Bilkent University

Department of Computer Engineering

Senior Design Project

The Aura Palette

Project Specification Report

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1. Introduction

Colors subconsciously play an essential role in people's lives. According to research conducted by Jonauskaite et al., colors can be associated with specific emotions and moods [1]. For example, in their study, research subjects associated the color red with fury or love, and white with relief and peacefulness. Similar studies in color psychology indicate that people associate the colors they observe with emotions such as joy, sadness, anger, disgust, love, fear, and many more. Hence, color psychology and color harmony are crucial concepts in the design and marketing industry, and choosing the color palette for a design is a critical step in the design process.

An example case is when people think of Valentine’s Day, a day associated with love, the colors that most people will think of are shades of red and pink and purchase gifts that are in these colors. Because of these associations, designers need to consider what colors to use in their designs to reach their audience. These designs include but are not limited to movie posters, commercials, the interior design of a room, and the user interface design of a webpage. In each of these mediums, people who will view the designs will subconsciously have bias depending on the color. Thus, choosing which color palette to use is a significant subject in the design process that can affect many people.

The Aura Palette, the project we will be working on, will focus on the issue of choosing a color palette by using the technology of machine learning. With this project, we aim to assist designers and any creative person in determining a palette for their creations by providing them with a tool. With this tool, the goal is to return a color palette recommendation to the requester depending on the keyword provided by them.

In this report, the description of Aura Palette, constraints of the application, certain ethical issues, and requirements will be discussed.

1.1 Description

The Aura Palette aims to be a tool for designers by assisting them with choosing a color palette to use in their creative works. Our application will have several beneficial features for users. They will be allowed to type one or multiple keywords and choose parameters such as the medium of the design. The application will return a color palette according to the given

keywords and limitations, and the user will be able to adjust the resulting palette. These key features will be essential to ensure that designers receive an accurate palette according to their needs and still have the flexibility to modify the colors to obtain the perfect palette for their projects. To ensure a satisfying user experience, we will match the given keywords and colors by using machine learning algorithms.

As aforementioned, the users will be allowed to use the provided color codes in the palette directly or modify the colors. These modifications include changing from RGB to CMYK if the medium of the creation is changed from digital to print, adjusting hue-saturation-brightness values, and choosing the color harmony applied to the palette. These customizations aim to provide freedom to the designers. The designers can also give certain constraints to the application by providing a color bias or excluding a color from the color palette. Another feature they will have access to is the regeneration of the palette to obtain a different palette. That is because some keywords can match multiple colors.

Within this project, we plan to tackle the engineering challenges ahead of us and provide process and product performances as our innovative solutions to the design field. There are already existing websites for generating or modifying color palettes in the market; however, we will introduce a new way of doing this. The process of color palette generation will be much different than the ones in the market. It will be much faster, and more accurate while offering more ways to obtain the desired palette. Our innovative works will provide incremental features to the generation of the color palette. Thanks to our intense research on academic studies of color theory, our product will be able to conduct a successful optimization on parameters we use on generation algorithms and create professional-grade color palettes. In addition to the quality of our algorithms, we will provide new features and ways to generate a color palette. This way, we aim to transform the color palette generation more efficiently. Currently, there are no products that generate palettes according to a keyword and allow users to make modifications depending on their medium and desired color values. This also means that we will have a better product performance in terms of speed and flexibility.

1.2 Constraints

1.2.1 Implementation and Manufacturing Constraints

- The Aura Palette will be a web-based application that can be accessed by any modern browser.
- Git and GitHub will be utilized for version control during development.
- React and Typescript will be used for front-end development. MaterialUI, TailwindCSS, and styled-components will also be utilized.
- Spectrum Web Components API [2] will be used to add the modification functionality to the palettes.
- For creating and training models, PyTorch [3] will be used.
- For the back-end development, a Python high-level web framework, Django [4], will be utilized.
- The current information regarding the datasets to be used is discussed in the Ongoing Discussions section of this report along with the implementation scenarios.
- New datasets can be added to the application even after release, to generate more new and unique color palettes.
- The words that will be used for color palette generation will only be in English to limit the dataset.

1.2.2 Economy Constraints

- The tech stack, libraries, and datasets we will be working with are free.

1.2.3 Social and Ethical Constraints

- The application will not track or store the keywords or the generated color palettes, and not use them for any purpose other than processing for color palette generation.
- The application will limit the words that can be written and filter the curse and slang words.

1.2.4 Security Constraints

- The collected information and data will not be stored or shared with any third parties.
- Every downloading procedure from the system must proceed in a secure way that prevents attackers from intercepting the procedure and having the opportunity to harm the user's system by downloading malware instead of our color palettes.

