

# Analysis of Iterative Procedure of Matching Two Drawings by DP Matching and Estimation of Time-Variant Transformation Parameters

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## Extended Abstract

### 1 The Problems

It is needless to emphasize the necessity of matching of handwritten drawings, especially in signature verification or character recognition problems [2]. For these problems, online equipments such as a tablet and an electric pen are simultaneously used. In an environment where online equipment can be used, using these is more efficient than simply using a pen and a sheet of paper. The latter is called “offline method”. There are several reasons why using online method is advantageous. In this method, data is originally a time-series data where data elements are the positions of the pen, the pressure, and the direction information. Two advantages of using online equipments arise from here. One benefit is that the analyser is free from the heavy computational load of image processing which is inherent to offline methods. Thus the analysis can also be “online” besides the data acquisition. Another benefit is that the analyser can use various information of writing which is usually not available in offline method. An example can be shown in the signature verification. If the holder of the signature intentionally writes a part of the signature in an abnormal direction, other person is not likely to be able to imitate it. Another simple technique for making the signature not likely to be imitated by other persons is to print a dot in the right end and begin the signature from the left end. The drawings appearing on the screen does not show the secret explicitly on the screen, but the analyser (computer) can firmly detect this secret and is likely to find the forgery which has not noticed the secret of the true signature. Thus we can believe that the online matching is especially useful in signature verification problems. It is clearly necessary to detect the difference between the genuine and forgeries written in a standard way.

### 2 Methodology

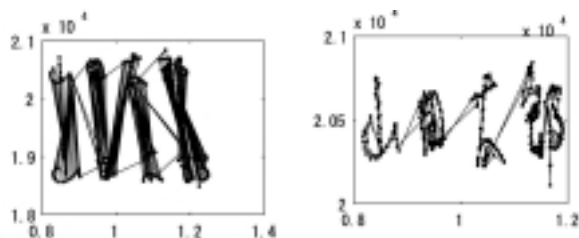
For the signature verification problems, we considered a two-stage method [3]: the first stage is to match the points of the whole signatures, and the second stage is to check the point where the special feature of the signature holder appears. This could be done by using not only the

position information but also other information such as the pressure and the angles of the pen. For the first stage, we proposed using a time-variant shift and scaling parameters for each points of the drawings. However, the parameters are unknown and also the corresponding points are unknown at the beginning. The parameters can be estimated using linear estimation theory and the fixed interval smoother [1]. The correspondence can be obtained by the DP matching. However, in our case, they are both unknown. So, we propose an iterative method of estimating them interchangeably.

### 3 Analysis

We obtained good results in the matching standard Kanji signatures([3, 4]). In this paper, we will show more results for standard Japanese Kanji signatures, Roman alphabet signatures by Japanese people, signatures by European people, and also some geometrically interesting drawings.

The left figure shows the DP matching result without doing any modification of the two original signatures. Since they were written at quite different positions, the matching was not successful. The right figure shows the result of our proposed algorithm iterated for 9 times. We can see the successful result from this.



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### References

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