Innovation in Agriculture Industry by Automated Sorting of Rice Grains

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Abstract: Rice is the staple food in southern parts of our country. The agricultural sector has become an important income source for our country. Absorption of nutrients provides good health. Hence it becomes very important to preserve the nutrients and use organic fertilizers during rice cultivation. This seems to be a challenging task, due to the lack of implementation of innovative technologies in the agricultural sectors. When the harvested rice grains are polished to increase its appearance vitamin B1 or thiamin is lost and the deficiency of this vitamin causes Beriberi. Due to availability of various rice grains, sorting becomes very important as there are many varieties of rice grains available in the market. Sorting the rice grains cannot be done manually as it is neither feasible nor efficient. Manual sorting is a difficult task and requires more time. Hence, there is a requirement for an automated intelligent and smart rice grain sorting scheme. The proposed scheme has the capacity to recognize and categorize the rice grains based on colour, shape and length automatically. The first step is the collection of rice grain images pertaining to various quality. These images are initially refined by eliminating the noise using median filter. Features are then extracted from these noise free rice grain images. The features include major axis, minor axis, eccentricity, length, breadth, area and intensity. Machine Learning (ML) algorithms are used to train the automated rice sorting system using a computer. The ML algorithms include Black Widow Optimization Algorithm with Mayfly Optimization Algorithm (BWO-MA) categorizes the rice grains into premium and low grades. The rice varieties taken for analysis include Jaya, Budda, Abbilasha, Mugad Siri, MugadSukand and Mugad. Automation in rice grain sorting would support the agricultural sectors to have a great financial upliftment.

Keywords: Median filtering; Improved canny algorithm; Black Widow Optimization Algorithm with Mayfly Optimization Algorithm (BWO-MA); Artificial Neural Networks (ANN), Rice grain sorting.

1. Introduction

Among the conventional practices, cultivation is mentioned to be one of the oldest techniques in agriculture industry[1]. This industry is of great importance and prominence to mankind. Typically, the physical and chemical attributes contribute to the quality of food grains[2]. Currently, many methods were used for rice sorting. The noteworthy methods are neural networks and Image processing algorithms[3]. Extraction of dimensions and parameter analysis is initiated by using image processing algorithms[4]. All the other existing conventional techniques are time intensive and expensive[5]. To overcome these problems, a substitution method is implemented using image processing and ANN with Mayfly optimization algorithm[6]. An instrument called dial micrometer is available to measure the length and breadth of each every rice grain[1]. This analysis is very cumbersome and the accuracy of the

results will depend on the number of rice grains used for test purpose[7]. By sorting the rice grains, the nutritional value is preserved and a good quality rice grains are supplied to people at market[4]. Rice grains contain carbohydrates, proteins, vitamins, minerals and very small quantities of lipids. Vitamins A, C, D, K and Vitamin B2, omega-3 fatty acids, calcium, phosphorus, and minerals such as zinc, iodine, iron, etc. are all abundant in them[8]. Hence, the nutritious rice grains provide good health to human beings.

The issues related to agricultural development includes the following problems like talented training mode based on the demand for rice grains,insufficiency in novel irrigation methods, lack of a proper mechanism for communication between the farmers, consumers and agricultural engineers and finally lack of modernization.

2. Background Study

2.1 Artificial Neural Network (ANN)

ANN is a computational model that is designed in a way that the human brain analyses and processes information[16]. It is based on Artificial Intelligent (AI) and connects various processing elements; each is similar to a single node[26]. ANN is comprised of interconnected processing components which are called neurons[27]. All nodes take various signals based on the internal weight as an input and produce a single output[28]. The generated output is the input for another neuron. The architecture of ANN is categorized into different layers such as input layer, various hidden layer, and output layer[9]. The input layer accepts the input and processes it. The output layer provides the final output[29]. The mathematical function is performed in the hidden layers and it doesn't have any direct interact with the user program[17].

