Programming Assignment 3 Report CSC 340-001
Alex Mello

Description of Assignment
Write a program that loads an image, extracts Harris Corners using the algorithm discussed in class, and displays the corners overlaid on the image.

Use the following two techniques to choose corners and compare them.

1. Find the max "cornerness" measurement in the image. Label all pixels whose "cornerness" is greater than a certain percentage of this value (i.e. 10%) as corners. The exact percentage you use will probably change based on the image.
2. Label the npixels in the entire image with the highest "cornerness" values as corners.

Harris Corner Algorithm

1. **Convert image to grayscale**
2. **Calculate x gradient:** Create a new array w/ same dimensions, for each pixel in the image subtract pixel to the right from the pixel to the left and store it in the new array
3. **Calculate y gradient:** Create a new array w/ same dimensions, for each pixel in the image subtract pixel to the bottom from the pixel to the top and store it in the new array
4. **Calculate xx/yy/xy:** Image1 = x gradient, Image2 = y gradient
   - For each pixel in Image1 multiply the pixel by itself and store in new xx array
   - For each pixel in Image2 multiple the pixel by itself and store in new yy array
   - For each pixel in Image 1 multiply by corresponding pixel in Image 2 and store in new xy array
5. **Sum xx/yy/xy:** Calculate sum of 3 pixel window for each array
   - For each pixel in each array add the: original pixel, the pixel above, the pixel below, the pixel to the left, the pixel to the right, the pixel to the top left, the pixel to the top right, the pixel to the bottom left, and the pixel to the bottom right
   - Store these values in a new corresponding array
6. **Calculate cornerness with formula:** Create a new array to store the cornerness values,
   - For each value in array calculate the determinant using:
     det = (xx [row][column] * yy [row][column]) - ((xy [row][column])**2)
   - For each value in array calculate the trace using:
     trace = xx [row][column] + yy [row][column]
   - For each value in array calculate cornerness using:
     array [row][column] = det - (0.05 * (trace**2))
7. **Rank the corners using one of the techniques in the assignment description**
8. **Draw circles on the ranked corners by using cv2.circle**

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Problems Occured:

- Overflow errors which might have been making values inaccurate
- Converting image to grayscale with my grayscale function - think I needed to make a new array with (rows, columns, 1) because I was using an array with 3 values per pixel and I didn't change that
- When calculating gradients I didn't make new arrays originally and that messed up the values and prevented me from getting any further
- Didn't realize I had to sum the xx, yy, and xy arrays, was just using xx, yy, and xy arrays
- Deepcopy array made a unit8 array which only allows values up to 255 which caused problems

Patterns from Results

- Does not pick up corners on faces well, mainly focuses on eyes, ears, corner of mouth, and neck area
- Shadows appear to make less circles show up in that area
- Red circles are hard to see on red images
- Works really well on flowers
- Works better on drawings/digital art than on pictures
- Works well on patterns

Assumptions

- Making a larger window size would pick up on bigger corners better but might make smaller corners less likely to get picked up
- Seems like smaller pixel images work better
- Will not pick up corners on flat/curved 3d areas like the cheek on a face

