

# Hemoglobin Level Estimation from Photographic images

NIRANJAN VERMA  
210020085

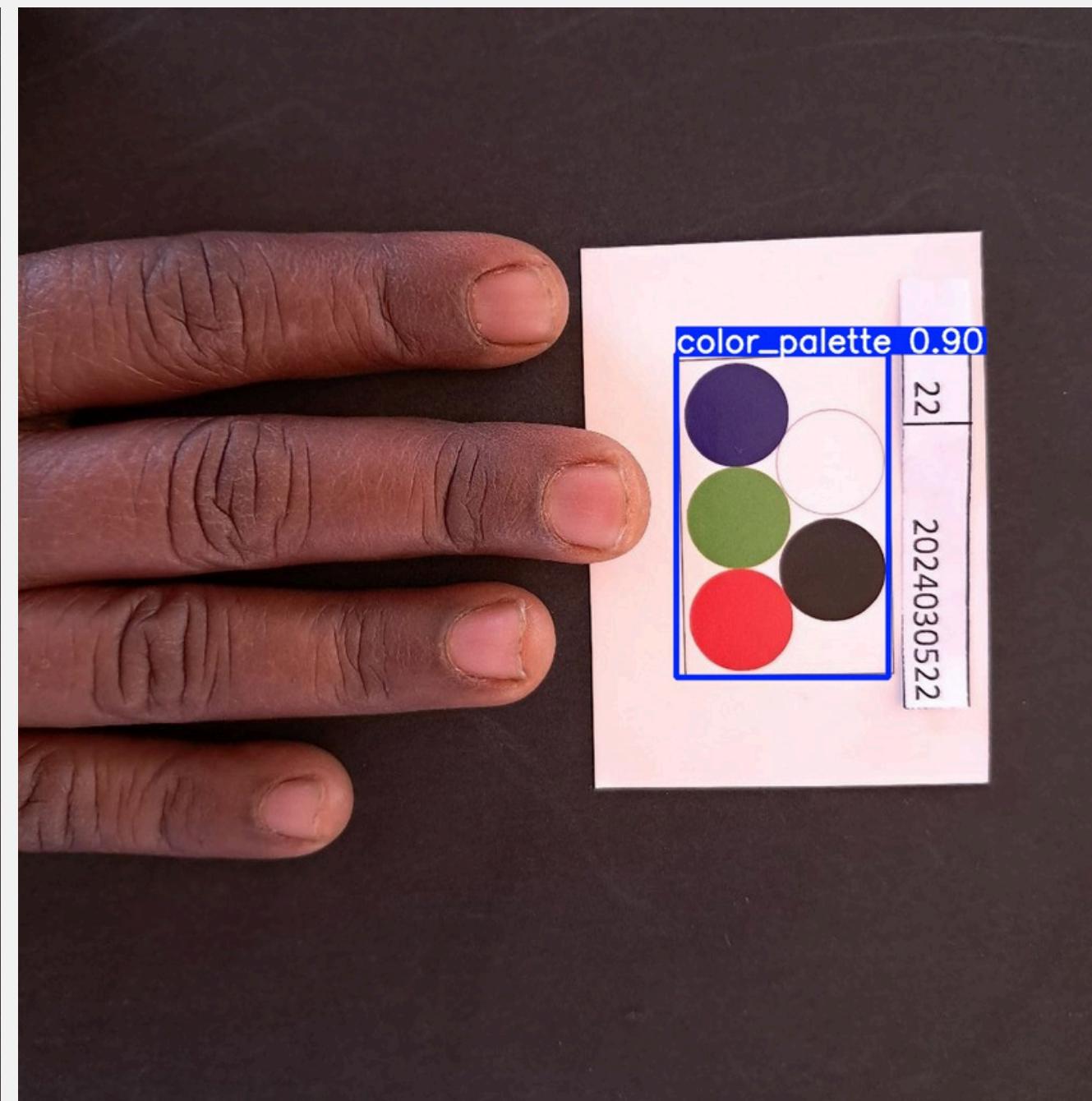
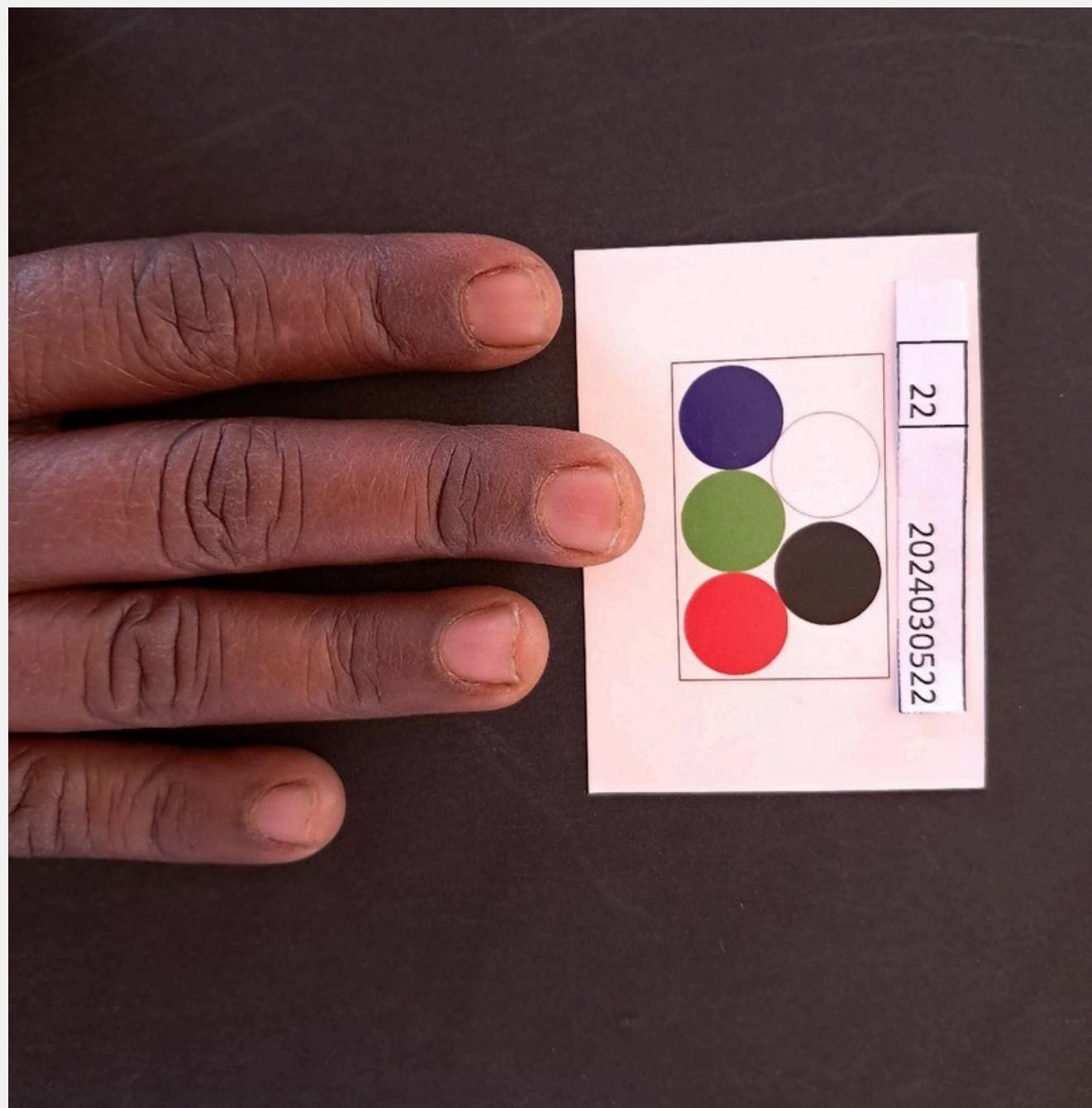
PROF. NIRMAL PUNJABI