ANN adapts its configuration based on the internal or external data that runs over the network during the learning process[10]. ANN has the ability to mitigate the error, possibility of recalling, and provides a high-speed data[30]. Therefore, it is utilized to solve the complex problem like prediction and classification[31]. ANN has been applicable for various filed such as prediction, character recognition and data forecasting etc., ANN learning can be either supervised or unsupervised[32]. Supervised training is one of the common neural networks training which is accomplished by providing set of sample data with the expected outcome from every sample to the neural network[18]. Unsupervised training is as same as supervised training the only difference is it does not provide the expected outcome to the neural network[11]. These unsupervised training is occurred when the neural network classify the input into numerous groups[19].

2.2. Mayfly Optimization

The main perception of the MFO technique is stimulated from the behavior of mayfly especially from the mating process of a mayfly[12]. The mayfly belongs to the Ephemeroptera order which is one kind of primitive group of insects called Balaenoptera[13]. The name of mayfly is derived from the event that they appear mainly in the UK in May month[20]. This optimization technique depends on the PSO and comprises the advantage of PSO, GA, and FA. Adolescent mayflies are visible to the naked eye after completing the hatching[14]. An adult mayfly exists only one or two days, until achieving the ultimate goal of breeding[21]. The male attracts the female by assembling swarms, few meters above the water, and perform a nuptial dance. The female fly enters the swarm and mates with a male[22]. This mating process exists for a few seconds. After completing the mating process, the female mayfly drops the eggs onto the surface of the water and the process goes on. The feasible solution to the problem is denoted by each mayfly position in the search[25].

At first, two sets of mayflies are generated randomly which contain the female and male populations[15]. The swarm is gathered by the movement of the male mayfly that indicates the male mayfly position[22]. Whereas the female mayfly does not gather the swarm but they fly to the male for the breeding process[16]. Selection of parents is done through the male and female populations[23]. Parent selection is the same way as the female attracts the male[33]. The selection is either done in a random process or by their fitness value[24]. At last, the finest female breed with the finest male mayfly and the process goes on[25].

The species of paddy variety are recognized using some features like colour, surface, contour and head[8]. Image processing based analysis offers solution for online monitoring of the rice grains and sorting them[5]. Automatic solutions based on computer vision have been developed to help in the identification of plant species to address these challenges [6].
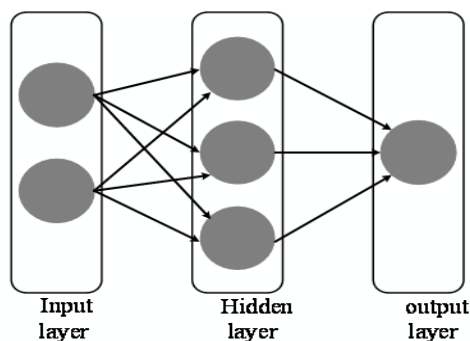

Fig.1: Basic structure of ANN

3. Objectives and Novelty

The major objectives include automated sorting of rice grains using Artificial Intelligence (AI). In addition to this the automated sorting is facilitated by measuring the length and color of the rice grains for various rice qualities. The proposed work is novel because, large quantities of rice varieties can be sorted at a faster rate[34].

4. Methodology

The primary method is the collection of images of rice corresponding to the varieties like Jaya, Budda, Abbilasha, Mugad Siri, MugadSukand and Mugad. The various features extracted from rice grains are major axis length, minor axis length, eccentricity, length and breadth[2]. The features are then used to train the ANN with BWO-MA on the computer[17]. Each image of rice grain should be allocated to its respective class. If the rice grains have not been tested it is categorized first and then sorted[18]. The proposed algorithms are validated using Rice sort Efficiency as the performance measure for various varieties of the rice grains[3]. The rice sorting system is sub-divided into small sections. They are discussed below. Capturing the images of rice grains images is done at first[19]. The features that are already mentioned are extracted from the rice grain images. The features are then classified by applying machine learning algorithms into their respective categories. The results of the machine learning algorithms are then used to sort the rice grains based on their quality[5].

