**EECS - 495 Biometrics 2015 Fall**
**Final Project Report**

# Pushing the Boundary of Biometrics Technologies – Twin Facial Recognition

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## 1. Related Work

The most challenging problem of face recognition is distinguishing identical twins. If we get over this challenge, then other problems can be solved easily. Before presenting our novel ideas, we did some survey of current work and got a really deep understanding about current research of twins face recognition. [1] did a survey of twins face recognition based on human being recognition. The authors asked volunteers to distinguish identical twin pictures under different conditions. They did three experiments and got results showed that under unlimited viewing time, controlled light condition and based on face feature type which is moles/scars/freckles performed better. This result gives a good direction for computer twin face recognition. [2] referred to seven different algorithms. Each algorithm compared the success rate of twins' pictures with different ages and general, and compared samples between 1 year earlier and 1 year later. [3] used three algorithms and did their experiment under three conditions, which are expressions, light and samples between one year earlier and later. [4] conducted a study of 3D detecting method to distinguish. Although there are a lot of researches on twin face recognition, the efficient algorithm and impact indicators are still limited. This paper proposed a combination method based on those related research and analyzing their results.

## 2. Research Idea

In our project, we used SIFT algorithm to extract the image features and RANSAC algorithm for feature matching. We mainly focused on finding the best performance of SIFT + RANSAC face recognition system under different conditions. Each image is a metadata and has eight different features (date, gender, race, year, weather, glasses, expression, yaw). For a normal face recognition scenario in a public dataset, all of these features are useful and distinguishable for recognizing face. It becomes, however, way more challenging to recognize (identical) twin faces only using race or gender information. Therefore, we only considered weather, expression and yaw as distinctive features, and thought that the combinations of these features would have a significant impact on twin face recognition. Images have different illumination depending on whether they are taken inside or in the rain. They also differ in terms of intensity change when the person in the picture is happy or has a blank stare, and in terms of image rotation. We chose 0, 45 and 90 degrees since they allow us to use front view, a rotated view that has relatively more features, and the profile view that can be used with its sharp features such as nose or chin shapes (e.g. generally, we can easily recognize a person when we look at their profile shadow projected on a wall). Each twin is arbitrarily labeled as Twin A and Twin B. We tested our system's performance with these following combinations;

- Happiness + Inside + 0 degree
- Happiness + Inside + 45 degree
- Happiness + Inside + 90 degree
- Happiness + Rain + 0 degree
- Happiness + Rain + 45 degree
- Happiness + Rain + 90 degree
- BlankStare + Inside + 0 degree
- BlankStare + Inside + 45 degree
- BlankStare + Inside + 90 degree
- BlankStare + Rain + 0 degree
- BlankStare + Rain + 45 degree
- BlankStare + Rain + 90 degree

## 3. Experiment

Although, there are near 200 pairs of twins, but the pictures in the folders are not in the same order. For example(just randomly say two folders to give a illustrate ), folder 90027 and folder 90028 have twin pictures, the 1st picture in the 90027 folder is happiness with 45 degrees, but the 1st picture in the 90028 folder may be happiness with 90 degrees, so we can't use the program to automatically open the image, we had to do it by hand and check every time to make sure we are comparing two pictures in same condition. This lead to that we can't get lots of comparisons.

Higher match score means more similar, since we are doing the experiments on twins, so higher match score causes higher FAR.