1.3 Professional and Ethical Issues

During the research of the project and in meetings regarding development, several ethical issues came to our concern. One of these involves filtering keywords and what to do when the user enters swear words, and derogatory or unethical terms that promote racism, sexism, xenophobia, homophobia, and other issues. These keywords will be filtered out and will not return any output. The application will not promote any kind of harmful stereotype. Another ethical concern that the users can have is whether the keywords will be collected by the developers or not. The keywords and parameters provided by the users will not be collected to assist the user's privacy concerns. The last issue to consider is what to do when certain colors have different effects on different cultures. However, according to research, this case is different: The match between colors and emotions is not affected by culture, but only whether these colors are appreciated or not was affected [5]. As couples of color and emotion are not affected directly by culture, this ethical concern does not require the tool to gather specific information about the user's culture or consider an additional parameter on culture.

As for the professional issues, we must follow a level of quality during the implementation of the algorithms. We must use specific inputs and expect specific outputs which must be correlated to our research on color theory. Other than the color theory, these algorithms must produce color palettes that are ready to use in professional work. Also, fine-tuning features on color palettes mustn't decrease this professional-grade quality. To ensure these requirements, we will peer-review our work and make sure that every part of the algorithm works properly and that the next part is ready for development.

2. Requirements

2.1 Functional Requirements

2.1.1 System Functionalities

- The system must provide users with different predetermined emotions to create a related color pattern.
- The system should enable users to enter a word or sentence which will be used for palette generation.

- The system will analyze the sentence and the algorithm will generate five colors according to the context of the words.
- The system should introduce color palettes and their values such as HEX or RGB codes, according to a given sentence or emotion.
- The system should provide a “properties screen” for each palette to change the specific color properties (hue, saturation, and lightness) manually to the user, which will give more flexibility to developers and designers.

2.1.2 User Functionalities

- Users will access the system through a website available to the public.
- Users can select whether the system should generate a color palette for the mode from scratch or according to a given limitation: to include or exclude a certain color and a specified medium (prints, webpage, poster, etc.).
- Users will be able to pin the color palettes that they liked so that they will not disappear once they generate another one.

2.2 Non-Functional Requirements

2.2.1 Usability

- The system must provide a simple and understandable design that prevents users from being confused and losing time while navigating.
- The system must guide the users via an efficient tutorial mechanism to what they should and can do with it since its aim is to make the users find their way in it intuitively.

2.2.2 Reliability

- The algorithms behind the color palette generation should work consistently. Generated palettes must be correlated to what users ask.
- The palettes that are generated by the system must fit the color theory studies we will use in our research and implementations.

2.2.3 Efficiency

- The system must process the user inputs through our mechanism to understand the input and color theory algorithms in no more than 10 seconds since one of the main purposes of our project is to decrease the time spent on creating color palettes.
- Optimization of the application is critical. Currently, with most AI-generated image creation applications, the creation process takes longer than our planned time.

2.2.4 Extensibility

- The system should be extended to give more palettes with more words and sentences. The project should work with not only emotional words but also sentences with more keywords from general topics after some while.
- In addition to creating palettes from scratch, the system should also be extended to give more colors according to the colors that the user entered.
- In the future, users may be able to create a palette for their type or medium of work, such as magazines, posters, or websites. In this way, we can adjust color settings in the best way for their type of work.
- In the future, login and sign-up mechanisms can be implemented for users to store their previously generated color palettes.

3. Ongoing Discussions

- As one of the possible solutions - the project can be implemented with the help of Pixabay, a website with millions of images. Based on the user's input request, Pixabay will return images, and our neural network will analyze these images and learn to generate new color palettes. Other stock photo browsers are also possible but Pixabay can be chosen due to economic constraints. Unlike Google Images, Pixabay and other image browsers tend to have more accurate results: As an example in the case of Google Images, when a user enters the keyword "sadness" one of the results tends to be a bright yellow emoji sad face in which the main color is yellow. According to research yellow is a color that is mainly matched with happiness [5]. This situation can lead to contradictory results. While the same error can occur with stock photo browsers, the initial research showed that the possibility is lower.
- With the use of tools similar to DALL-e [6] that generate an AI-driven image with the given user input, it is possible to extract the palette from the AI-created image using

Pigmnts, an npm library built using Rust. However, a negative aspect of this solution is that it will not be time-wise optimized.

- The third approach is to initially have a limited set of available keywords that users are allowed to input. Thus, the program would have the access to the base color and can generate full palettes according to it faster. The dataset will be created by the members of this project group according to Color Theory Academic Research Papers.

4. References

[1] D. Jonauskaite, C.A. Parraga, M. Quiblier, C. Mohr. “Feeling Blue or Seeing Red? Similar Patterns of Emotion Associations With Color Patches and Color Terms.” *i-Perception,* vol. 11, no. 1, Jan. 2020.

[2] Spectrum Web Components, [Accessed 15/10/2022]. https://opensource.adobe.com/spectrum-web-components/index.html

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[5] L.-C. Ou, “Color emotion and color harmony,” in Handbook of Color Psychology, A. J. Elliot, M. D. Fairchild, and A. Franklin, Eds. Cambridge: Cambridge University Press, 2015, pp. 401–418.

[6] DALL-E, https://openai.com/dall-e-2 [Accessed 15/10/2022].