Seeing the unseen – Lie Detection using Human Emotions

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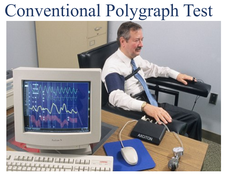
Introduction

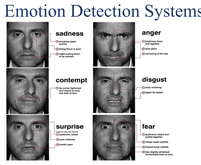
Conventional Polygraph Test



Pros and Cons

- Claimed accuracy rate of 60 - 70% (Federal Systems) [1]
- Difficult to deceive but not impossible
- Requires a court order and performed as a formal trial
- Deception techniques and trainings for polygraph are widely available [2]

Emotion Detection Systems

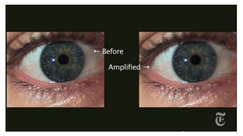


- Claimed accuracy rate over raw video feed using CNN's 57% (Commercial Systems) [3], [4]
- Can be performed with just the video feed of the subject while being investigated
- Not a stand alone lie detector, assists in lie detection.

What if we can amplify very small changes in a video?
Eulerian Video Magnification [5], [6], [7]

Pulse Rate Estimation

Respiration Rate Estimation



Improved Dynamic Biometrics with Phase Based Amplification

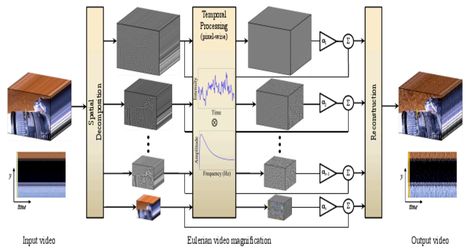
Micro-expression Detection and Amplification

What if we use amplified video feeds and use multiple modalities with deep learning in assisting lie detection?

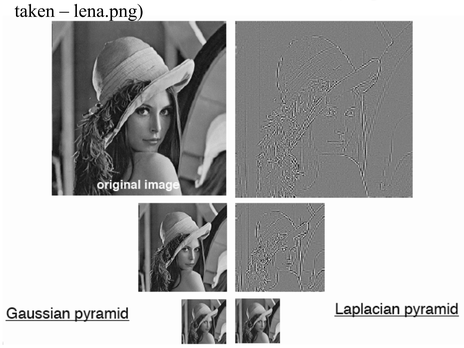
Objectives

- Implementation of EVM (Eulerian Video Magnification) using a portable language like Java.
- Automate detection of faces using Viola-Jones.
- Use EVM technique for pulse estimation, respiration rate estimation, biometrics, micro-expression detection and amplification
- Integrate the above techniques and use deep learning for better estimation of concealed emotions and thereby assist lie detection

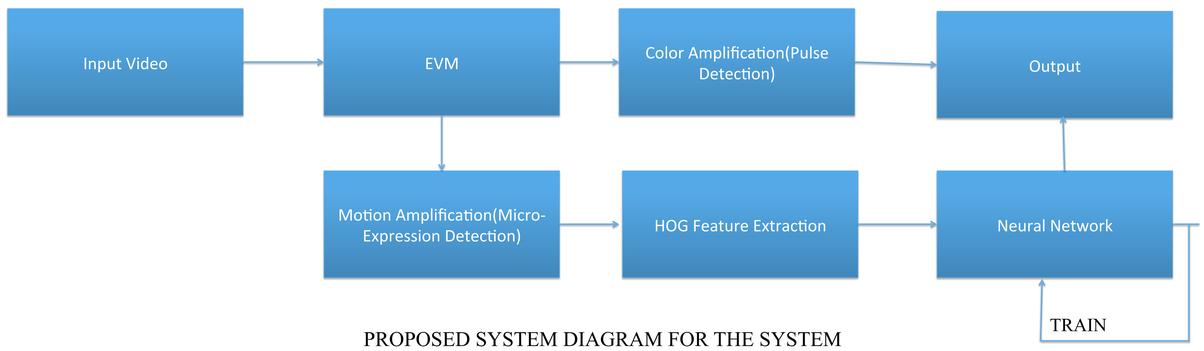
Eulerian Video Magnification Block Diagram
(taken from Reference 5)



GAUSSIAN vs LAPLACIAN PYRAMID (image taken – lena.png)



LIE DETECTION ASSISTANCE SYSTEM



PROPOSED SYSTEM DIAGRAM FOR THE SYSTEM

STEPS USED FOR EVM

- Convert image from time domain to frequency domain using fourier transformation.
- Filter out and then amplify the desired frequency
- Convert the image back to time domain
- Stack up the image upon the original image and display the result

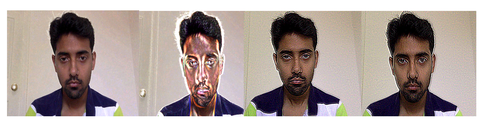
COLOR MAGNIFICATION vs MOTION MAGNIFICATION

- For color magnification Gaussian pyramid structure is used.
- For motion magnification Laplacian pyramid structure is used.

PULSE DETECTION

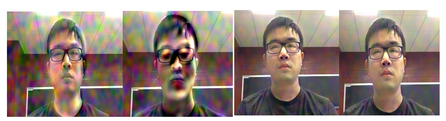
- Color magnified video passed as input to this system.
- A region of interest(ROI) is selected (in our case forehead is taken as the region of interest).
- Calculate the intensity variation of the ROI for all the color channels.
- Pass the intensity variation matrix through a smoothing filter of your choice to reduce noise (in our case its Butterworth Filter).
- Calculate the frequency of the peaks to get an approximate measure of BPM(beats per minute)

Results



MOTION MAGNIFICATION

PULSE DETECTION



COLOR MAGNIFICATION

PULSE(UNIQUE HEART RATE MONITOR - ANDROID APP)	PULSE(α = 50)	PULSE(UNIQUE HEART RATE MONITOR - ANDROID APP)	PULSE(α = 100)
85	73	87	77
81	67	89	73
90	77	90	82
75	65	77	87

- Alpha denote the amplification factor
- Pulse measured in BPM(Beats per minute)
- Android App(Unique heart rate monitor) used to test system
- Accuracy observed was 86.3%

Conclusions

- Proper lighting conditions required for the system to detect pulse from color amplified video frames.
- Pulse detection works with some error percentage which could be corrected by using smoothening filter(Butterworth Filters or Sine Wave with the same frequency as the video data).
- Motion amplification amplifies the subtle motion (such a muscle movement while breathing, eye ball movement while blinking etc).
- Large movements while running the system makes its difficult to capture micro-expressions. Thus the system requires the person being observed to be very stable.
- Micro expression requires training of the Neural Network which requires optimization.
- Once the neural network is trained, we could easily detect emotions(which could be used for lie detection) and use the pulse data along with it to create the desired system.

References

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