In terms of nutrient secureness, rice grain sorting in agriculture yield a greater hazard if pesticides are used. In decades, sorting of rice grains is done manually by the naked eyes with the help of experience[35]. In this article, it is needed to discover the quality of rice grains based on the category. By utilizing the combination of machine learning and image processing techniques, it is possible to sort rice grains based on quality and category. This work has two partitions: The first part is a rudimentary part, in which image pre-processing and segmentation is implemented to increase the image quality and mitigate the noise. The feature selection and categorization is carried out as a second stage of the work. Figure 2 shows the proposed methodology.
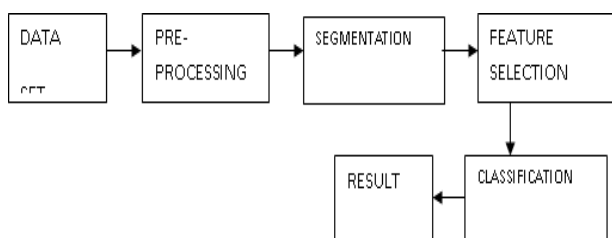

Fig.2: Overall flow of the Proposed Architecture

The rice grain classification and identification approach have four various phases: pre-processing, segmentation, feature selection and classification. The first stage is preprocessing, where the rice grain images are composed and employed with the preprocessing stage, where the filtering approach (median filtering) has been performed. The filtering process usually helps to get rid of unwanted noise from the input image, then to enhance the contrast of the image; the histogram equalization has been performed. Once the preprocessing gets completed, by using the improvised edge detection and segmentation algorithms, the sorting of rice grains are performed as an automated process. Once the rice grain image is segmented the segmentation output goes to the feature selection process. As a novel contribution to the feature selection, a hybrid algorithm called a Black Widow Optimization Algorithm with Mayfly Optimization Algorithm (BWO-MA), for solving global optimization problems. The main reason is that the mayflies mutated to enhance the exploration ability of the algorithm. Once the feature selection process is complete then output is sent to the classification process. A combined (BWO-MA) with Artificial Neural Networks (ANN) based diagnostic model for sorting of rice grains. The proposed method is to extract an automatic set of features for classifying and identification of the quality of rice grains. The proposed method has high efficiency in improving classification accuracy.

5. Results and Discussion

This automated system is successfully able to identify various parameters based on the variety of captured sample images of rice grains as shown in Figure 3. This scheme is effectively capable to extract features and parameters from the rice grain images and store the corresponding data for the features for further processing. The system is also able to evaluate the number of rice grains in each image. Apart from this, the system is able to process multiple images using the proposed machine learning algorithm.

It contains 920 images with high resolution and it captured by placing the three cameras in different locations. Nearly, 520 images are used for training, 200 images are used for testing and the last set of 200 images is used for validation. The data set contains some visual features. Based on the visual features the objective function is decided and iterated further till a minimum value is obtained. Furthermore, the effectiveness of the system is validated by comparing the evaluation metrics of the proposed approach with the existing approaches. The evaluation metrics are computed by the confusion matrix attained from the experimental outcomes. For this analysis, Accuracy, Precision, Recall, F1_score and specificity are taken as an evaluation metrics.

5.1. Evaluation & Results

In this work, Machine learning technique is incorporated with the meta-heuristic algorithms namely Artificial neural network (ANN) with hybrid mayfly and black widow optimization algorithm (BWO-MA) to effectively recognize the hand gesture. The evaluation metrics results showed better performance of the proposed ANN with BWO-MA approach. Furthermore, different images are taken as an input from the open source dataset to classify the quality from the given images. Figure 4 illustrates the classified regions of the given input images. The quality of the rice is identified using this automated AI based image processing scheme.
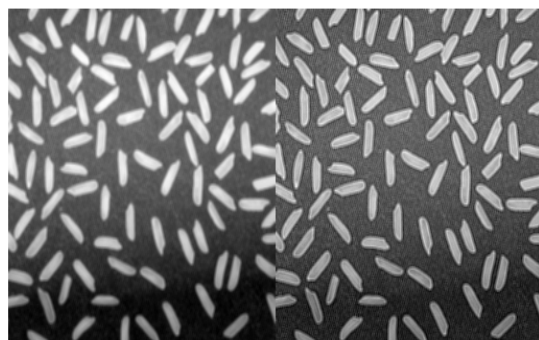