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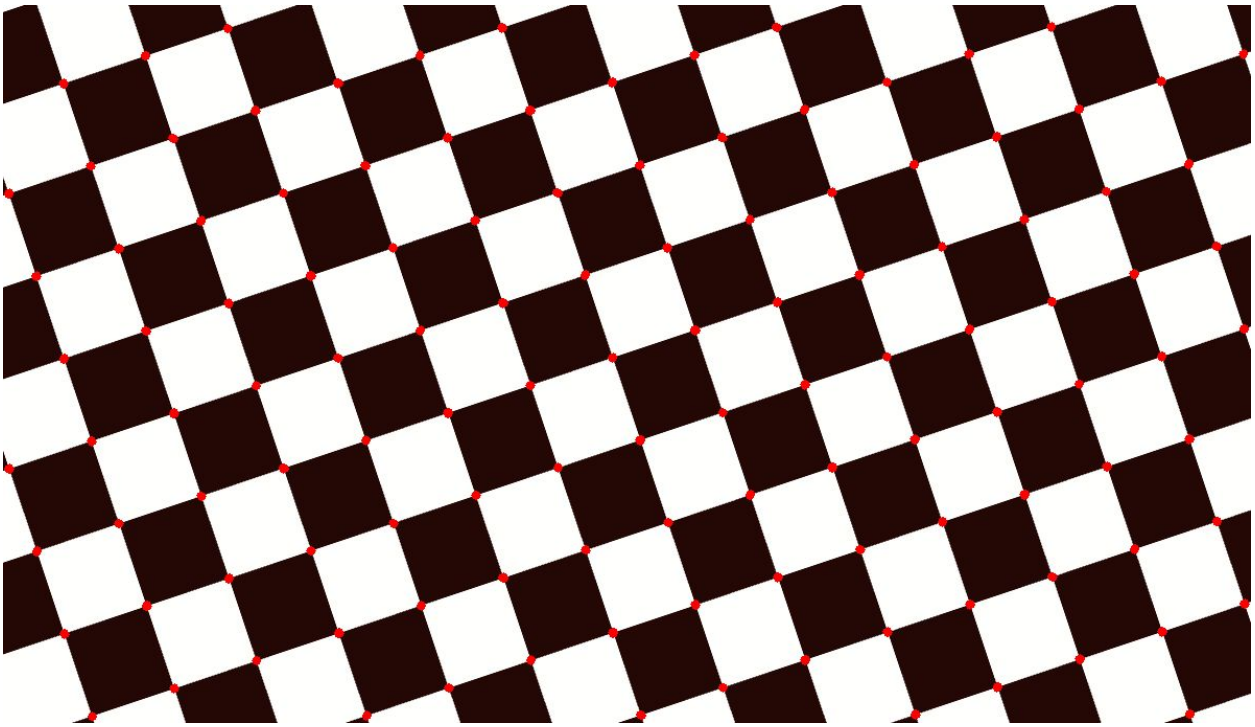

