Photographic Mosaic

Isabell Jansson, Ronja Grosz

1 Introduction

Photographic mosaic is a popular technical method that creates an image out of smaller images. When viewing the image at low magnification the smaller images can be seen, but when viewing the image at a distance, the motive of the image is seen clearly.

This project is about creating a photographic mosaic in matlab using three different methods. With an image database an original image is made using a S-CIELab comparison, a CIELab comparison and a CIELab comparison with error diffusion.

2 Method

In this project, three approaches have been analyzed and the image quality for the results have been compared through S-CIELab. S-CIELab is metric based approach to measure the visibility of the distortion in the reproduction compared to the original. All approaches are described below.

2.1 Approach 1 - S-CIELab comparison

The database images are stored together with their corresponding images in the CIEXYZ color space. They are also scaled down and cropped to equal sizes. Since an image in the database will represent a patch in the resulting image, the size has to be further studied in order to find a convenient patch size. This will be analysed further on in the report.

In this approach, patches are selected from the original image, converted to CIEXYZ color space, and compared with the database images in the CIEXYZ color space. The comparisons are done with S-CIELab which makes this algorithm very slow. The selected patches from the original image have to have equal sizes as the database images.

2.2 Approach 2 - CIELab

As in the first method, the database images are scaled down and cropped. The mean XYZ value for each scaled and cropped database image is saved as CIELab along with the RGB version of the scaled and cropped image. The processed RGB database images are later used to create the new photographic mosaic image.

The original image, that is the motive for the photographic mosaic, is scaled down. Each pixel in the original image is compared to the mean XYZ value for every database image. The comparison is made in the CIELab space where the euclidean distance between the pixel and the mean XYZ value is calculated (both converted to CIELab). The pixel in the original image will be replaced with the RGB database image that has the shortest euclidean distance to the pixel in the CIELab color space.

2.3 Approach 3 - CIELab with error diffusion

This approach is an improvement of the previous approach. When a pixel in the down sampled images has been matched to a database image, it will result in a difference between the original image and the result image. To compensate for this error, error diffusion is used. Since the original image has three channels, error diffusion has to be applied in all channels separately. This is done by computing the difference between the XYZ values for the pixel and the mean XYZ values for the patch. This error is spread to adjacent pixels that have not yet been processed. The adjacently pixels are now compensated for the error and the patch closest to the new pixel value will be chosen. The comparison is made in the CIELab color space as for the previous approach, choosing the image with the closed euclidean distance in the CIELab color space.

2.4 Quality metric

These three approaches are compared through a quality measurement based on the difference between each image and the images they are based on using the S-CIELab model. This quality metric is made through calculating the S-CIELab values for the photo mosaiced image with the sampled original image and the sample per degree from Equation 1, where *ppi* is calculated through Equation 2 for viewing the images on a projector on the distance 4 metres. Since the images contain of smaller images, every patch can be seen as a pixel. The mean value of the S-CIELab values are then a measurement of the quality of the photo mosaiced image depending on the pixel per inch and the viewing distance from the image.

$$SamplePerDegree = ppi * d * tan(\frac{\pi}{180}) \tag{1}$$

$$ppi = \frac{d_p}{d_i} \tag{2}$$

3 Result

The result is three photo mosaiced images made with the three different methods, Apporach 1 in Figure 1, Apporach 2 in Figure 2 and Apporach 3 in Figure 3. The resulting quality measurements with S-CIELAb can be seen in Table 1. The calculations were based on the resolution for a projector with screen resolution 1020x720 and diagonal size 72 inches. The images were assumed to be viewed at a distance of four metres.