### a. Compare twins' pictures in happiness and blank stare and both in 0 degree

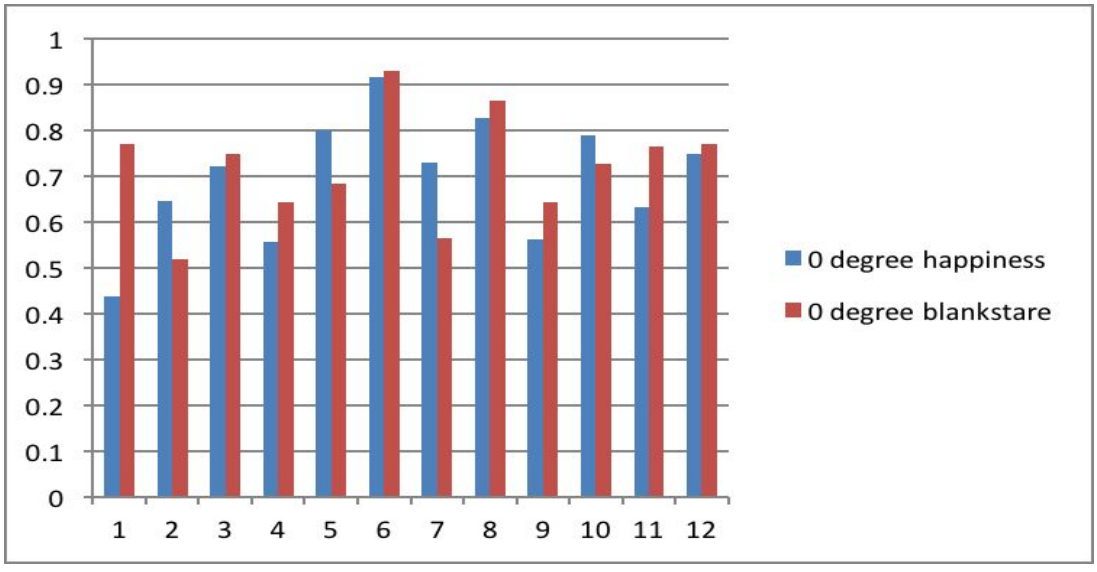

**fig.1 0 degree face direction with different face expression taken indoor**

8 happiness have higher match score than blank stare, which indicates in 0 degree situation, blank stare gives better result.

**b. Compare inside 45 degrees facing detection with different face expression**

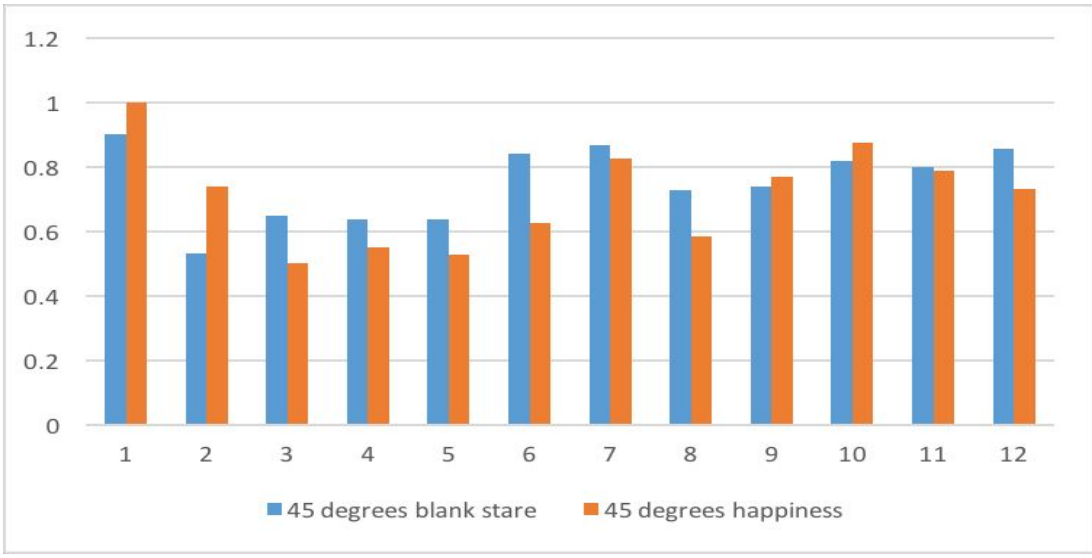


**fig.2 Inside 45 degrees facing detection with different face expression**

In fig.2, x-axis is the number of picture samples and y-axis is the similarity percentage between twins' pictures. According to fig. , the blue bar represents 45 degrees face direction with blank stare, and the orange bar represents 45 degrees face direction with smiling. Under the same facing direction condition when twins taking pictures inside, and because the higher percentage means the more similarity between twins' pictures as well as the more similarity means the worse performance of detecting method, as the image shows, the performance of different face expression is unstable when twins facing 45 degrees among above 12 pairs of data.

