Converting Notes to Solmizations on the Sheet Music with Template Matching Method

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ABSTRACT

Inspired by a powerful sheet music recognition app - notation scanner. In order to help people who aren't good at fast reading sheet music, this article describe the implementation details of OMR(optical musical recognition) technique, which can be applied to converting notes on the sheet music to solmization. Additionally, a user interface also be designed for conveniently converting.

Keywords: OMR, OCR, DIRS

1. INTRODUCTION

To achieve the purpose of music sheet converting. A technique will be introduced -OMR. OMR is an abbreviation of optical music recognition. Nowadays, there are two frameworks to implement OMR - General and Refined[1].[2] Both of them incorporate four steps to achieve the converting goal. General incorporates staff line identification, musical objects located, musical feature classification, musical semantics. The refined incorporates preprocessing, music symbols recognition, musical notation reconstruction, final representation construction. The two methods are similar and, in this paper, I will only implement the general one. At the same time, I will take the worldwide well-known song - **An die Freude** to test and validate my algorithm.

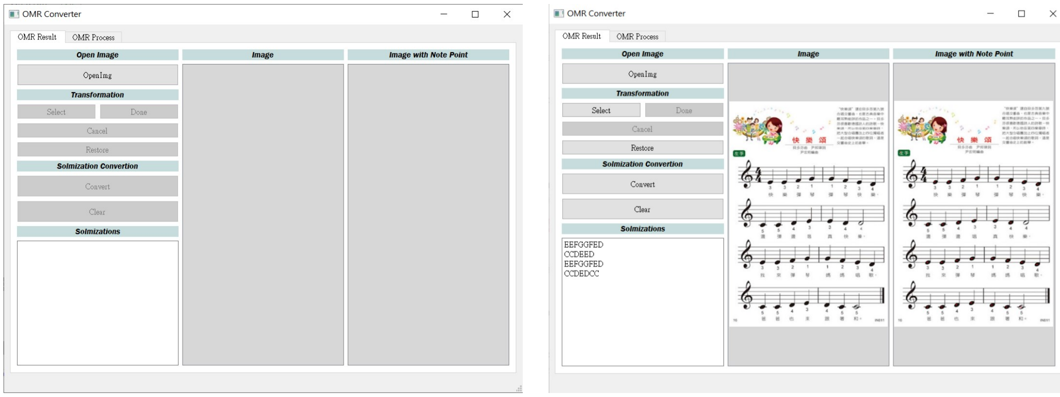
The structure of this article is designed as follows: Section 2 introduces the objective of this paper. In section 3, some functions of the UI will be instructed in this section. Section 4 will introduce the general OMR method implementation in detail. Section 5 provides summaries and conclusions of this paper.

2. OBJECTIVE

- Converting notes on the sheet music to solmization to help people who aren't good at fast reading sheet music
- Creating a user interface to make people achieve the converting without effort

3. USER INTERFACE

Fig.1a shows our user interface.[3] When opening an image, the image will show on the "Image" box. Transformation area offers the functions of selecting transformation area, canceling the selecting area. If you don't like the transformation image, pressing "Restore" button to restore to the original image. In Solmization Conversion area, pressing "Convert" to convert notes to the solmizations and "Clear" button offer a option to clear all image. Once pressing "Convert" button, the image with note points will show up ,and he note point is marked with red point, which is not so conspicuous. Finally, the Solmizations area will show the solmizations we convert from the sheet music. Fig.1b shows the conversion result.



(a) User Interface (b) User Interface with conversion result

Figure 1. UI

4. METHOD

4.1 Preprocessing

The preprocessing are as follows:

1. Perspective Transformation
2. Noise Removal
3. Binarization

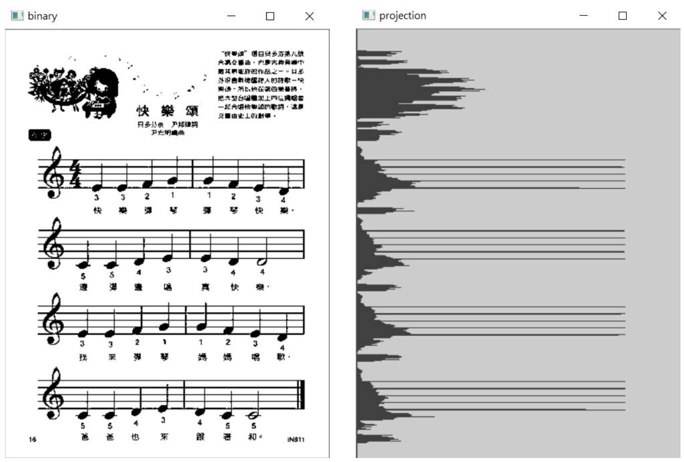
The three steps preprocessing are shown in Fig.2. First, the perspective transformation prevent sheet music from askew situation. Secondly, noise removal is a common image preprocessing, and, in this article, a 3x3 gaussian filter is adopted. The last one is binarization.

