

1 / 13

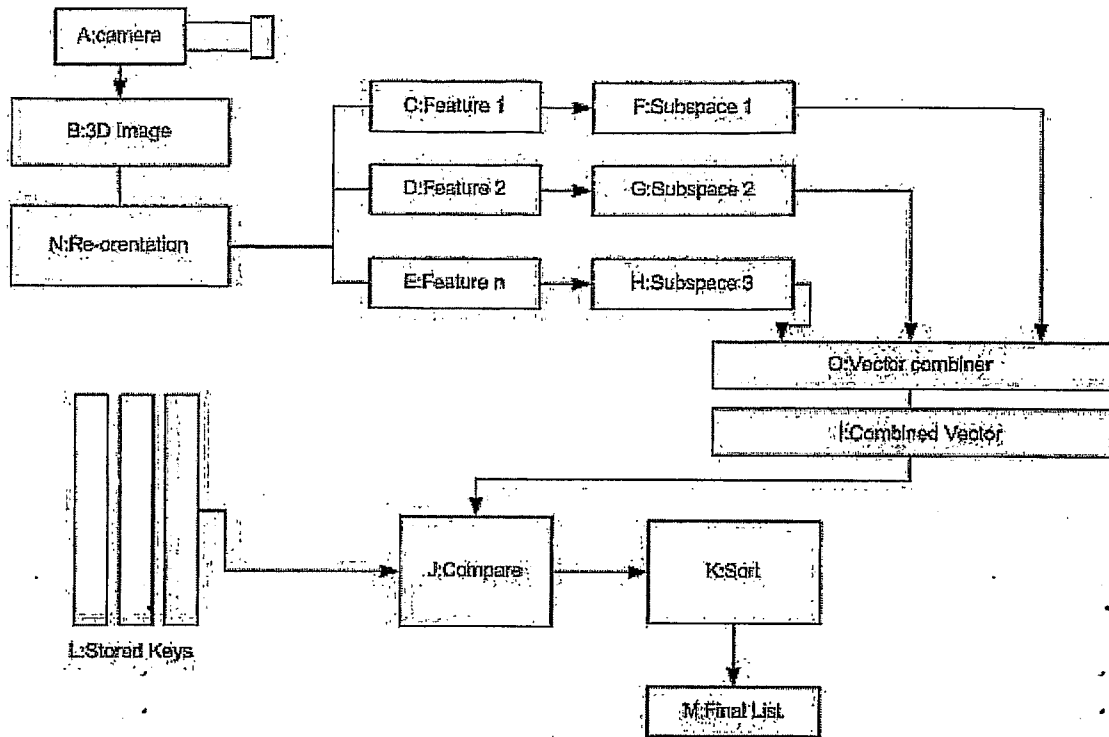


Fig. 1: Identification System

