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# 3D Twins and Expression Challenge

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# OUTLINE

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- Dataset Description
- Algorithm
- Experimental Setup
- Results

# 3D Twins Expression Challenge (3D TEC) Dataset

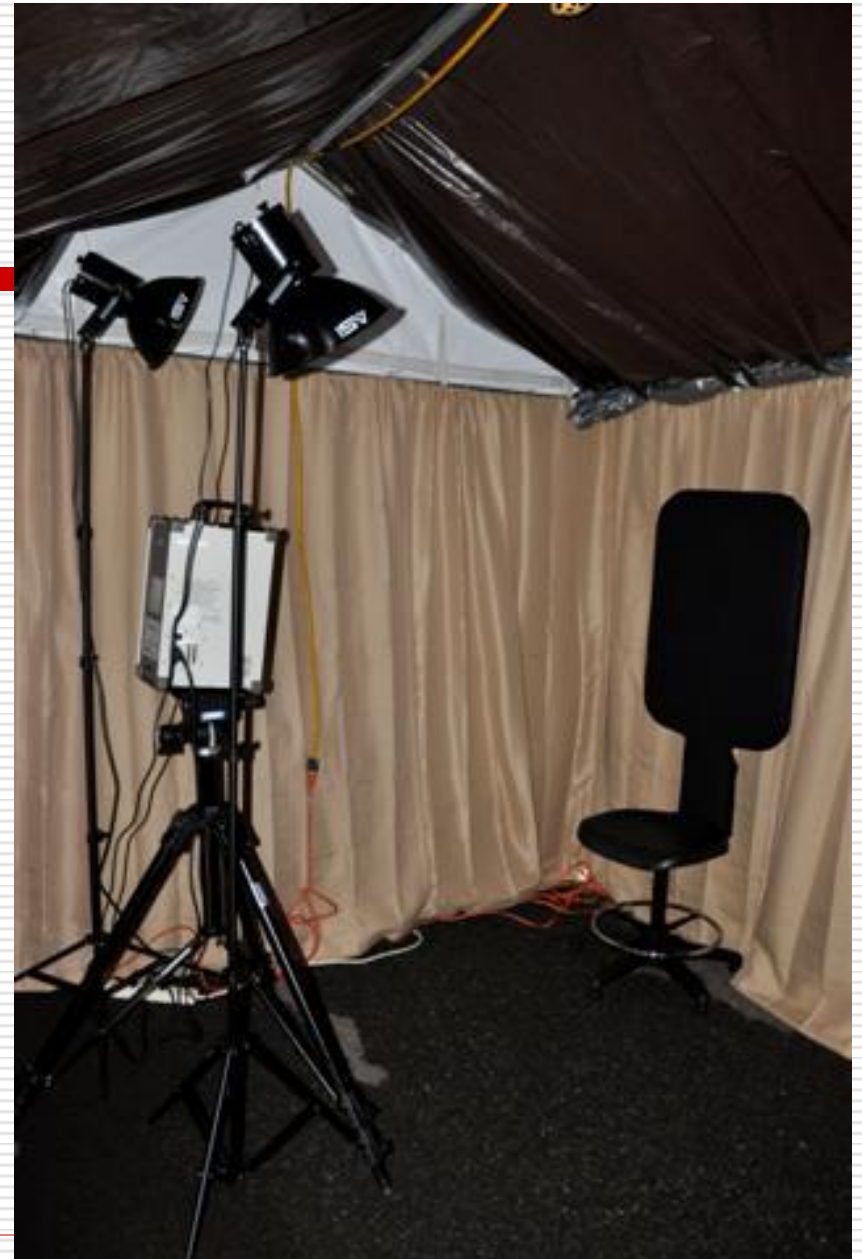
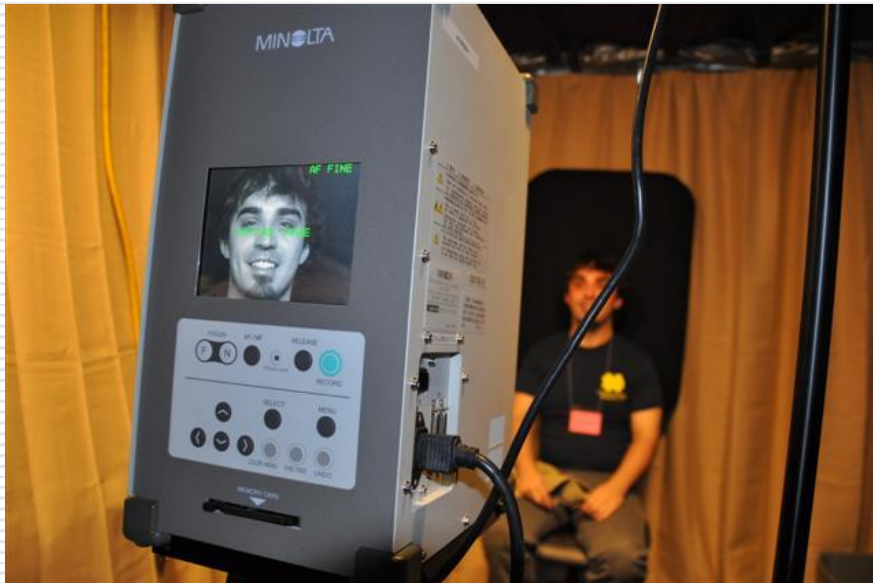
- ❑ 107 pairs of identical twins, 214 unique subjects.
- ❑ Neutral and smile expressions
- ❑ 428 images in total
- ❑ For each pair of twins, the images were acquired in a 10 minute window
- ❑ Single session data



