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Stage 3

Lips Detection

Lips detection is a widespread issue in the sphere of Image Processing. In general, it is not easy to detect lips since the color difference between human skin and lips is not that much different.

For lips detection, the first thing that comes to my mind is somehow separate the image into horizontal parts (say eyes in one block, nose in one and lips in another). For this purpose, I did a small research and so that there were observations that showed human's face's lips and hair have got the lowest intensities in general. So, the first step could be to make the image binary (since we'll get white for skin and black for objects on skin such as nose, lips, etc). Then, to see the intensities, we can use horizontal projection - the vector of pixel intensity sums over the row. Since the lips are on lower part of face, the lip region is taken as upper and lower lip maximum intensity interval. As we get the region of lips, we may do morphological filters. Two basic morphological operators are dilation and erosion. We use dilation to enlarge the boundaries of region foreground pixels. Thus, lips region will get bigger and minimum corners can be detected on the lips. Then, we shall detect the corners of the lips in some way (a research says there is Harris corner detector that does this). After detecting the corners, one thing we can do is to think of a normal distance that a man's lips can have from each other and see if the corners distance is closer to that predefined distance. So, in such a way, we can detect lips.

However, I think this can also detect some other shapes. Say if image is rotated by 180 degrees, since hair and lips have lower intensities, we can get the eye of the person because we take into consideration the lower half of the image.. In such cases, I would also consider checking if the shape of region is oval or a circle more likely.. If that's an oval, then the possibility of being a lips is more. That's also possible that the person is smiling with teeth and the shape is much circly. In that case, I would see if the inner region contains some rectangles(teeth). I think if the program has all the checks, we can detect the lips.

Ears detection

For ear detection, I would use images with rotations for ear to be seen as a whole. I would try to detect the sharp step edge around the ear. Then, since ear has concave areas, shape index will give the information if the region contains ridges and valley areas. There is the shape index technique, which is rather helpful in this case. See below image.
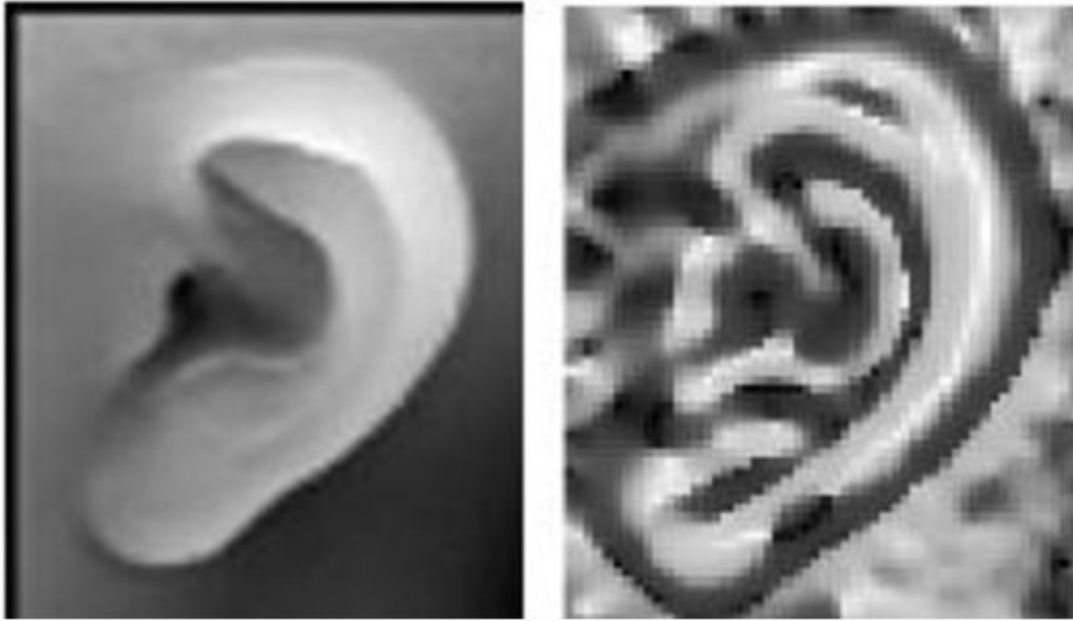
(a) 3D ear depth map   (b) its corresponding shape index value m

For ear detection, I would try to write some patterns of valleys and ridges. I think human ears they have similar structure in case of that and if the patterns were found in a region say with distance from each other at 1/10 cm, it would possibly be an ear. One can easily notice that those patterns have a rotated C shape (especially the ear edge). I would try to take the shape of the ear, remove the inner part and see if it has the rotated C shape. Then I would also assume that the head in the image is rotated, that there is an ear in a whole. I think besides ears, there is no object on face on a rotation in a whole in the same rotated C shape and valleys and ridges. So, that's an ear most possibly.

Before getting into eye socket detections, let's detect eyes :)

A good eye detection technique would be to detect the human face skin at first which will provide face candidates. This is followed by morphological processing and noise elimination which produces eye candidates. The final two candidates are selected by applying rules that define the structure of a human face. It is observed from the results that this technique is successful for 90% of frontal face images, which show two clearly illuminated eyes. However, this technique does not work for most profile images. The method also fails when one or both eyes are closed. But whatever, let's now take this technique as a good one since in our dataset we have all the eyes open and 90 percent of success is not bad you know.

So, when eye pixels are detected, we can clearly go back to the original image and with pixels of detected regions, show the eyes of people. Then, for eye sockets, we know that it should have an oval shape. We can do geometric shape detection and on original image see if that oval's inner part (but not the most inner - the blob) has pixels close to ~250(white). In such

a way, we can easily detect the sockets, since eye bounding boxes are detected and we just need to see if there's an oval inside which has some whites not in inner part.

Eyebrows detection

Eyebrows detection is so easy when one can detect eyes. Eyebrows are hair in upper part of eye (eye pixels plus some 20-30 pixels for high resolution images). We need to specify a shape (ovalistic) and detect a min of eye's width object of that shape. I think that dilation would also help us, since it would make eyebrows much more seen.