A Digital Photograph

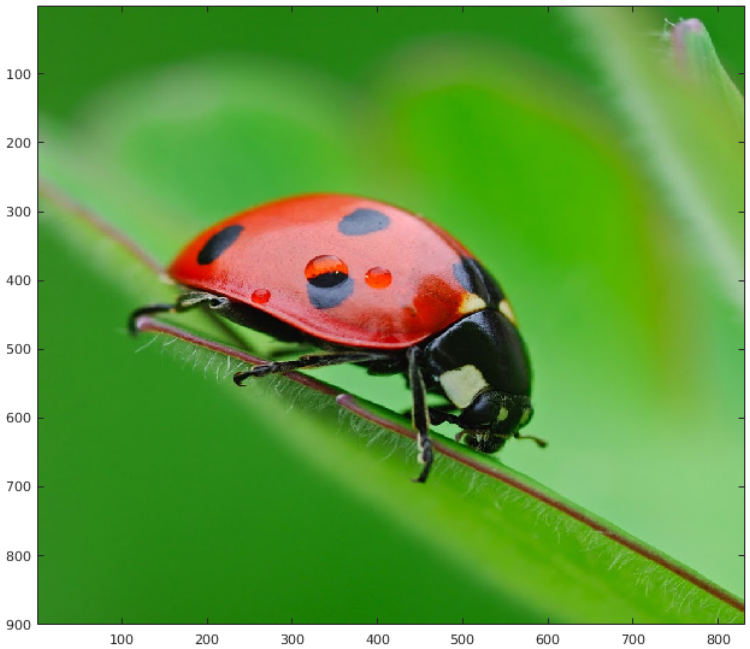


Photo is matrix of pixels. Each pixel has a red value, green value, blue value between 0 and 255.

The ladybug is

$$900 \times 813 \times 3$$

Making it grayscale will make the size 900×813.

A Digital Photograph

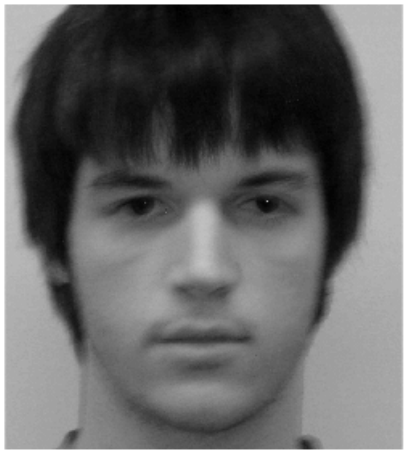
The grayscale photo is 900×813.
Concatenate columns to make one vector. It has how many elements:

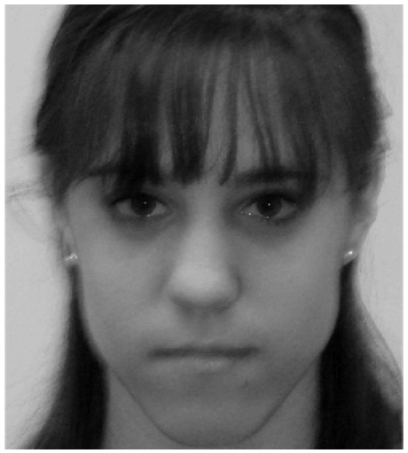
$$900 \times 813 = 731,700$$

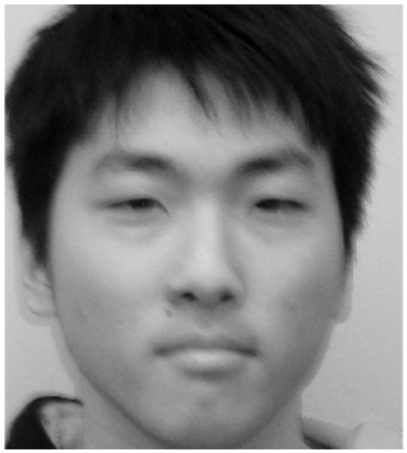
A Collection of Vectors

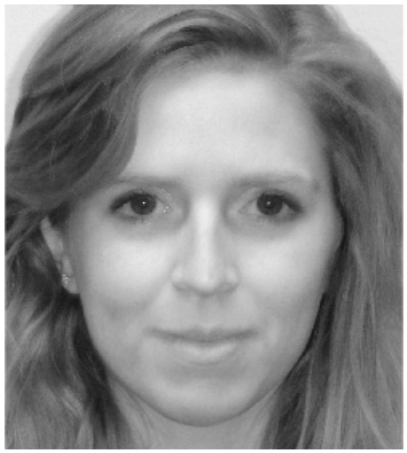
Here is a partial collection of photos, each $1204 \times 1076 = 1295504$

Perform Gram-Schmidt to find the associated orthonormal collection.