Fig. 3: Input sample images of rice

Fig. 4: Output images

Table 1. Comparative analysis for Rice Sorting

S.No	Techniques	Sorting Score (%)
1.	Support Vector Machine (SVM)	95
2.	Decision Tree (DT)	96
3.	Navies Bayes (NB)	95
4.	ANN - BWO-MA	98

The table 1 illustrates the evaluation metrics for different approaches. The evaluation metrics in Figure 5, for this analysis are accuracy, sensitivity, precision,

F1-measure and specificity. The accuracy for the SVM, DT, NB and proposed ANN-BWO-MA approaches are 96%, 97%, 96% and 99% respectively. As shown in Figure 6, the confusion matrix for ANN-BWO-MA classifier indicates that the performance of rice sorting is efficient. The classification algorithm model provides morethan 95% recall value between operation cycles, and false discovery rate less than 3 %. Inparticular, 2-3 % of the data assigned trained class data misclassified between ANN-BWO-MA and other classification techniques like SVM, NB and DT. However, ANN-BWO-MA classification model assigned 99% of the labeled data pertaining to rice grain sorting correctly.

Fig. 5: Confusion Matrix for Rice Grain Sorting

The well-designed ANN-BWO-MA are compared with the other popular classification methods for both quantitative and qualitative comparison. The ANN-BWO-MAis capable of sorting the rice grains at a faster rate with flexibility. For validation during experimentation, 200 datasets corresponding to various qualities of rice grains are used and the accuracy of sorting is depicted in Figure 6.
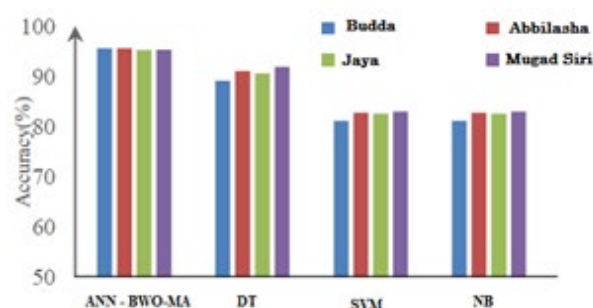

Fig. 6: Pictorial Representation for Accuracy

6. Conclusion

The experimental result used to develop a machine learning model for better classification ofdifferent phases of the dumper operation cycle. The feature extractionmethod addressed with the help of SVM, DT, NB and ANN-BWO-MA classifiers. This method is found to reduce the computational complexity by reducing the dimensions of large data sets associated with the rice images. This is done by transforming a large set of variables into a smaller one that still contains most of the information without any loss. Further the model is protected against over fitting by using 3 folds cross validation. Thus to sort the rice grains, a prominent machine learning-based BWO-MA with ANN was proposed in this work. Along with different models, it showed huge matrices and classified output with visual interaction from the classification outcomes. Also, we implemented image processing techniques such as histogram equalization, canny algorithm segmentation to enhance the classifiers for transforming the input image to the more suitable with our classifier. In this work, pre-processing, segmentation, BWO-MA feature selection and ANN classifier approaches are used to enhance the level of prediction and identification on the images of rice grains. The simulation results demonstrated that the proposed machine learning method is a way better than that of the conventional machine learning prediction models. This proposed method has high computational efficiency for sorting the rice grains as compared to the existing machine learning-based classifiers with high accuracy.The major advantage is increase in productivity and the disadvantage is that the lack of implementation in modernized methods to tackle variation in climatic changes.

References

1) Rafi Muhammad, SandyantoAdityosulindro, "Biosorption of Brilliant Green Dye from Synthetic Wastewater by Modified Wild Algae Biomass", Joint Journal of Novel Carbon Resource Sciences and Green Evergreen Asia Strategy, pp: 133-140, 2022.

2) Irma Alfie Yassin, ReinnyPatrisina, ElitaAmrina, "Location-Allocation Model for Victims and Health Workers during Post Earthquake-Tsunami Health Crisis in Padang City", Joint Journal of Novel Carbon Resource Sciences and Green Evergreen Asia Strategy,pp: 234-245, 2022.