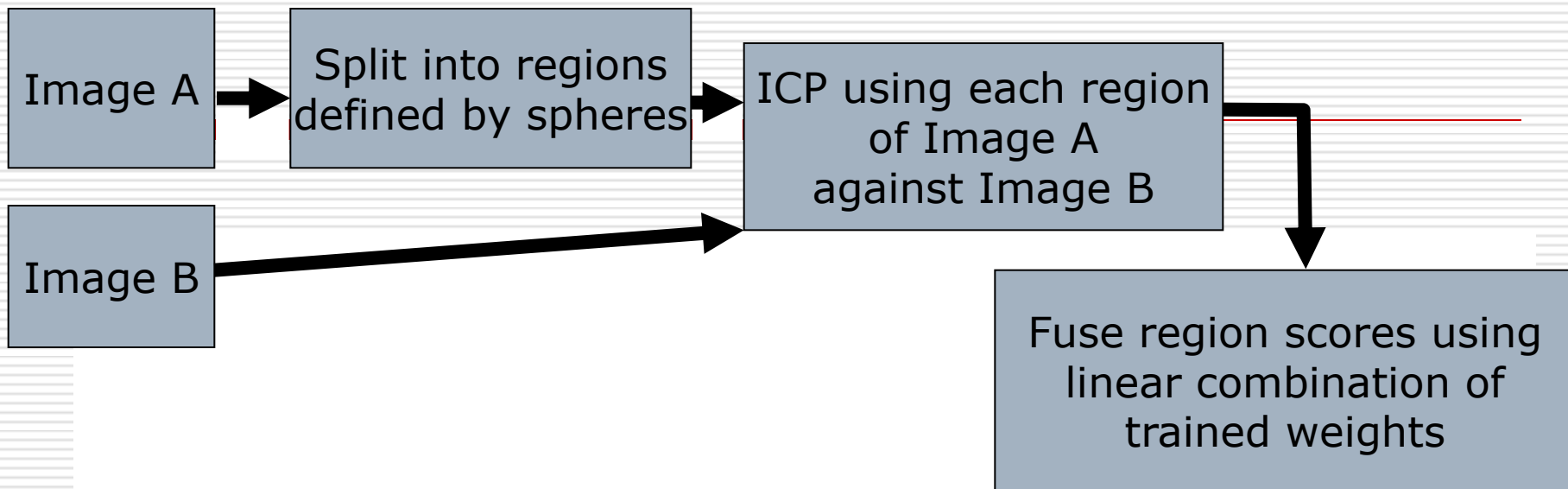
# Data Acquisition

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- ❑ Twins Days Festival, Twinsburg, Ohio
- ❑ Minolta VIVID 910 range scanner



# ICP-based Algorithm using Regions



- Uses ICP (Iterative Closest Point) for matching a set of regions.
- Use minimum rule to fuse Image A and Image B, call this  $E_{\min}$

Two variations:

- Gallery normalization  $E_{pkn}(p, g_k) = \frac{E_{\min}(p, g_k)}{\sum_{j=1, j \neq k}^N \frac{E_{\min}(g_j, g_k)}{N-1}}$ 
  - ( $E_{pkn}$ )

- Gallery and probe normalization:

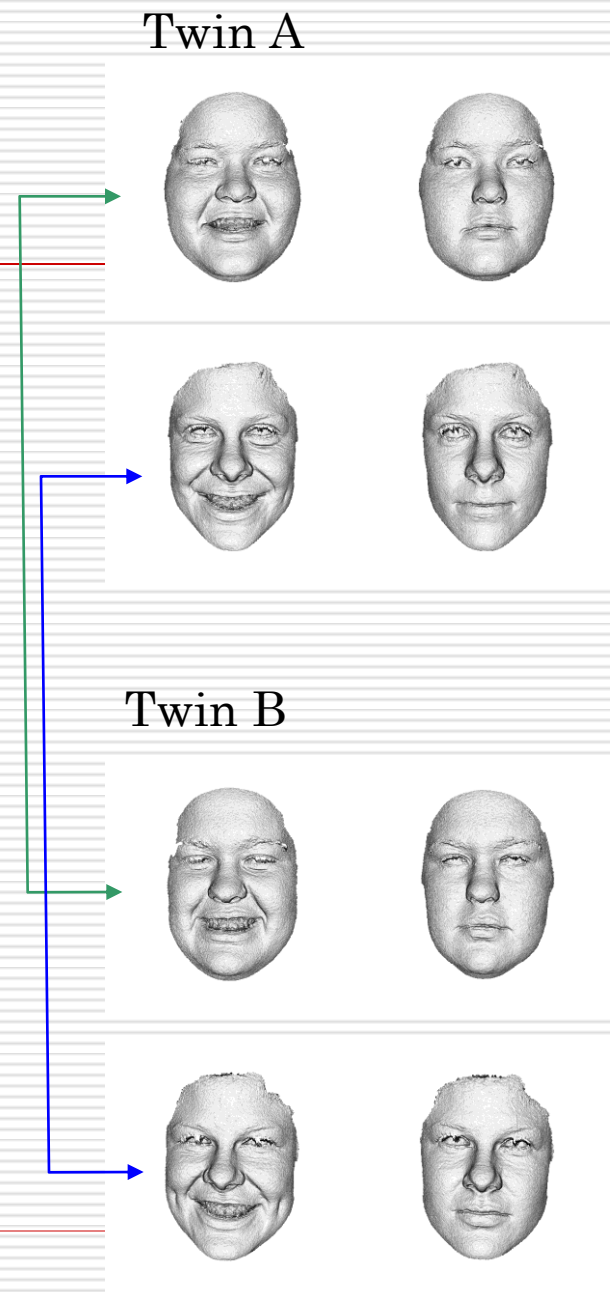
- ( $E_{\min\max}$ ) Does min-max normalization over the gallery for each of the probe images using  $E_{pkn}$

# Experimental Setup

- For each pair of twins, label one “Twin A” and the other “Twin B” and define gallery and probe sets, each having 214 images.
- Identification experiment and two verification experiments using the four gallery and probe sets

No.	Gallery	Probe
I	A Smile, B Smile	A Neutral, B Neutral
II	A Neutral, B Neutral	A Smile, B Smile
III	A Smile, B Neutral	A Neutral, B Smile
IV	A Neutral, B Smile	A Smile, B Neutral

The gallery and probe sets



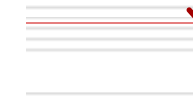
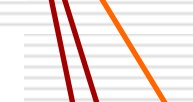
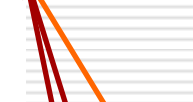
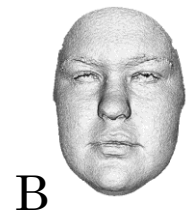
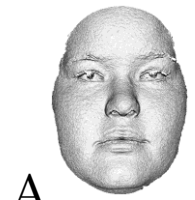
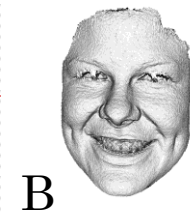
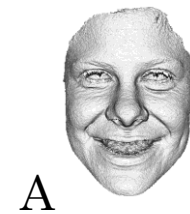
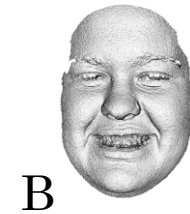
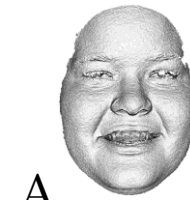
# Smiles vs. Neutrals (I & II)

Probe

Gallery

- Models a scenario where the gallery depicts one expression and the probes another
- For identification, the main challenge for the algorithm is to distinguish between the twins