# Color Calibration

- Extract Color Palette -----
- Extract individual circles
- Get the mean color of each circle
- Compare with reference color
- Get a transformation function for transformation of mean color to reference color
- Calibrate all the images using the transformation function obtained

# Extract Color Palette

Done using Yolo Object detection



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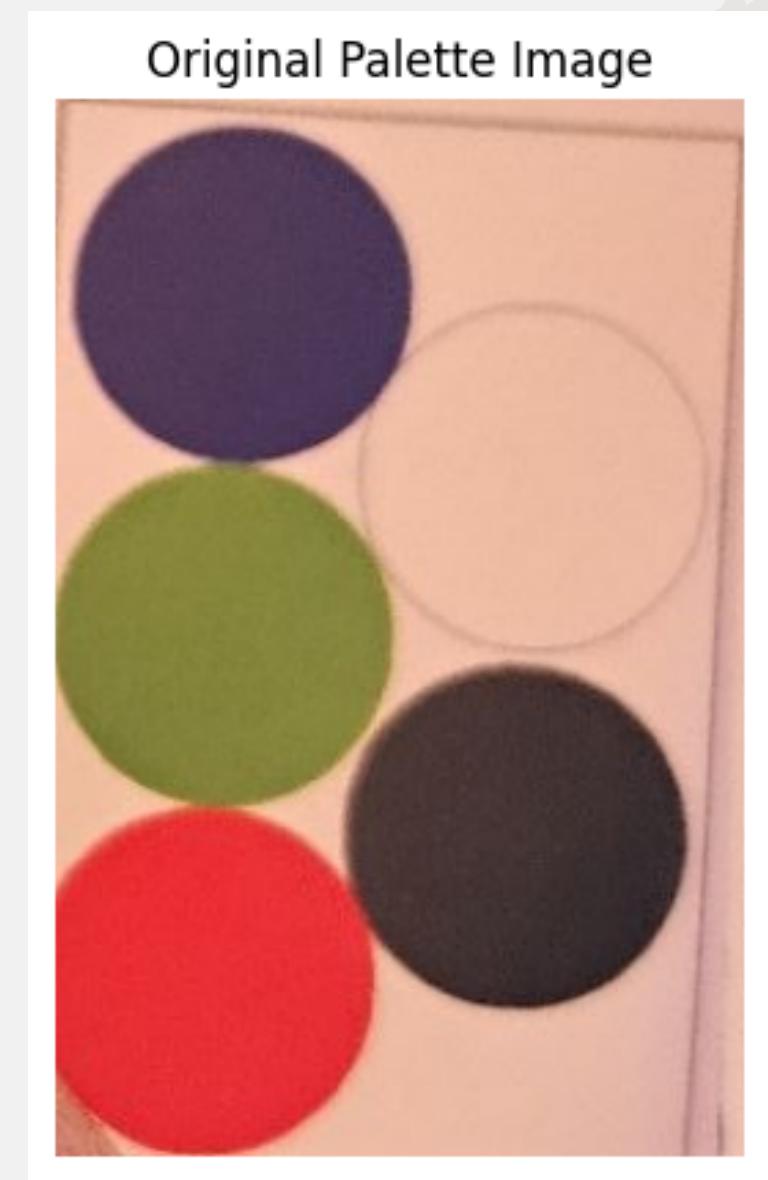
# Extract Individual Circles

- Hough Circle
- Deep Learning based segmentation

# Hough Circle Detection



# Hough Circle Detection Problem



# Hough Circle Detection

Eye: In 285 images out of 412 images, 5 color circles were detected ( although not perfect )