**c. Compare twins' pictures in happiness and blank stare and both in 90 degrees.**

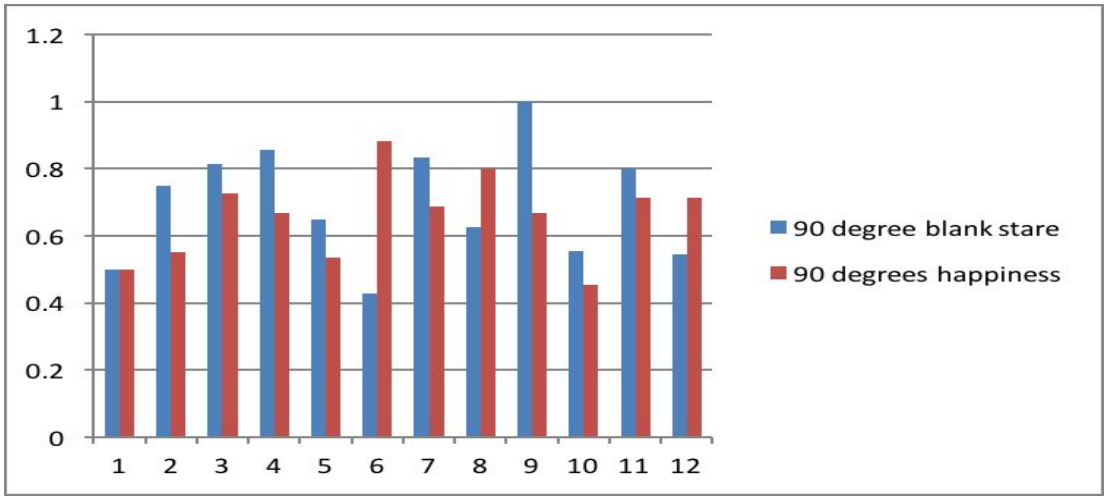


**fig.3 90 degrees face direction with different face expression under inside condition**

In 9 pairs, blank stare has higher match score than happiness, which indicates in 90 degrees situation, happiness gives better result.