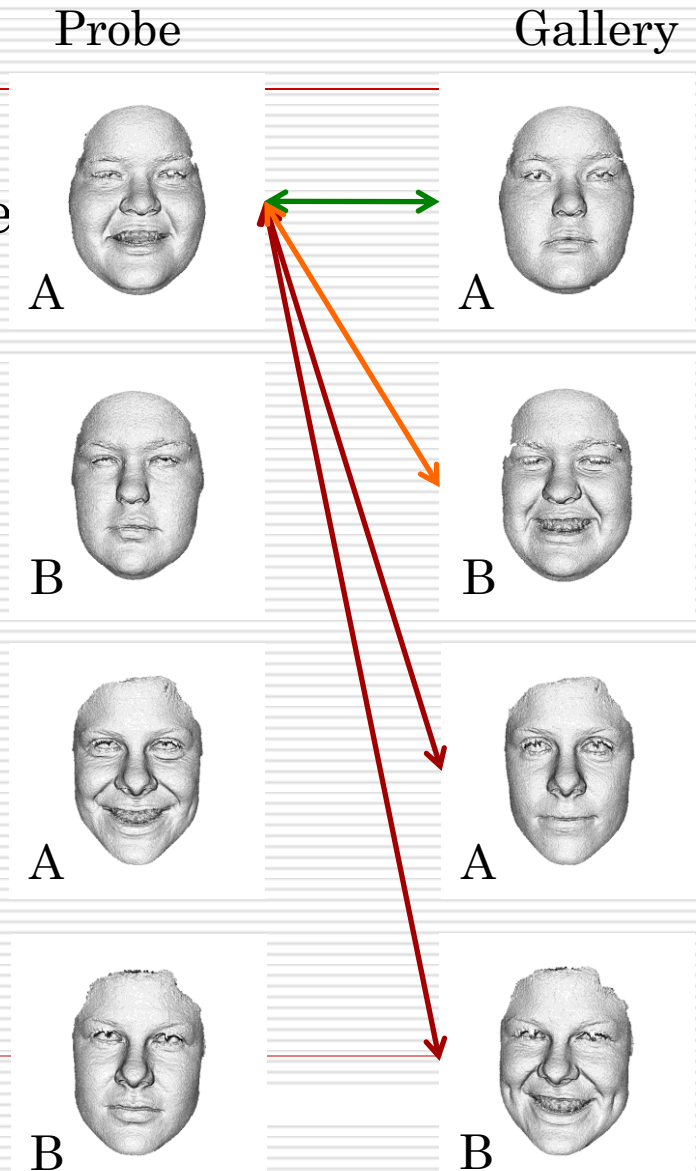
No.	Gallery	Probe
I	A Smile, B Smile	A Neutral, B Neutral
II	A Neutral, B Neutral	A Smile, B Smile
III	A Smile, B Neutral	A Neutral, B Smile
IV	A Neutral, B Smile	A Smile, B Neutral



# Twin A Smile + Twin B Neutral vs. Twin A Neutral + Twin B Smile (III & IV)

- Models a worst case scenario where the system does not control for expression
- For identification, the main challenge would be to distinguish between a twin of the same expression from the probe's image with a different expression.

No.	Gallery		Probe	
I	A Smile,	B Smile	A Neutral,	B Neutral
II	A Neutral,	B Neutral	A Smile,	B Smile
III	A Smile,	B Neutral	A Neutral,	B Smile
IV	A Neutral,	B Smile	A Smile,	B Neutral





# Rank-1 Recognition

No.	Gallery		Probe	
I	A Smile,	B Smile	A Neutral,	B Neutral
II	A Neutral,	B Neutral	A Smile,	B Smile
III	A Smile,	B Neutral	A Neutral,	B Smile
IV	A Neutral,	B Smile	A Smile,	B Neutral

- As expected Rank-1 Recognition Rate is significantly different for Experiments I/II compared to III/IV.
- And Rank-2 Recognition Rate is not

