Calibracor: A Novel Free Software for Digital Image Color Calibration

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KEYWORDS

Colorimetry, color control, neural network, image processing, free software

ABSTRACT

This study introduces *Calibracor*, a free web application that identifies the X-Rite Color-Checker in digital images and automates the color calibration process using grayscale samples from the color reference target. The approach adopted in this project is based on segmenting the color chart and then applying image processing, the calibration itself. As a result, *Calibracor* has reduced the average Delta E from 31.4 to 6.5 between the original and the treated images. Emphasizing accessibility, automation and reliability, this research addresses challenges posed by color distortions in digital images and contributes for the improvement of color improvement representation.

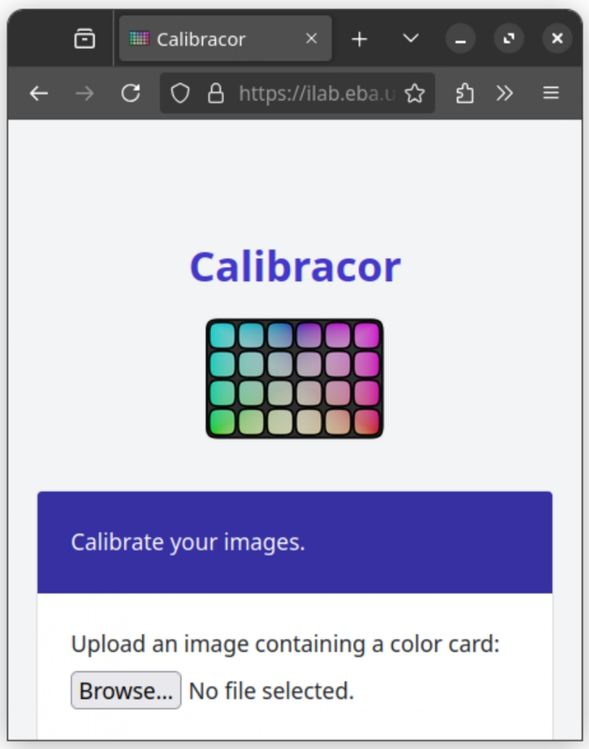


Figure 1: Screenshot of the *Calibracor* web application.

1. INTRODUCTION

The widespread integration of high-resolution cameras in smartphones and advanced computational processing has revolutionized image capture. Some color distortions occur during the capturing and significantly affect the accurate representation of the real colors in critical applications. The color calibration process is often intricate, requiring user expertise and it is used to deal with color distortions that can happen during the capture process, significantly affecting the precise representation of true colors in critical applications. These distortions significantly impact the accurate representation of colors in applications such as fine arts reproduction, restoration process of historical objects and many other purposes (Leão and Westland, 2019).

Calibracor (Figure 1) employs neural networks to identify the position and orientation of a color chart in an image and utilizes its grayscale samples to enable automated calibration. Once the color chart has been identified, the software applies white balance and contrast curve correction operations over the image.

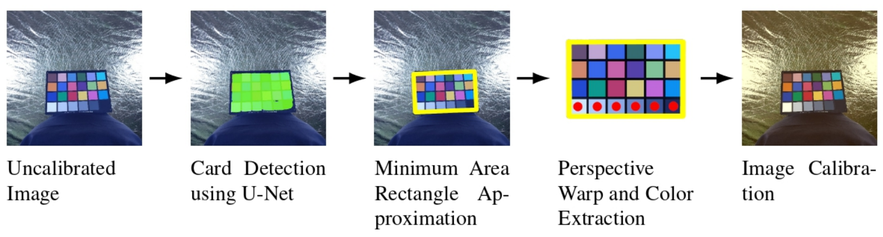


Figure 5: Calibration Process

2. METHOD

The approach adopted in this project is based on segmenting the 24-color ColorChecker chart from X-Rite and then applying image processing, the calibration itself.

For the chart detection a image dataset was created to train a neural network to segment the images. The training dataset consisted of 700 images, each of which was manually annotated, these annotated images were then used to train the U-Net (Ronnemberger et al, 2015).

Color Information Extraction: With a minimum area rectangle detection over the segmented area, the chart is mapped into a template by using perspective warping, exemplified in Figure 2. This template provides known positions for each color sample, enabling the extraction of the data necessary for calibration.

Image Processing: The image calibration process is done with white balance correction and contrast curve adjustment, both based on the grayscale tones present in the color chart. Specifically, white balance correction ensures that neutral tones appear truly neutral by adjusting the colors accordingly while contrast curve adjustment improves the image's exposure and tonal range by optimizing the contrast between light and dark areas.

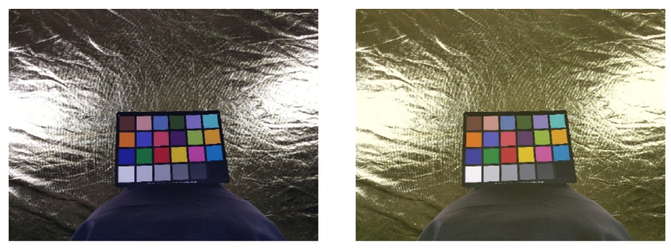
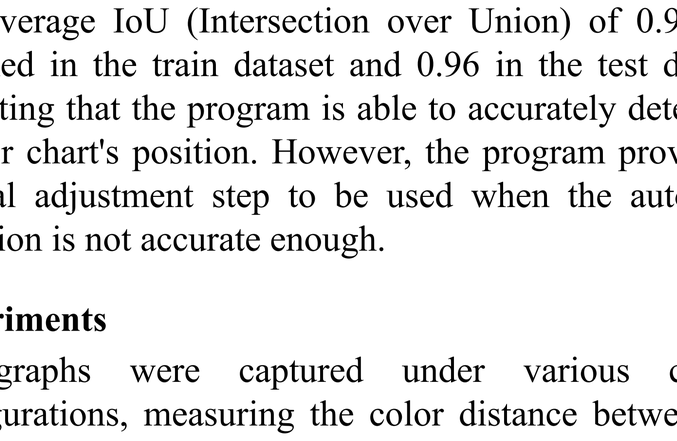


Figure 3: An image before and after calibration.

The average IoU (Intersection over Union) of 0.93 was obtained in the train dataset and 0.96 in the test dataset, indicating that the program is able to accurately determine a color chart's position. However, the program provides a manual adjustment step to be used when the automatic detection is not accurate enough.

Experiments

Photographs were captured under various camera configurations, measuring the color distance between the images and before and after calibration, as showed in the Figure 3. the accuracy of the calibration has been measured by using the ΔE metric, and the Graphic 1 shows some of these results.



Graphic 1: Calibration results

4. CONCLUSIONS

The proposed tool works as a useful tool for interested users, reducing the color distortion in images by a significant amount. This software has been made available as a web application at the address “*https://ilab.eba.ufmg.br/calibracor*”.

5. REFERENCES

Leão, A., and Westland, S. 2019. How Accurate Can Be the Smartphone Camera for Cultural Heritage Color Reproduction with Auto Settings? In Archiving Conference.

Ronneberger, O., Fischer, P., and Brox, T. 2015. U-Net: Convolutional Networks for Biomedical Image Segmentation. In Medical Image Computing and Computer-Assisted Intervention – MICCAI 2015, Springer International Publishing.

A QR code that leads to *ilab.eba.ufmg.br/calibracor*.