(a) Original (b) Gray (c) Binary

Figure 2. Image preprocessing

4.2 Staff line identification

After the preprocessing, we get a binary and noise-removed sheet music image. Next, we want to identify the lines of this staff. By acquiring the information of these lines, we can generate the music sheet without the staff lines or get the coordinates of the lines for musical object location. The most widely used method for detecting staff lines is based on horizontal projections.[1] This is a technique that maps a two-dimensional binary image to a one-dimensional histogram by recording the black pixels in each row of this binary image. Fig.3b shows the projection image.



(a) Binary (b) Horizontal Projection

Figure 3. Horizontal Projection

Under such projection, it is easy to find that the peaks of the histogram are where staff lines are. In the meantime, we can separate the staff lines from the sheet music and get the following two image(Fig.4) :

(a) Line Removed Image (b) Staff Lines Image

Figure 4. Line Image

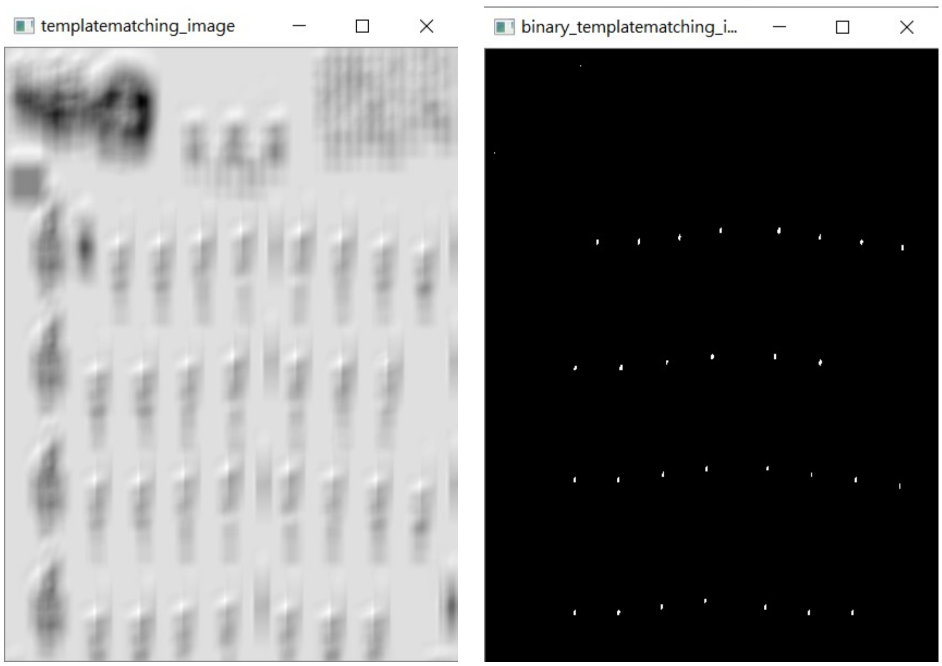
These two images will come in handy when we are in the task of "Musical Object Located" and "Musical Semantics".

Figure 5. Template

4.3 Musical objects location

In this section, we use the pattern recognition technique - template matching to achieve the task of musical objects location. Fig.5 is a quarter note template we use.

In this case, we only apply the template matching technique with one template so that we can only locate the quarter notes on the sheet music. Fig.6a shows the result of sheet music after the template matching