significantly different<sup>†</sup>

No.	Rank 1 Rec. Rate
I	94.39%
II	94.39%
III	73.36%
IV	73.36%

No.	Rank 2 Rec. Rate
I	97.67%
II	97.67%
III	96.73%
IV	96.73%

# All vs. All

# Verification

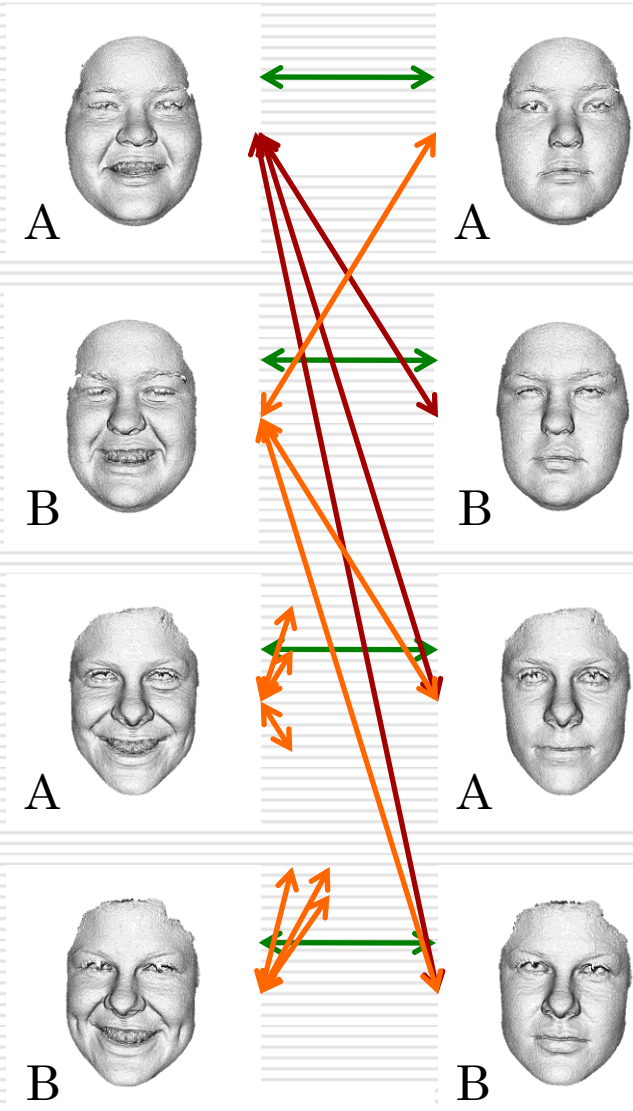
# Twins vs. Twins

Gallery

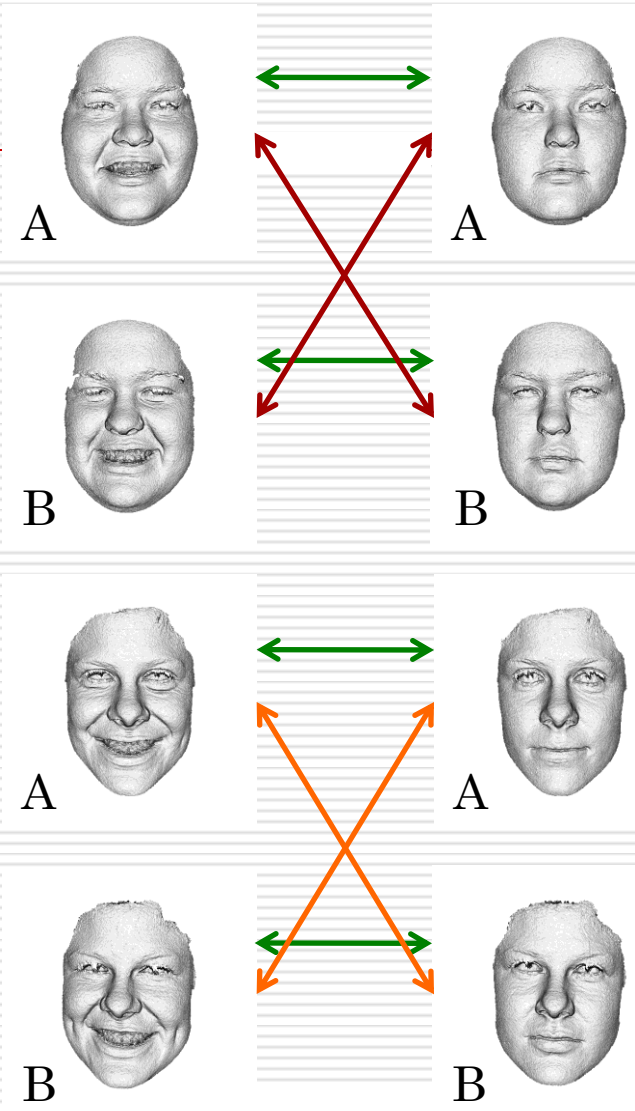
Probe

Gallery

Probe



$N = 214$



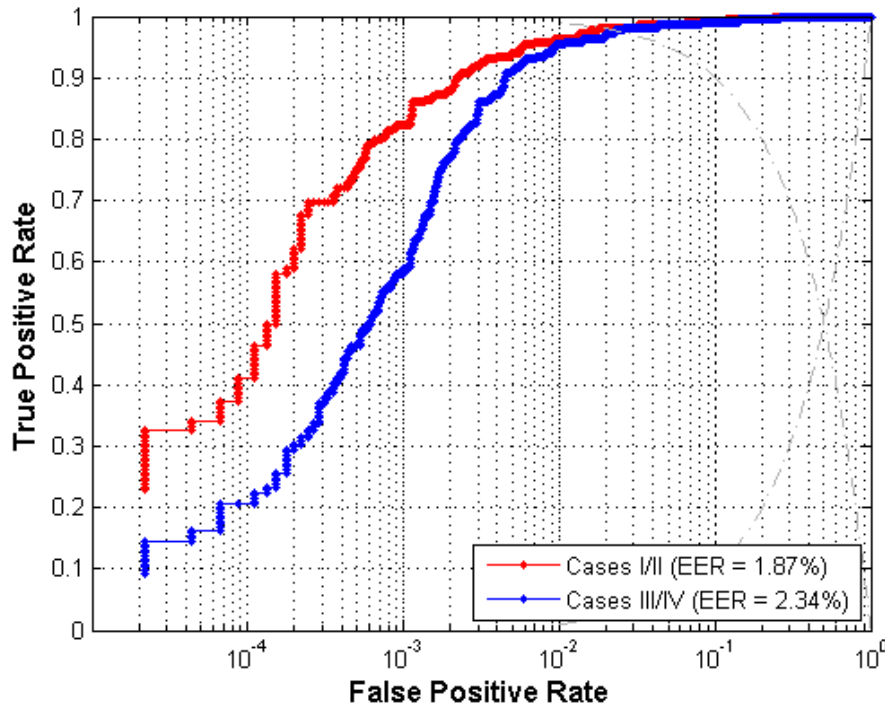
