Combined Zernike Moments, Histogram of Oriented Gradients and Binary Pixel Feature Extraction Technique for Recognizing Hand Written Bangla Characters.

Presented By

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Outline

- Introduction
- Literature Review
- Character Recognition System
- Proposed System
- Implementation
- Experimental Results
- Conclusion & Future Work
- References

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Introduction

➢ Electronic conversion of images of typed, handwritten or printed text into machine-encoded text, whether from a scanned document, a photo of a document or a scene photo.

➢ Bangla being the 7th most used language a fully working OCR system for handwritten characters hasn't been developed [1].

➢ Various applications have made this a popular research topic.

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Literature Review

➢ T. K. Bhowmik et al. worked with SVM-based hierarchical architectures for handwritten Bangla character recognition and they achieved 88.38% [2].

➢ S. Bhowmik, et al. worked with MLP classification algorithm using HOG features for handwritten characters and achieved 87.35% accuracy but they put low focus on local regions [3].

➢ N. Das, et al. worked with SVM and MLP classification algorithm using shadow features, longest run features and quad tree based features and achieved 80.87% accuracy for SVM [4].

➢ A. Khotnazad, et al. worked with Zernike Moments for feature extraction technique for English Characters and achieved 99% accuracy [5].

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Character Recognition System

➢For both training and testing stage

Image Acquisition → Binarization → Noise Removal → Skew Correction → Segmentation → Image Scaling → Feature Extraction → Classification

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Proposed System

➤For both training and testing stage

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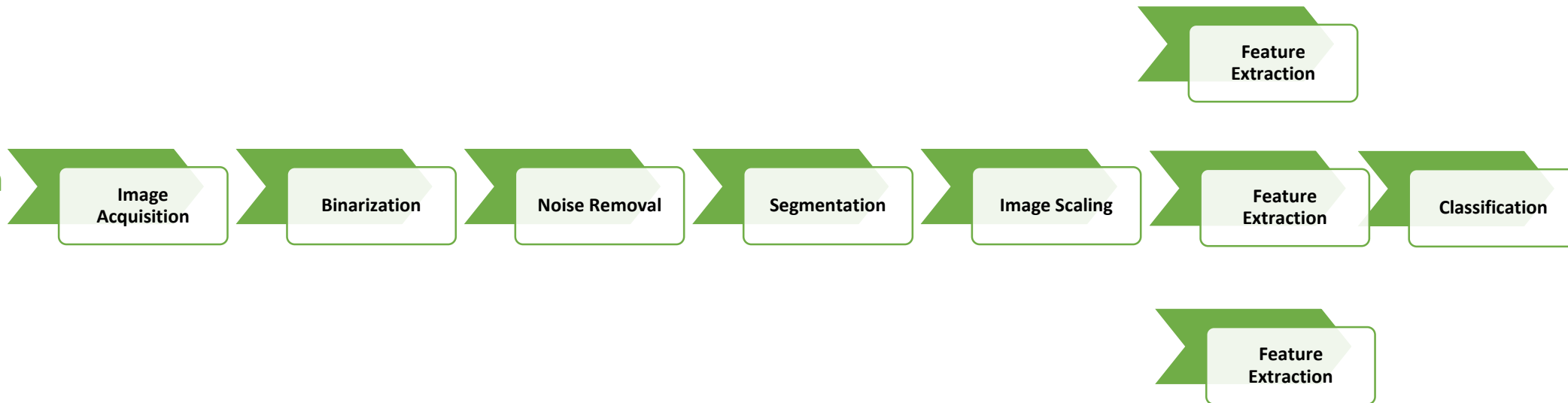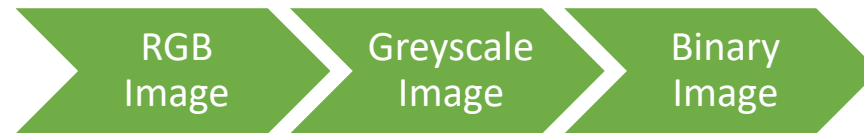
Implementation
Image Acquisition

❑ Documents images can be acquired through scanners, cameras.

❑ Have used dataset [6].

❑ Used a total of 30,000 images for 60 characters. 500 image for each characters.

❑ 400 images for training and 100 images for testing.

❑ No compound characters were used only Bangla vowels, consonant and numeric characters were used.

