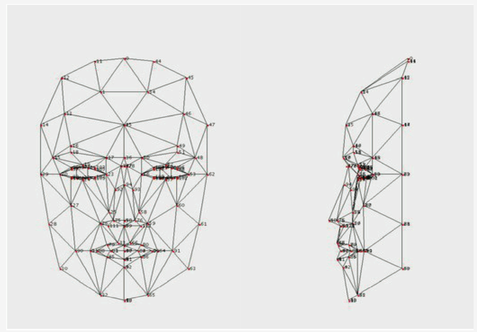
The result of both analysis is passed to the Visualiser to visually inform the user of the detected emotion.

3 Application in Action

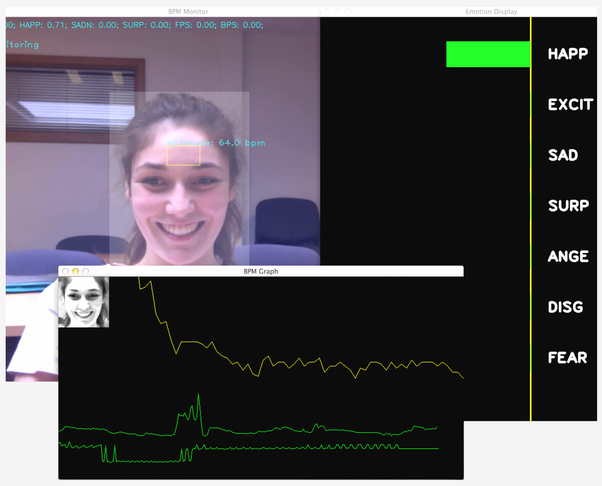
a Face detection stage



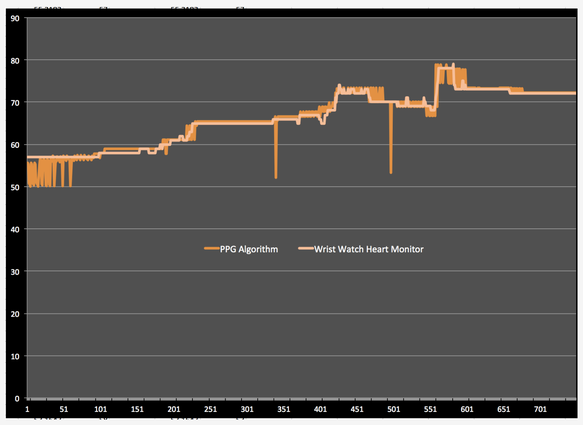
b Analyse the facial expression using Action Units



c Measure pulse & visualise the detected emotion



d Comparative analysis



Possible Real-world Applications

- Angry driver recognition as a safety feature in future cars.
- Effect of art on emotions – provides artists with quick feedback.
- Teaching applications that can identify feelings of students.

4 Conclusion

Challenges

- Algorithms are sensitive to illumination and lighting condition.
- Cognitive to physiological signal mapping is complex.
- Pulse detection algorithm is sensitive to noise caused by movement.

Current Status

- The core facial expression analysis library is still under development.
- Application currently supports a basic GUI.

[1] Open Source Computer Vision - http://opencv.org/
[2] GTSVM - http://ttic.uchicago.edu/~cotter/projects/gtsvm/
[3] OpenCV, "Introduction to Support Vector Machines. http://docs.opencv.org/doc/tutorials/ml/introduction_to_svm/introduction_to_svm.html
[4] W. Verkruysse, L. O. Svaasand, and J. S. Nelson, "Remote plethysmographic imaging using ambient light.," *Optics Express*, vol. 16, pp. 21434–45, 2008

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