Color alignment in industrial printing: An application

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1 Summary of Previous and Current Work

Printing industry has been advanced a lot these days. Although, selecting a printing method considering printing quality and cost along with uncontrolled parameters like temperature, humidity and even base paper quality, make it hard to have a desire printing mostly when you must compare to a previous printed master template. It makes it even harder when you have your own ink space and you have to reach to this specific master template.

Recently I was working on an application in the domain of industrial printing which helped the users to obtain the most similar pattern to a template design in terms of color with less time and ink waste and more accuracy. We had a printed product according to the Lamigraf (the reference company) needs composed of some printed layers over each other finally covered by a transparent plastic layer. Figure 2 shows a sample product. In this image the background paper is seen on the left side as a narrow strip, and the base color of each layer is located on this background as parallel triangles. Printing machine uses these triangles to register different layers correctly. The upper side of the image is the test pattern which should become similar to the bottom master pattern as much as possible.

To reach this goal, we proposed to analyze the colors of each layer independent to other layers. Due to the limitations in the company processes, we could only work with the registration triangles. A problem with this solution is the background color affect on the foreground that can be controlled when the background itself is a printing layer. Figure 1 illustrates the processes of the work. We describe them in details in the following:

1. **Registration:** Applying normalised correlation coefficient.
2. **Background detection:** Computing SVD on sliding windows, taking areas lower than a threshold, computing histograms of colors on them, and cutting undesired areas from histograms.
3. **Triangle detection:** Cutting outside edges of background using vertical profile of background, Clusterizing the colors in two fold by EM, and finding triangles through sampling background color in clusters.
4. **Similarity:** Converting colors to L*a*b space, dividing space into parts and computing the histograms in this space, and computing earth mover's distance on the feature vectors.
5. **Parameters estimation:** Computing Kriging interpolation on the nearest features from database to current feature vector. Feature vector is computed by "ink formula + machine parameters + mean master foreground color + mean master background color + mean test foreground color + mean test background color + similarity".
6. **Histogram mean:** Fitting a Gaussian model on the color space.

A typical qualitative result is shown in Figure 2.

2 Future Work and Challenges

Regardless of this project, I have started my PhD since May and as the future work, we intend to concentrate on human pose recovery and computer interaction. A challenge in this part is time efficiency

for real time applications especially for multi-camera systems. Working with depth data has been easier since launching new depth sensors like Kinect. Although, difficulties still remain due to the noise in or density of point clouds, objects' boundaries, etc. Model free approaches in depth data has been reported as high speed solutions to pose recovery, however, their segmentation accuracy needs more work. Gesture classification highly depends on how we model the object or the way we extract features. Some other difficulties can be mentioned as motion modeling, motion analysis and scene analysis.

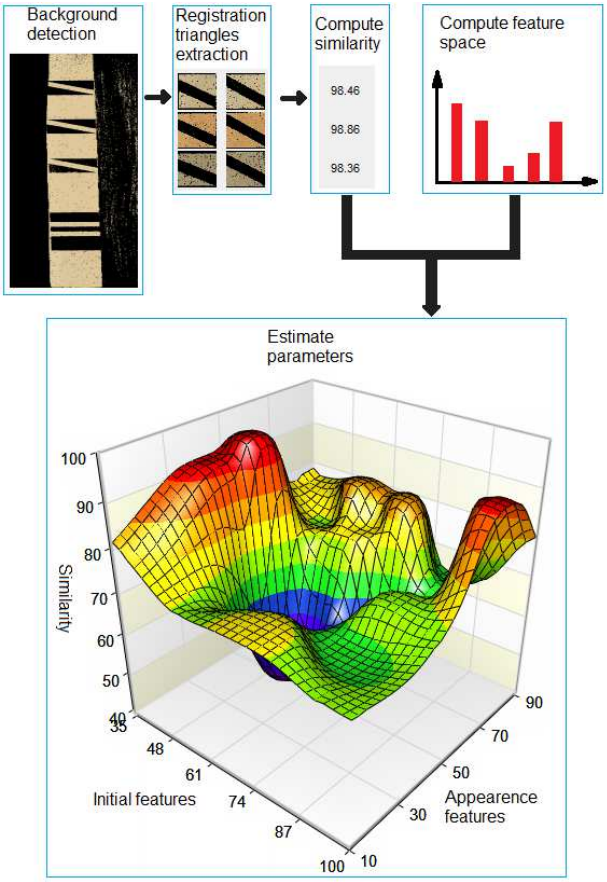

Figure 1: A schematic of the process.

Meysam Madadi received his Bachelor degree in Software Engineering at BuAli Sina university of Hamedan and M.S. degree in Computer Vision and Artificial Intelligence at Universitat

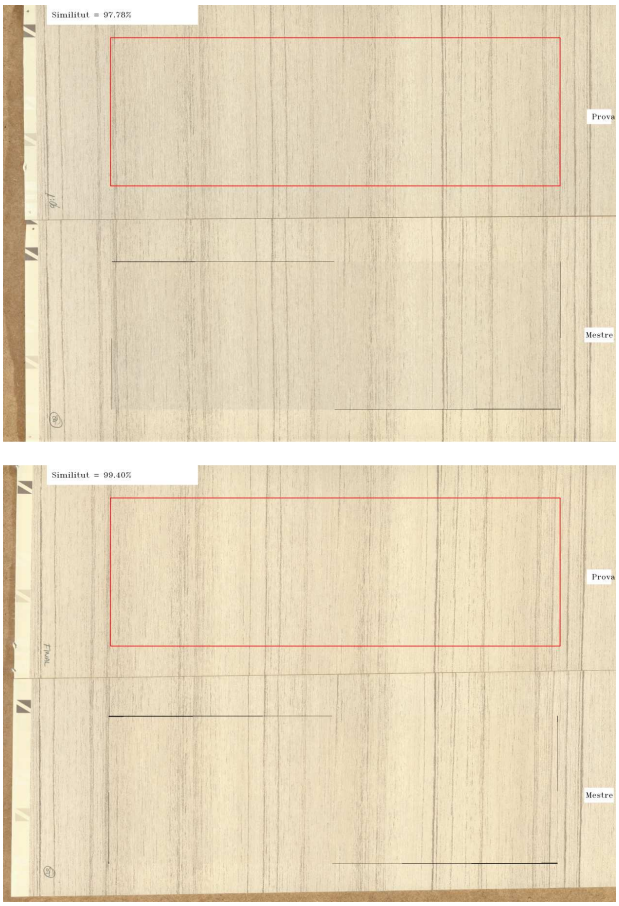

Figure 2: A typical qualitative result of the project. Upper image is the initial design and the bottom image shows the design after improvements. Red boxes are the registration areas located at the bottom master pattern and replaced for visual purposes. Registration triangles can be seen at left.

Autònoma de Barcelona (UAB) in 2007 and 2013, respectively. He has started his research activities by focusing on information retrieval and data mining since his bachelor project, continuing in master specifically on computer vision and image processing. He gave a special attention to pose recovery and human behavior analysis from his master thesis. He is interested in generating and developing new algorithms in these topics applying the knowledge in computer vision and retrieval systems besides machine learning, algorithms design in artificial intelligence, statistics, linear algebra, different geometries and many other relevant areas.