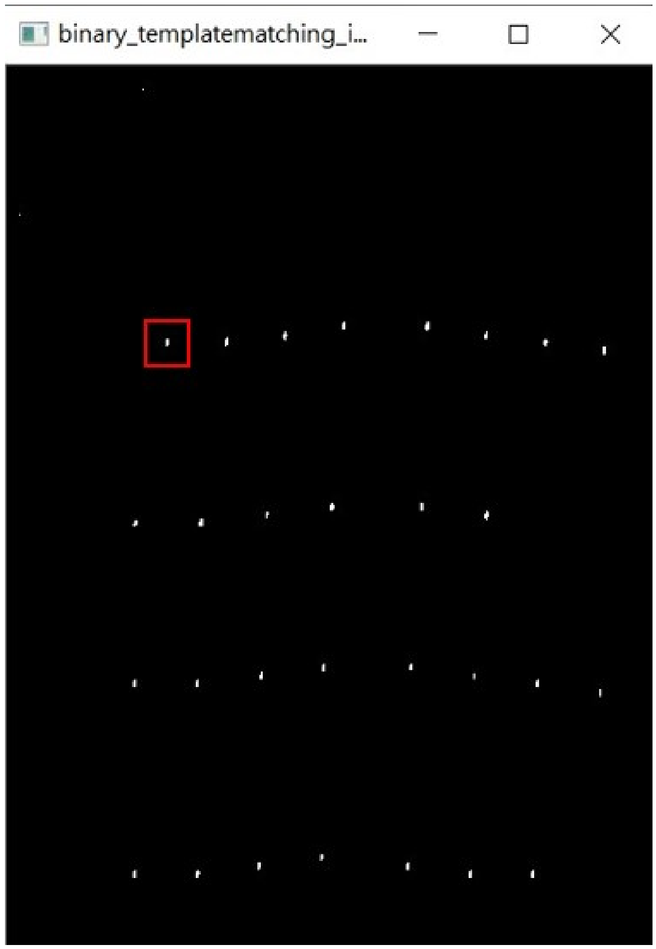
(a) Template Matching Result (b) Template Matching Binary

Figure 6. Template Matching

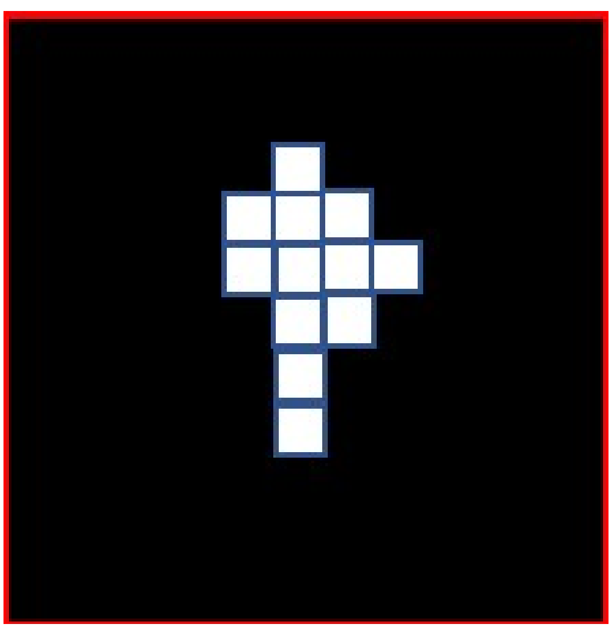
The more white area shows the higher probability that the template may locate. Then, we binarize the Fig.6a and get the Fig.6b Now, we can get the approximate location of the quarter note.

The next step is to find the specific location of the quarter note. Fig.7b shows the the zoom-in red-bounding box of Fig.7a

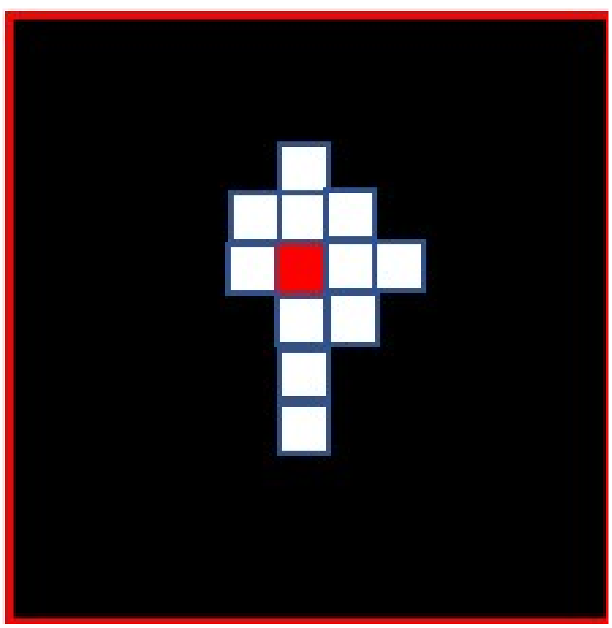
There is a connected component composed of multiple white pixels. The central idea of getting a specific location is to find the center of this connected component. Like the Fig.7c shows. First of all, we traverse the whole image. When encountering a white pixel, we record the value, x coordinate and y coordinate of this pixel and turn it to a black pixel. Secondly, checking the four adjacent pixels of this pixel. If a white pixel exists, then repeat the step 1. It is not until the every white pixel in this connected component is found that we stop repeating step 1. Thirdly, we add up all of the x and y coordinates and sum up their average x and y, which is also the average x and y of this connected component. Finally, after traversing the whole image, we get the specific location of the quarter note in the music sheet. Fig.8 shows the quarter note location with red points(quite not conspicuous though).