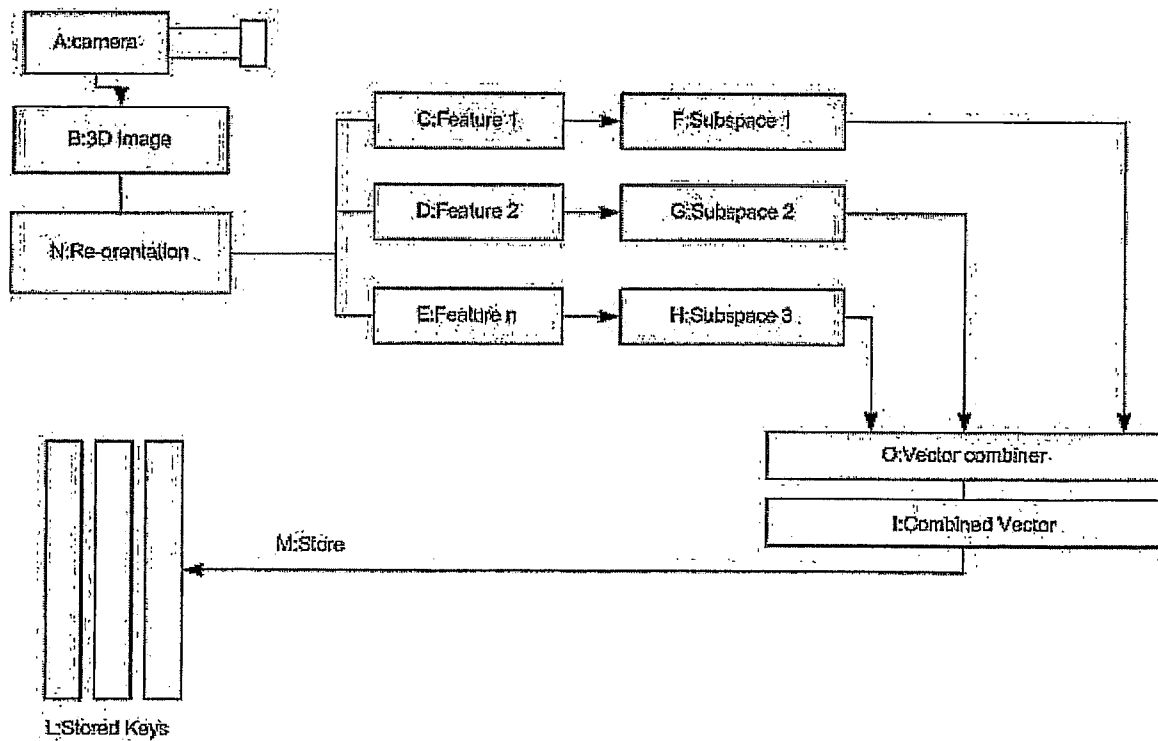
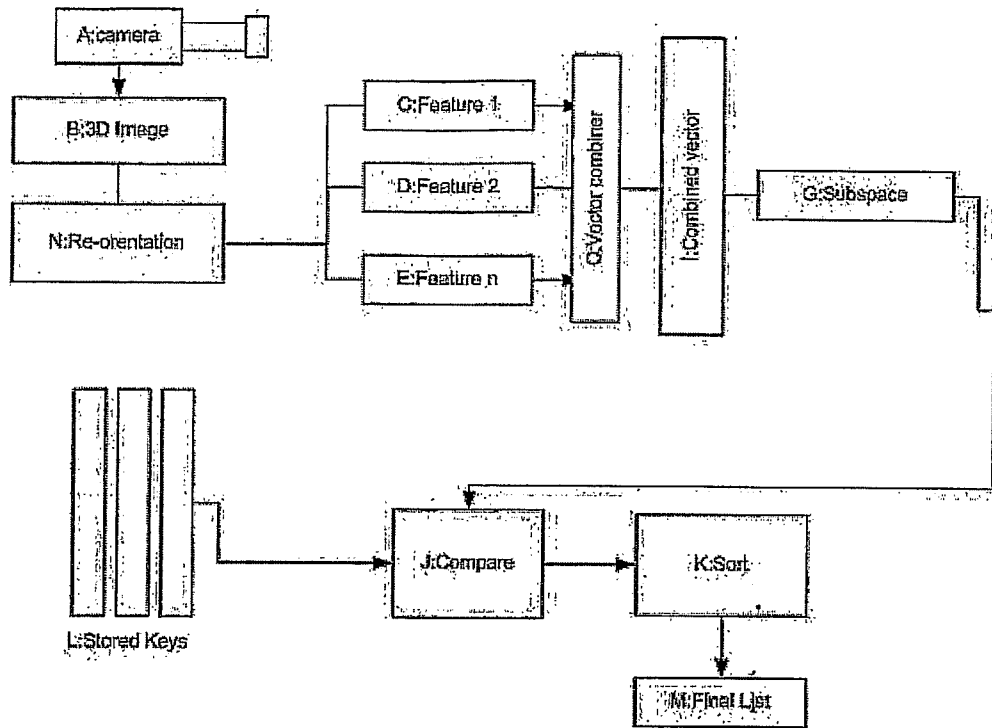
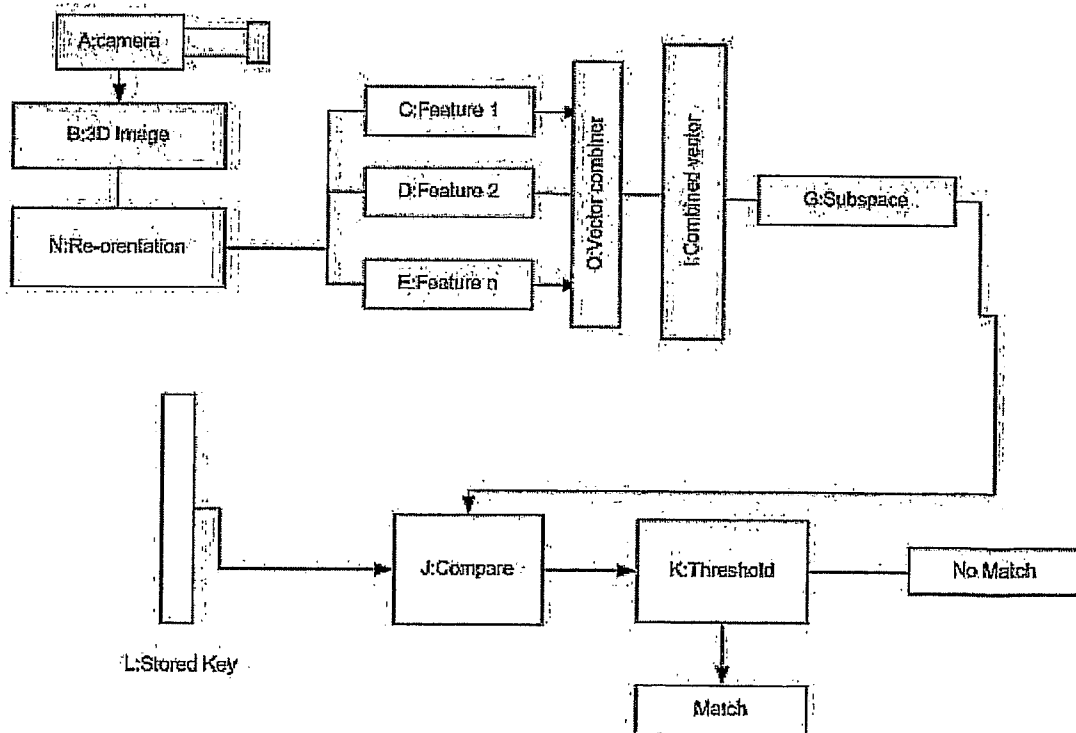