Fingernail: 416/425

Palm: 389/426

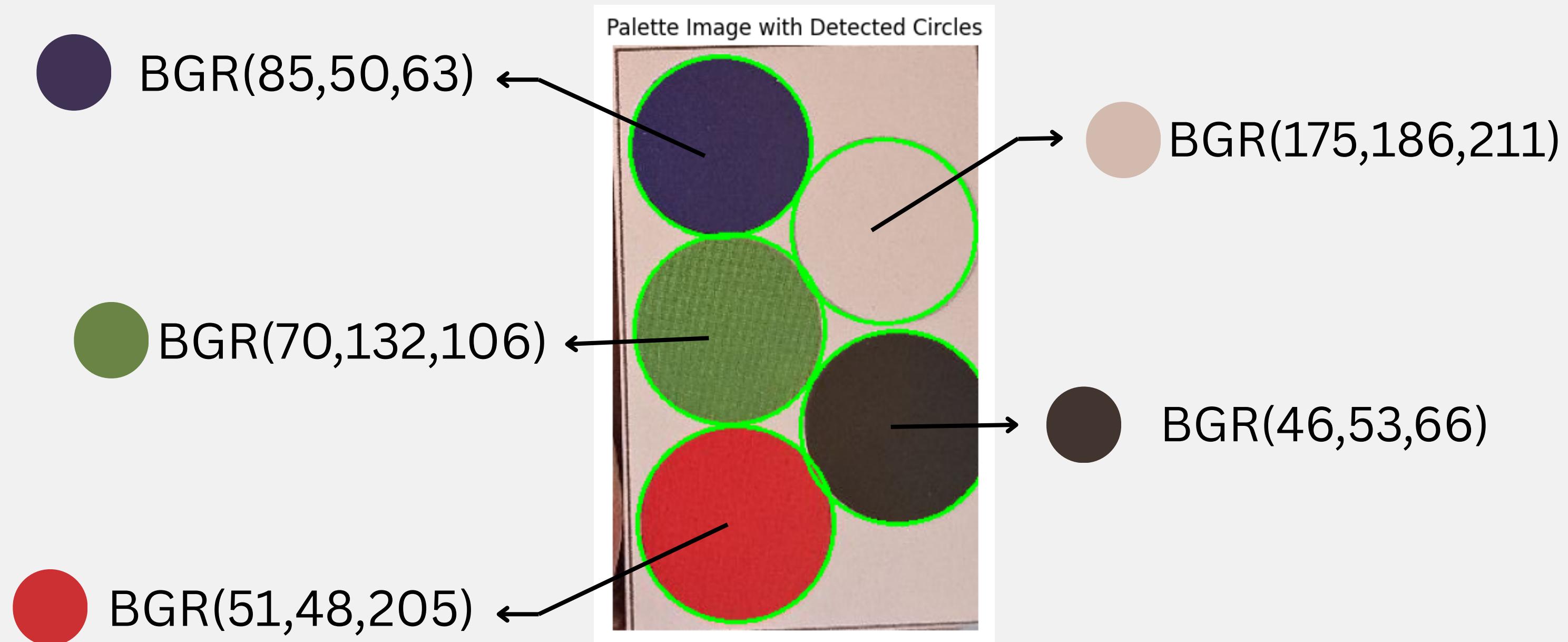
Tongue: 300/425

This was the best I could achieve by fine tuning the houghs circle parameters

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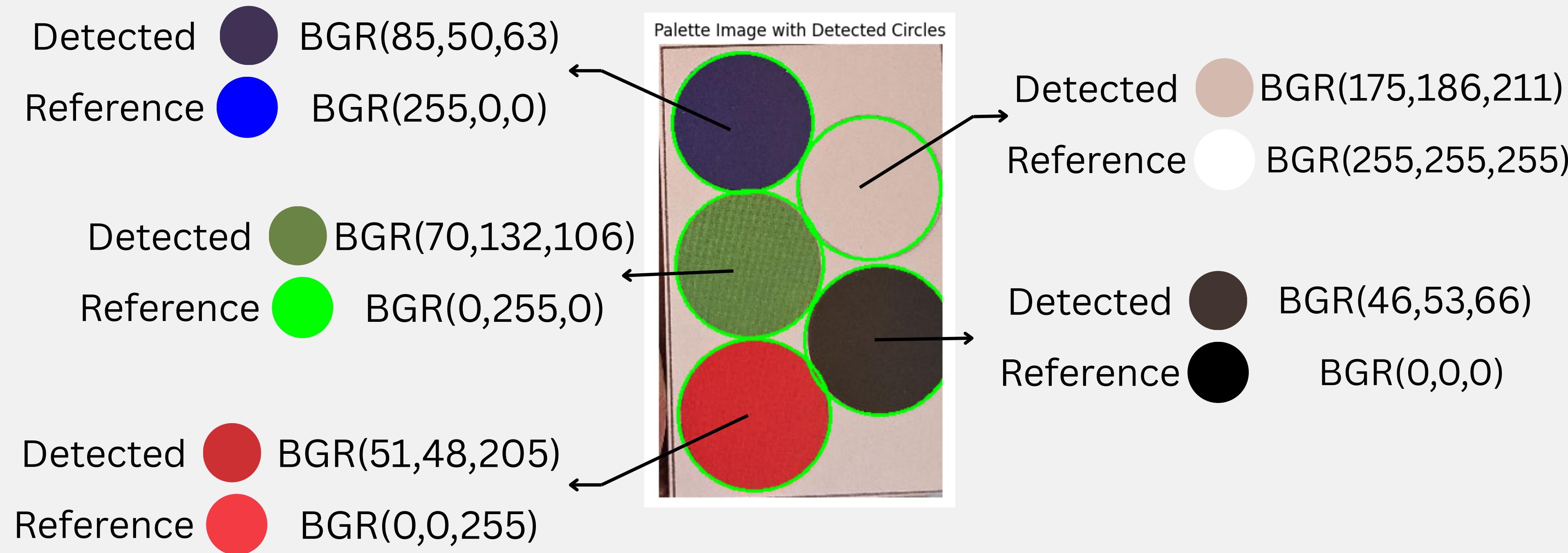
# Mean Colors



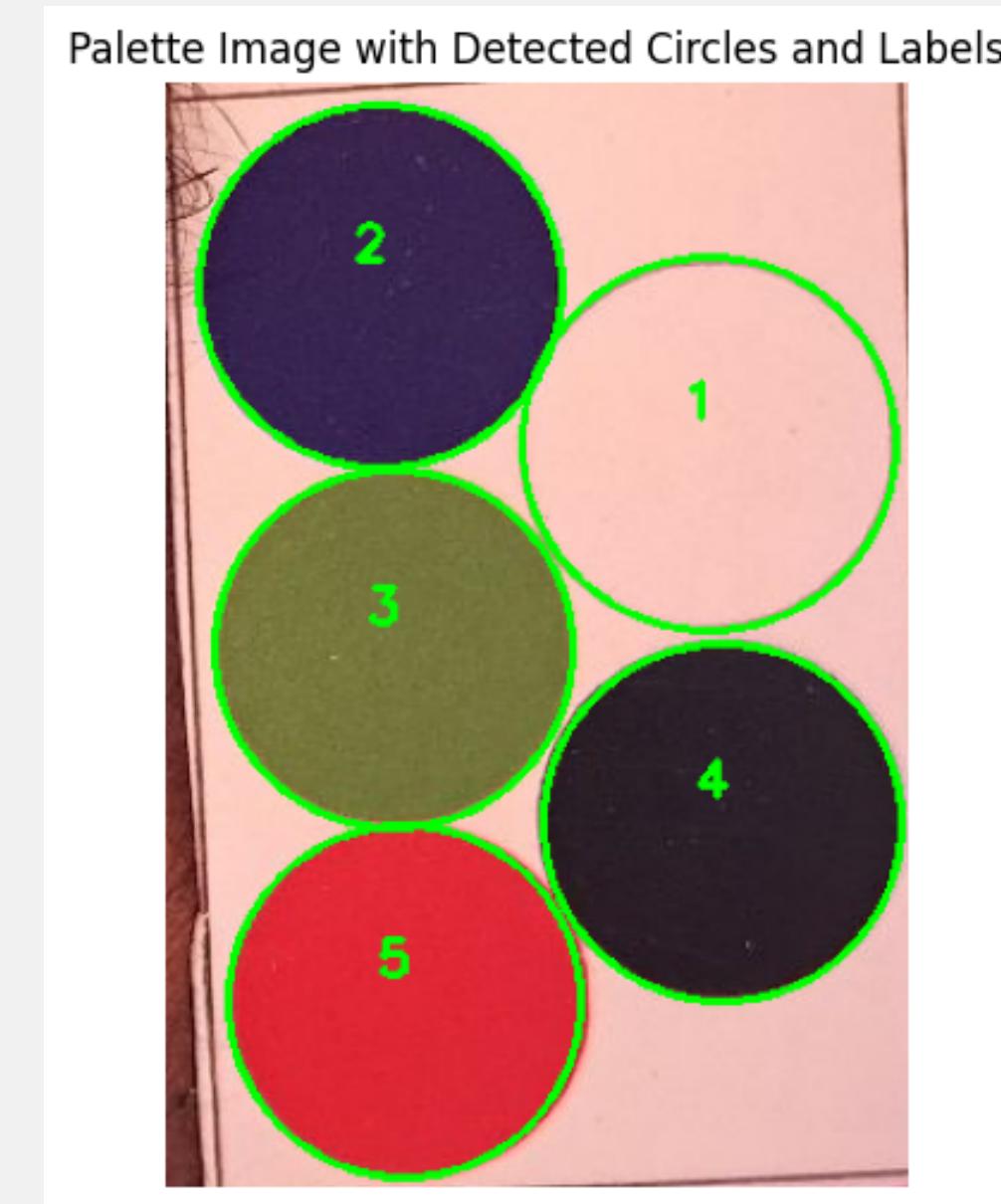
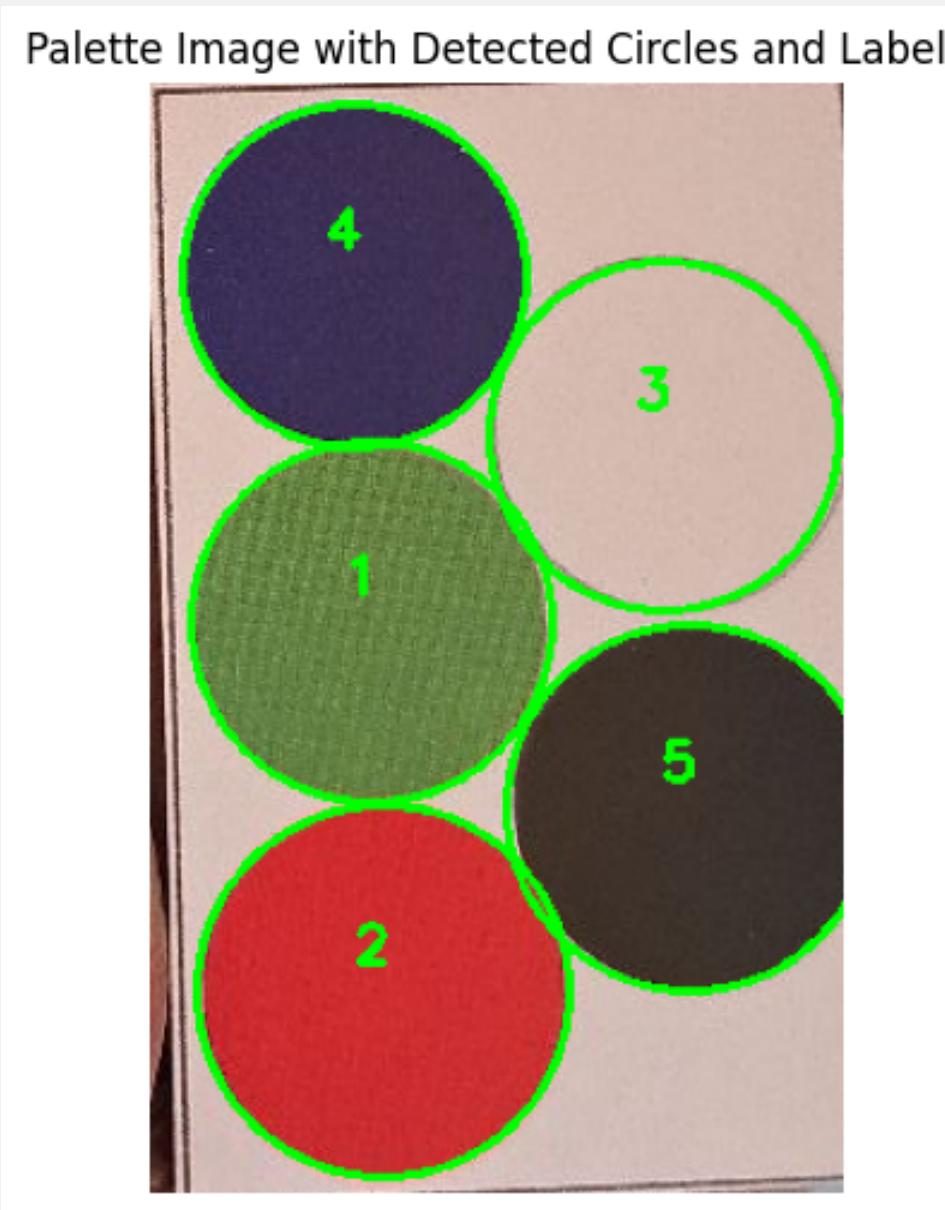
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# Mean Colors & Reference Colors