(a) Template matching binary



(b) Connected component



(c) The center of connected component

Figure 7. The approximated note location looks like a connected component of multiple pixels

Figure 8. Quarter note location with red points

4.4 Musical Semantics

Now, we have gotten locations of the note and locations of the staff lines from “Musical Objects Location” and “Staff lines Identification”. Next, we can get the solmization with the following coding method that Fig.9 shows:

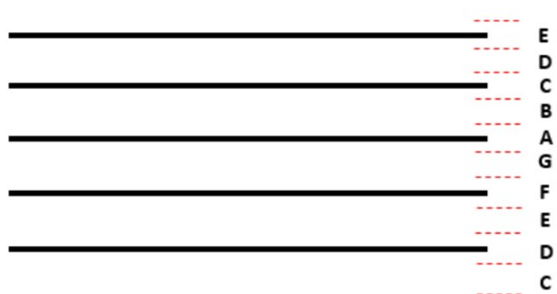


Figure 9. Coding method for solmization conversion

If a note is located between any two red dotted line, we encode it with the corresponding solmization. The **An die Freude** after solmization conversion is shown in the Fig.10

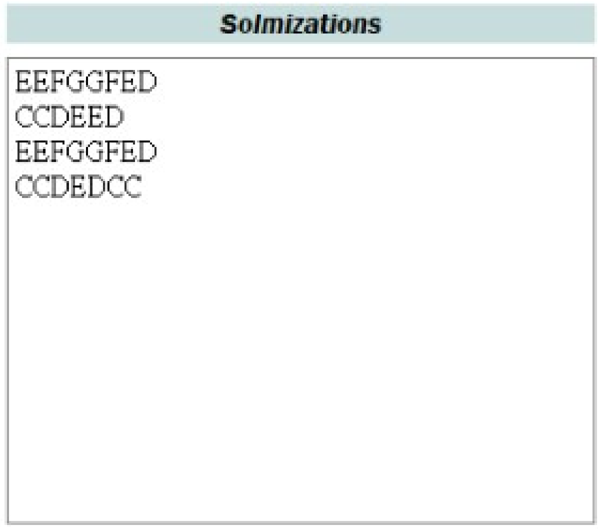


Figure 10. Musical semantics result

5. SUMMARY AND CONCLUSION

Fig.11 is the OMR flow chart we implement in this article. We get the solmization in the end, however, there are still a lot of defects in this algorithm. First, there are some limitations for template matching, for example, if the matching target tilts or has a different size with the template, the template matching algorithm will crash drastically. Second, an inadequate binary value may pose a big trouble in line identification. On the other hand, in this article, we only use one template so that the half note doesn't be recognized. These defects need to be improved in the future.

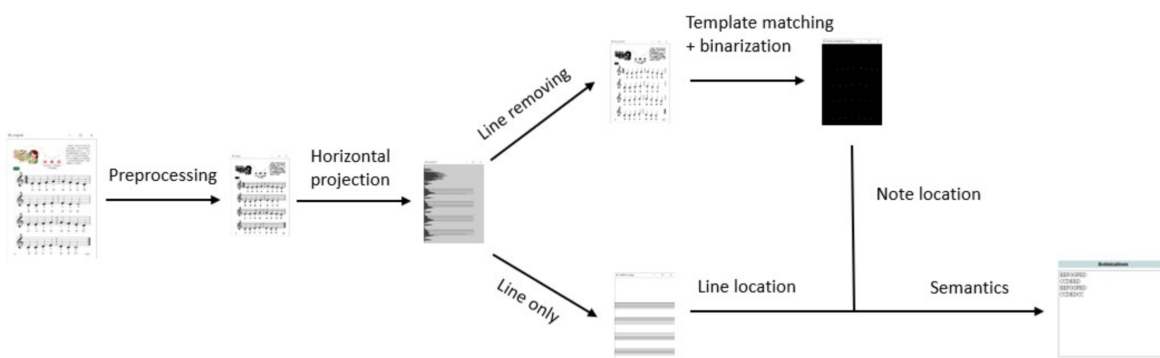


Figure 11. OMR flow chart

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[3] Al-Ani, M., "International journal of advanced research in computer science and software engineering," (11 2015).