Fig. 2: Training system

2 / 13

Fig 3 : Identification system using
Combiner before the subspace methodFig 4 : Verification system using
Combiner before the subspace method

3 / 13

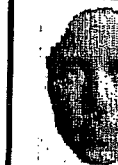
01	02	03	04	05
				
Front neutral expression	Facing 45° up	Facing 45° down	Happy expression	Eyes closed
06	07	08	09	10
				
Angry expression	2 nd Neutral	Eyebrows raised	3 rd Neutral	Farther from camera

Fig. 5. Example face models taken from a 3D face database

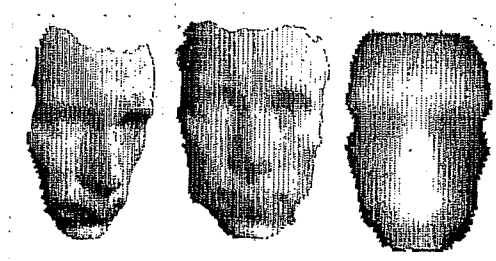


Fig. 6. Orientation of a raw 3D face model (*left*) to a frontal pose (*middle*) and facial surface depth map (*right*)

4 / 13



Fig. 7. Average depth map (*left most*) and first eight eigensurfaces

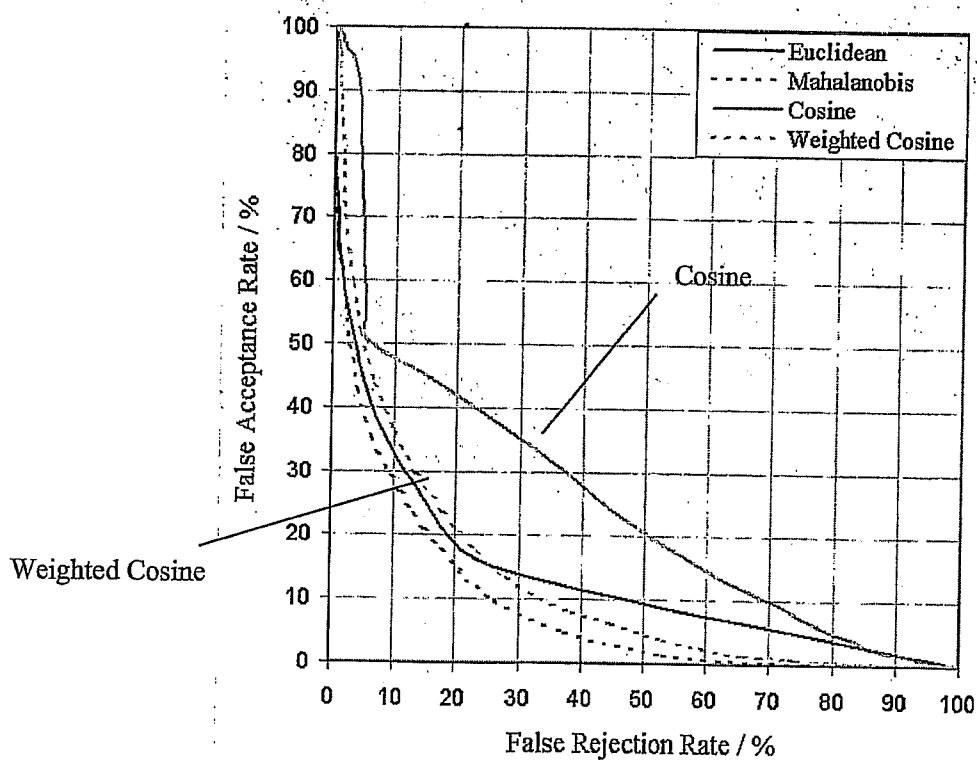


Fig. 8. Results from previous 3D face recognition systems using facial surface depth maps and a range of distance metrics

