Improving Image Registration Accuracy through User Interaction

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1. Introduction

Multi-modal image registration has become an important way for researchers and art conservators to unveil secrets about classic paintings.

For most users, the current state-of-the-art algorithm by Conover et al. [1] is a black box with several parameters working on the entire input. This research aims to provide an intuitive UI which can help the user in the registration process.
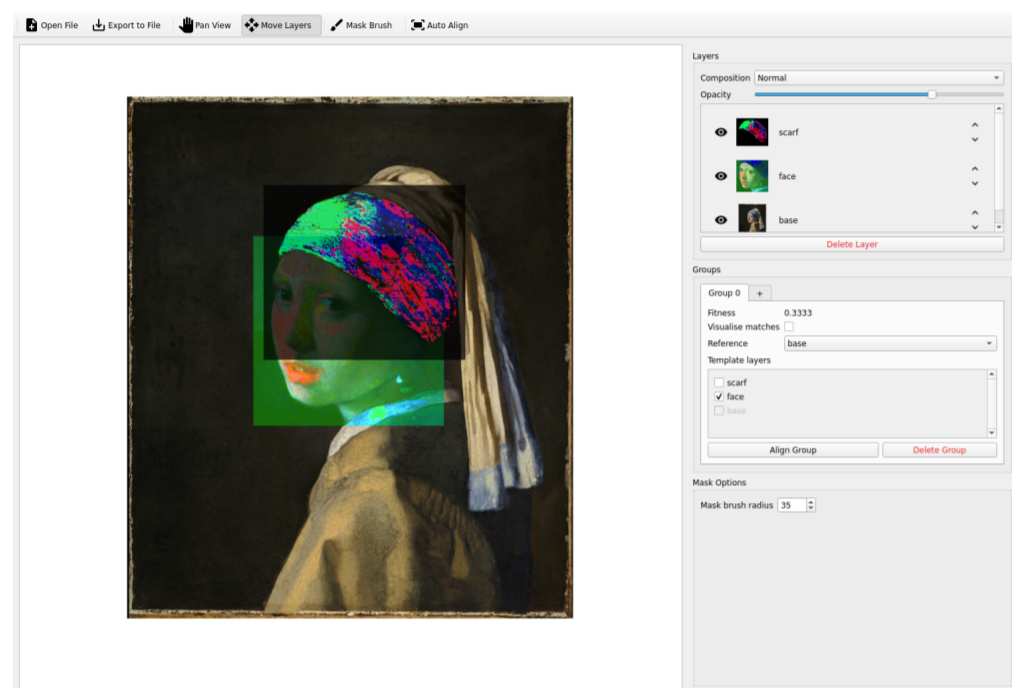

Figure 1. A complete view of the GUI while it is being used to align images

2. Purpose

Can user interaction improve the accuracy of the image registration?

What are intuitive and useful interactions for the user?

How can the parameters of the underlying algorithm be optimized efficiently?
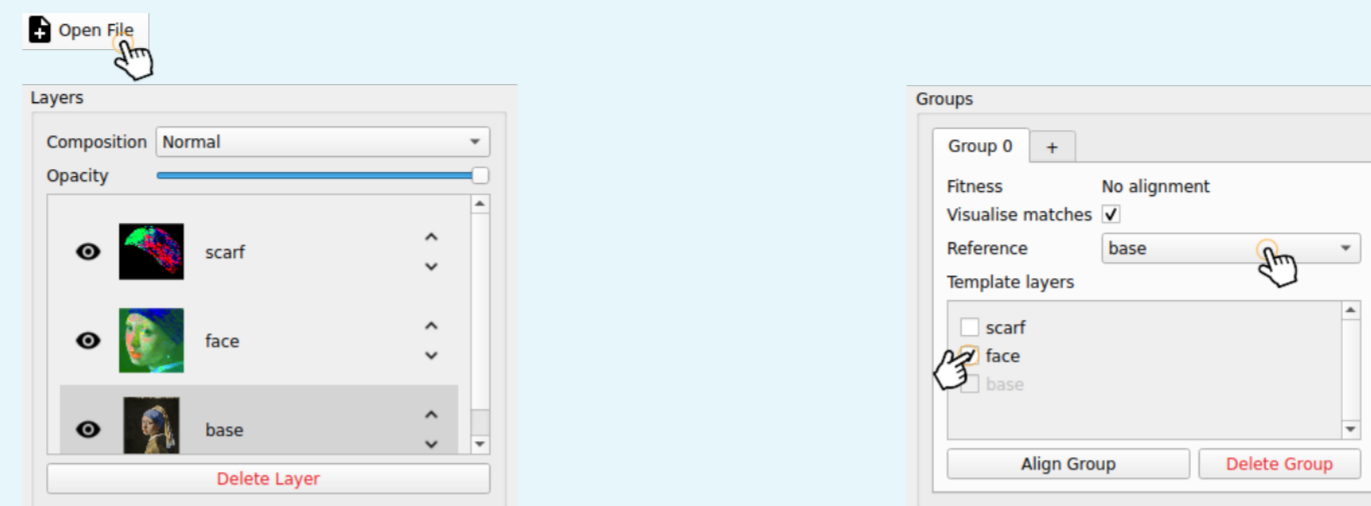
3. User Study

A user study was conducted to evaluate the intuitiveness of an early version of the GUI, below are some important conclusions that followed from that study.

