VISUALYRE: Multimodal visualization of lyrics

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ABSTRACT

In this paper, we present Visualyre, a web application that synthesizes images based on the semantics of the lyrics, and the mood of the music. We use a multimodal approach, generating initial images with a text-to-image generative models from the lyrics (text) of a song, followed by a style transfer model conditioned to the mood of the music (audio). Our target user base is the independent music artist community, by providing a means for composers and songwriters to generate suitable images for their music (such as album covers). We discuss the possible usage of such application, as well as the possible improvements in future iterations.

CCS CONCEPTS

• **Human-centered computing** → *Graphical user interfaces; Web-based interaction*; • **Computing methodologies** → *Neural networks*; • **Applied computing** → *Sound and music computing*.

KEYWORDS

deep learning, image generation, style transfer, lyrics, mood detection

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1 INTRODUCTION

Since the development of Generative Adversarial Networks (GANs) in Computer Vision in 2014, deep learning-based image generation techniques have been increasingly popular [8]. In this paper, we propose one practical application of text-to-image GAN models: album art generation from music and lyrics. Album art has often accompanied commercial music as an accompanying abstract, yet crossmodally coherent visual representation [2]. However, such

artwork may not be easily obtainable, especially for independent musicians who lack the financial means or artistic resources to create it themselves. As such, we propose that GANs, despite their limits on semantic representation, may provide a possible solution. By generating images based on the lyrics of a given song, GANs can capture some extent of the semantic relationships that exists in a particular song.

GAN models are composed of two neural networks, a generator that tries to replicate real images from a dataset, and a discriminator that distinguishes real images from replicates. The training of the model converges when the discriminator is unable to distinguish real images from replicates created by the generator.

One particularly interesting application of these networks has been in the area of visual art, for example, Elgammal et al. [4] utilized GANs to generate art based on the Wikiart dataset, spanning paintings from the 1400s to the 2000s. Participants in the follow-up experiment rated the generated images as more inspiring, and aesthetically pleasing than (human-painted) contemporary art.

However, GAN-synthesised images are often visually indeterminate [9]; for our goal of generating album art, they may not be good enough to adequately represent the meanings or emotions conveyed on a given song. As such, we also propose the addition of a second module in our architecture, the usage of audio analysis to determine the mood of a song to consequently fine-tune the synthesized images using Style Transfer [6]. Style Transfer is a deep-learning based method that combines the neural representations of two images, resulting in a third image that is a blended mix of the two constituent images. We first collect a set of ‘emotional’ images that correspond to each different mood categories classified by the audio analysis models. Next, based on the mood classification of the song, we merge the GAN-synthesized image with a corresponding ‘emotional’ image through style transfer. We think that by employing a multimodal approach that uses both lyrics and audio is a better way to create images that are close to the vision that the author had in mind for an album art, than generating images based solely on the lyrics as we are augmenting the images with additional information not present in the lyrics.

In sum, we develop **Visualyre**, a web application that generates images for musicians to use as an album art. Our proposed model architecture for Visualyre consists of three core modules used in sequence. First, a GAN synthesizes images based on the lyrics (lyrical) of a song. Followed by an audio analyzer that classifies the mood of the song from audio features. Finally, a style-transfer module augments these images by combining them with priorly selected

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images that matches the (musical) mood of the song. We hope that this provides a reliable means for musicians to generate album art, particularly for musicians who may not have the means to obtain one otherwise.

2 RELATED WORK

There has been previous interest in methods of visualizing music. One approach is the visualization through musical moods. Laurier et al. [12] designed an application that visualizes moods probabilities in real-time, displaying the probability of each mood during a specific time frame using bar charts. Husain et al. [11] followed the same approach, designing visual textures based on the relationship between moods and different visual elements, such as color and shapes.

Another approach is the visualization from lyrics. Funasawa et al. [5] created a system to identify keywords within each line, and used image retrieval to form a slideshow that displays images corresponding to words in each line of lyrics.