5 / 13

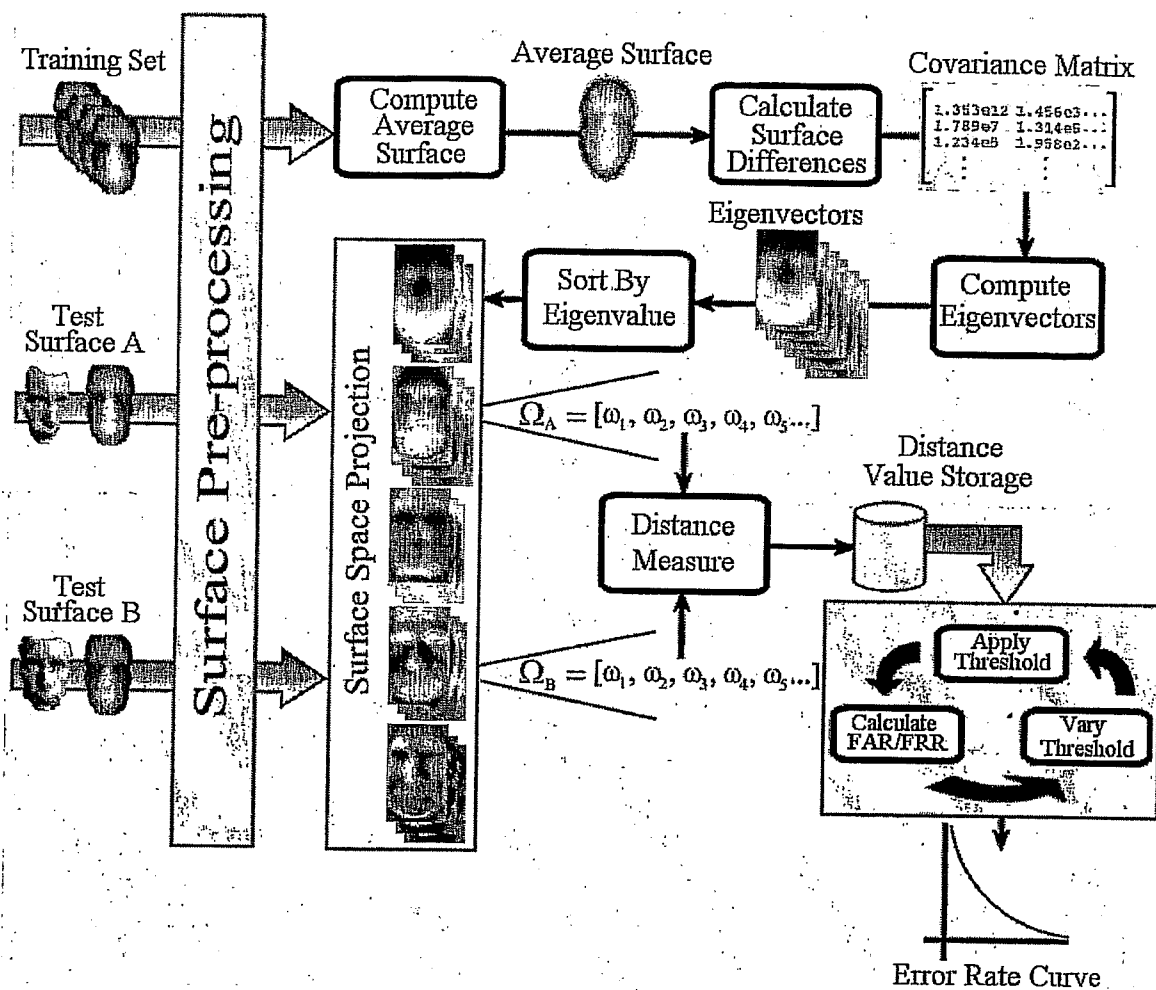


Fig. 9. Experimental framework for evaluating verification systems

6 / 13

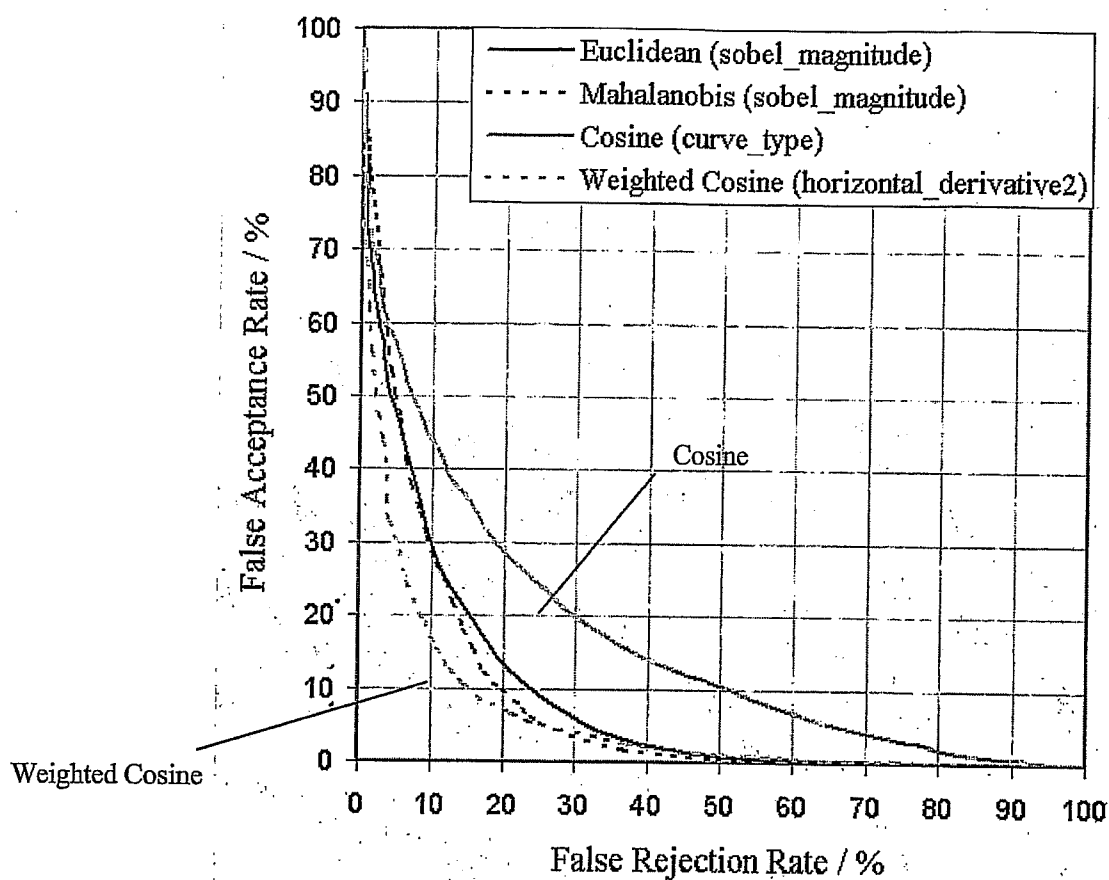


Fig. 10. Error rates of 3D face recognition systems using optimum surface representations and distance metrics.