$N$  genuine scores and  
 $N^2 - N$  imposter scores

$N$  genuine scores and  
 $N$  imposter scores

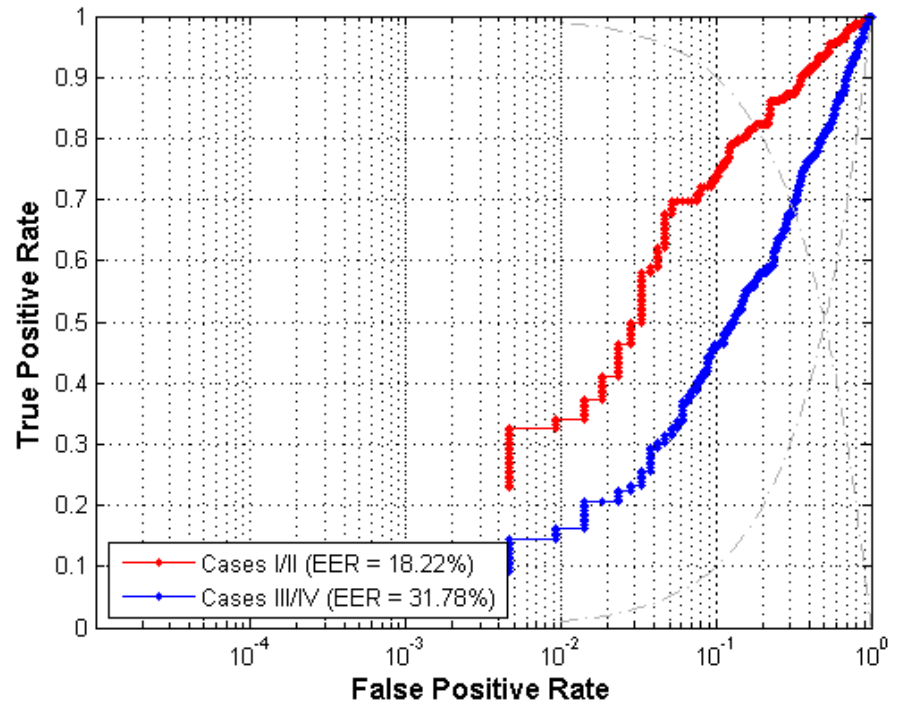
# Verification ( $E_{\min}$ )

No.	Gallery		Probe	
I	A Smile,	B Smile	A Neutral,	B Neutral
II	A Neutral,	B Neutral	A Smile,	B Smile
III	A Smile,	B Neutral	A Neutral,	B Smile
IV	A Neutral,	B Smile	A Smile,	B Neutral