3) Mahale, B. "Rice quality analysis using image processing techniques", International conference on Convergence of technology, pp. 1-5, 2014.

4) Neelamegam, P ." Analysis of rice granules using image processing and neural network". Information & communication Technologies IEEE conference, 2013.

5) Jagdeep Singh Aulakh ,Dr. V.K. Banga, "Grading of rice grains by image processing", International Journal of Engineering Research Technology, Vol. 1 Issue 4, 2012.

6) S. Kanchana, S. Lakshmi Bharati, M. Ilamran and K. Singaravadivel, " Physical Quality of Selected Rice Verities", World Journal of Agriculture Sciences, pp. 468-472, 2012.

7) Chet ana V. Maheshwari, Kavindra R. Jain, Chintan K. Modi, " Non -destructive Quality Analysis of Indian Gujarat -17 Oryza Sativa SSP Indica (Rice) Using Image Processing", International Journal of Computer Engineering Science , Vol. 2 Issue 3, 2012.

8) DollawatNgampak, PunpiiPiamsanga, " Image Analysis of Broken Rice Grains of Khao Dawk Mali Rice", Knowledge and Smar Technology, 7th International conference, pp.150-120, 2015.

9) Bhavesh B. Prajapati, Sachin Patel, "Classification of Indian Basmati Rice Using Digit al Image Processing as per Indian Export Rules", International Research Journal of computer Science Engineering and Applications, Vol. 2 Issue 1,2013.

10) Bhupinder Verma, " Image Processing Techniques for Grading Classification of Rice", International Conference on Computer and Communication Technology (ICCCT), pp. 220-223, 2012.

11) N. A. Kuchekar, V. V. Yerigeri, "Rice Grain Quality Grading Using Digital Image Processing Techniques", IOSR Journal of Electronics and Communication Engineering, Volume 13, Issue 3, pp: 84-88, 2018.

12) Harpreet Kaur, Baljit Singh, " Classification Grading Rice using Multi-Class SVM ", International Journal of Scientific and Research Publications, Vol. 3, Issue 4, April 2013.

13) Ruchi Bansal, Jagdeep Singh, Ranjodh Kaur, "Machine learning and its applications: A Review",Journal of Applied Science and Computations, Vol VI, Issue VI, pp: 1392-1398, 2019.

14) Shilpa J. Bhonsle, "Grain Quality Evaluation and Organoleptic Analysis of Aromatic Rice Varieties of Goa, India", Journal of Agricultural Science, pp. 99- 107, Vol. 2, No. 3; September 2010.

15) G.Ajay, M.Suneel, K.Kiran Kumar, P .Siva Prasad, "Quality Evaluation of Rice Grains Using Morphological Methods", International Journal of Soft Computing and Engineering, pp. 35-37, Vol. 2, Issue 6, January 2013.

16) Maheshwari, C.V, Jain K R, Mod C K, "Non -destructive Quality analysis if Indian Basmahtioryza SSP Indica (Rice) using image processing", Communication systems and Networking Technologies International conference, pp. 189 – 193, May 2012.

17) Qing Yao, Jianhua Chen, Zexin Guan, "Inspection of rice appearance quality using machine vision", Global Congress on Intelligent Systems, 2009.

18) Tejas G. Patil, Sanjay P. Shekhawat, Artificial Neural Based Quality Assessment of Guava Fruit, Evergreen - Joint Journal of Novel Carbon Resource Sciences and Green Asia Strategy, pp: 389-395, 2022.

19) Sujatha, K., Bhavani, N.P.G., Cao, S.-Q., Ram Kumar, K.S, Soft sensor for flame temperature measurement and IoT based monitoring in power plants, Materials Today: Proceedings, Volume 5, Issue 4,pp: 10755-10762 , 2018.

20) Sujatha, K. Pappa N., Combustion Quality Monitoring in PS Boilers Using Discriminant RBF, ISA Transactions, Vol.2(7), pp.2623-263, 2011.