Image 1
Ranked on 35% max cornerness values

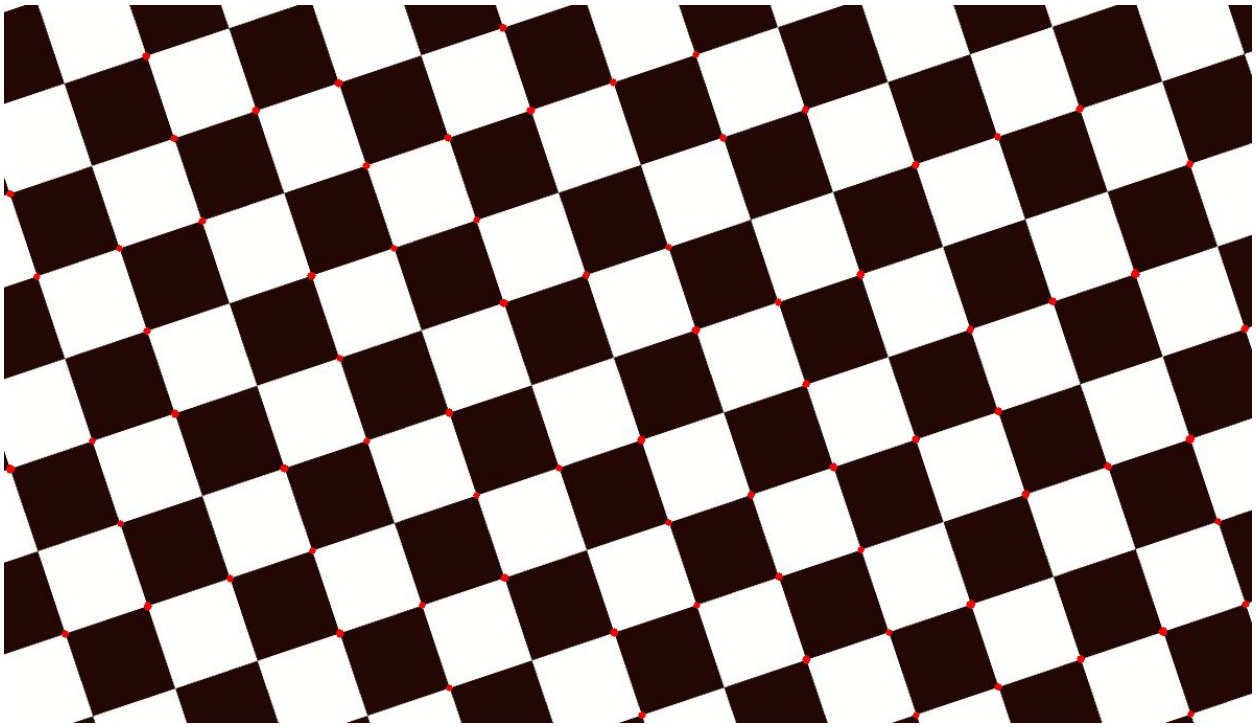

Image 1
Ranked on number - 100 pixels

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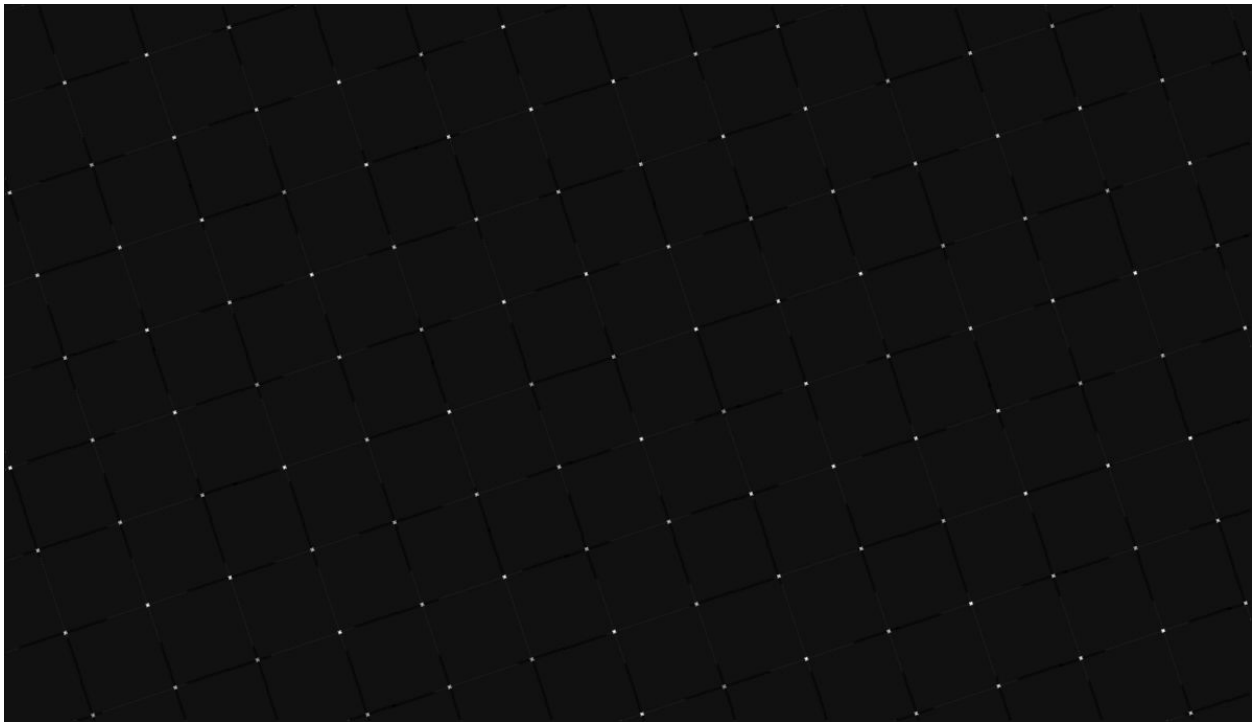