Visuallyre adopts both approaches in a multimodal fashion. The lyrics are visualized line-by-line, but rather than using keywords to retrieve existing images, it uses image generation to synthesize new images using each sentence as an input. The moods extracted from the audio are visualized via Style Transfer, using pictures related to each mood as texture images, generating images suitable for use as album art.

3 SYSTEM DESCRIPTION

Visuallyre aims to support independent musicians by generating an album artwork according to the semantics and emotional moods of the input song. Particularly, this system uses the lyrics (text) and music (audio) of the song as features for the generation of the image. To fine-tune and adjust the generated images, Visuallyre employs Style Transfer, achieving a similar effect to image filters available in smartphone camera applications.

Multiple modules are needed to create representative images of a particular pair of audio files and lyrics. The modules of Visuallyre include a text-to-image generation model to synthesize images from lyrics, an audio analyzer to evaluate the moods of a song file from its audio features, and a style transfer model to adapt an image to a particular mood. The system architecture is shown in Figure 1.

3.1 Image generation

Images generated by a text-based image generation model are conditioned to features extracted from an input sentence with a text-encoder. Multiple approaches have been proposed over the years, such as using a stacked approach to refine the images [19], employing attention to synthesize fine-grained details [18], and inferring semantic information to guide the generation [10].

DM-GAN [20] makes use of dynamic memory to refine the content of the synthesized images, even if the quality of the previous images is not good. This generative model is trained using the MS COCO Dataset [15], which contains a total of 123,287 images (82,783 for training and 40,504 for validation) with five captions per image.

Visuallyre uses DM-GAN to visualize the lyrics, generating an image for each sentence in the input lyrics.

3.2 Audio Analysis

Listening to music encompasses perceiving emotionality [13]. Therefore, it is essential to understand the emotions portrayed by the artist in their songs in order to generate a representative album art.

We utilize binary classifiers for four different emotions to capture the mood present in musical pieces. These classifiers are trained to detect anger, happiness, sadness, and relaxation by using the musical features extracted from the audio signal of a song. They were introduced by Laurier et al. [16] initially using Support Vector Machines, and were recently ported to deep convolutional neural networks by the Music Technology Group [1].

For our model, we normalized the positive label of these classifiers and applied them towards the enhancement of the generated images (see section on Style Transfer), to give them an artistic feel.

3.3 Style Transfer

Style transfer is the process of changing the style of an image to match the style of another image, while still preserving its original content [17]. In previous research, models were restricted to only change the style of a specific image, as these models had a different trained model for each style image [6, 14]. Ghaidi et al. [7] introduced a style prediction network that can predict the style embeddings from an arbitrary style image, effectively enabling stylization using any pair of content and style images. Their network is trained using content images from the ImageNet¹ dataset and the Kaggle Painter By Numbers (PBN)², a dataset consisting of 79,433 paintings.

3.3.1 Style Sampling. For Visuallyre, we prepared a small dataset, Style Bank: A collection of style images based on the four different moods of the binary classifiers used in the audio analysis (anger, happiness, sadness, and relaxation). We chose images from Unsplash³ by using search queries related to the target four moods, such as 'fury,' 'joy,' 'calm,' and 'sorrow.' Our intention is to use style-transfer to combine these 'mood' images with the images generated by the GAN model. To determine which 'mood' image should be combined with the GAN generated image, we rely on the mood classification scores from the audio analysis. We first normalized these scores computed at an earlier step, to obtain an audio-based Mood Probability, assigning a probability to each mood based on the score of the classifiers. The higher the score the most likely that a mood will be sampled for style transfer. After selecting a mood, we select an image representative of the chosen mood as the style image from the Style Bank.

We sample eight different style images, applying Style Transfer to a synthesized image previously selected by the user. Together with the original synthesized image we show the user a total of nine different images to choose from.

