IDENTIFICATION OF RAPHAEL'S PAINTINGS FROM THE FORGERIES

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INTRODUCTION

We describe a statistical model for authenticating Rafael's works of art, especially his sketches. This technique takes advantage of multi-scale representation in the frequency domain of the high resolution digital scans of the original works.

METHODS

1. Select a block from each picture. As most of these pictures contain people, we select the part for eyes in each picture. See Fig. 1 for an example.

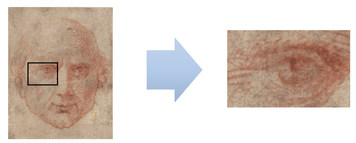

Figure 1: Processed sample: Painting No.23

2. Resize the blocks into 128×128 gray image. The gray level is converted to $1 \sim 256$.
3. For each block, perform FFT and divide the frequency magnitude into four parts: the diagonal parts D, the vertical parts V, the horizontal parts H and the centered part C.(See Fig.2 for an example.)
4. Perform inverse FFT on C and resize the picture to 128×128.
5. Iterate 3 through 4 for several times and obtain $V_1, H_1, D_1, V_2, H_2, D_2, \ldots$
6. Calculate *relationship coefficients* v_i, h_i, d_i, which is defined as the coefficients for the model

$$\begin{aligned} S_i(x,y) \sim 1 &+ S_i(x+1,y) + S_i(x,y+1) + S_i(x-1,y) + S_i(x,y-1) \\ &+ S_{i+1}(x,y) + S_{i+1}(x+1,y) + S_{i+1}(x,y+1) + S_{i+1}(x-1,y) + S_{i+1}(x,y-1) \end{aligned}$$

   Here S stands for V, H, D respectively.
7. For each picture, assign the coordinates $(v_1, h_1, d_1, v_2, h_2, d_2, \ldots)$.
8. Perform *Dimensionality Reduction* using *Hausdorff distance* and convert the the coordinates into point in 3D.
9. Call a SVM separator with RBF kernel, train it on the 21 known paintings and use it to discriminant the undecided ones.

PREDICTION

For the remaining 7 paintings that are not decided, we firstly collect features from them using the method introduced above. Then we apply the trained support vector machine to do the prediction. The results are as follows.

Painting No.	Predictition
1	Forgery
7	Forgery
10	Rafael
20	Rafael
23	Forgery
25	Forgery
26	Rafael

Table 1: Prediction of undecided paintings

PHILOSOPHY

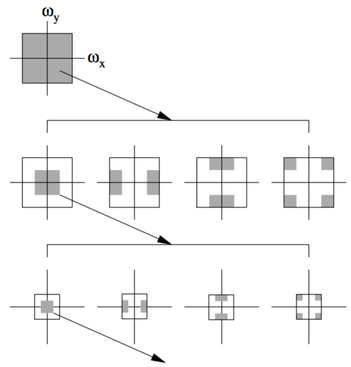

Figure 2: Multi-scale frequency domains

The philosophy here is that different painters have distinct styles of sketching, which is reflected in the frequency domain of the original paining. We construct a model of statistics from a multi-scale point of view and detect consistencies and inconsistencies from different scales. This gives rise to a very promising insight to how forgeries and originals differ.

RESULTS

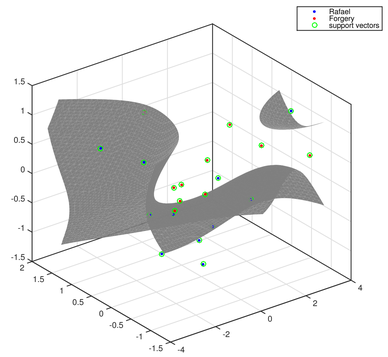

Figure 3: SVD training results for the collected features of the 21 known paintings using "QP" method.

We train a SVD for the collected features of the 21 known paintings and then use it to do the classification for them. As we can see in figure, the SVD has yielded a classification of high accuracy, with all the real painting recognized and only one forgery misclassified to the real one(see table below). This indicates that our method achieves accuracy of 95.24%.

		Prediction	
		Rafael	Forgery
OriginalPainting	Rafael	10	0
	Forgery	1	10

CONCLUSION

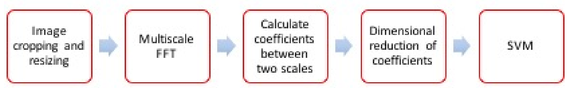

Figure 4: Routine of the model

The routine of our model is shown in Fig. 4.
With such a model, we achieve the accuracy of 95.24% on the training set. We consider such a high accuracy not a coincidence, as we have fully taken advantage of multiple scales of frequency domain.

REFERENCES

[1] Daniel Rockmore Siwei Lyu and Hany Farid. A digital technique for art authentication. *Proceedings of the National Academy of Sciences of the United States of America*, 2004.

CONTRIBUTORS

Contributors	Commitment
Kailai Xu	Algorithm & Coding
Yu Yang	Coding & Model Training
Long Chen	Report Editing & Discussion
Zhengyi Zhu	Literature Survey