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Implementation
Preprocessing

❑ Binarization

RGB Image → Greyscale Image → Binary Image

❑ Noise Removal
  ✓ Median filter is used for removal of noise.

❑ Skew Correction
  ✓ achieved in two steps
    (a) estimation of skew angles
    (b) rotation of the image by that angle in the opposite direction.

❑ Segmentation
  ✓ Three types:
    ✓ Line Segmentation
    ✓ Word Segmentation
    ✓ Character Segmentation
❑ Image Scaling

  ✓ Scaled all images to 32 x 32
  ✓ Provides a constant dimension for feature extraction

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Implementation
Feature Extraction

❑ **Zernike Moments**

✓ Moments describe numeric quantities at some distance from a reference point or axis.

✓ Zernike Moments Simply the projection of the image function onto these orthogonal basis functions[5].

✓ Advantages: translation, rotation and scale invariant, higher accuracy for detailed shape

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Implementation
Feature Extraction (cont'd)

❑ **Histogram of Oriented Gradients (HOG)**

- ✓ Counts occurrences of gradient orientation in localized portions of an image. [7]

- ✓ Similar to edge orientation histograms, scale-invariant feature transform descriptors.

- ✓ Differs in that it is computed on a dense grid of uniformly spaced cells and uses overlapping local contrast normalization for improved accuracy.

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Implementation
Feature Extraction (cont'd)

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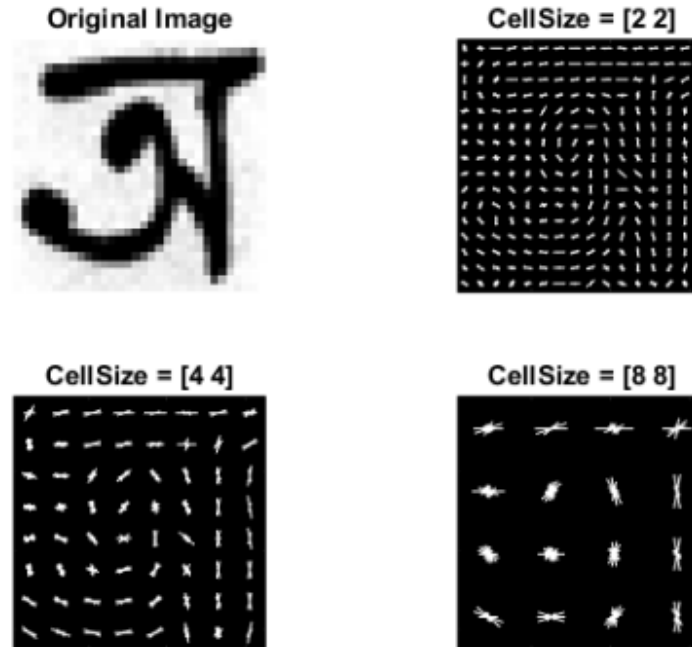- Experimental Results
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Fig. 1. HOG features for different cell size for Bangla Character 'অ'

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Implementation
Feature Extraction (cont'd)

❏ **Binary Pixel**
- ✓ After converting an image to binary image the image matrix is carpeted into a row vector which is used as feature.
- ✓ Widely used as a feature extraction technique for printed characters [8].

Fig. 2. Binary image of a Bangla Character 'ক' [8].

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Implementation
Feature Extraction (cont'd)

❑ All three feature vectors are concatenated for creating a new feature vector which is used in to the system.

| 0.3880 | 0.0938 | 0.3448 | 0.1260 | 0.1135 | 0.0781 | 0.1386 | 0.0818 | 0.122₄ |

(b)

| -0.8551 | -1 | 0.9698 | -1 | -0.6055 | -0.8685 | -0.9520 | -0.0035 | -0.1993 |

(c)

| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |

(d)

(a)

Fig.2: (a) sample character (b) Zernike Moments features of sample character (c) HOG features of sample character (d) Binary pixel features of sample character

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Implementation
Classification

❑ **Support Vector Machine**

✓ Support Vector Machine is a supervised machine learning algorithm used for classification or regression problems.

✓ Uses kernel trick to transform data and then based on these transformations it finds an optimal boundary between the possible outputs[9].