3.4 Graphical User Interface

Visuallyre synthesizes an album art in a sequential manner, involving the usage of different modules. To make this process as seamless and dynamic as possible for the end user, we opted for a responsive

¹<https://www.image-net.org/>

²<https://www.kaggle.com/c/painter-by-numbers>

³<https://unsplash.com/>

Figure 1: System Architecture: Lyrics are used to synthesize images with a text-based image generator. The audio file is analyzed to evaluate the presence of four different moods. This evaluation is used to sample which style images are used in Style Transfer.

layout and a minimalist design, showing the components only as they are needed. Figure 2 shows the graphical user interface of Visualyre and its different components.

- **Song input:** a form where users add lyrics and upload an audio file.
- **Navigation menu:** buttons that enable travel to the next step or to the previous one. An additional button indicates if the system has finished analyzing the moods from the submitted audio file.
- **Progress tracker:** allows users to check their current step at any time. The name of each step provides a subtle description on the desired action during a specific step.
- **Image selection:** a grid where users can select or hover over generated or stylized images. Multiple images are displayed simultaneously, using pagination to display further images when necessary. To advance to the style selection, a user must select a synthesized image. Similarly, a selection of a stylized image is required to download an image.
- **Lyrics display:** a container where users view the input lyrics during the selection of synthesized images. When an image is hovered or selected, the system displays a fragment of the lyrics, highlighting the sentence used to generate each synthesized image.

It is worth noting that the entire process occurs on the same page without reloading or redirecting to another URL. The UI components and their respective content change reactively according to the user's interaction with the Visualyre.

4 SYSTEM INTERACTION

The procedure of how to use Visualyre from start to finish is described as follows:

- (1) The user clicks **START HERE** on the home screen and is redirected to the song input form.
- (2) The user inputs the lyrics in the text field and uploads an audio file. The **CONTINUE** button is then enabled.
- (3) The user clicks **CONTINUE** and is redirected to the image selection. In the background, the generator starts generating images from the lyrics while the audio analyzer starts to evaluate the moods from the audio file.
- (4) The images are generated and they are shown in a grid-like fashion.
- (5) The audio analyzer finishes evaluating the moods from the input file. The top left button in the navigation changes to **READY** indicating that the mood detection of the audio file has finished.
- (6) The user selects a synthesized image. The mood detection has already finished and the **CONTINUE** button is enabled.
- (7) The user clicks **CONTINUE** and is redirected to the style selection.
- (8) Style transfer is applied to the synthesized image by sampling style images conditioned to the results of the mood detection from the audio file.
- (9) The stylized images are created and they are shown in a grid-like fashion.

Figure 2: Graphical User Interface of Visualyre and its components. This figure shows the selection of a synthesised image from the image generator prior to applying style transfer.

- (10) The user selects a stylized image, the image is shown on the left with a **DOWNLOAD** button.
- (11) The user proceeds click **DOWNLOAD**, acquiring their desired stylized image.

5 DISCUSSION AND FUTURE DIRECTIONS

In this paper, we propose a novel application of text-to-image computational techniques in the form of Visualyre, an approach for lyric visualization that combines two modules (text-based image generation via DM-GAN and style transfer) to sequentially generate images based on lyric segments and the overall mood of the songs. Combined with the in-built possibility for user selection and input, we think that this method allows for the generation of a final image that can capture some aspect of semantic meaning or mood from a song. However, more detailed user experience (UX) research is needed to quantitatively and qualitatively determine the usefulness of this application for the indie music community.

Moving forward, we consider some areas where Visualyre can be improved on. Firstly, our GAN module is currently generating images to every line in the lyrics. Some of these lines may be too short or contain only abstract concepts, which are very difficult for the image generation model to synthesize. As such, one improvement could be to generate images only when the line contains at least one word with a concrete meaning. Secondly, Visualyre only supports lyrics written in English. Another improvement is adding multilingual support for the application, perhaps by training GAN

models with multilingual datasets, or by adding machine translation capabilities within Visualyre's architecture. Finally, we note that the downloadable images have low resolution. We plan to use Super Resolution models [3] to enable high-resolution download in future iterations.

With Visualyre, one of our goals is to bring a modest contribution to the independent music community, by generating artwork to match the musical and artistic intentions of the artists. In the future, we will explore other possible applications, such as allowing users to browse music through synthesized images.

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