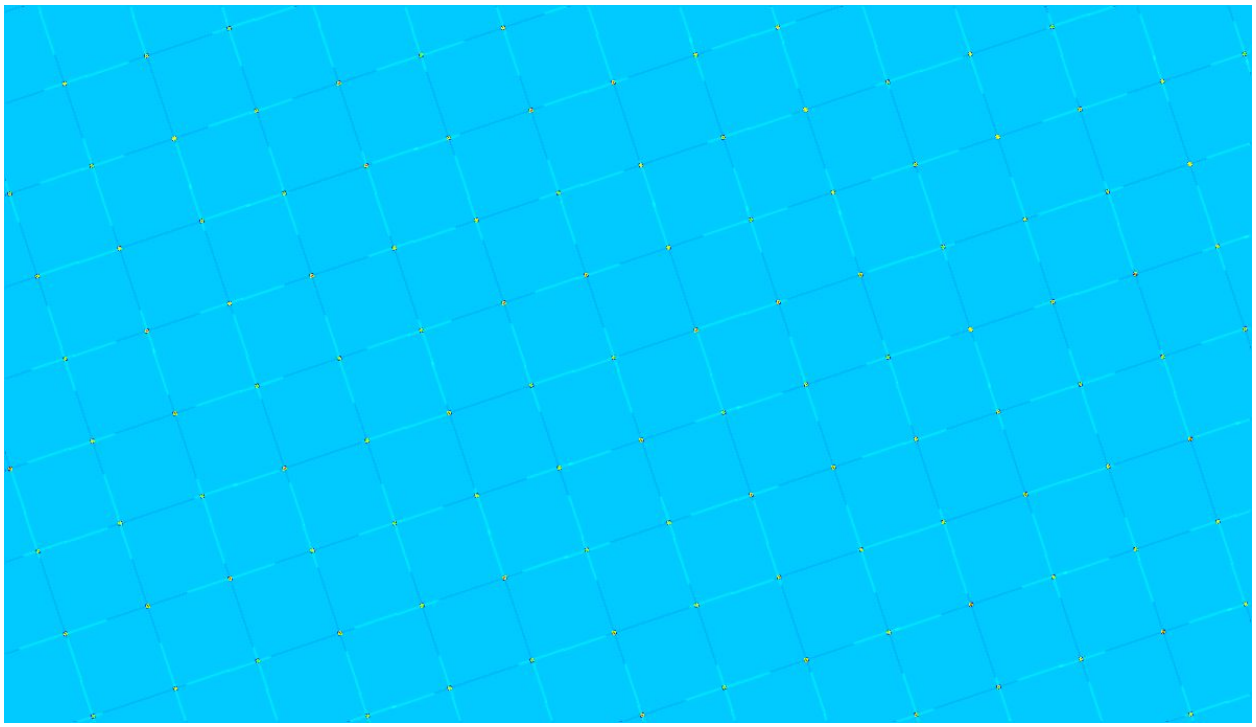

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Image 2
Ranked on 35% max cornerness value
Picks up on lots of small plant corners

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Image 3
Ranked on 40% max cornerness value
Picked up on plants since they have smallest corners probably

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Image 4
Ranked on 20% max cornerness value
Picks up the outline of the guy mainly
Actually picks up corners well since it is a drawing and there is a definitive line

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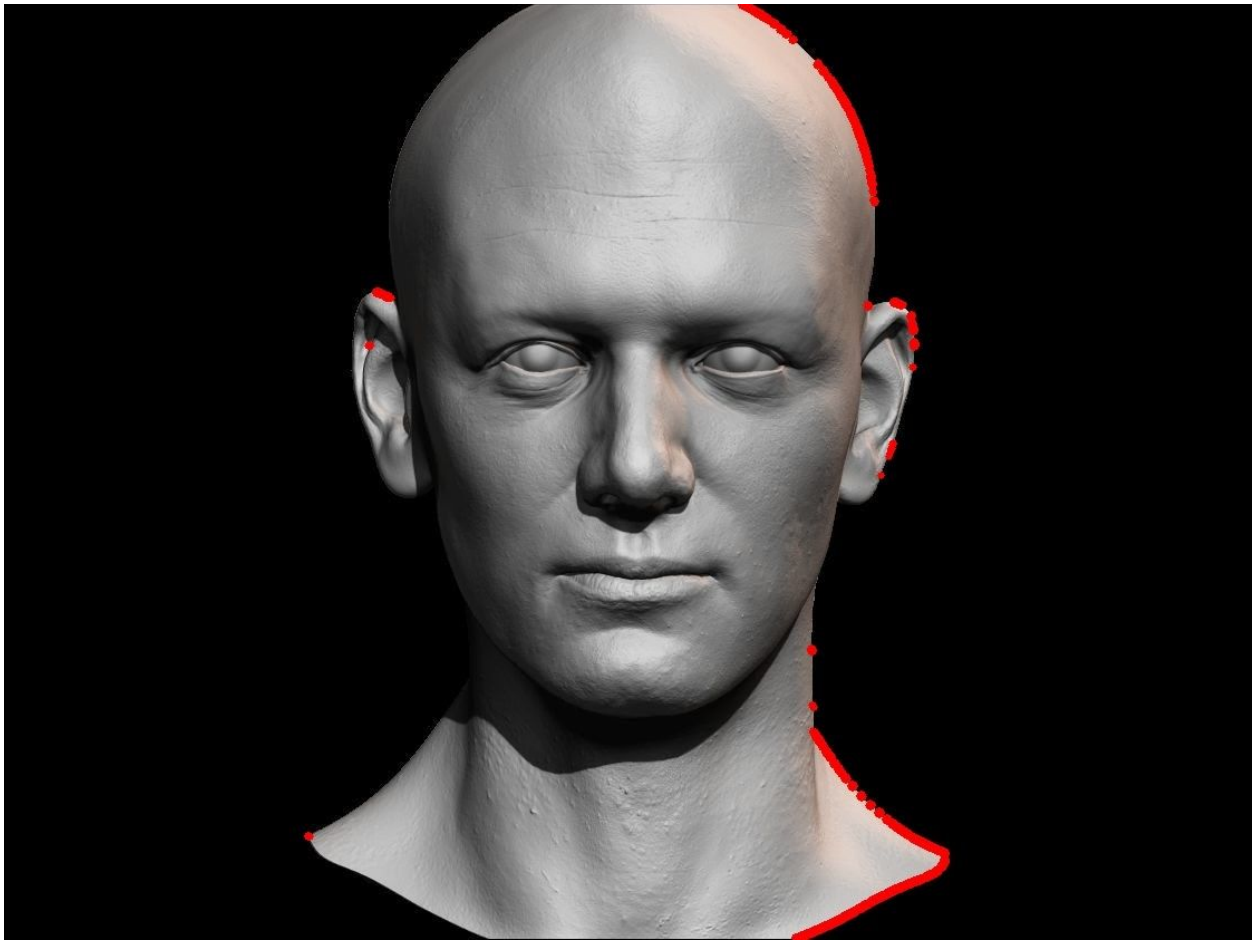