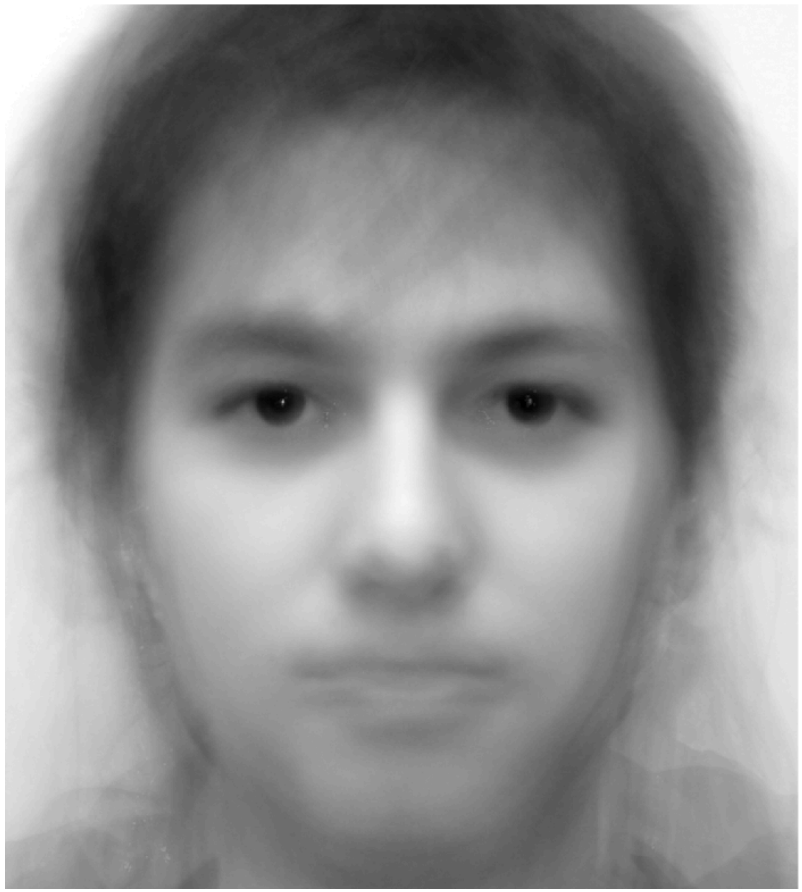






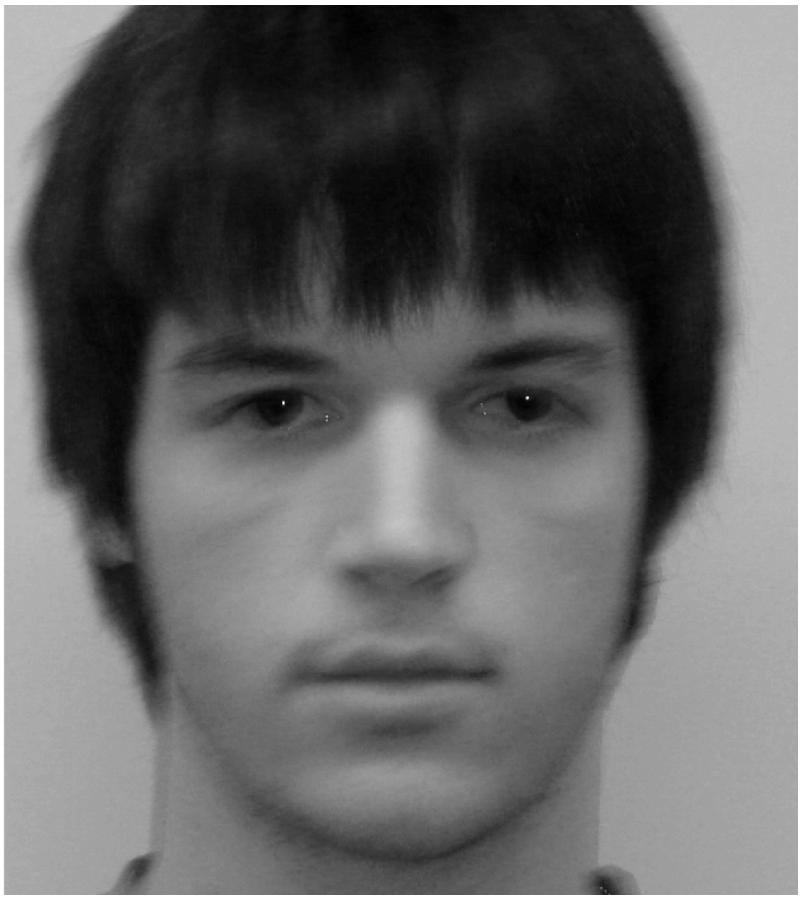
The Mean

15 total, sum them, divide- We'll use only 4 for Gram-Schmidt



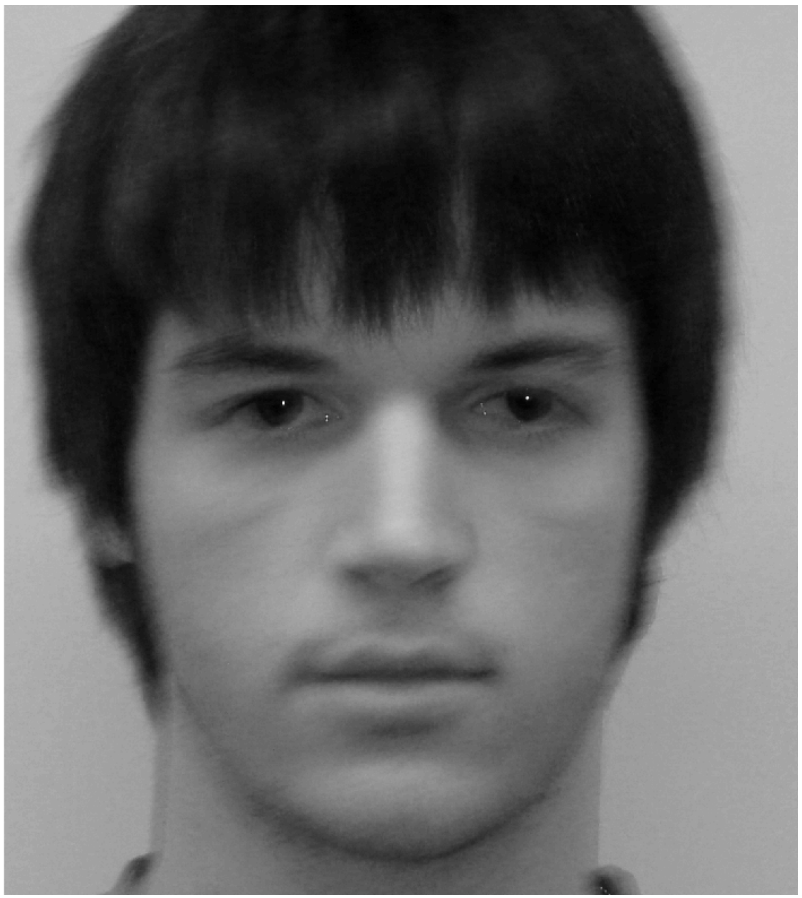
Vector 1

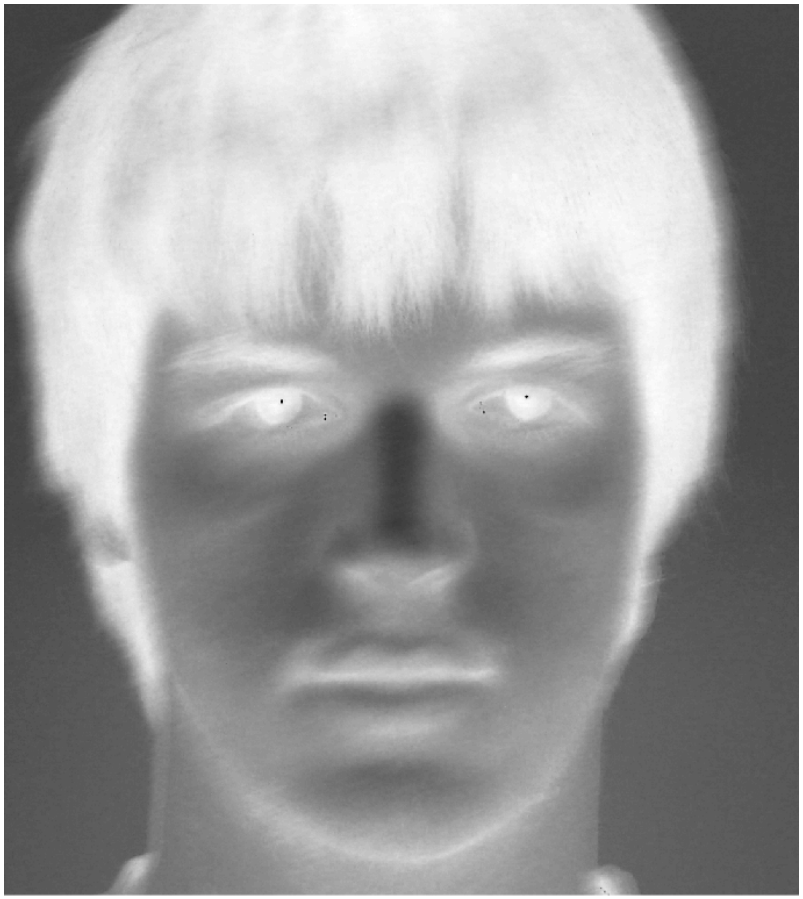
Gray scale is always scaled out to be between 0 and 255, so normalizing won't change it. Multiplying by -1:



Vector 1

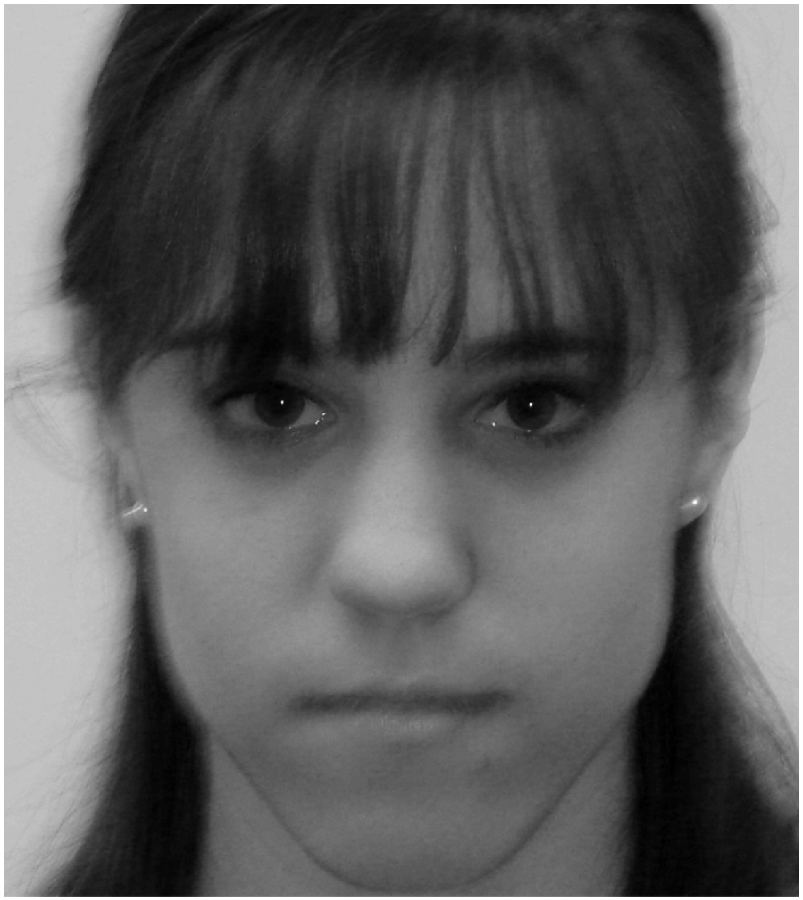
Gray scale is always scaled out to be between 0 and 255, so normalizing won't change it. Multiplying by -1:





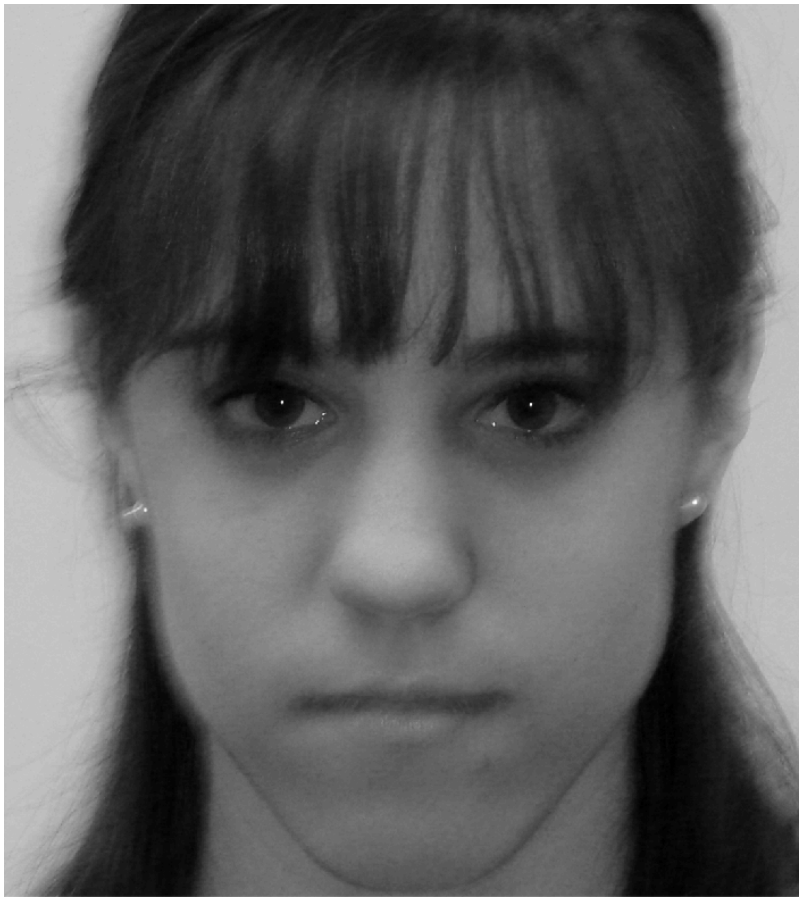
Vector 2

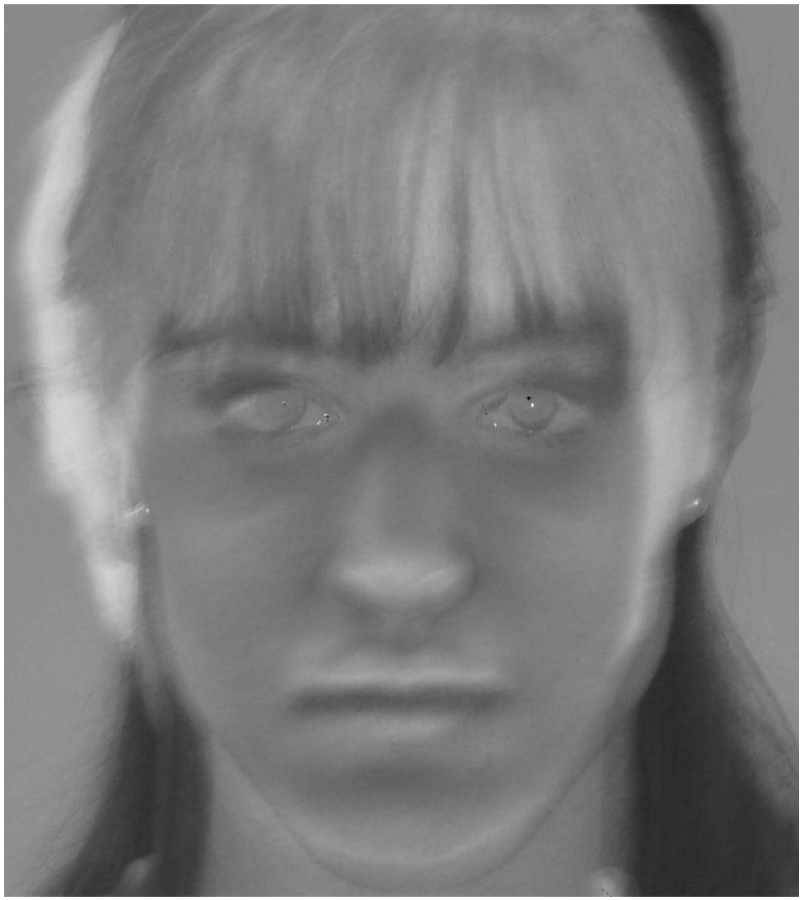
$$\mathbf{v}_2 = \mathbf{x}_2 - \frac{\mathbf{x}_2 \cdot \mathbf{v_1}}{\mathbf{v}_1 \cdot \mathbf{v}_1}\mathbf{v}_1$$