The numbering on each circle is random. So we need to map each circle to its reference color, for all the color palettes separately.



# Mean Colors & Reference Colors

```
reference_colors = {
    "black": (0, 0, 0),
    "white": (255, 255, 255),
    "red": (0, 0, 255),
    "green": (0, 255, 0),
    "blue": (255, 0, 0)
}
```

Computed Euclidean Distance b/w reference color and measured color to know which color does the measured color belongs

```
for label, ref_color in reference_colors.items():
    if label in used_refs:
        continue # Each reference color is used only once
    ref_arr = np.array(ref_color, dtype=np.float32)
    dist = np.linalg.norm(mc_arr - ref_arr)
    if dist < best_dist:
        best_dist = dist
        best_label = label
        best_ref = ref_color
```

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# Transformation

## 1. 3x3 Matrix

$$R_{\text{ref}} = x_1 * R + y_1 * G + z_1 * B$$

$$G_{\text{ref}} = x_2 * R + y_2 * G + z_2 * B$$

$$B_{\text{ref}} = x_3 * R + y_3 * G + z_3 * B$$

$$\begin{Bmatrix} R' \\ G' \\ B' \end{Bmatrix} = M * \begin{Bmatrix} R \\ G \\ B \end{Bmatrix}$$

# Transformation

## 2. 3x4 Matrix

$$R_{\text{ref}} = x_1 * R + y_1 * G + z_1 * B + c_1$$

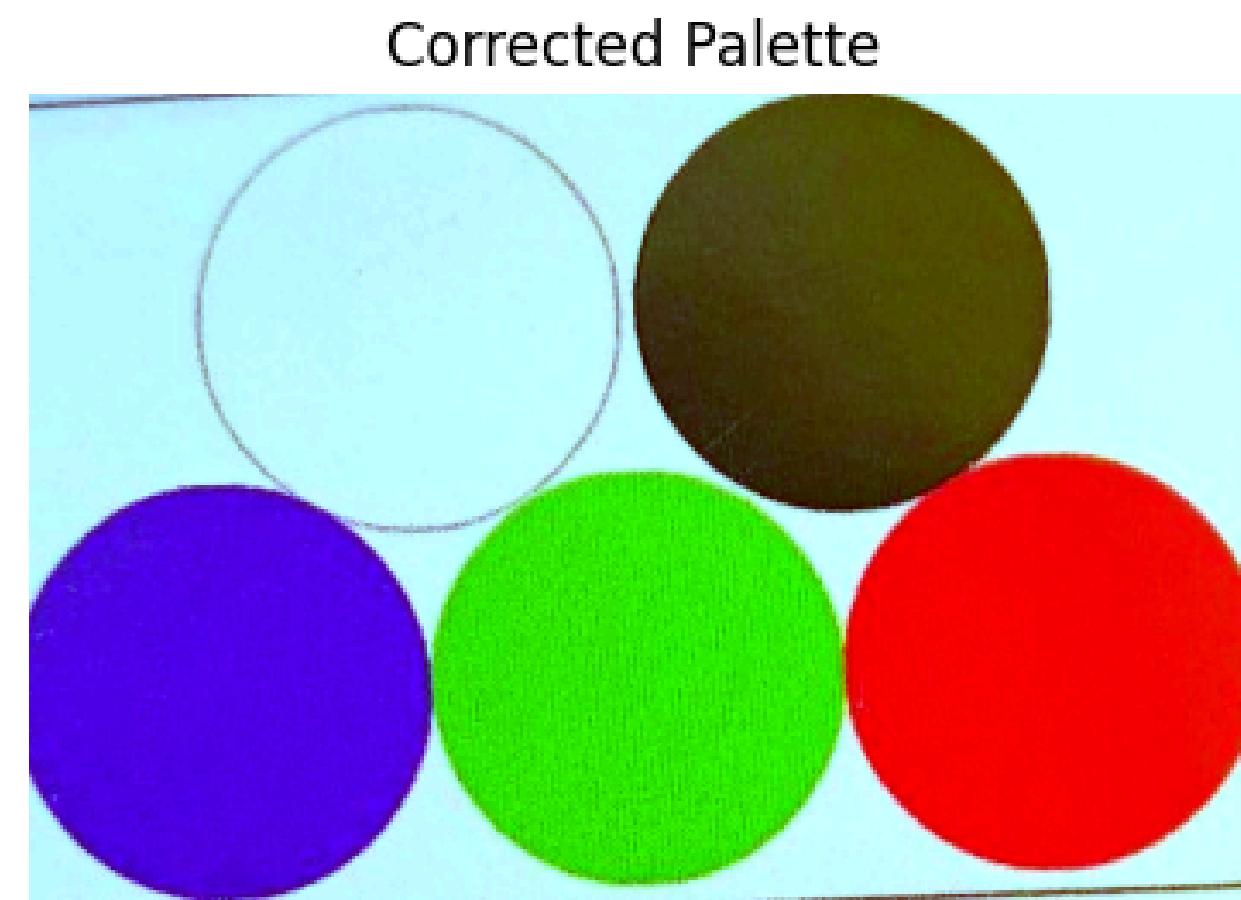
$$G_{\text{ref}} = x_2 * R + y_2 * G + z_2 * B + c_2$$