✓ 3 popular kernels are used generally
  o Linear
  o Radio Basis Function (Gaussian)
  o Polynomial

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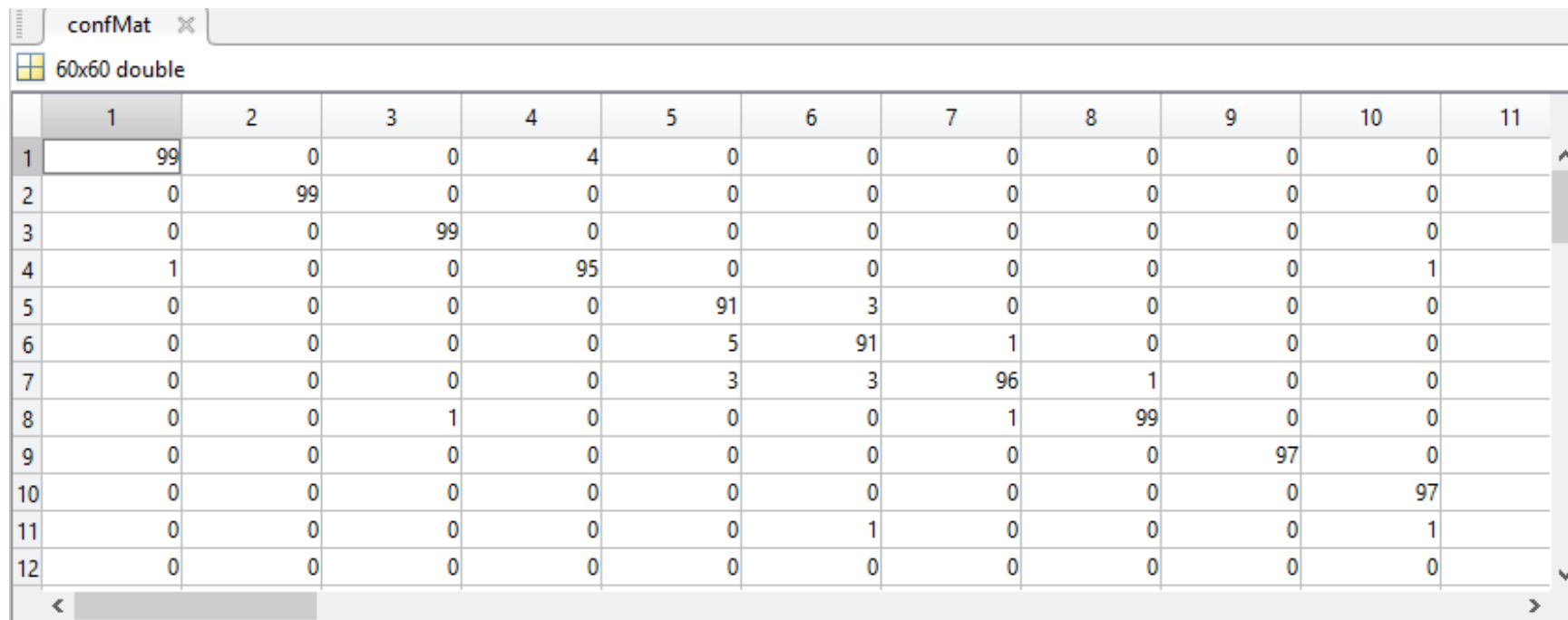
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Implementation
Validation

❑ A total of 30,000 images are used for the whole system. 24,000 for training and 6,000 for testing.

❑ From the testing 24,000 images 4,800 images were separated for validation set for selecting various parameters.

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Experimental Results

Fig. 3. Partial Confusion Matrix for combined features.

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Experimental Results (cont'd)

Table 1. Accuracy rate corresponding to different feature extraction techniques for different characters.

Characters	No. of Testing data	No. of Correctly Identified Data			
		Zernike Moments	Raw Binary Pixels	Histogram of Oriented Gradients	Combined
১	100	42	88	87	91
৩	100	46	91	93	98
অ	100	68	96	99	99
আ	100	78	73	91	99
ক	100	24	65	83	99
গ	100	33	77	88	95
ঞ	100	67	38	91	92
য	100	28	42	75	90
স	100	33	79	77	95
ঝ	100	50	52	85	97
ঢ়	100	57	46	92	92

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Experimental Results (cont'd)

Table 2. No. of correctly identified characters when using different feature extraction techniques.

