CS 191 Independent Component Analysis (Image) Exercise Report

Submitted by
Femo Bayani and Mikaela Ramos

INTRODUCTION

Independent Component Analysis (ICA)

Independent component analysis (ICA) is a recently developed method in which the goal is to find a linear representation of non-Gaussian data so that the components are statistically independent, or as independent as possible. Such a representation seems to capture the essential structure of the data in many applications, including feature extraction and signal separation [1].

IMPLEMENTATION

Data Preparation

We chose two similar images:

Image A	Image B

These images are sized at 500 x 800 pixels and are stored as JPEG files.

Preprocessing

These images are first gray-scaled, then mixed into one "noisy" image with varying alpha (transparency) values for each image. A total of 9 transparencies were applied, starting from 0.1 to 0.9. This results in 9 different mixed images with varying transparencies used for each image (0.1 and 0.9, 0.2 and 0.8, and so on).

Additionally, these 9 images are flattened from a 2D representation into a 1D representation before being added to the list.

Independent Component Analysis

The implementation used for ICA is the FastICA class from the scikit-learn Python package. The list of the 9 flatted mixed images are fitted into the ICA:

```python
ica = FastICA(n_components=2)
ica.fit(noisy_imgs)
```

Afterwards, the restored images are obtained:

```python
restored_imgs = ica.inverse_transform(ica.transform(noisy_imgs))
```

Then, the transformed image with the middle-most alpha value (in this case, 0.5 alpha) is taken, and placed side-by-side with a negative version of it

```python
restored_img = restored_imgs[len(restored_imgs) // 2]

restored_img = np.array(restored_img).clip(0, 1).reshape((img_height, img_width))
restored_img = np.hstack(
    (restored_img, np.ones([img_height, img_width]) - restored_img)
)
```

RESULTS

This results in this image:
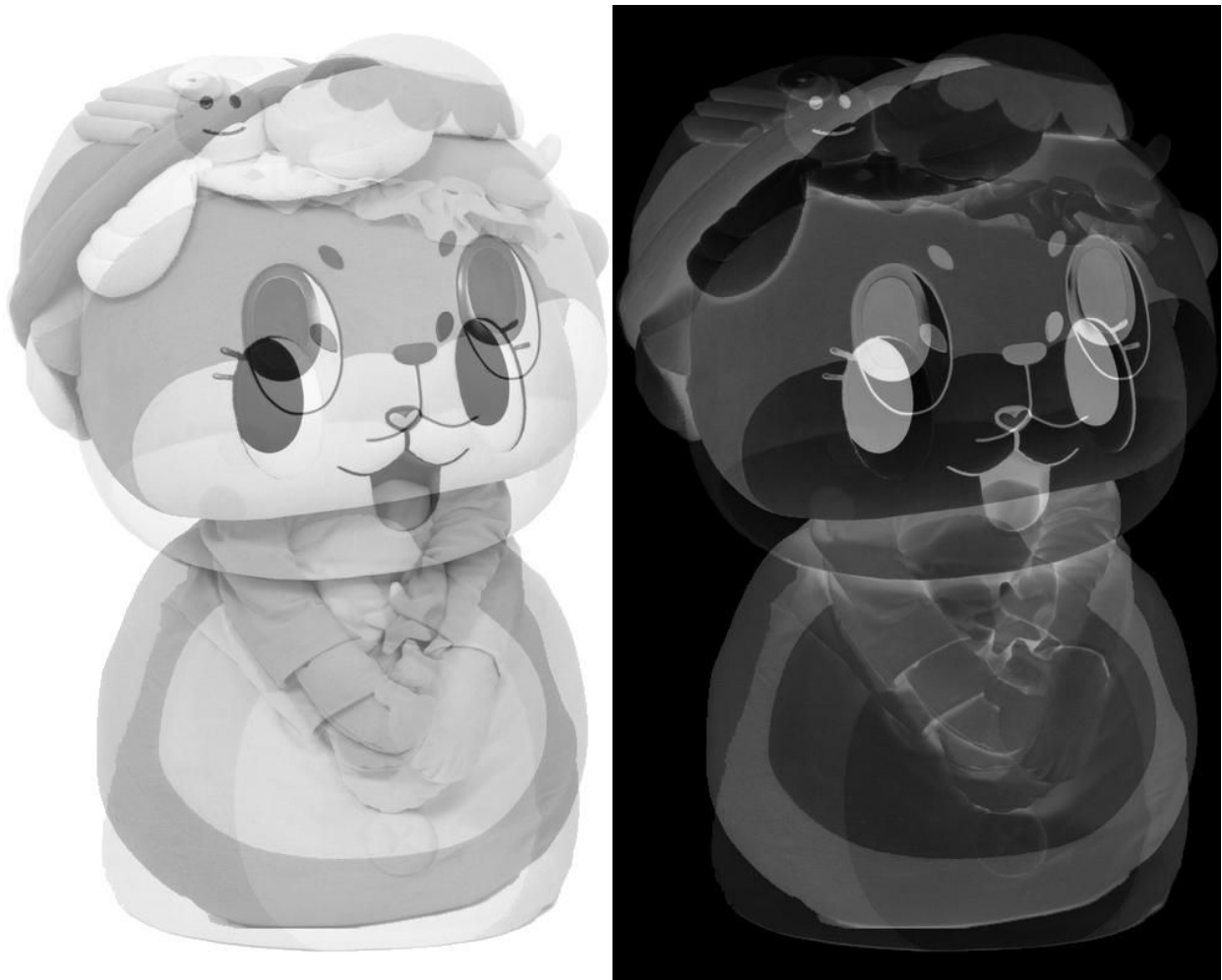
CONCLUSION

After fitting ICA to a set of noisy images, the original images could not be obtained and the restoration based on the noisy images did not show results that primarily showed either of the original images.

REFERENCES

[1]   Comon, P. (1994). Independent component analysis, a new concept?. Signal processing, 36(3), 287-314.