

# Background and Literature Review

## 1 Related prior work

Relevant prior work fall into four rough categories. There is a large body of work on the subject of general automatic colour transfer and colour grading by example, transferring the “style” or specific colours in an example image to another image. There have been several prior attempts at transferring specifically images wherein skin colour is prominent, and these we will discuss in detail. There are also several examples of practical application of skin transfer algorithms, where different application demonstrate practical uses of usually relatively simple skin transfer algorithm that is part of a larger project; we will discuss several of these projects. Finally, there is the field of skintone enhancement software, where algorithms are usually intended to adjust the user skin colour towards a more pleasing tone and not to a specific target colour. We include the latter because unlike the other categories of prior work there are several studies of adjusting skintone on a mobile device, which is part of the requirements for this project.

## 2 Colour transfer by example image for general images

Colour transfer refers to modifying the colours of an image to give it the desired appearance and style demonstrated by an example image, which we will refer to as the target image. Figure ?? illustrates an example of this effect.

There have been a wide range of work done in this area beginning with the seminal work of Reinhard et al. in 2001 [1].

While these techniques are interesting possibilities to try when transferring human skin colour, because these prior studies are all concerned with different problems that can arise with general images but not specifically for human skin colour, studies that specifically relate to human skin colour demonstrate that the general colour transfer techniques can be improved upon.

## 3 Transfer of human skin colour

Several studies have been done specifically on the transfer of human skin colour.

Seo et al. [?] has a purpose closest to the purpose of this project, to transfer human skin colours. The authors show results that improve in realistic appearance compared to the Reinhard’s algorithm.

It is not clear how fast the algorithm can run particularly on a mobile device, nor the range of colours that the algorithm can transform a single skin colour, and it is in these areas that our project will attempt to improve upon.

Yang et al. Performed the most recent study

### 3.1 Survey of methods for changing and matching skin colour in Photoshop

There are a wide range of online video tutorials available for adjusting human skin tone in individual images using Photoshop. The purposes of these videos include giving the subject of an image the appearance of a tan, matching the skin tone of the subject to a desired skin tone on another individual, or matching the skin tone of a subject's face to the rest of the subject's body, which is often a slightly different colour [2] [3] [4]. We surveyed a range of these videos and summarize the techniques of the most relevant videos with reasonably realistic results. See Appendix ?? for a more detailed description of three of these Photoshop processes.

#### Summary of Photoshop techniques

Levels and curves are frequently used for small brightness adjustments [5] [4] [3]. For large brightness adjustments, one technique was found (see Appendix ??), where the skin area is brightened in a conversion to black and white, and then the luminosity blend mode is used to place the colour back into the image. Sometimes highlights and shadows are adjusted separately; curves or the "blend if" function (which blends in an effect only if the original pixel is above a certain threshold of brightness) can be used to achieve this effect [2].

There are many different methods to match colour, and the colour can be adjusted separately from the brightness or simultaneously - often one would affect the other [4] [3]. Methods for matching colour include matching the ratios of cyan, magenta and yellow by making adjustments with the selective colour tool, or using curves or levels on individual colour channels. Adjustments are made either by eye or to numerically match a target color [6] [4] [3]. Often to reduce the vividness of the colour adjustments the saturation must be slightly decreased [5] [4].

After all other effects are applied, the opacity of the overall effect is often reduced from 100% for a more natural appearance [5] [4].

#### Limitations of Photoshop techniques

These Photoshop techniques are generally meant to be tailored to each specific image that a human is adjusting. There are many junctures where the specific numerical amount of an adjustment often have to be judged by eye. While Photoshop has a method for automating processes using actions, the processes are meant for increasing ease of use by artists who can make additional adjustments and are familiar with the tool, rather than in commercial applications where the process is entirely automated [7].

Another limitation is that Photoshop operates at a higher level of abstraction than image processing software making use of libraries such as OpenCV. Image processing code has much more control over processes that can be applied to images, and the regions on the image that processes are applied to.

Finally, some Photoshop effects may be proprietary and are of course limited to the platforms that Photoshop supports, while a program developed with a platform such as OpenCV can be made open source and adapted to uses on a variety of different platforms.

## References

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