7 / 13

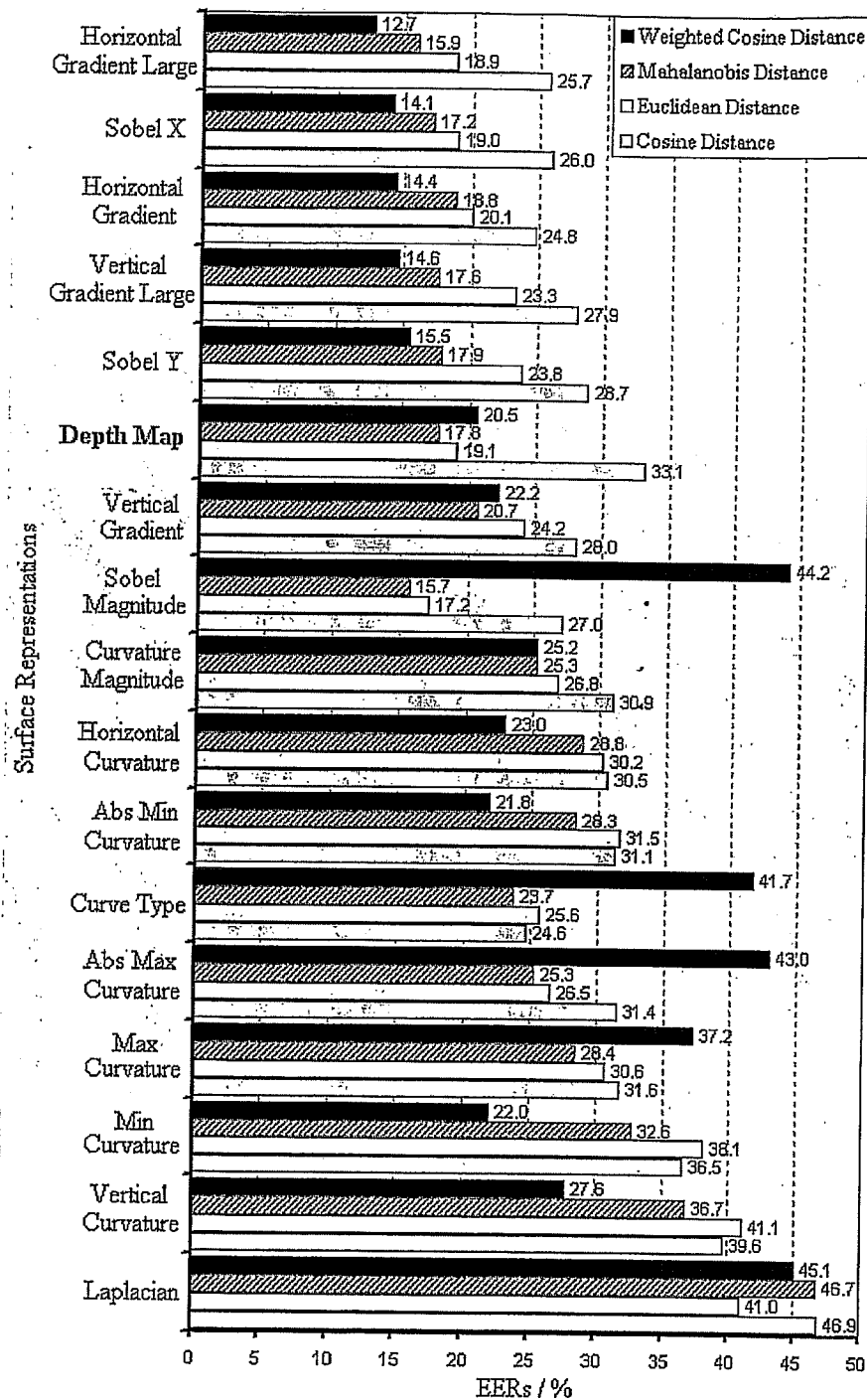


Fig. 11. Equal error rates of 3D face recognition systems using a variety of surface representations and distance metrics

8 / 13

Horizontal Gradient		Vertical Gradient		Horizontal Gradient Large		Vertical Gradient Large	
	-1 1		-1 1		-1 0 0 1		-1 0 0 0 1
Applies the 2x1 kernel to compute the horizontal derivative		Applies the 1x2 kernel to compute the vertical derivative		Horizontal gradient calculated over a greater horizontal distance		Vertical gradient calculated over a greater vertical distance	
Laplacian		Sobel X		Sobel Y		Sobel Magnitude	
	0 1 0 1-4 1 0 1 0		-1 0 1 -2 0 2 -1 0 1		1 2 1 0 0 0 -1 -2 -1		
An isotropic measure of the second spatial derivative		Application of the sobel derivative filter in the horizontal direction		Application of the sobel derivative filter in the vertical direction		The magnitude of the X and Y sobel derivatives	