$$B_{\text{ref}} = x_3 * R + y_3 * G + z_3 * B + c_3$$

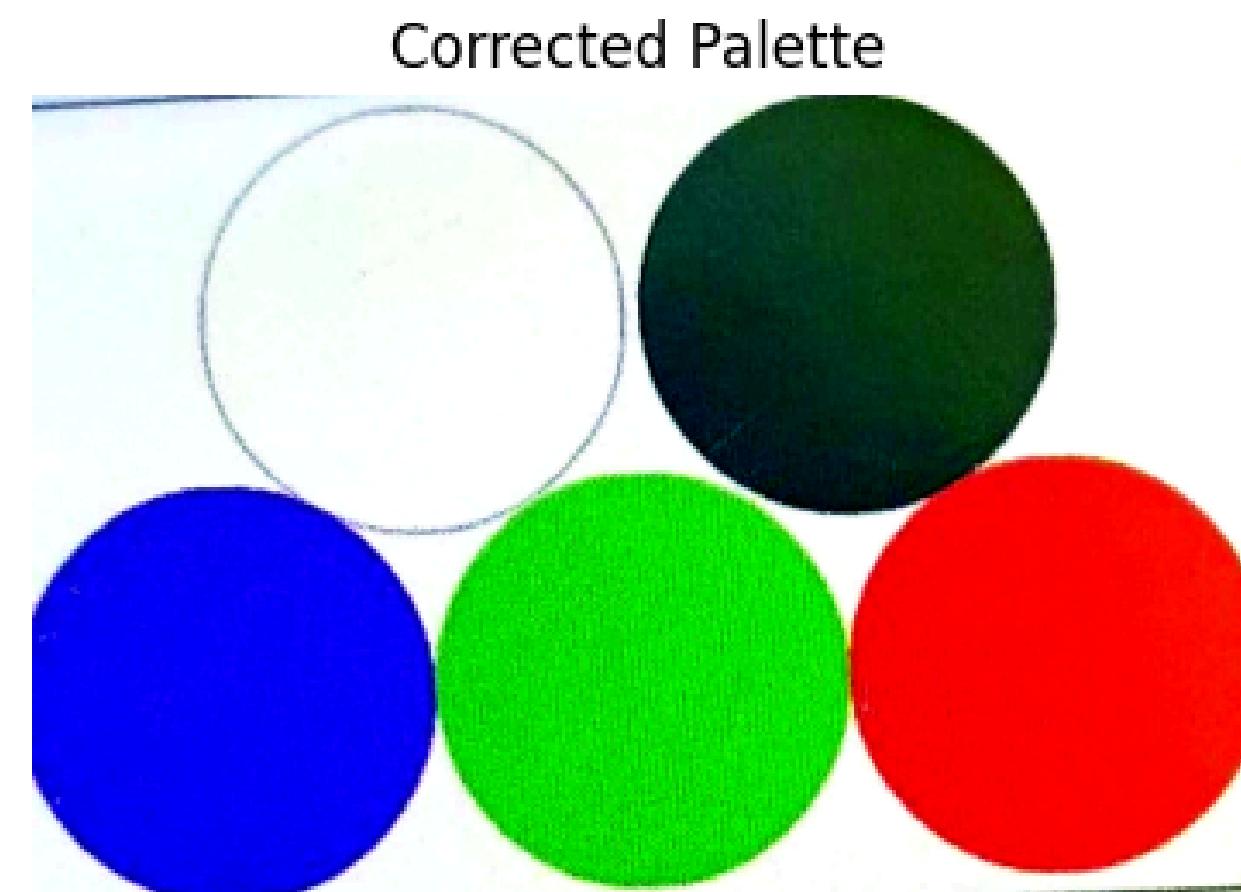
$$\begin{Bmatrix} R' \\ G' \\ B' \end{Bmatrix} = M * \begin{Bmatrix} R \\ G \\ B \\ 1 \end{Bmatrix}$$

