## 5   Computer Vision (JGD)

(a)  Explain the key elements in "FaceNet" that enabled it to achieve a major breakthrough in face recognition performance, with impressive pose-invariance as illustrated below, and illumination invariance.                [5 marks]



(b)  Explain the Bayer pattern of colour separation used in many sensors for image acquisition, with reference to its effects on spatial resolution, the relative importance of luminance versus chrominance resolution, and the relative pixel densities of the various colour planes.                [3 marks]

(c)  Consider the following pair of $(6 \times 6)$ filter kernels:

| -1 | -1 | 2 | 2 | -1 | -1 |
|----|----|---|---|----|----|
| -1 | -3 | 4 | 4 | -3 | -1 |
| -1 | -4 | 5 | 5 | -4 | -1 |
| -1 | -4 | 5 | 5 | -4 | -1 |
| -1 | -3 | 4 | 4 | -3 | -1 |
| -1 | -1 | 2 | 2 | -1 | -1 |

| 1 | -1 | -1 | 1 | 1 | -1 |
|---|----|----|---|---|----|
| 1 | -2 | -3 | 3 | 2 | -1 |
| 1 | -3 | -4 | 4 | 3 | -1 |
| 1 | -3 | -4 | 4 | 3 | -1 |
| 1 | -2 | -3 | 3 | 2 | -1 |
| 1 | -1 | -1 | 1 | 1 | -1 |

(i)   Why do these two kernels constitute a quadrature pair?                [2 marks]

(ii)  To what kinds of image structure, and which orientations, are these detector kernels most sensitive?                [2 marks]

(iii) How would these kernels be applied directly to an image for filtering or feature extraction?                [2 marks]

(iv)  How could their respective Fourier Transforms alternatively be applied to an image, to achieve the same effect as in (iii) but faster?                [2 marks]

(v)   What is the "DC" response of each of the kernels, and what is the significance of this?                [2 marks]

(vi)  How could these kernels be combined to locate facial features?   [2 marks]