All vs. All



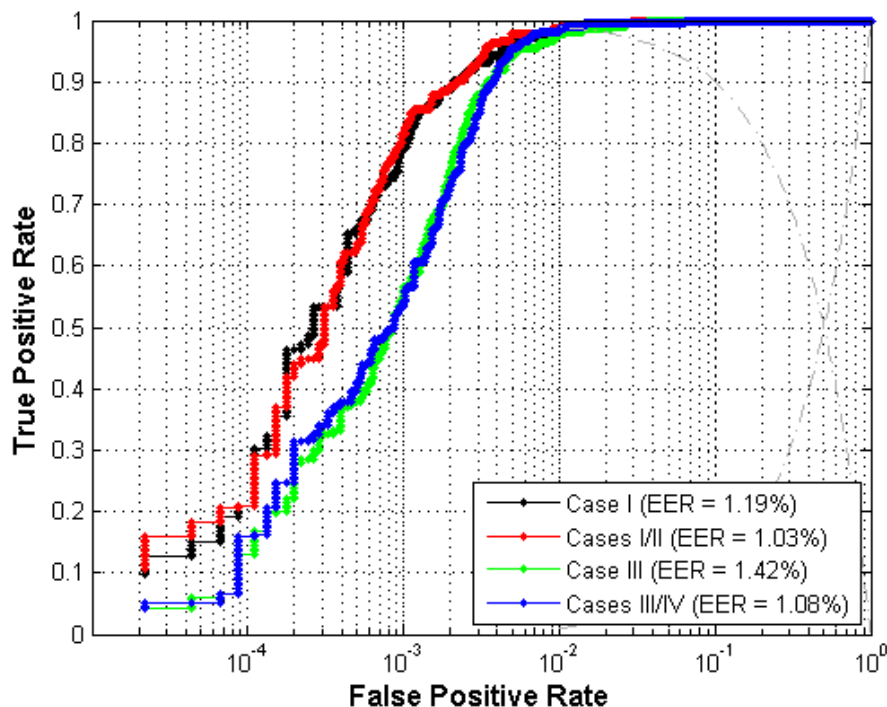
Twins vs. Twins



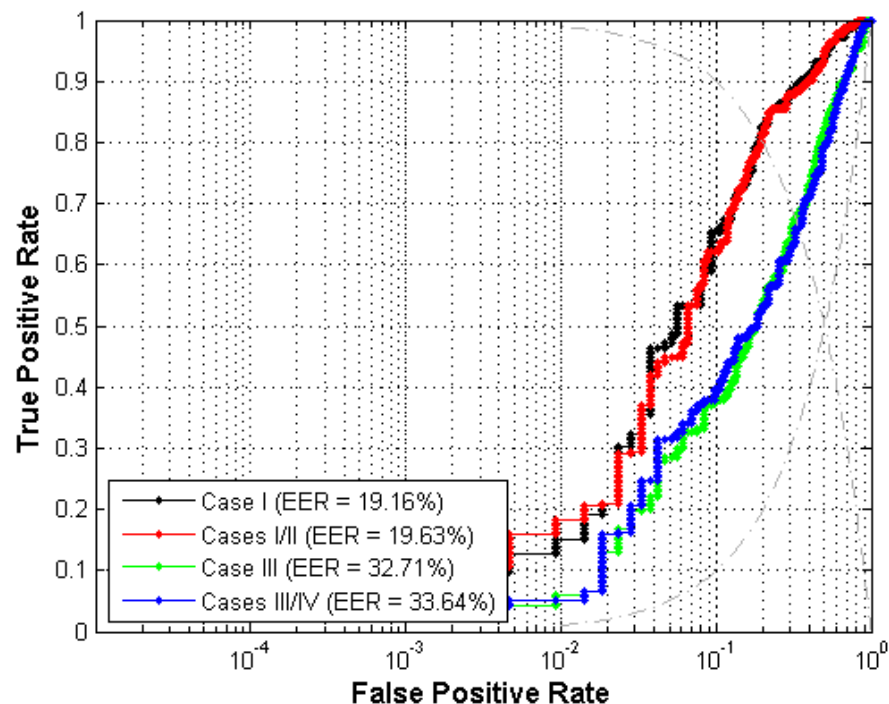
# Verification ( $E_{pkn}$ )

No.	Gallery		Probe	
I	A Smile,	B Smile	A Neutral,	B Neutral
II	A Neutral,	B Neutral	A Smile,	B Smile
III	A Smile,	B Neutral	A Neutral,	B Smile
IV	A Neutral,	B Smile	A Smile,	B Neutral