S-CIELab	ΔE	ΔE + Error Diff.
3.2547	3.8157	3.6876

Table 1. Quality measurement with S-CIELab for all three approaches

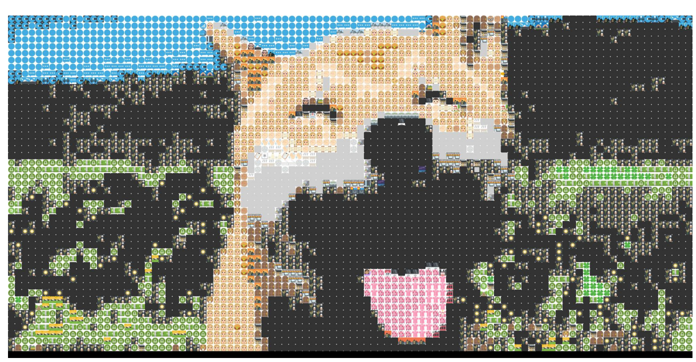

Fig. 1. Result from Approach 1

• *Isabell Jansson, isaja187, Ronja Grosz, rongr946.*

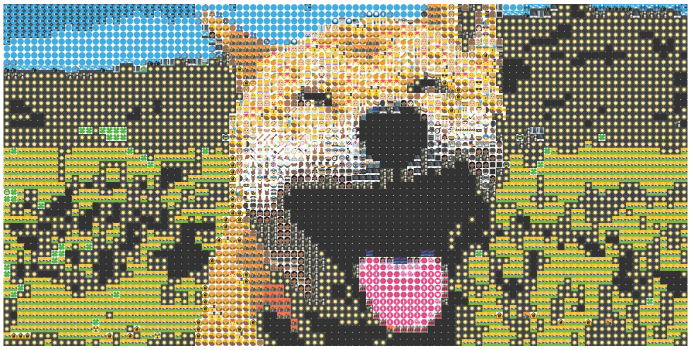

Fig. 2. Result from Approach 2

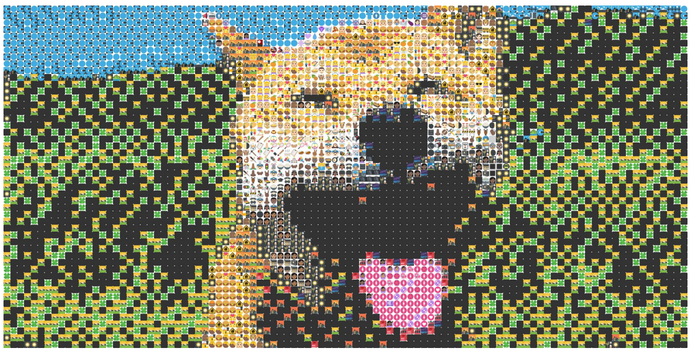

Fig. 3. Result from Approach 3

4 Discussion

The first method was very time consuming because it had to compare a patch from the original image with the images in the database through S-CIELab measurements. This makes it a very computationally heavy method and therefore it takes more time than the other methods.

4.1 Quality

The result of the quality measurement depends on which distance from the image you will view it from and the resolution of the image. For example if you are viewing a photo mosaic at a close distance it will not resemblance the original motive much. But if you are viewing the photo mosaic at a distance, where you cannot distinguish the images it consists of, the photo mosaic will look more like the original motive. Therefore it is important to know at which distance and with what resolution and size the photo mosaic will be looked at to get a usable quality measurement.

The quality of the photo mosaic also depends on the color representation of the image database. If the original image contains a lot of green and the database contains no green images, the photo mosaic will not resemble to the original color wise. Therefore it is important to have a database that has a wide color spread. An improvement for this project would be to pick out images from the database that best represents the original image and only use these for the photo mosaic. This could make the computations faster.

4.2 Choosing patch size and downsampling scale

The original image is downsampled to 5 % of the original image. Since every pixel is replaced with an image from the database, the more the original is downsampled, the smaller the resulting image will be. If the original image is more downsampled, the quality will be worse. But if the original image is less downsampled, the runtime will increase. Downsampling to 5% is a good compromise of quality and runtime.

The patch size will also affect the size of the result image. By choosing a bigger patch size the database images appear more clearly and the mosaic effect will be more distinct. But a smaller patch size is more similar to the original pixel and the result will look more like the original (the patch will look more like some colors than an image). Since the aim of the project is to reconstruct an image out of smaller images, it was important that the smaller images are clearly visible and the patch size was chosen to be at least 20x20 pixels. By using a patch size of 20x20 and a downsampling scale to 5%, the original image and the result image have equal sizes. It has also been tested to use a downsampling scale of 10% of the original image. This results in a bigger image than the original, but the quality is higher since the amount of pixels that are matched to a patch in the database has increased. This image can be found in the Appendix.

5 Conclusions

The conclusion is that the first method resulted in a better photo mosaic image according to the quality measurement. This method maintains details from the original better since compares a patch in the original image instead of a pixel. The first image is blurred compared with the other images, which can lead to a lower S-CIELab value. S-CIELab is sensitive to sharp edges. Error Diffusion improves the result, homogeneus areas are better represented with this method. It also reproduce detail better than the second image.

6 Future work

The runtime for the first approach could be decreased by selecting a smaller set of images from the database that represent the image gamut. The result could also be improved by a light compensation in the CIELab color space.