	Total Testing Data	Correctly Identified Data	Accuracy
Zernike Moments	6000	2819	46.98%
Binary Pixels	6000	3996	66.60%
Histogram of Oriented Gradients	6000	5257	87.62%
Combined	6000	5693	**94.88%**

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Experimental Results (cont'd)

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Accuracy Comparison of different feature extraction techniques
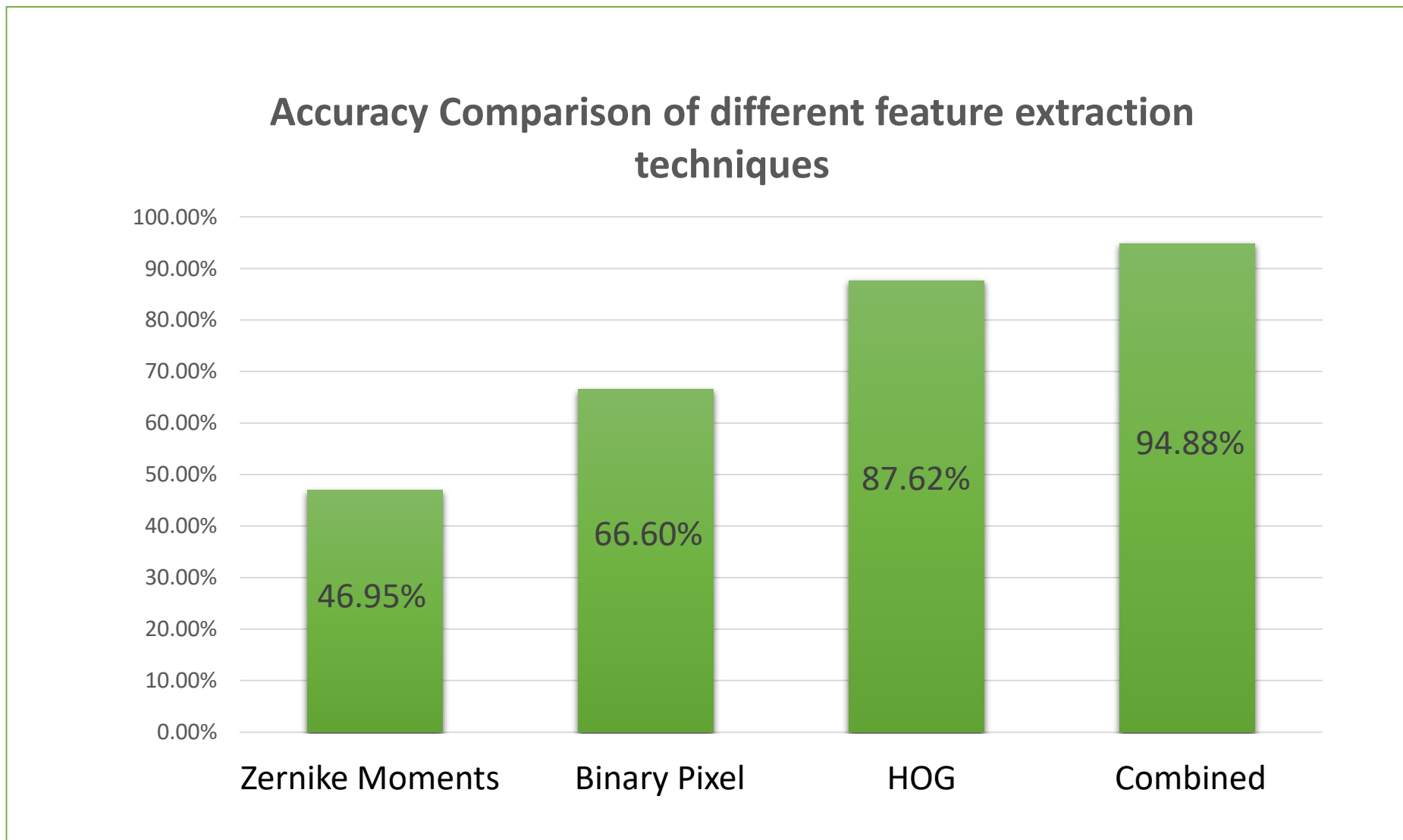
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Conclusion & Future Work

❑ **Conclusion**

✓ Zernike Moments provides 46.95% , Binary Pixels provide 66.60%, HOG provides 87.62% and Combining these provides 94.88% accuracy for the system.

✓ Combining the features provide a much better accuracy than the individual feature extraction techniques.

❑ **Future Work**

✓ Compare with other ensemble feature extraction techniques.

✓ Check performance for Gaussian and Polynomial kernels in SVM.

✓ Implement other classification algorithms for performance analysis.

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Thank you

Any Questions ?