

An Open Source Photo Mosaic Maker Based on Color Distances

Social risks of Photoshopped Images and How Standards are Made to Mitigate such Risks

A Thesis Prospectus

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

The technical topic focuses on the alternative ways to construct photo mosaics. A photo mosaic is formed by tiling many small images (tiles) to approximate a target image. It is a great way of presenting a collection of images that contribute to a common topic. With the growing popularity of photo-sharing on social media platforms, photo mosaics are more frequently made and becoming more prevalent. A famous example of a photo-mosaic, created as an internet meme, is a picture of Leonardo DiCaprio crying, made as a collage of photos of Oscar winners (Meaker, 2016).

However, existing solutions often require licenses, are time-consuming to use, and often produce unsatisfactory results. To address these problems, I developed an open-source desktop application that can efficiently construct photomosaics. Unlike previous works, my solution provides explicit options to trade-off between the characteristics of the resulting photo-mosaic.

The STS topic concerns the risks of the prevalence of edited photos, which is loosely coupled with the technical topic. With the recent advancements of computer vision and image processing, easy-to-use photo editing tools are also readily available for the general public. Therefore, editing pictures before posting have become increasingly popular in recent years. In this work, the STS topic is centered around the differences in the understanding of social risks by the public and expert communities, and the evolution of risk governance.

Technical Topic

Commonly, photo mosaics are made manually by professionalists using photo editing software such as photoshops. However, it is often tedious work to arrange hundreds or thousands of tiles in a grid to construct a photo mosaic. Therefore, a number of software and websites such as mosaically.com are developed to automate this process. However, they require users to upload tiles to websites, which is time-consuming and has privacy concerns, and they require licenses to use or have limited features for non-premium users. Moreover, they do not arrange the tiles based on the similarity between the colors of the tiles and the target image or cannot use the tile fairly.

To address these issues, I formulate the photo mosaic building process as an optimization problem and develop an open-source application to solve the problem. The objective is to minimize the color disparity between each tile and the chunks of the target image. The objective can be formulated differently depending on whether each tile can be used exactly once or multiple times. If a tile can be used for arbitrary times, then the problem is merely selecting the best tile for each chunk and can be solved easily. If a tile is only allowed to be used exactly once, then a one-to-one correspondence between the tiles and the chunks of the target image needs to be established, provided that the target image is downsampled appropriately so that the number of chunks in the target image is equal to the number of

tiles. This problem is reduced to linear sum assignment in combinatorial optimization and can be solved efficiently using the Jonker-Volgenant algorithm.

To model the color disparity between a tile and a pixel of the target image, Euclidean distances between the weighted average color of the tile and the color of the pixel are used. The color can be represented in different color spaces, such as Red-Green-Blue, Hue-Saturation-Value, and CIELAB color space, providing visually different results. Here, the computation of the weighted average of a tile can be tuned to adjust the importance of the center and the border of the image.

Finally, all of the aforementioned features are implemented in Python and are packaged as a binary file using PyInstaller so it can be used on all major operating systems (Windows, macOS, and Linux) without the need to install a Python interpreter. The source code is licensed under the permissive open source license, MIT License, and is available for public use. The project is near-complete. I implemented most of the core features, but there are also contributions from other programmers who embrace open-source.

STS Topic

On social media platforms and for advertisements, pictures are the primary ways to attract audiences. With the recent advancements of computer vision and image processing, easy-to-use photo editing tools are readily available for the general public. Due to the impressive abilities embedded in these softwares to beautify human portraits and natural sceneries, editing pictures before posting has become increasingly popular in recent years. According to Aspinall (2020), 71% of people will not post photos on social media without editing.

Study of Risks in Expert Communities

However, the risks associated with these edited photos are known to the experts even before easy-to-use editing software is available for the public. In the early 2000s, photo editing softwares required professional skills to master and were usually only employed by celebrities to make perfect body images or cosmetic advertisers to enhance the visual effect of their cosmetic products (Rajanala et al., 2018).