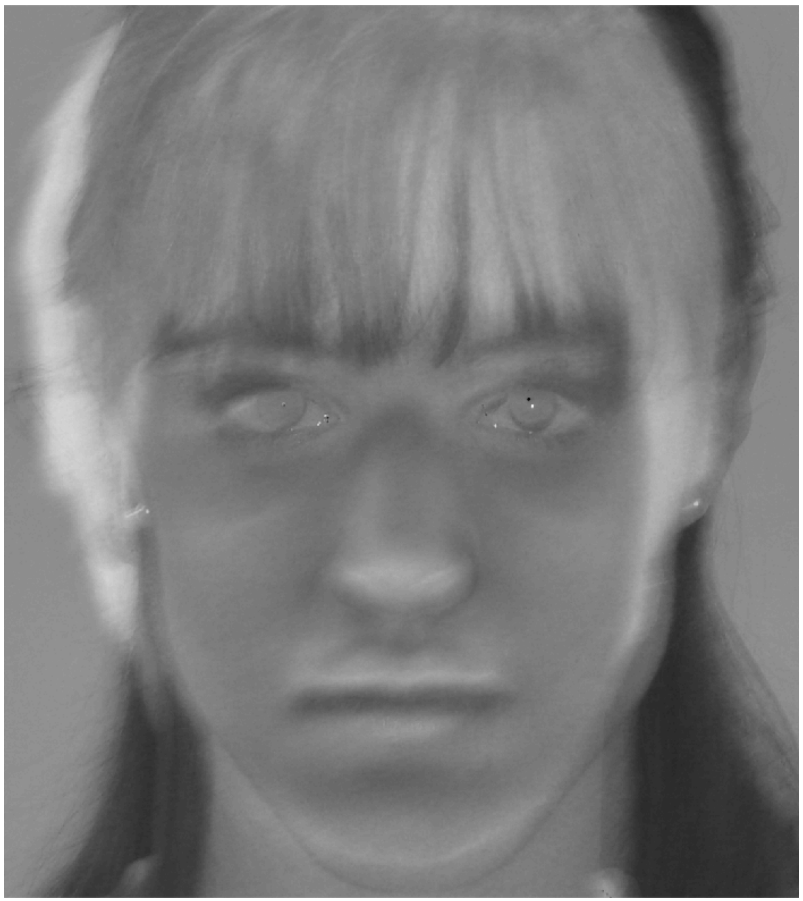
Vector 2

$$\mathbf{v}_2 = \mathbf{x}_2 - \frac{\mathbf{x}_2 \cdot \mathbf{v_1}}{\mathbf{v}_1 \cdot \mathbf{v}_1}\mathbf{v}_1$$