# Transformation

1. 3x3 Matrix

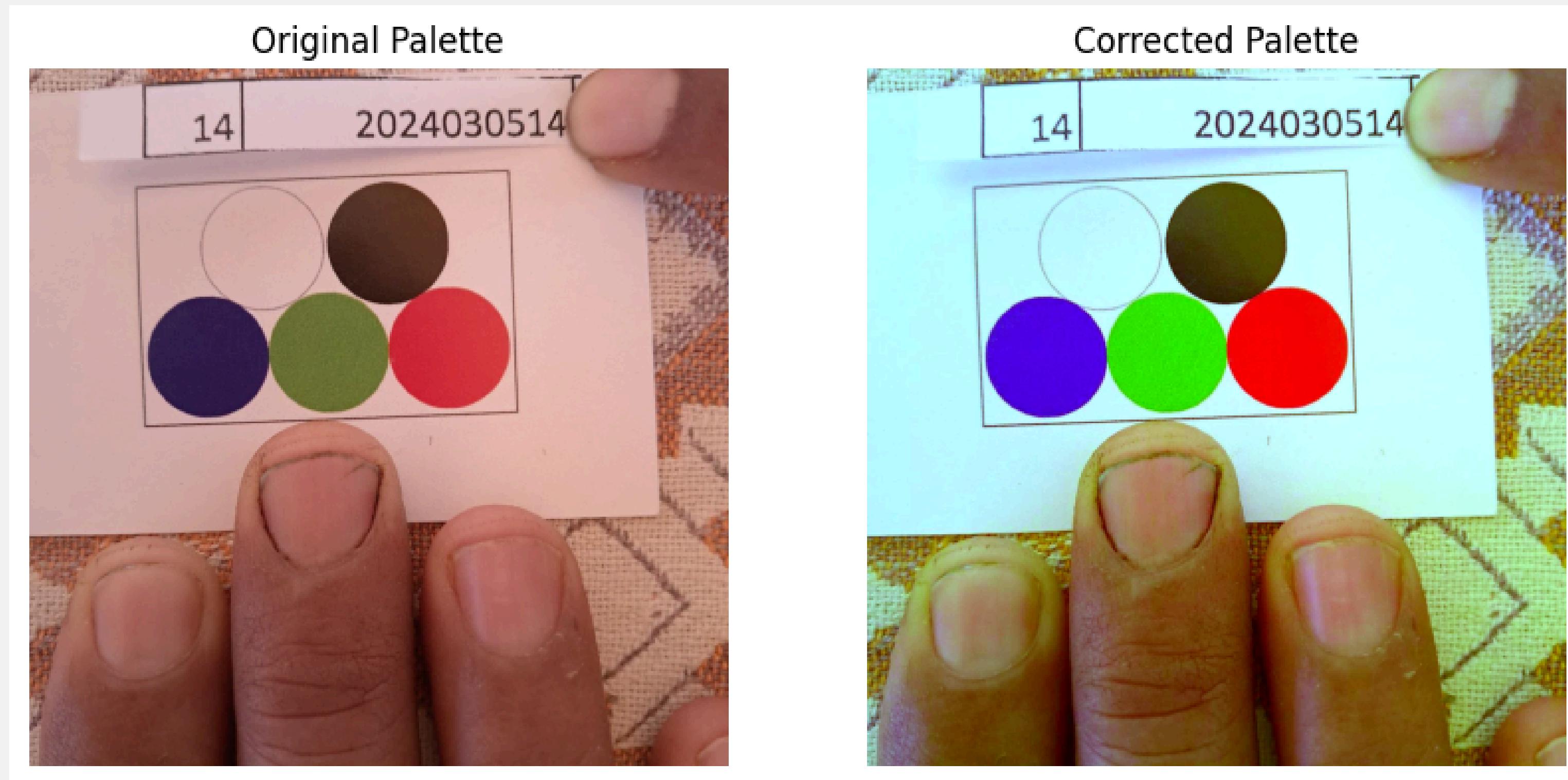


2. 3x4 Matrix



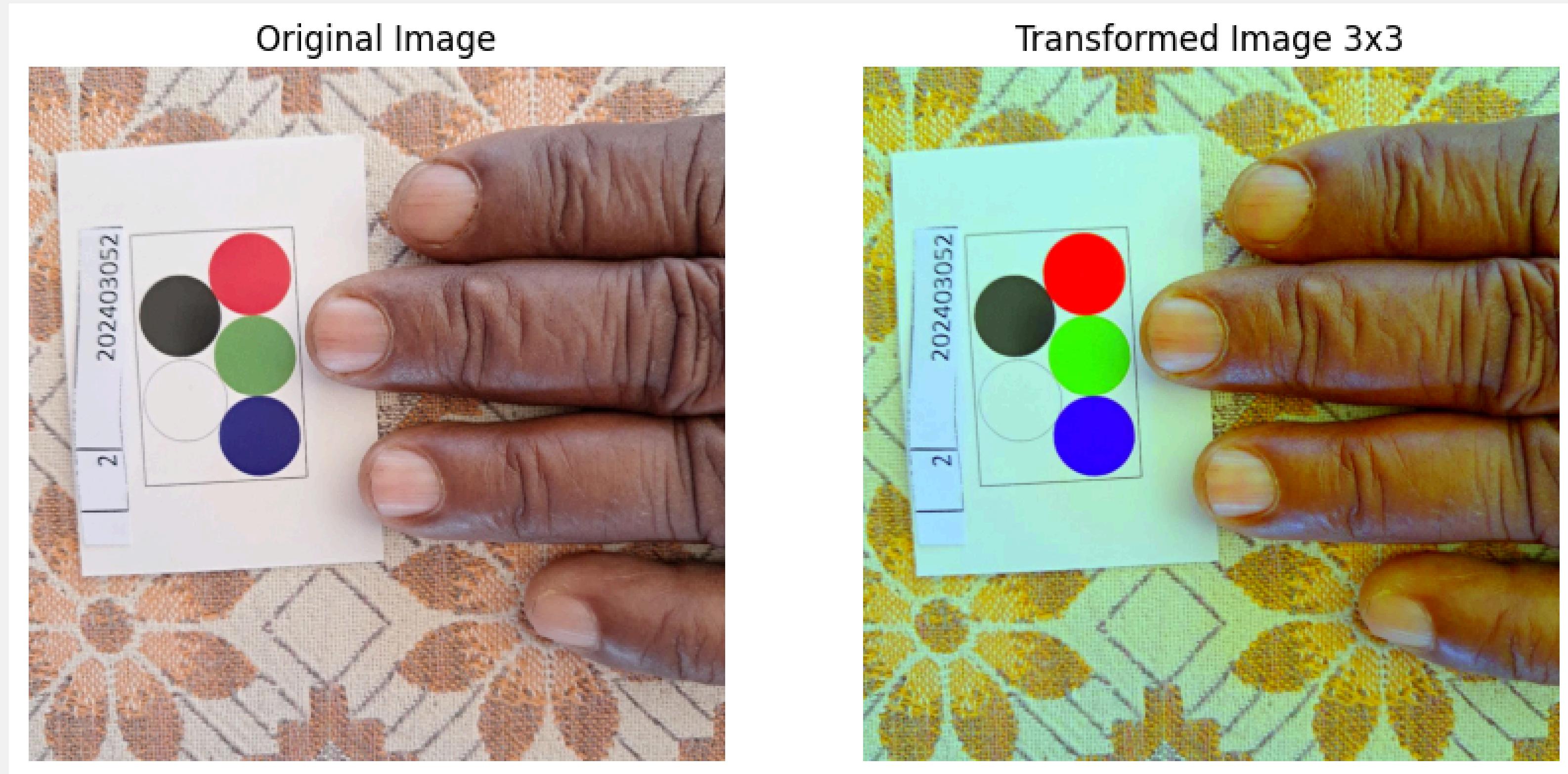
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