21) MuslihudinMuslihudin, WiwiekRabiatulAdawiyah, EkoHendarto, RatriDamaryantiMegasari, Muhammad Fadil Ramadhan, Environmental Constraints in Building Process a Sustainable Geothermal Power Plant on The Slopes of Slamet Mount, Central Java, Indonesia, Joint Journal of Novel Carbon Resource Sciences and Green Evergreen Asia Strategy,Pages 300-309, 2022.

22) BhoopendraDwivedy, Anoop Kumar Bhola, C.K. Jha, Clustering Adaptive Elephant Herd Optimization Based Data Dissemination Protocol for VANETs, Joint Journal of Novel Carbon Resource Sciences and Green Evergreen Asia Strategy,Pages 812-820, 2021.

23) Paras Bhatnagar, ShivendraKaura, Sanjeev Rajan, Predictive Models and Analysis of Peak and Flatten Curve Values of CoVID-19 Cases in India, Joint Journal of Novel Carbon Resource Sciences and Green Evergreen Asia Strategy, Pages 458-467, 2021.

24) Takaya Fujisaki, Evaluation of Green Paradox: Case Study of Japan, Joint Journal of Novel Carbon Resource Sciences and Green Evergreen Asia Strategy,Pages 26-31, 2018.

25) K. Sujatha, V. Srividhya, Soft Sensor for Capacitance Tracking in Quality Assurance of Fruit Ripening Process,MATERIALS TODAY: PROCEEDINGS, Vol. 5, no. 10, pp.20785-20792, 2018.

26) K. Sujatha, NPG. Bhavani, A Smart Phone App with Geo-Spatial Information for Forecasting COVID-19 from Lung X-ray Images, Information and Communication Technology for Competitive Strategies, 2022.

27) K. Sujatha, Electronic Aid Design of Fruits Image Classification for Visually Impaired People,SMART INNOVATION, SYSTEMS AND TECHNOLOGIES, Vol. 196, no. , pp.727-734, 2021.

28) Kazuhide Ito, Micro- and Macro-Scale Measurement of Fungal Growth under Various Temperature and Humidity Conditions, Joint Journal of Novel Carbon Resource Sciences and Green Evergreen Asia Strategy,pp: 32-39, 2014.

29) Takashi Watanabe, Ignorance as a Limitation for the Application of Scientific Methods to Environmental Protection Activities, Joint Journal of Novel Carbon Resource Sciences and Green Evergreen Asia Strategy, pp: 41-48, 2015.

30) Muhammad H. Mahmood, Muhammad Sultan, Takahiko Miyazaki, Shigeru Koyama, Desiccant Air-Conditioning System for Storage of Fruits and Vegetables: Pakistan Preview, Joint Journal of Novel Carbon Resource Sciences and Green Evergreen Asia Strategy, pp: 12-17, 2016.

31) Arihiro Kano, Moses KibunjaKamita, Takuma Iwasaki, Mitsuru Shindo, Bongkrekic Acid induces Selective Cytotoxicity in Tumor Cells, revealed by CCK-8, Joint Journal of Novel Carbon Resource Sciences and Green Evergreen Asia Strategy,pp: 23-27, 2017.

32) Mohammed Ali Berawi, Sutan Akbar OnggarSiahaan, Gunawan, Perdana Miraj, PekkaLeviakan Determining the Prioritized Victim of Earthquake Disaster Using Fuzzy Logic and Decision Tree Approach, Joint Journal of Novel Carbon Resource Sciences and Green Evergreen Asia Strategy,pp: 246-252, 2020.

33) A. Dey., A Brief Review of Machine Learning and its Application, International Journal of Computer Science and Information Technologies, Vol.7,pp:1174-1179, 2017.

34) S. Diksha, K. Neeraj., A Review on Machine Learning Algorithms, Tasks and Applications, International Journal of Advanced Research in Computer Engineering and Technology,Vol. 6,pp:1548- 1551, 2017.

35) H. M. K. K. M. B. Herath, G. M. K. B. Karunasena and R. D. D. Prematilake ., Computer Vision for Agro-Foods: Investigating a Method for Grading Rice Grain Quality in Sri Lanka, Transactions on Computer Systems and Networks, Vol:502., pp 21–34, 2022.