IMPROVED PCA BASED FACE-RECOGNITION BY IMAGE PROCESSING

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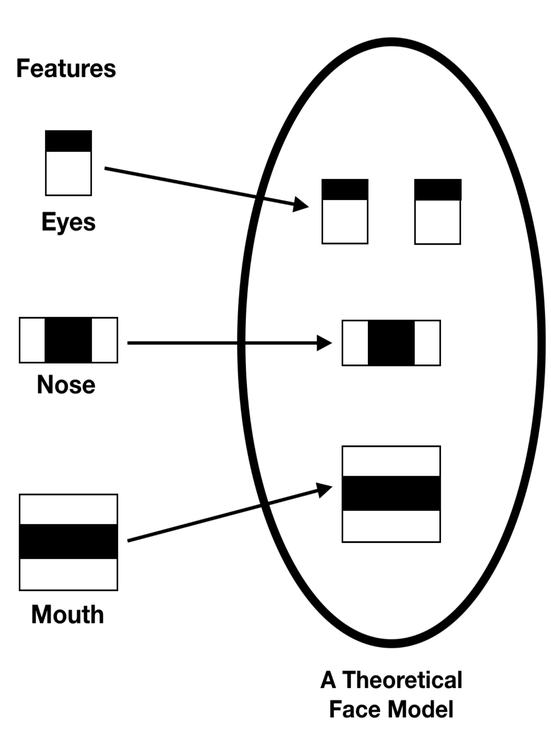
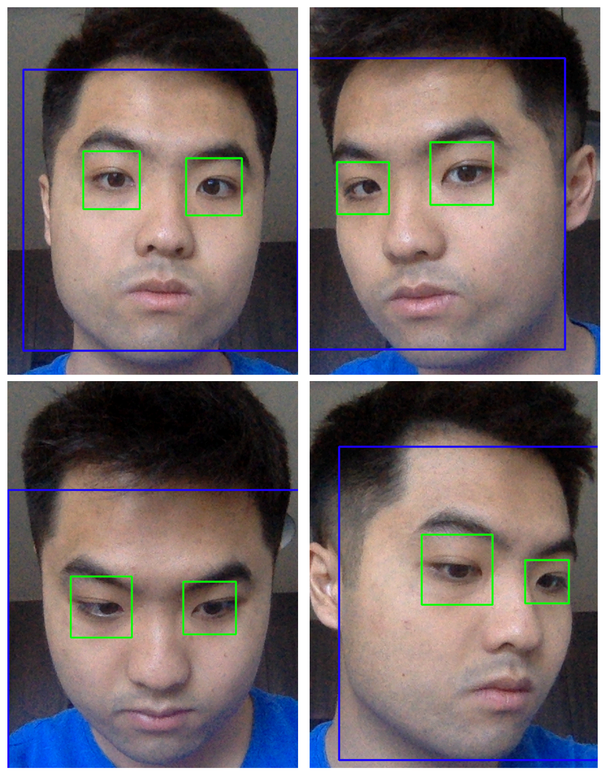
1. ABSTRACT

- Traditional face recognition algorithms have limitations of requiring large amount of training images but still failing sometimes under complex background; Traditional face recognition often focus more on improving recognition algorithm instead of detection algorithm, which often induces unexpected results even with sufficient amount of training images.
- Image Processing is a technique to enhance raw images received from cameras/ sensors for better data analysis. With a set of image processing technique, the traditional face recognition algorithm can be improved.
- Image processing techniques are applied in face detection stage to ensure the quality of all training images is good.
- HAAR feature algorithm is applied for face detection and Principal Component Analysis is applied for recognition.

2. HAAR FACE DETECTION & RESULT

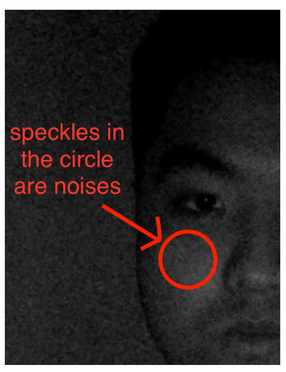




- HAAR features are a set of square symbols, which can distinguish the human eyes, noses and lips, those basic human facial features.
- Use each mask (the blocks in the picture) to do convolution through the entire face image to find the feature.
- The result from convolution are going to determine the what facial feature it is.
- The face are found at **different angels.** (top 4 pictures at right)
- **HOWEVER**, the algorithm fails in **bad lighting and noisy** conditions.

3. GAUSSIAN BLUR & IMAGE RESTORATION

- In bad lighting condition, normal imaging devices usually generat too much noise (like those speckles in the left image).
- Applying Gaussian Filter to denoise the image before further processing.



Apply Gaussian Blur

Apply 3x3 Gaussian Filter, which removes some speckles but meanwhile maintain the face feature not too blurry!