**d. Compare degrees' changes in the same face expression.**

**i. Blank Stare**

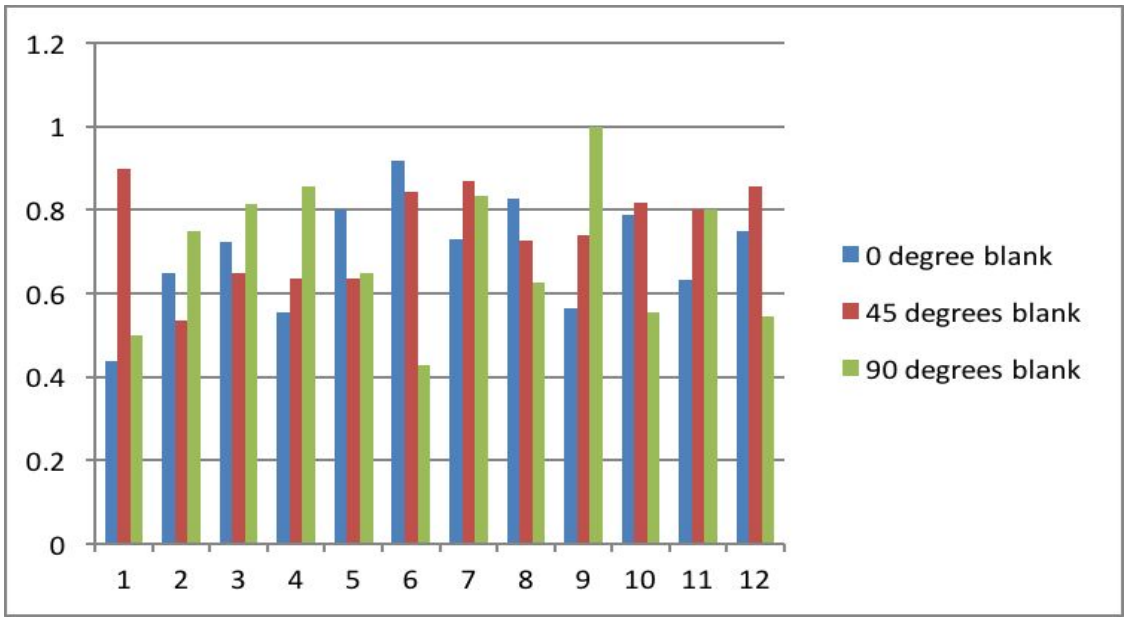


**fig.4 different face rotation with blank stare face expression taken inside**

We can see in most cases, 0 degree gives lowest match score, and then 90 degrees, 45 degrees is the worst.

**ii. Happiness**

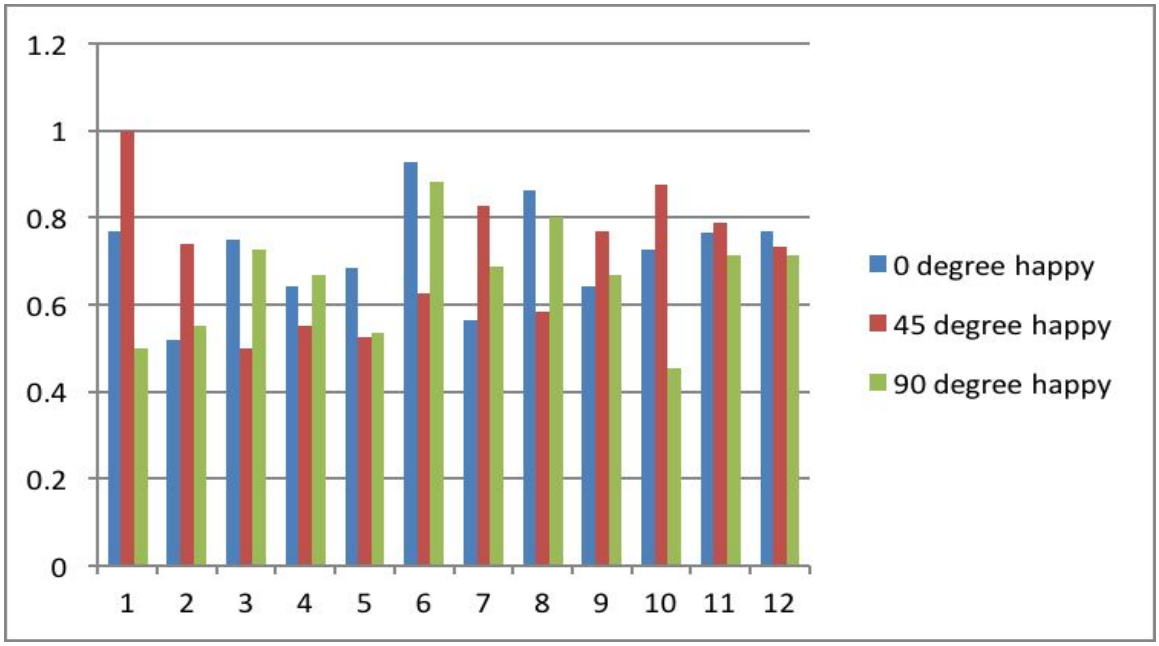


**fig.5 different face rotation with happiness face expression taken inside**

When it comes to happy face, 0 degree is no longer a best choice, 90 degrees seems better.