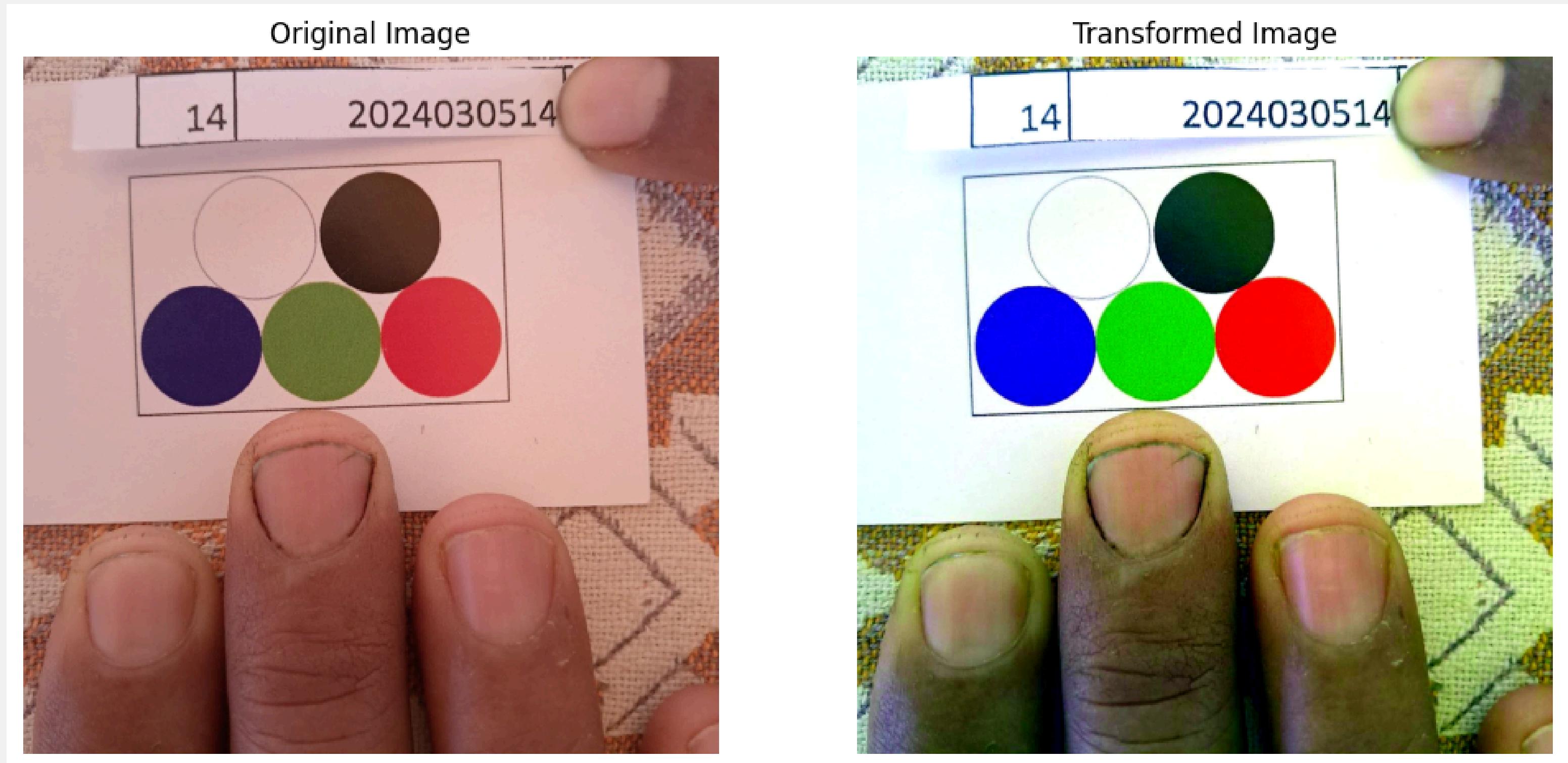
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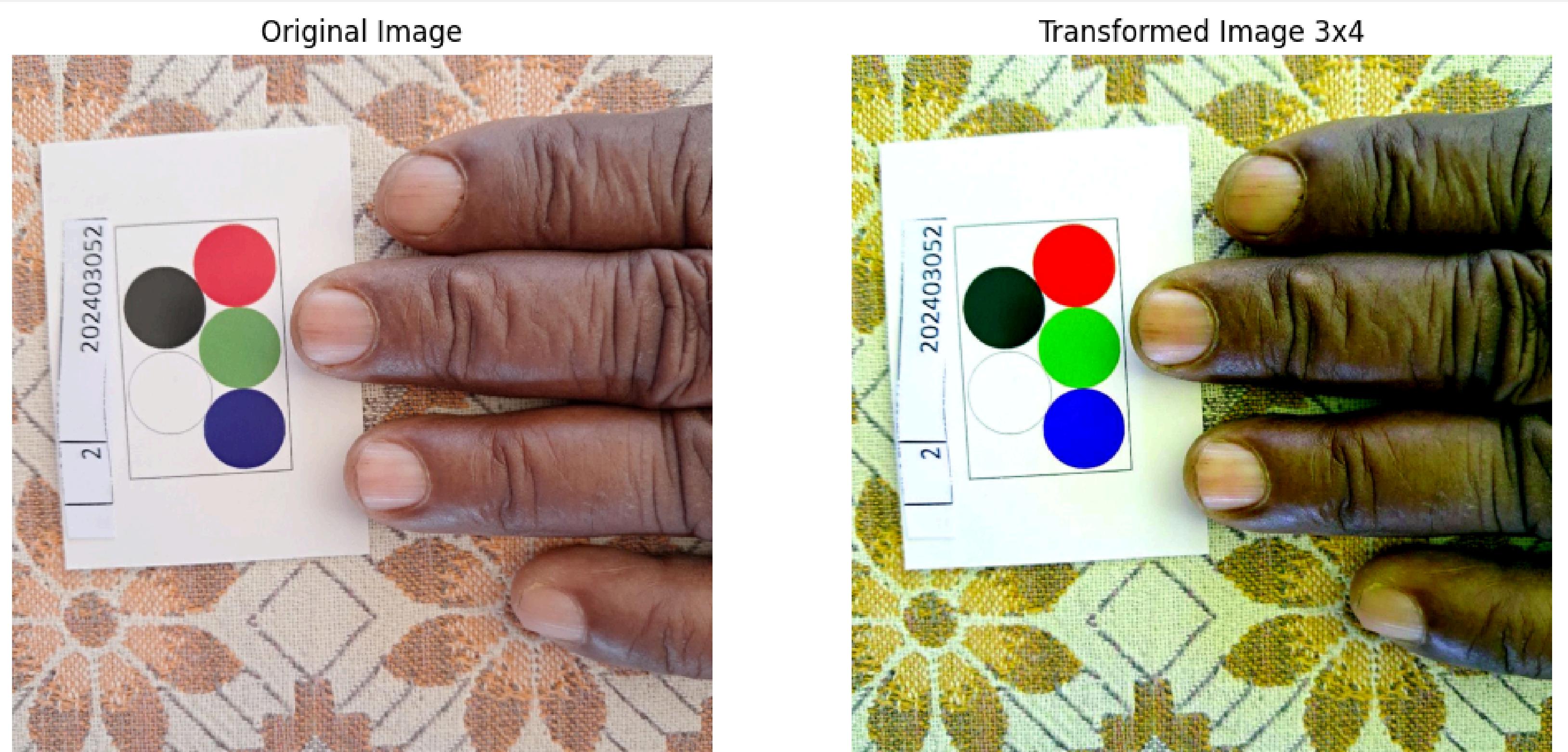
# Transformation