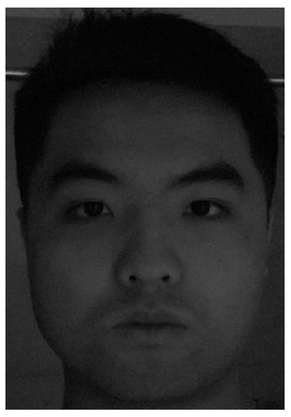
- Cameras will catch one frame in which head is in fast motion, which will cause motion blur. Image restoration helps deblur the degraded image.
- Implemented by using least square algorithm, based on guessing principal.

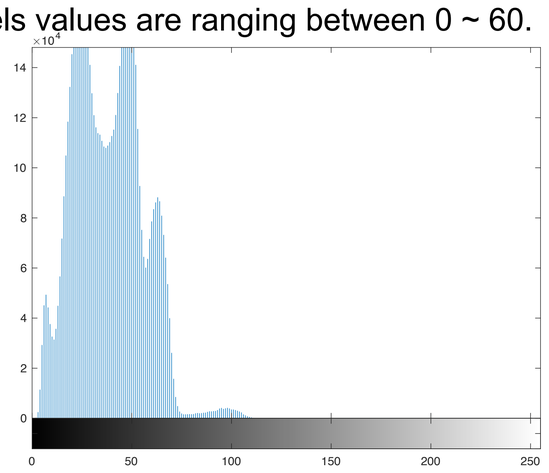
ULS Motion Deblur

Since unconstrained least square, the algorithm only works after denoising. Otherwise, the noise will be also deblurred.

4. HISTOGRAM EQUALIZATION

- This procedure is executed after Gaussian Blur and Image Restoration, which means, the image should be neither too noisy nor too blurry.
- The histogram has shown that most pixels values are ranging between 0 ~ 60.

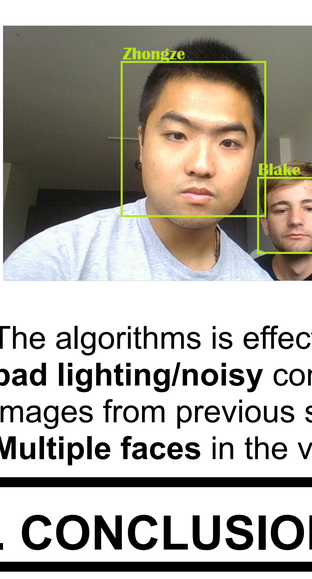


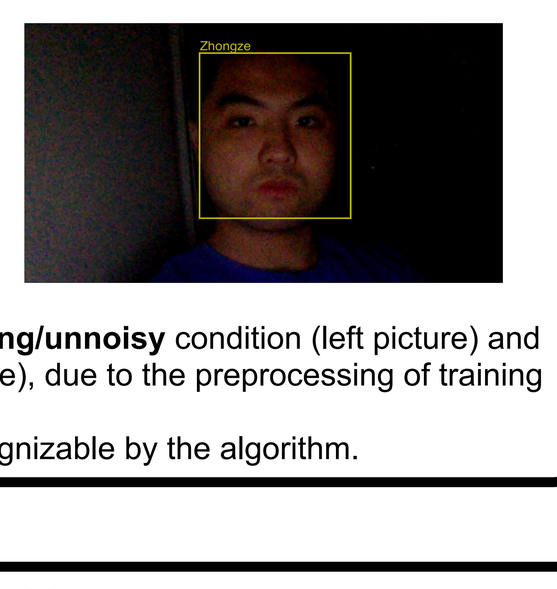


- By histogram equalization, the pixels values will be adjusted by following equations.

$$P_k = \frac{amount\ of\ pixels\ with\ intensity\ k}{total\ number\ of\ pixels}, \quad s = T(i) = floor((L-1) * \sum_{k=0}^{i} p_k) = floor(9 * \sum_{k=0}^{i} p_k)$$

- Where ***Pk*** stands for the probability that a random pixel has the intensity ***k***.
- Pixels with high intensities will be evenly spread out after adjustment.





- Now the face has a good contrast and clear shape and it is ready to proceed to recognition stage.

5. PCA FACE RECOGNITION & RESULT

- Principal Component Analysis (PCA) will be applied to all training images.
- PCA analysis transform the training faces to Eigenfaces which can summarize the generality of all the training face.
- Calculate the Euclidean distance between Eigenfaces and the detected faces to determine whether the face from camera can be recognized.

- The algorithms is effective in **good lighting/unnoisy** condition (left picture) and **bad lighting/noisy** condition (right picture), due to the preprocessing of training images from previous steps.
- **Multiple faces** in the video are also recognizable by the algorithm.

6. CONCLUSION

Difference to the traditional Face Recognition

- Instead of improving on recognition algorithm and adding more training images, we improve the face-detection algorithm, which saves a lot of development cost.
- The algorithms can work on all kinds of imaging devices like cameras, monitor phone cameras and so on.

Things can be worked on

- A better denoising filter or algorithm needs to be designed.
- Developing a constrained least square algorithm in image restoration stage will have better effects on face-detection.

7. ACKNOWLEDGEMENT

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