At that time, a number of studies already pointed out the potential risks of these perfect photos. The study by Levine and Murnen (2009) revealed that teenage girls who are the heavy receivers of “mass media”, which they defined to include “TV, children’s book and videos” under the influence of photo editing, are more easily subject to weight and shape concerns in early childhood. Additionally, the study of Shen (2015) referenced the data from the American Academy of Pediatrics, which confirmed a “119% increase in the number of children under age 12 hospitalized due to an eating disorder between 1999 and 2006”.

Moreover, there can also be problems with photoshopped pictures of sceneries not including humans. The author of the book “Against Happiness: In Praise of Melancholy”, said, citing the Grand Canyon as an example, that “people expect to witness static shots of the photoshopped globe...many tourists come away from the actual canyon disappointed. The real canyon didn’t quite measure up to their internal portrait” (Wilson, 2008). Indeed, a lot of times people just expect nature to match the potentially overly filtered and beautified images on the internet and social media platforms, causing them to end up in disappointment.

The Divergence between Public and Expert Understanding or Risks

Despite the risks of photo editing being extensively studied, the knowledge of these risks seems to be scoped in the expert communities and did not diffuse to the public. Although no direct surveys have been done to study the public’s perception of risks of extensive use of photo editing, there are related studies showing people’s underestimation of risks when pursuing unnecessary strict diets or cosmetic surgeries, encouraged by the prevailing beauty standards spread by perfected body images. For instance, a case study of participants of a plastic surgery procedure that has the highest fatality rate among women, “Brazilian butt lift”, showed that “even the most effective informed consent process (that shows the risks of the procedure)” cannot stop the motivated patients (Fadavi et al., 2020).

Therefore, the divergence between the public and expert understanding of risks combined with the fast increase in photo capturing and processing power of smartphones catalyzed the emergence of successful photo editing softwares such as Facetune, which are well-received by the public. The app has 60 million downloads and brought the company that made Facetune, Lightricks, \$50 million revenue in 2018 (Halon, 2019). The popularity of unrealistic beauty standards such as thin bodies causes further troubles. Young women in China got themselves into eating disorders because of their pursuit of thin bodies, which is popular on Chinese social media platforms (Zhou, 2021).

Risk Governance: A coproduction process

Citing the risks of photo editing, the American Medical Association adopted a policy that discourages the use of photoshop that can “promote unrealistic expectations of appropriate body image” in 2011. Despite the policy in place, the industry did not respond after the 2 year period. In 2013, however, Verily magazine became the first to realize the importance of being photoshop-free and enforced a strict no-photoshop policy (2013). Soon after, Aerie, a women’s underwear company under the American Eagle brand, initiated a campaign named Aerie real and pledged to be photoshop-free (Yi, 2017).

Not only did these movements result in commercial success reflected by a significant increase in readership and sales (Yi, 2017), they also got the legislature's attention. In 2014, a bill was introduced to direct “Federal Trade Commission (FTC) to submit a report to Congress assessing the prevalence, in advertisements and other media for the promotion

of commercial products and services in the United States, of images that have been altered to materially change the appearance and physical characteristics of the faces and bodies of the individuals depicted” (Horwath, 2019). This was viewed as the preliminary step to regulate the use of photoshop in commercial advertisements.

Next Steps

Technical topic: The technical project is mostly done, but some additional features can be included to improve user and development experience

1. Incorporate optional transparency blending used as in existing approaches to enhance the overall effect.
2. Develop an approximate match algorithm to speed up photo mosaic construction for large/fine-grained images
3. Add continuous integration support to replace manual building so the latest application is always available to download for all major operating systems.

STS topic:

1. Review the negotiation process (if any) between the public and legislators during the coproduction of standards/governing policies.
2. Research on the standards on social media platforms. The current sources mainly concern the use of photo editing in commercial advertisements, not on social media platforms.
3. Research for more quantitative evidence on the social risk of photoshopped images.

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