All vs. All



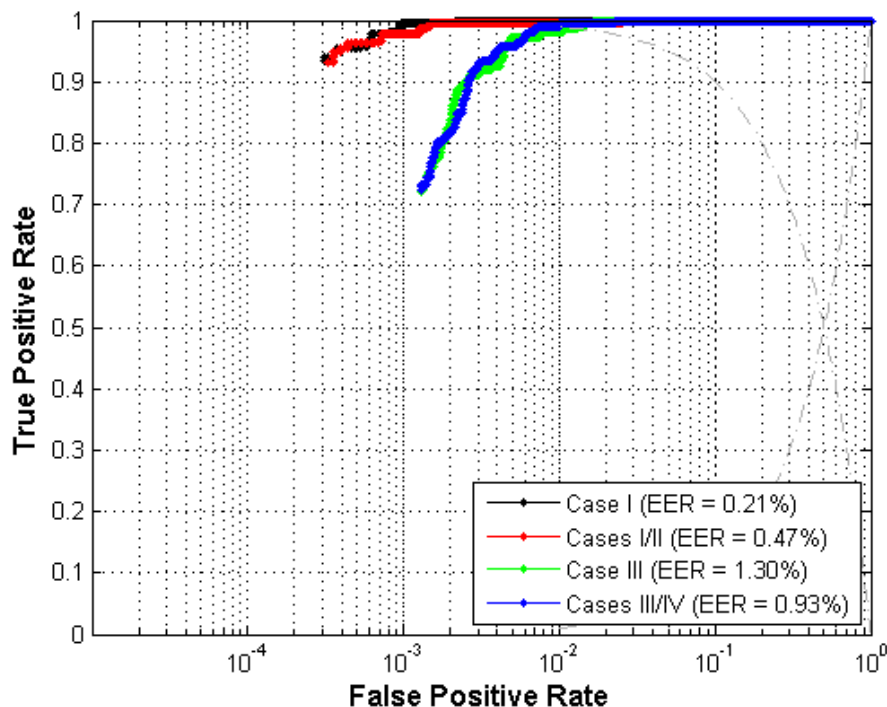
Twins vs. Twins



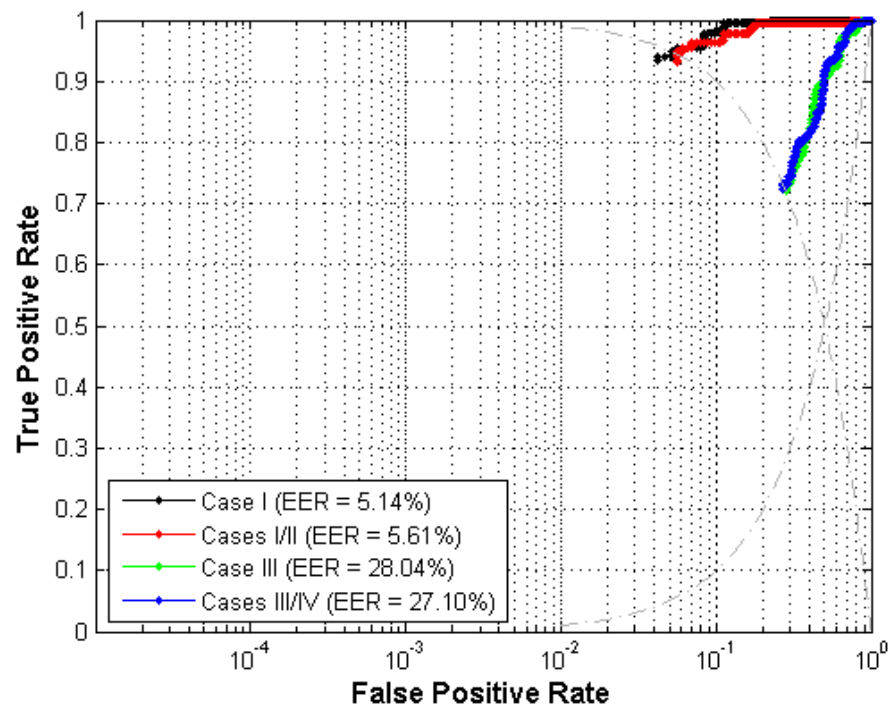
# Verification ( $E_{\min\max}$ )

No.	Gallery		Probe	
I	A Smile,	B Smile	A Neutral,	B Neutral
II	A Neutral,	B Neutral	A Smile,	B Smile
III	A Smile,	B Neutral	A Neutral,	B Smile
IV	A Neutral,	B Smile	A Smile,	B Neutral

All vs. All



Twins vs. Twins



# Conclusion

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- ❑ Introduced a dataset containing identical twins that is more challenging than the FRGC v2 dataset while being smaller
- ❑ Showed that distinguishing between twins is a difficult problem in 3D face recognition
- ❑ The problem becomes more difficult when expressions come into play

# ACKNOWLEDGEMENTS

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# QUESTIONS?

The 3D TEC dataset can be acquired from  
[http://www.nd.edu/~cvrl/CVRL/Data\\_Sets.html](http://www.nd.edu/~cvrl/CVRL/Data_Sets.html)