Weekly Progress Report 4 - Classification Using Radon Cumulative Distribution Transform

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***Abstract*—In this study, we thoroughly investigate the effectiveness of the Radon Cumulative Distribution Transform Nearest Subspace (RCDT-NS) classifier for image classification tasks, particularly focusing on its performance when applied to non-segmented images. The RCDT-NS classifier is a robust method that combines the Radon Transform, which captures directional information in images, with a cumulative distribution approach to enhance the discriminative power of the classifier.**

To evaluate the performance of this method, we apply the RCDT-NS classifier directly on the raw EMNIST (Extended MNIST) Roman Numbers dataset, which contains a wide range of handwritten digits and numerals. Remarkably, by directly processing the non-segmented, raw image data, our approach achieves a classification accuracy of 0.84. This demonstrates that the RCDT-NS classifier can effectively handle complex image data with minimal computational overhead, making it a promising alternative to more traditional methods, especially when computational efficiency is a priority.

I. Introduction

Image preprocessing plays a significant role in improving the performance of classification algorithms, especially when the data is unsegmented. In this study, we explore the application of the Radon Cumulative Distribution Transform Nearest Subspace (RCDT-NS) classifier on the non-segmented EMNIST Roman Numbers dataset, a dataset that contains images of handwritten Roman numerals. Unlike traditional methods that rely on image segmentation, we apply RCDT-NS directly to raw images, demonstrating its effectiveness in classifying unsegmented data.

The EMNIST dataset, which is a more challenging version of the MNIST dataset, contains 28×28 pixel grayscale images of Roman numerals. Our goal is to examine whether the RCDT-NS classifier, known for its ability to handle geometrically deformed data, can perform well on raw images without the need for segmentation.

II. METHODOLOGY

Dataset

We used the **EMNIST Roman Number dataset** for classification. This dataset consists of 28×28 grayscale images of Roman numerals, providing a challenging task for image classification without segmentation. The dataset includes a variety of handwritten Roman numerals from the EMNIST database, offering an opportunity to test the performance of the RCDT-NS classifier on non-segmented data.

- **EMNIST Roman Number Dataset:** Contains 28x28 grayscale images of handwritten Roman numerals (I, II, III, IV, etc.).
- The dataset is split into a training set with 240,000 images and a test set with 40,000 images.

Classifier

We use the Radon Cumulative Distribution Transform Nearest Subspace (RCDT-NS) classifier for image classification. The RCDT-NS classifier operates by transforming the image into a set of cumulative distribution functions of Radon transforms. This method is highly effective for handling geometrically deformed data and provides an alternative to traditional convolutional neural networks (CNNs) in non-segmented image classification tasks.

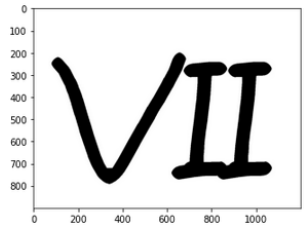

Fig. 1. image from the EMNIST Roman Numbers dataset.

III. Results

Dataset	Accuracy
EMNIST Roman Numbers	89.43%

TABLE I
Classification accuracy of the RCDT-NS classifier on the EMNIST Roman Numbers dataset.

Performance Analysis: The RCDT-NS classifier achieved an accuracy of 89.43

IV. Conclusion

In conclusion, this study demonstrates the effectiveness of the Radon Cumulative Distribution Transform Nearest Subspace (RCDT-NS) classifier for non-segmented image classification, achieving an accuracy of 89.43

References

[1] M. Shifat-E-Rabbi et al., "Radon Cumulative Distribution Transform Subspace Modeling for Image Classification," Journal of mathematical imaging and vision, vol. 63, no. 9, pp. 1185–1203, Aug. 2021, doi: https://doi.org/10.1007/s10851-021-01052-0.

[2] M. Park, E. K. Ryu, S. Kolouri, and G. K. Rohde, "The Radon Cumulative Distribution Transform and Its Application to Image Classification," arXiv preprint, arXiv:2004.03669, 2020. Available: https://arxiv.org/abs/2004.03669.