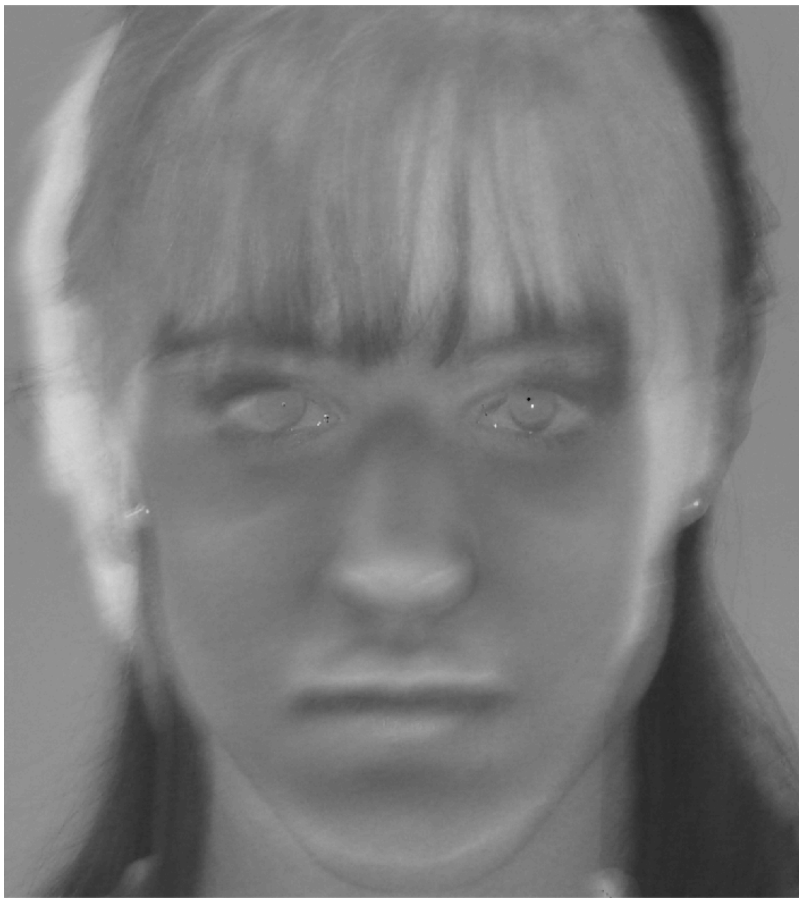


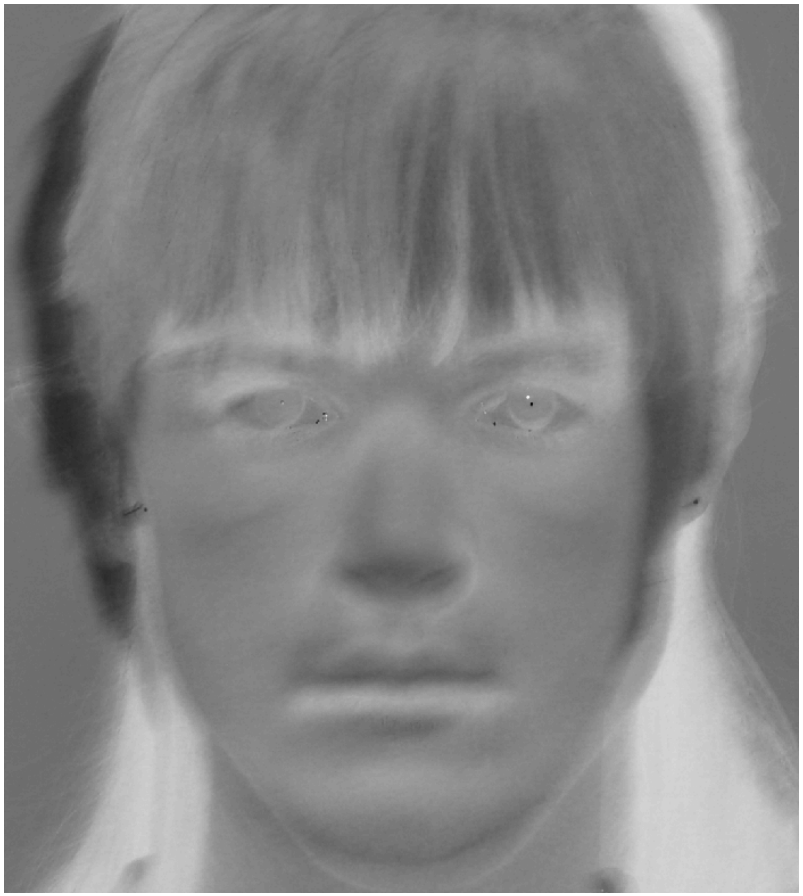


$\mathbf{v}_2$ versus $-\mathbf{v}_2$

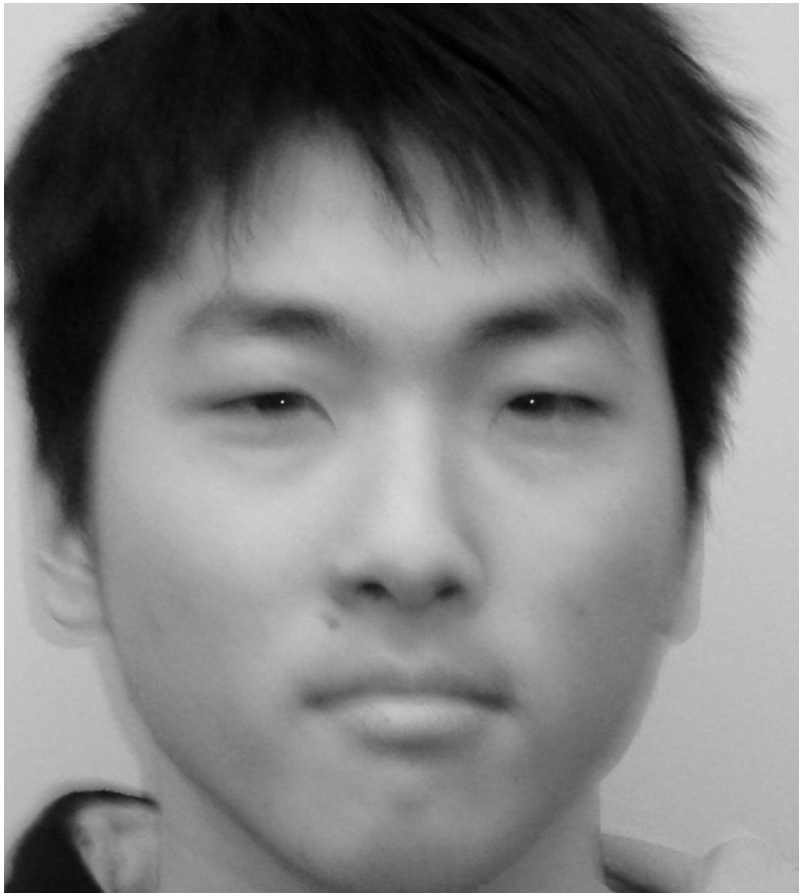


$\mathbf{v}_2$ versus $-\mathbf{v}_2$