## 2. 3x4 Matrix

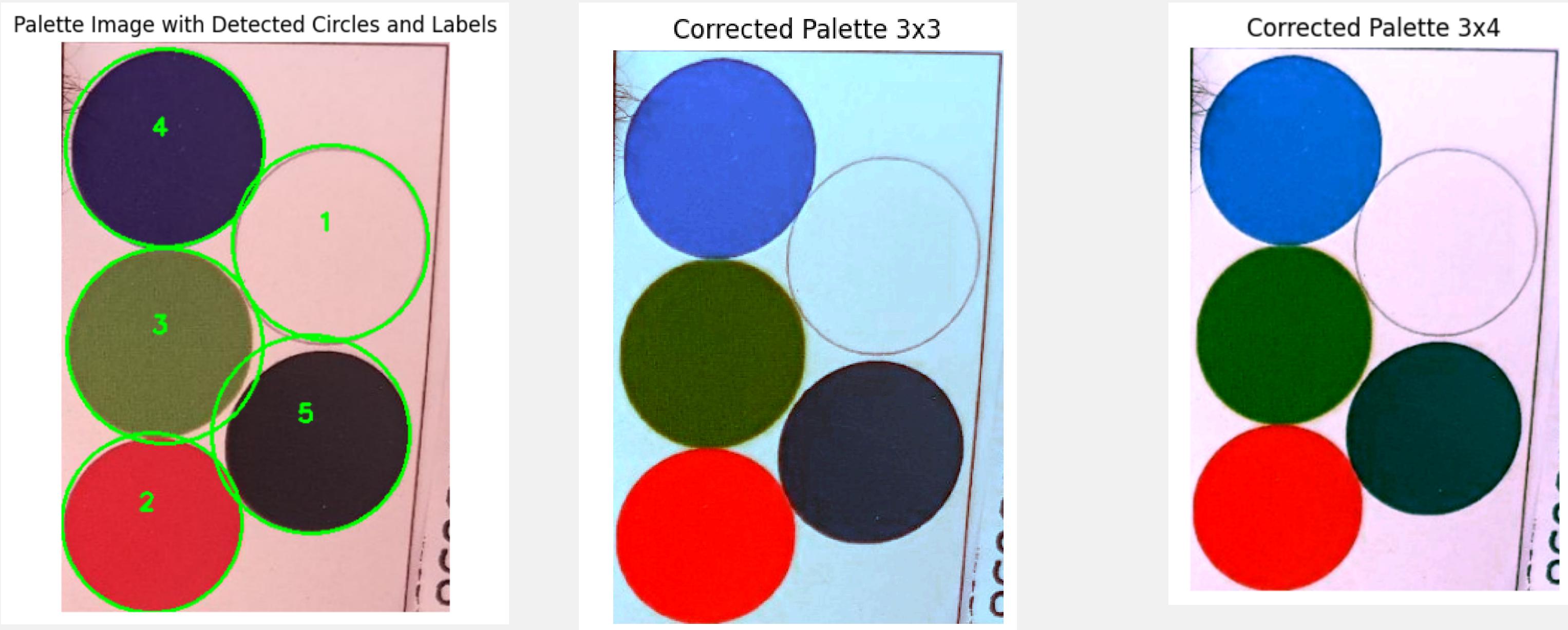


# Transformation

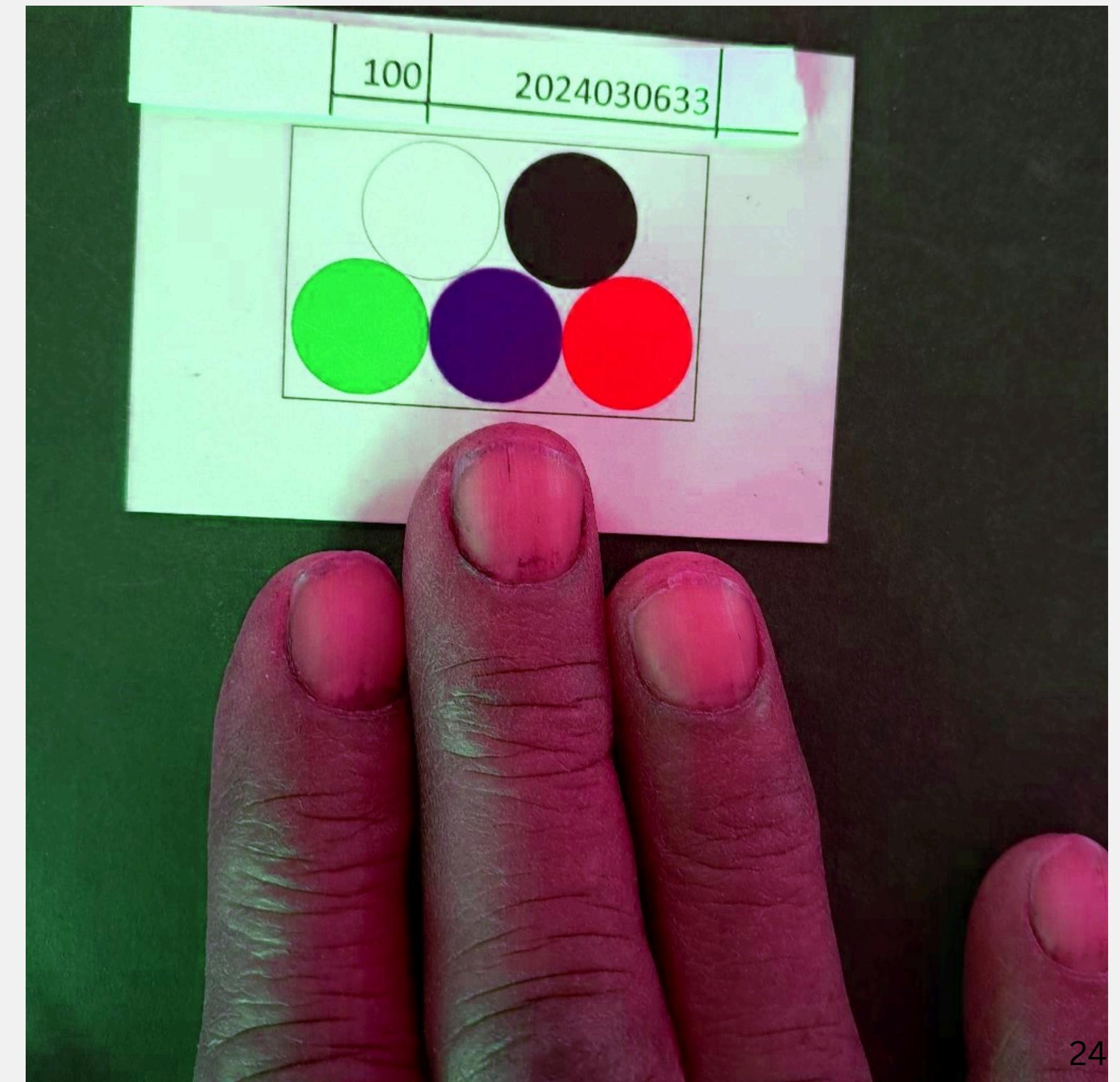
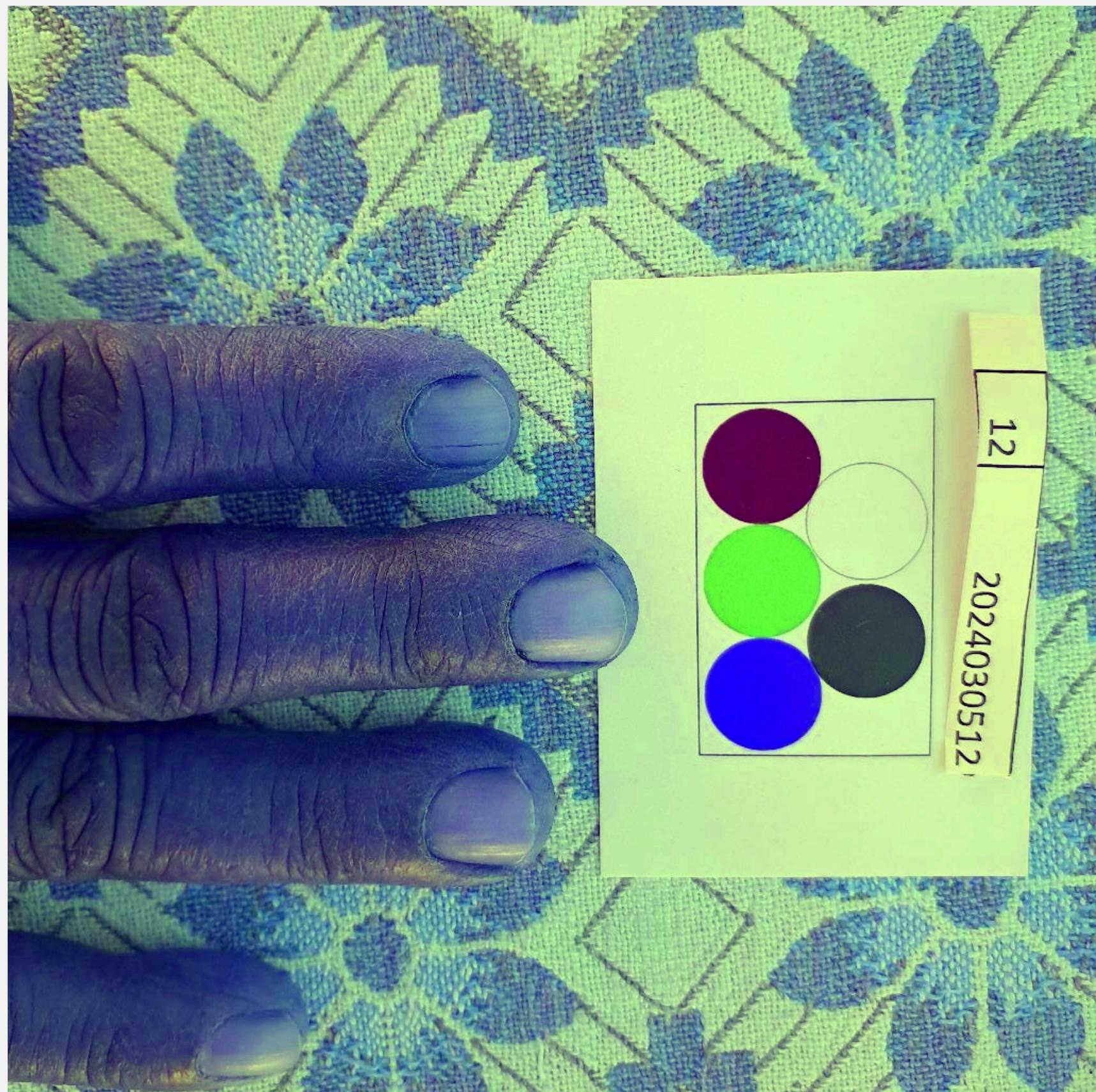
## 2. 3x4 Matrix



# Problems



# Problems



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Thank you