Image 5
Ranked on 5% max cornerness - Trying to get corners on the face
Didn’t pick up any corners on the guys actual face

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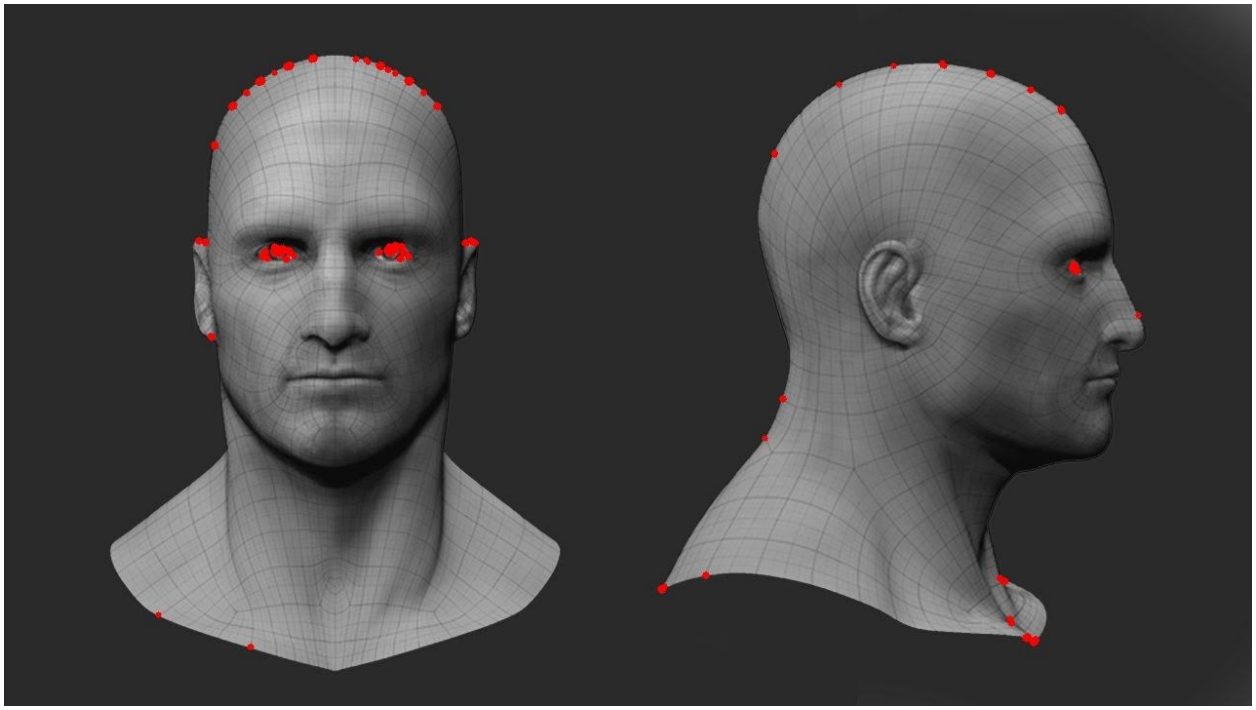