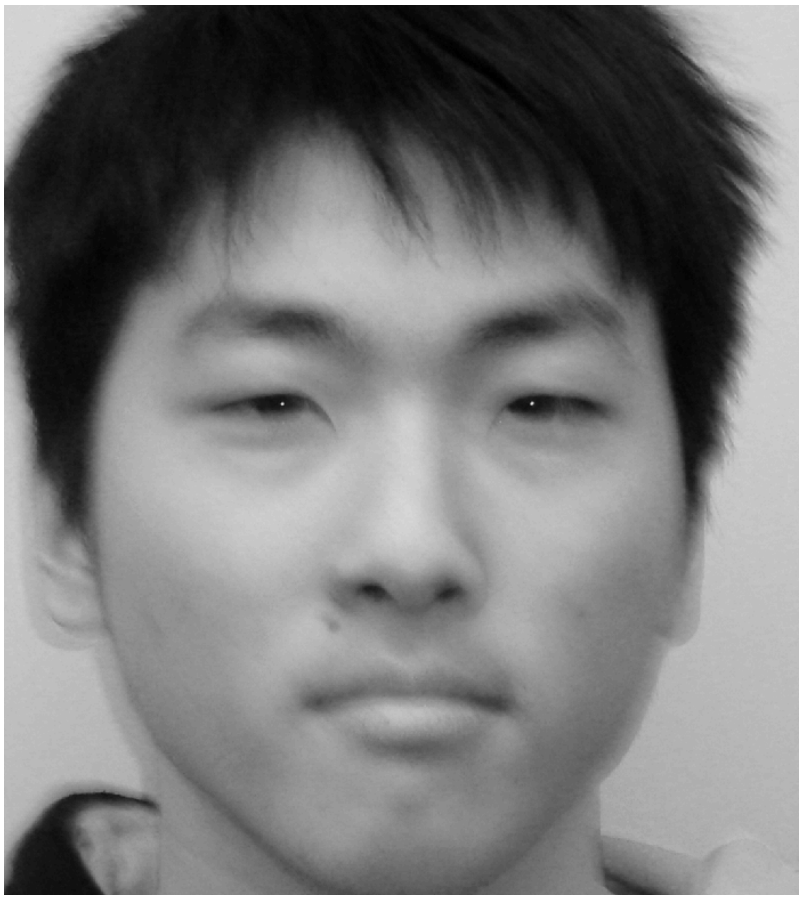


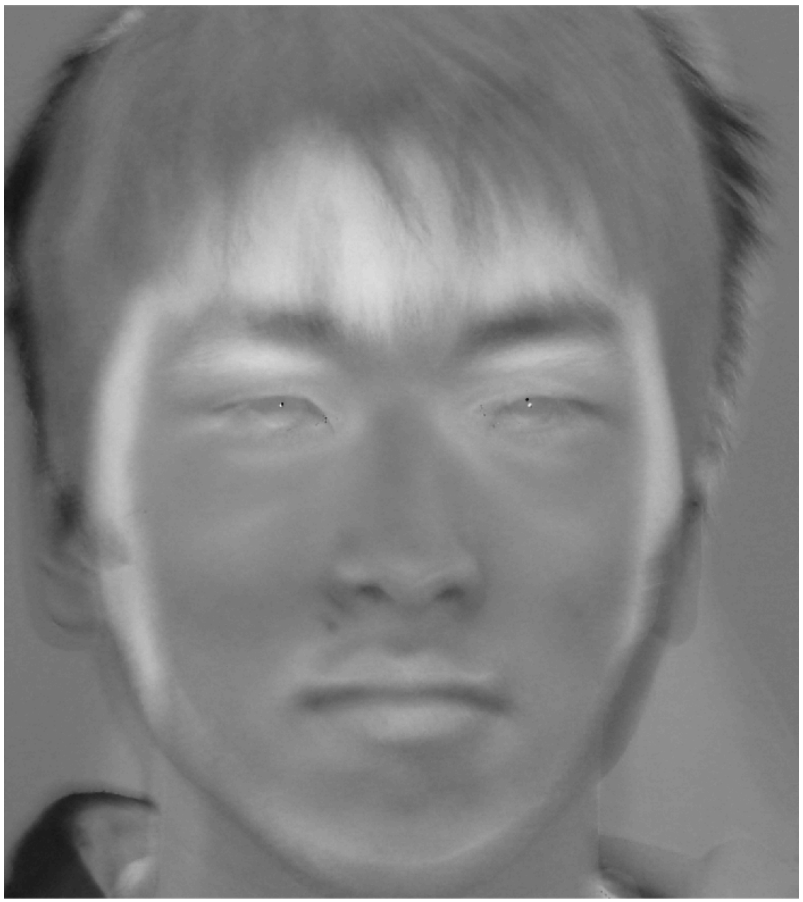


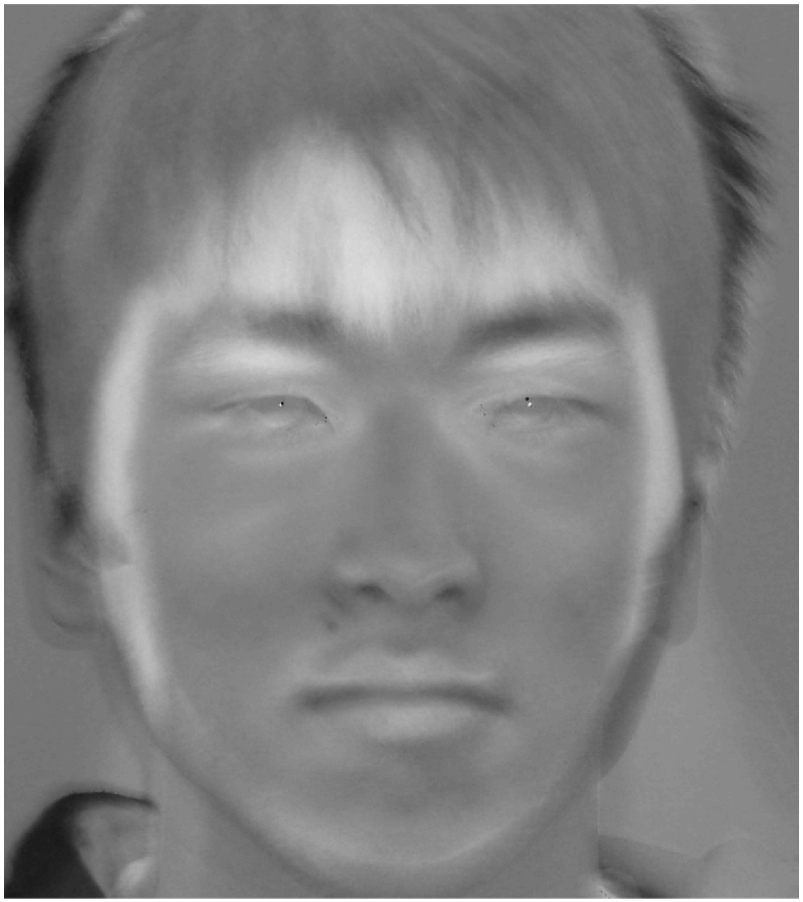
Vector 3

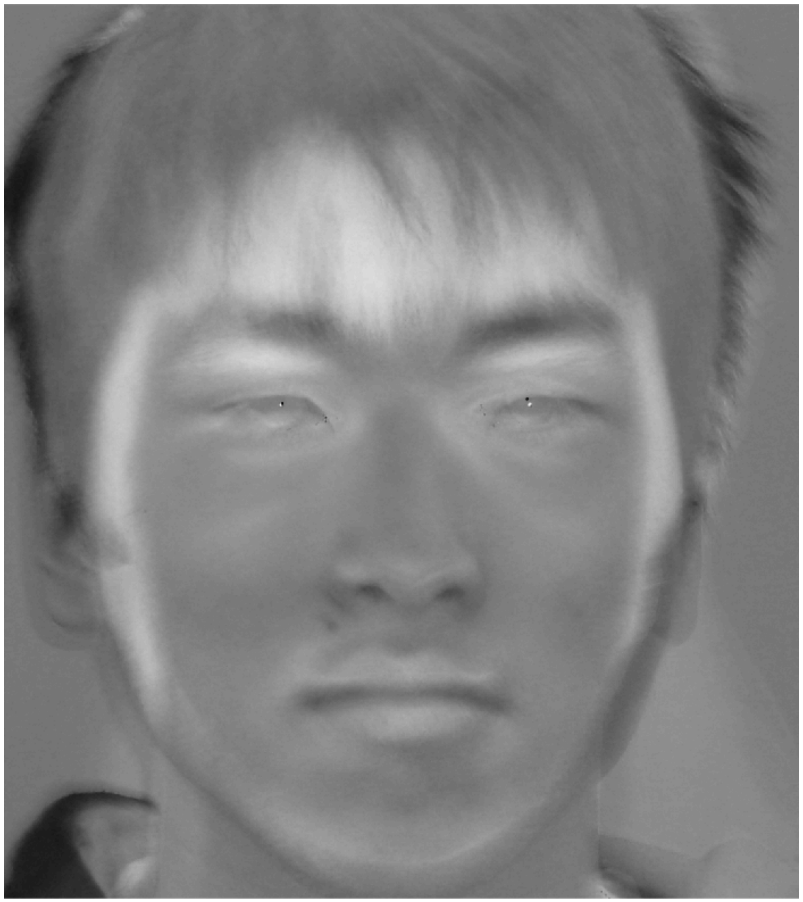