### e. Inside condition and rain condition

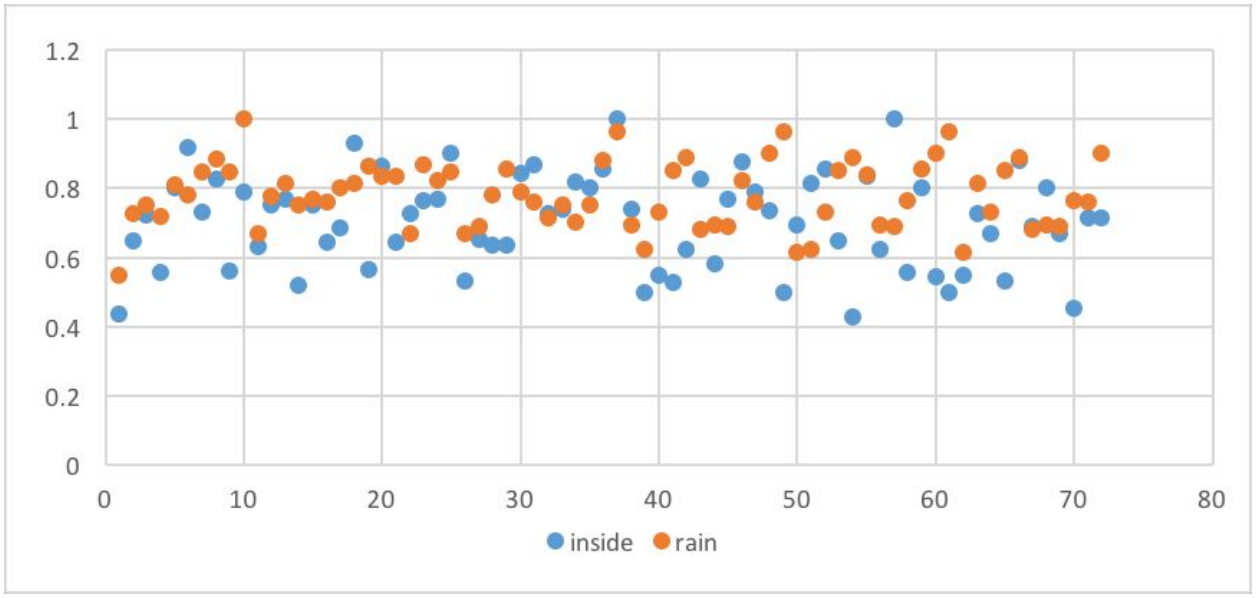


**fig.6 Inside condition and rain condition**

In fig.6 , the x-axis is the number of picture samples and y-axis is the similarity percentage. According to the image, with the same facing rotation degree and same face expression, the blue points represent pictures taken under indoor condition and the orange points represent pictures taken under rain condition. Because the higher similarity percentage means detection performs better, we can see that the

performance of controlled light which is inside condition shows better than the performance of rain condition. That is to say, if we want to obtain a good identical twins detection results, taking twins pictures indoor will help a lot.

## 4. Conclusion

In conclusion, when comparing front faces, blank stare gives better distinction between twins. For 45 degree, there isn't an obvious better expression. And for 90 degrees, face with happiness distinguishes twins better.

With the blank face expression, front face gives better result than 90 degrees than 45 degrees; with happy face expression, 90 degrees' face gives better result than 45 degrees than 0 degree.
In most situations, inside lighting condition gives better distinction.

And as a combination, the best condition to distinguish twins is 'inside lighting, 90 degrees' face, happiness'.(after comparing the two most likely condition 'inside lighting, 0 degree's face, blank stare' and 'inside lighting, 90 degrees' face, happiness', we find the latter one is better)

## References


[1] Biswas, Santosh, Kevin W. Bowyer, and Patrick J. Flynn. "A study of face recognition of identical twins by humans." *Information Forensics and Security (WIFS), 2011 IEEE International Workshop on*. IEEE, 2011.

[2] Paone, Jeffrey R., et al. "Double trouble: Differentiating identical twins by face recognition." *Information Forensics and Security, IEEE Transactions on* 9.2 (2014): 285-295.

[3] Phillips, P. Jonathon, et al. "Distinguishing identical twins by face recognition."*Automatic Face & Gesture Recognition and Workshops (FG 2011), 2011 IEEE International Conference on*. IEEE, 2011.

[4] Vijayan, Vipin, et al. "Twins 3D face recognition challenge." *Biometrics (IJCB), 2011 International Joint Conference on*. IEEE, 2011.