- The physical user interactions should follow the flow of the registration process
- Duplicate buttons in different places in the GUI can help the user discover the features of the application
- The application should clearly convey what it is currently doing and what the user can expect from it
- Subtle differences in labels should be avoided, especially when the two actions are very different

The final design of the GUI can be seen in Figure 1.
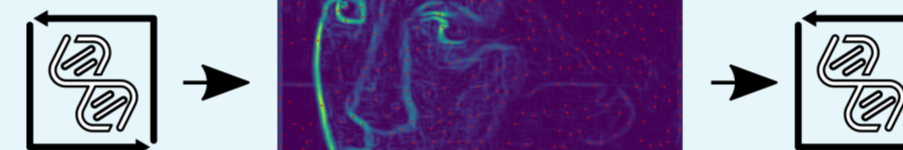
4. Method

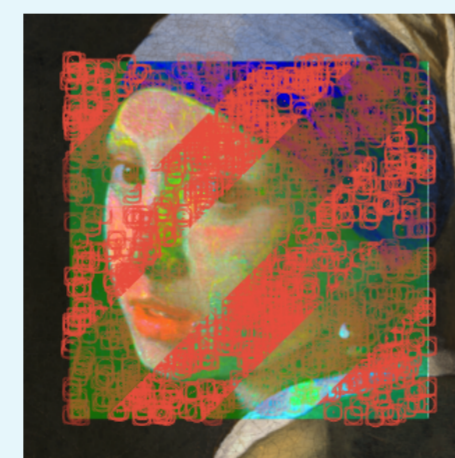1. The user imports layers from PNG or multi-layer TIF files

2. The user selects the reference and template layers to align

3a. The algorithm estimates a rough initial transformation

3b. The parameters are optimized in two steps using a genetic algorithm, first a good candidate solution is found by optimizing a subset of the parameters, after that the remaining parameters are mutated and optimized

4. The alignment and optionally the matching feature points are visualized

5. The user can adjust the mask and re-align or choose to export the layers as PNG or TIF files

References

[1] Damon M. Conover, John K. Delaney, and Murray H. Loew. 2015. Automatic registration and mosaicking of technical images of Old Master paintings. *Applied Physics A* 119, 4 (01 Jun 2015), 1567–1575. https://doi.org/10.1007/s00339-015-9140-1

5. Results

Figure 2. Comparison between the registration results when using a set of default parameters (left) and automatically optimized parameters (right)
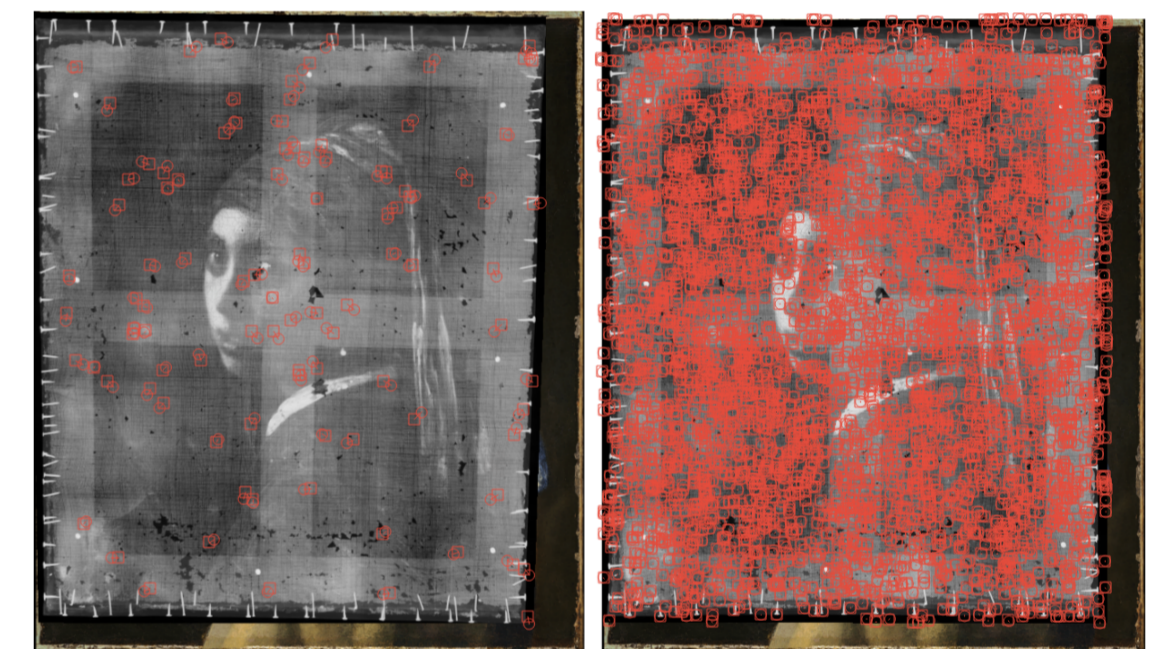

Figure 3. Comparison between control-point pairs found with a set of default parameters (left) and with automatically optimized parameters (right). Also visible in these images is that the rough initial transformation is not always correct.

6. Conclusion

The presented tool shows potential to improve image registration accuracy, but the current user interaction on its own is not sufficient. An additional interaction that could be implemented is to allow the user to specify a rough initial transformation.

Automatically optimized parameters provide better alignment results than a default set would, while taking complexities away from the user.

The GUI itself was received well during the user study, but could use some more common quality of life features (such as undo, redo, export to Photoshop, help menu) to further improve the user experience.

User interaction can improve image registration accuracy, but not yet in its current form as presented here.