Horizontal Curvature		Vertical Curvature		Curvature Magnitude		Curve Type	
							
Applies the sobel X kernel twice to calculate the second horizontal derivative		Applies the sobel Y kernel twice to calculate the second vertical derivative		The magnitude of the vertical and horizontal curvatures		Segmentation of the surface into 8 discrete curvature types	
Min Curvature		Max Curvature		Abs Min Curvature		Abs Max Curvature	
							
The minimum of the horizontal and vertical curvature values		The maximum of the horizontal and vertical curvature values		The minimum of the absolute horizontal and vertical curvatures		The maximum of the absolute horizontal and vertical curvatures	

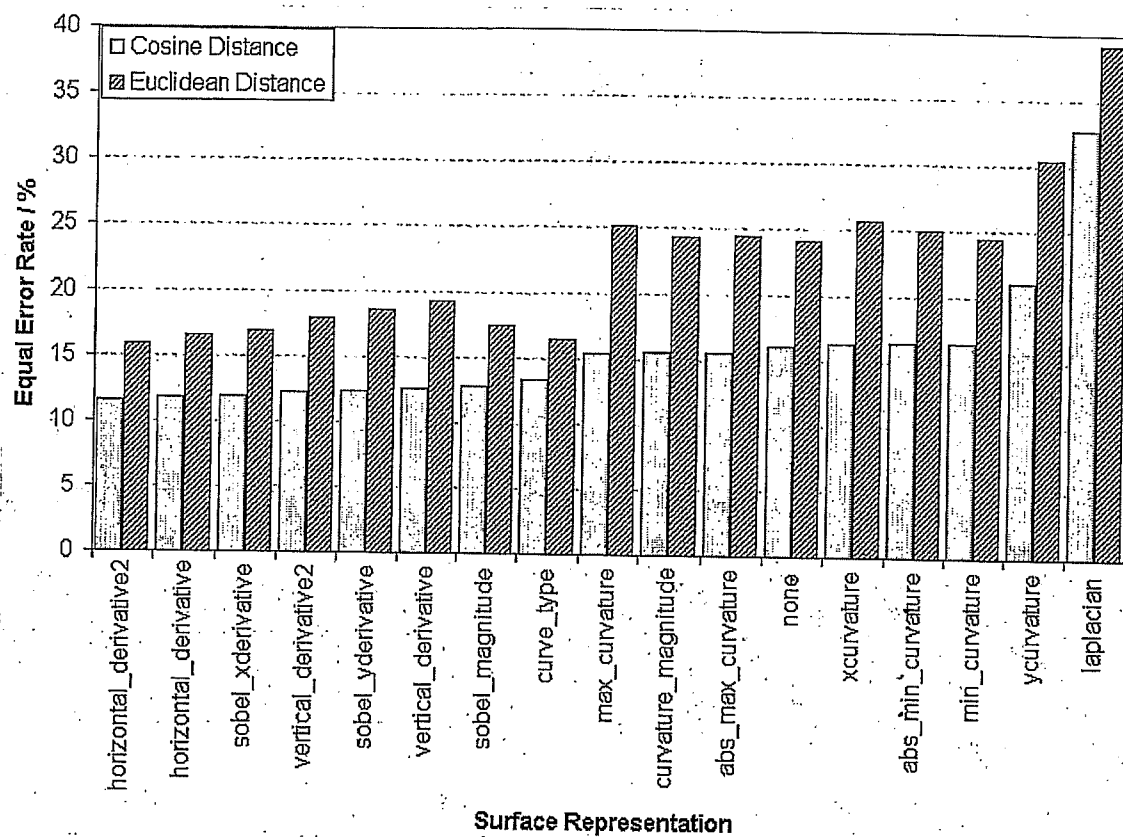
Figure 12. Brief descriptions of surface representations with the convolution kernels used.