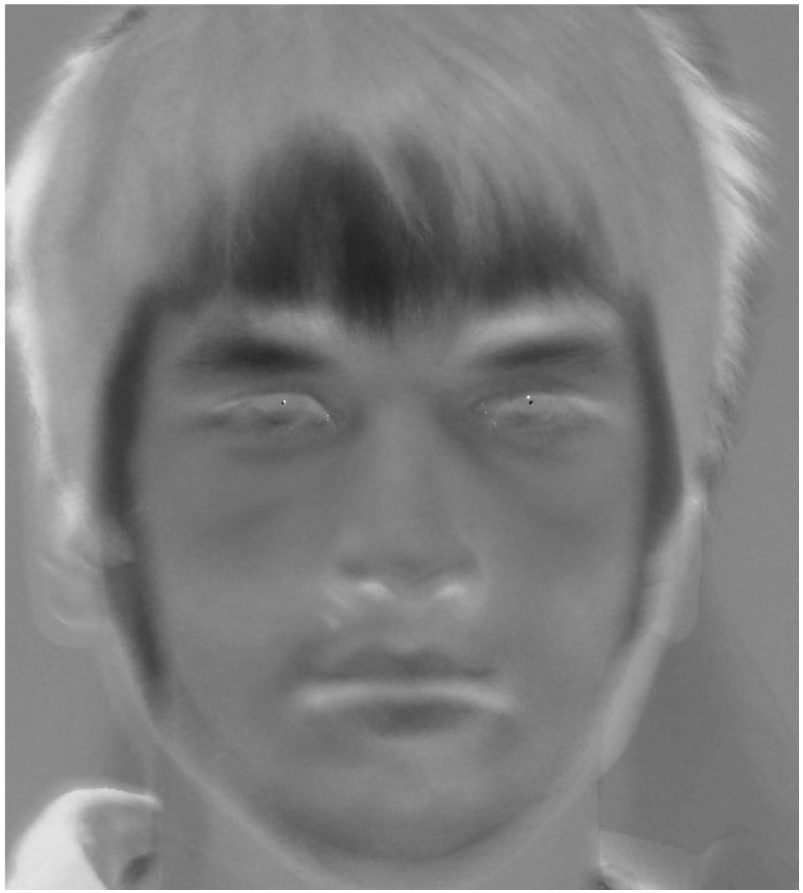
Vector 3



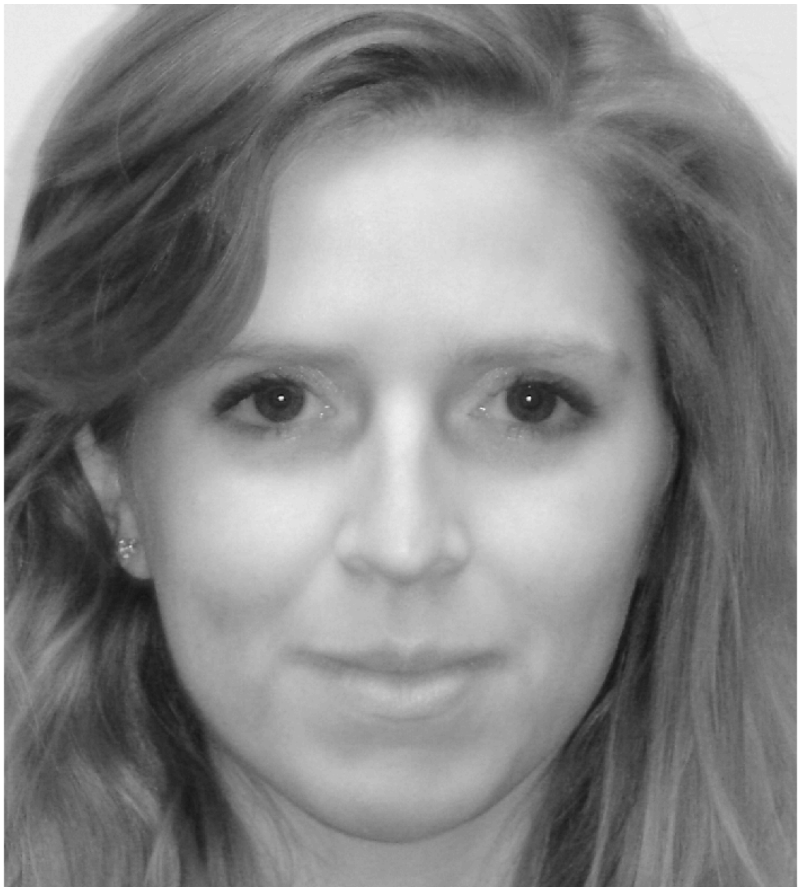




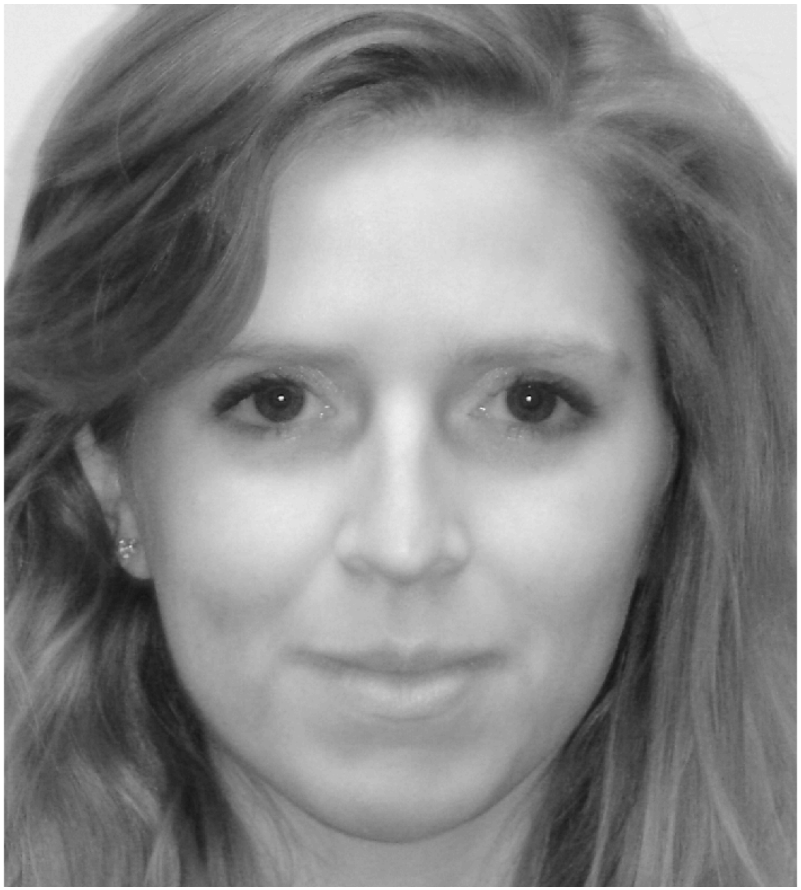


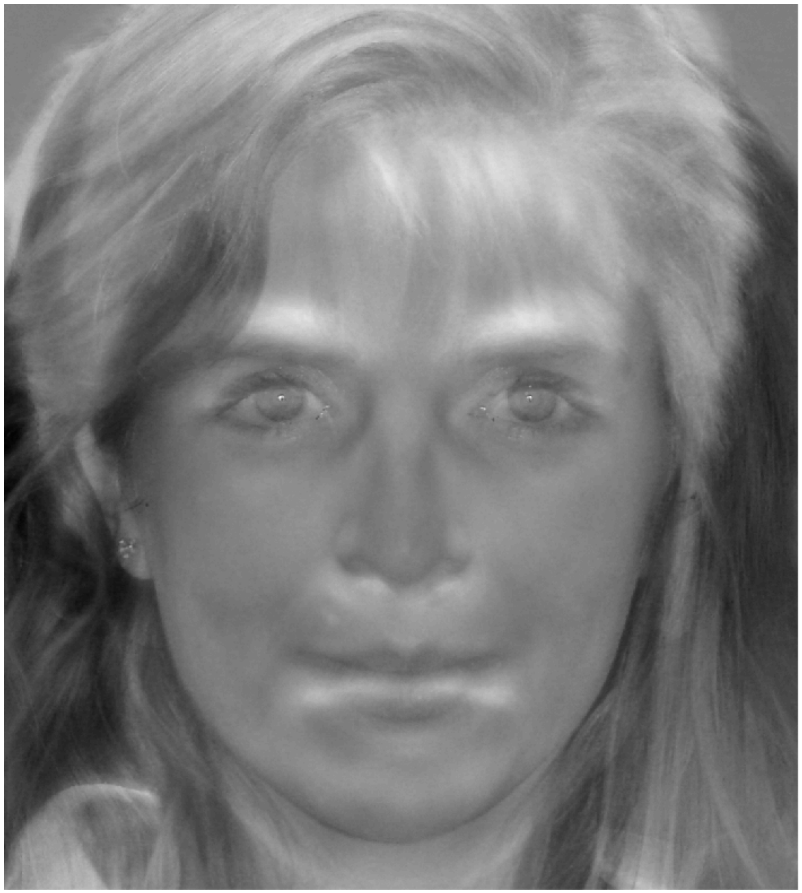