Image 6
Ranked on 5% max cornerness - Trying to get corners on the face
It picked up the eyes but not the face which is interesting

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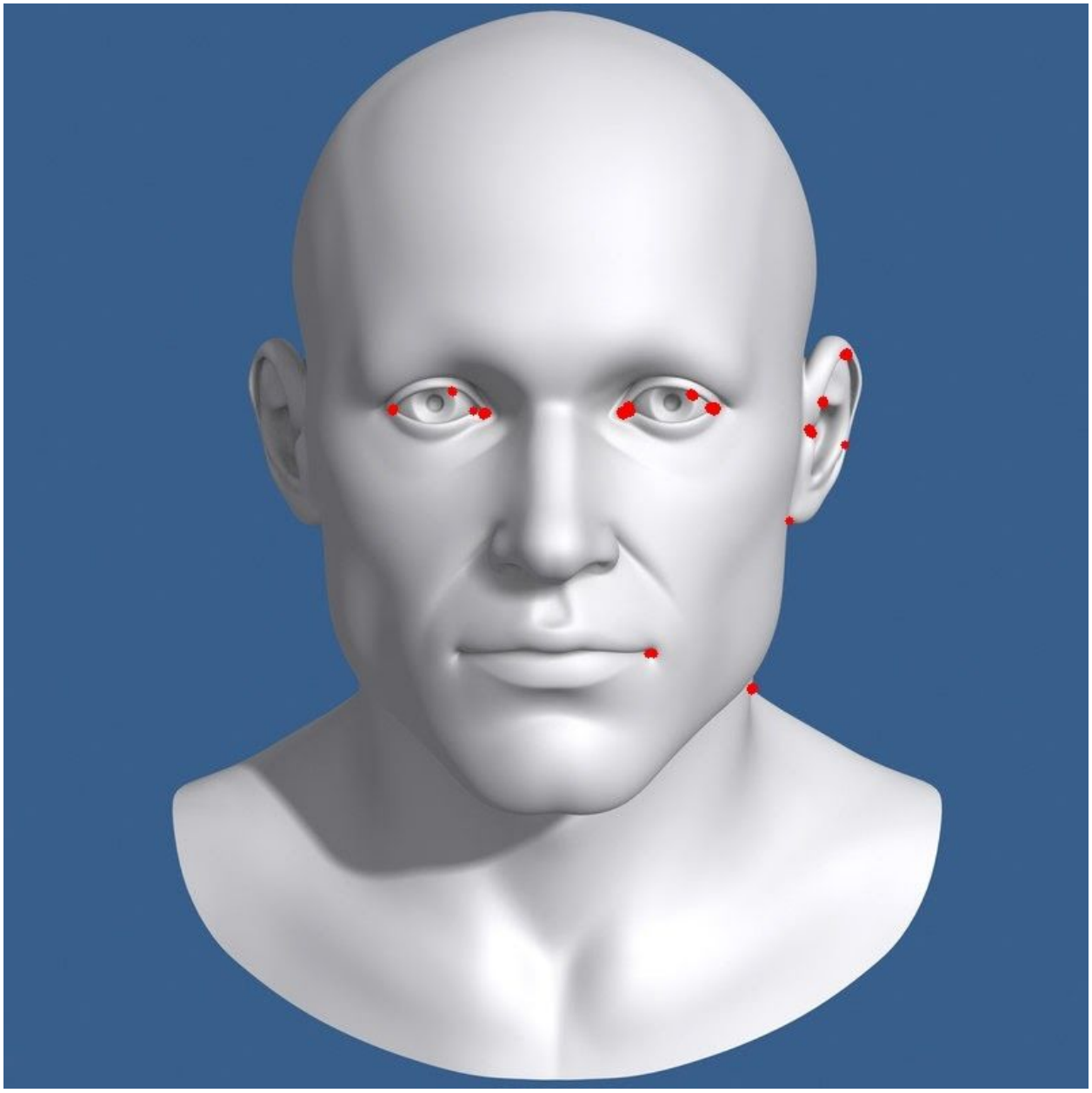

Image 7
Ranked on 5% max cornerness - Trying to get corners on the face
It picked up good corner spots but not as many as I hoped for, also the left ear has no corners?