9 / 13

Horizontal Derivative	Vertical Derivative	Horizontal Derivative 2	Vertical Derivative 2
 -1 1	 -1 1	 -1 0 0 1	 -1 0 0 0 1
Applies the 2x1 kernel to compute the horizontal derivative	Applies the 1x2 kernel to compute the vertical derivative	Horizontal gradient over a greater horizontal distance	Vertical gradient over a greater vertical distance
Laplacian	Sobel X	Sobel Y	Sobel Magnitude
 0 1 0 1 -4 1 0 1 0	 -1 0 1 -2 0 2 -1 0 1	 1 2 1 0 0 0 -1 -2 -1	
An isotropic measure of the second spatial derivative	Application of the horizontal sobel derivative filter	Application of the vertical sobel derivative filter	The magnitude of Sobel X and Y combined.
Horizontal Curvature	Vertical Curvature	Curvature Magnitude	Curve Type
			
Applies sobel X twice to calculate the second horizontal derivative	Applies sobel Y twice to calculate the second vertical derivative	The magnitude of the vertical and horizontal curvatures	Segmentation of the surface into 8 discrete curvature types
Min Curvature	Max Curvature	Abs Min Curvature	Abs Max Curvature
			
The minimum of the horizontal and vertical curvature values	The maximum of the horizontal and vertical curvature values	The minimum of the absolute horizontal and vertical curvatures	The maximum of the absolute horizontal and vertical curvatures