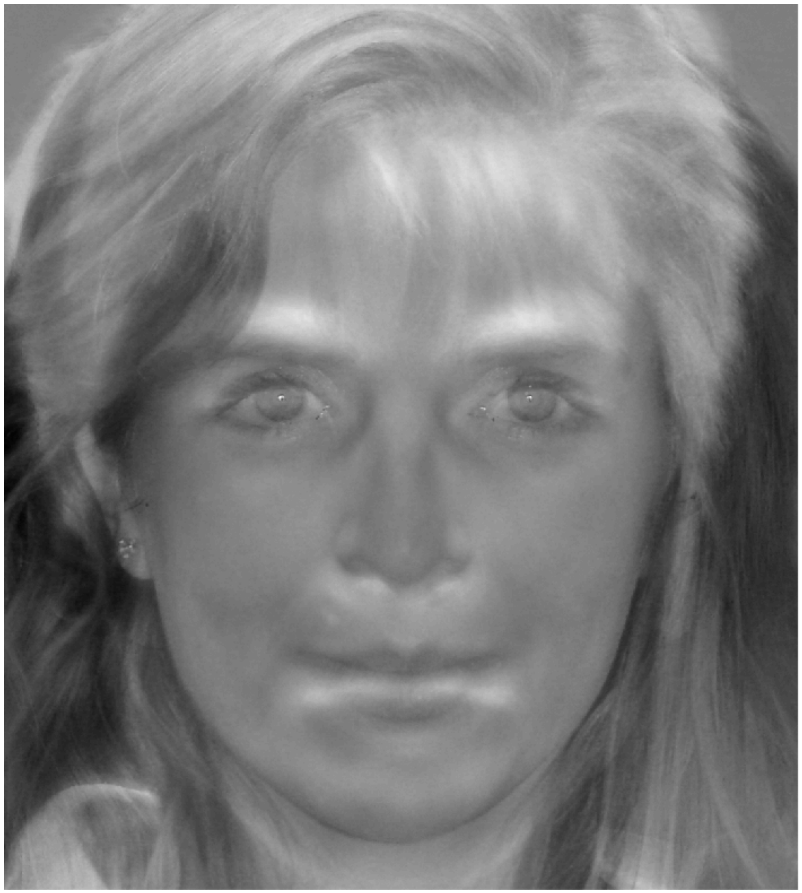
Vector 4

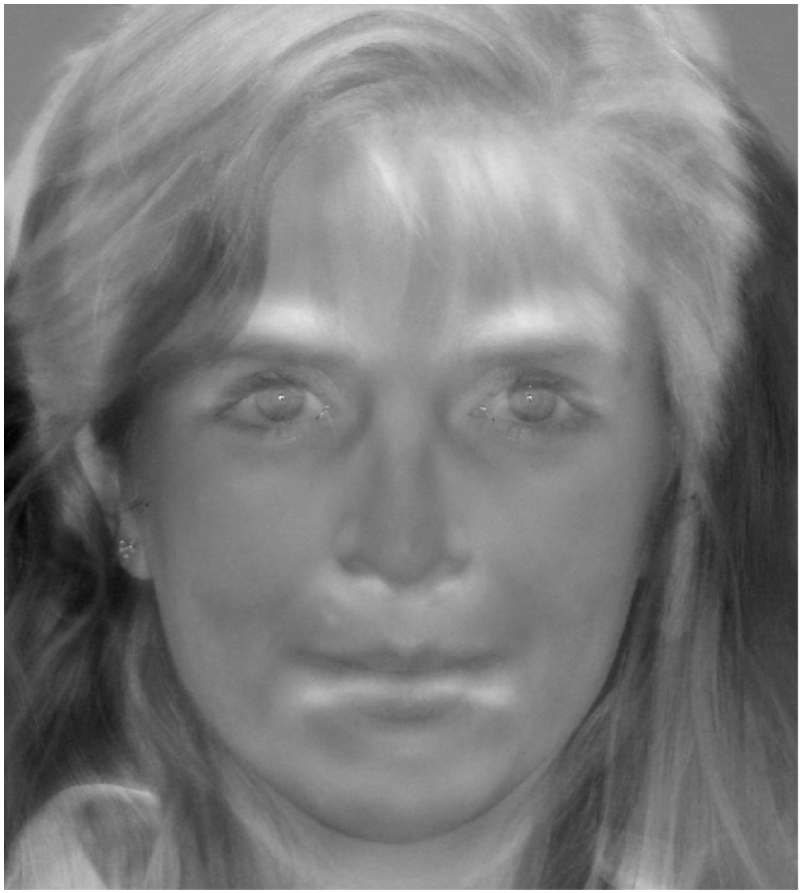


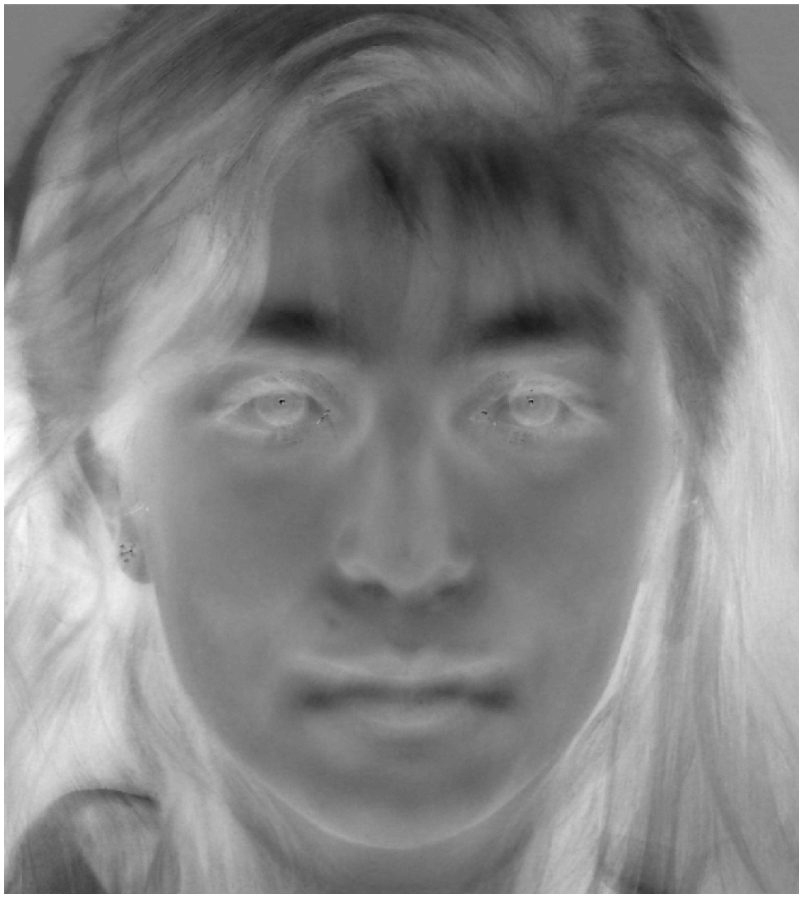
Vector 4











An Orthonormal Set (Pos Top, Neg Bottom)