RICE CLASSIFICATION : AN IMAGE PROCESSING AND MACHINE LEARNING APPROACH

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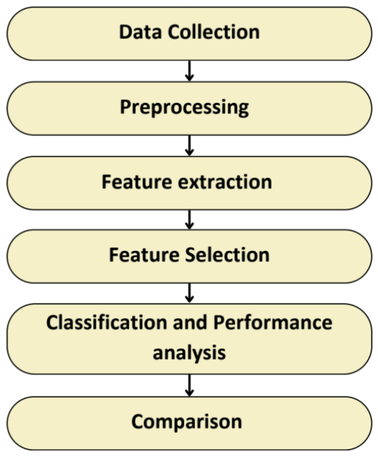
ABSTRACT

Rice classification is an essential component of the food and agricultural industries since it ensures quality control, market value, and consumer preference. Manual Inspection is subjective, inconsistent, and time-consuming because it depends on visual evaluation. While automated methods have improved the process by classifying rice based on size, shape, and color, they often struggle to differentiate visually similar varieties. We suggest a texture-based classification method that incorporates both local and non-local texture features to overcome this limitation and provide a more robust and reliable approach. Our method improves feature discrimination by extracting more texture information through the use of advanced image processing and machine learning techniques. In comparison to conventional approaches, experimental results suggest that integrating local and non-local texture descriptors improves classification accuracy.

INTRODUCTION

Rice, as a staple food consumed by over half of the global population, plays a vital role in ensuring food security and supporting the agricultural economy. The classification of rice into various categories, based on attributes such as shape, size, texture, and nutritional value is essential for quality control, commercial trade, and industrial processing. Traditionally, rice classification has relied on manual inspection techniques that evaluate visual and physical characteristics. However, these methods are not only time-consuming and labor-intensive but also susceptible to human error, resulting in inconsistent and unreliable outcomes. To address these limitations, this study proposes an automated rice classification framework utilizing image processing and machine learning techniques. The approach leverages both local and non-local texture feature extraction methods to capture comprehensive grain characteristics, thereby improving the robustness and accuracy of classification.

METHODOLOGY



IMPLEMENTATION

SL.NO	NAME	SAMPLE IMAGE
1	BASHMOTI	
2	KATARI POLAO	
3	LAL BINNI	

- A dataset comprising 690 high-resolution (853×853) images of rice grains was collected from Mendeley Data, as published by Islam et al. (2023). The dataset includes three rice varieties: Lal Binni, Katari Polao, and Deshi Bashomati.
- Preprocessing of the images was carried out using a combination of Median, Gaussian, and Wavelet filtering techniques to reduce noise and enhance image quality. Both RGB and grayscale versions of the images were evaluated to assess improvements in sharpness and entropy.
- Texture features were extracted using a combination of local descriptors, such as Weber Local Descriptor (WLD), Wavelet Transform, and Gabor filters, as well as non-local descriptors including Tamura features and the Shearlet Transform.
- To support multiscale texture analysis, combinations of local and non-local features were explored. Notably, Tamura-Gabor and Shearlet-Wavelet feature combinations were investigated for their complementary information across different resolution levels.
- Feature selection was performed using box plot analysis and ANOVA testing, with a significance threshold of $p < 0.05$. This step helped reduce the feature space while retaining only the most relevant features for classification.
- For classification, XGBoost was used as the primary machine learning algorithm due to its robustness and high accuracy. The model performance was evaluated using Accuracy, Precision, Recall, and F1-Score as performance metrics.
- To ensure the robustness and generalizability of the proposed approach, the results obtained from XGBoost were compared with two additional classifiers: K-Nearest Neighbors (KNN) and Support Vector Machine (SVM), across all extracted and combined feature sets.

RESULTS

METHOD	NAME	XGBOOST				SVM				KNN			
		ACC	PREC	RECALL	F1	ACC	PREC	RECALL	F1	ACC	PREC	RECALL	F1
LOCAL	WLD	89.85	90	90	90	61.59	60	62	62	81.15	81	81	81
	GABOR	93.47	94	93	93	62.31	64	62	62	57.97	58	58	58
	WAVELET	97.1	97	97	97	94.20	94	94	94	92.02	92	92	92
NON-LOCAL	TAMURA	97.1	97	97	97	87.68	88	88	88	95.65	96	96	96
	SHEARLET	94.2	94	94	94	33.33	11	33	33	91.30	91	91	91
COMBINATIONS	TAMURA-GABOR	97.1	97	97	97	52.89	51	53	52	57.97	59	58	58
	TAMURA-WLD	97.83	98	98	98	60.85	61	61	61	84.05	84	84	84
	TAMURA-WAVELET	97.82	98	98	98	97.82	98	98	98	89.13	89	89	89
	SHEARLET-GABOR	97.1	97	97	97	33.33	11	33	33	50	50	50	50
	SHEARLET-WLD	97.1	97	97	97	33.33	11	33	33	50	50	50	50
	SHEARLET-WAVELET	97.82	98	98	98	55.79	56	56	56	50	50	50	50
MULTISCALE		98.55	99	99	99	98.3	98	98	98	97.16	97	97	97

Table 1. Performance comparison of classifiers using different feature extraction methods.

CONCLUSION

By combining advanced texture analysis with machine learning, this work delivers a robust solution for automated rice grain classification. Techniques like Tamura, Gabor, Wavelet Transform, and WLD effectively captured key grain characteristics, while multiscale feature extraction enhanced classification by preserving texture details across resolutions. ANOVA and p-value analysis enabled efficient feature selection, reducing complexity without compromising accuracy. XGBoost emerged as the best-performing classifier with a peak accuracy of 98.55%, outperforming KNN and SVM. These results highlight the potential of multiresolution approaches, with future improvements possible through dataset expansion and deep learning integration.

REFERENCES

1. W. Srimulyani and A. Musdholifah, "Identification of rice variety using geometric features and neural network," *IJCCS (Indonesian Journal of Computing and Cybernetics Systems)*, vol. 13,no. 3, pp. 301–312, 2019.
2. I. Cinar and M. Koklu, "Identification of rice varieties using machine learning algorithms,"*Journal of Agricultural Sciences*, pp. 9–9, 2022.
3. M. Koklu, I. Cinar, and Y. S. Taspinar, "Classification of rice varieties with deep learning methods," *Computers and Electronics in Agriculture*, vol. 187, p. 106285, 2021. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0168169921003021
4. K. Robert Singh and S. Chaudhury, "A cascade network for the classification of rice grain based on single rice kernel," *Complex Intelligent Systems*, vol. 6, pp. 321–334, 2020