Fig. 13

10 / 13

Fig. 14

11/13

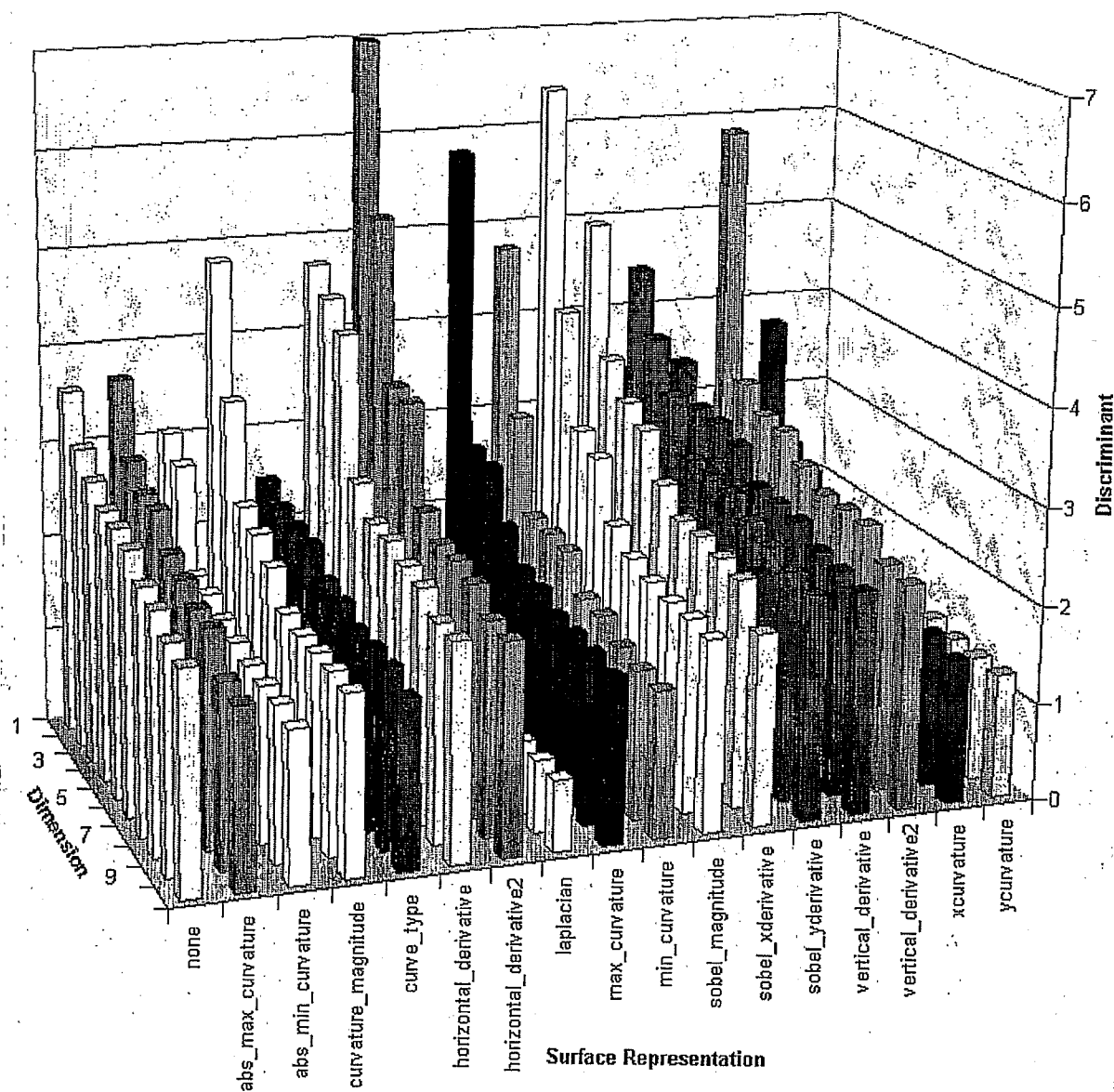
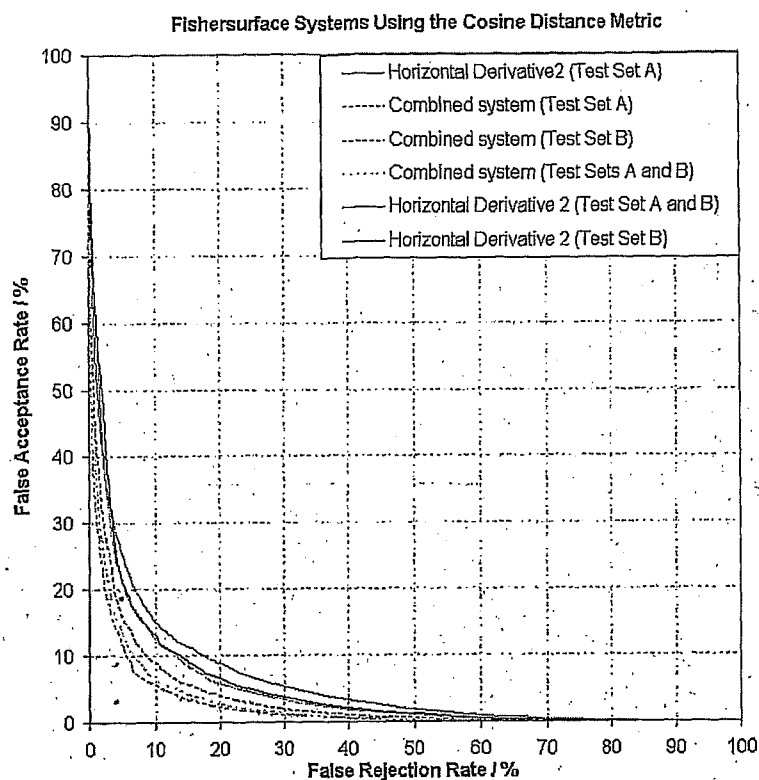
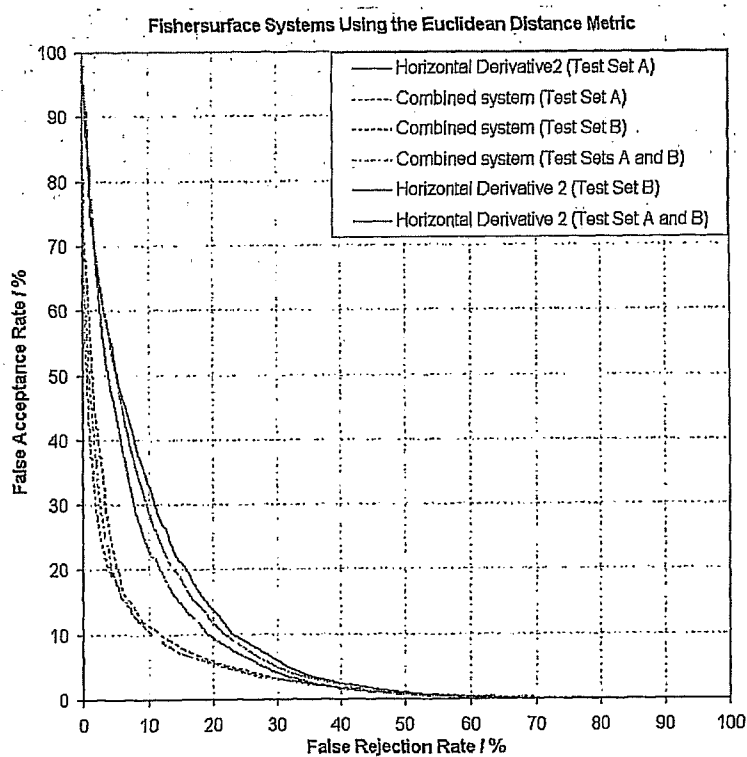


Fig. 15

[illegible]

Fig. 16

13 / 13

Fig. 17Fig. 18