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Review Article

QUALITY ANALYSIS OF RICE GRAINS USING ANN AND SVM

DIVYA MOHAN[1], MURUGANANTH GOPAL RAJ[2]

[1]Assistant Professor, Dept. of ECE, Ahalia School of Engineering and Technology, Palakkad, India.
[2]Prof. & Head, Dept. of EEE, Ahalia School of Engineering and Technology, Palakkad, India.

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ABSTRACT

Rice is the most favorable and most consuming food for all the human being in all over the world. Market for rice depends on the quality of it. Currently the type and quality of rice are assessed by visual inspection method through naked eye. This process is however tedious, time consuming, needs human expertise and depends on physical fitness of the inspector. To overcome these drawbacks, in this paper, an automated system is introduced which identifies and classifies the rice grains based on digital image processing techniques. Image processing method is most suitable as it is a non-contact technique, where in the image of the rice grains are captured. The captured images are pre-processed, segmented and features are extracted through MATLAB. From the extracted features the quality of rice is assessed based on Neural Networks (NN) and Support Vector Machine (SVM) classifier algorithms. A comparative study is made between these two methods and the results infer that SVM based classification outskirts its counterpart.

Keywords: Rice, Neural Network, Support Vector Machine, Colour Feature, Geometric Features.

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INTRODUCTION

India is the second largest cultivator of rice through approximately 44 million hectares of land. 65% of Indian population eats rice and it accounts to 40% of the rice production. About 50 million of households rely on rice cultivation as main source of income and employment. Currently, 6000 rice varieties are being cultivated in India. Out of these the major rice variety cultivated in south India includes, polished white rice (ponni), brown rice, Palakkad matta rice, fragrant biryani rice and Kavuni (Black) rice. The quality of rice depends on moisture content, grain purity, cracks, presence of immature grains, grain dimensions, whiteness, milling degree and chalkiness. Of these parameters, grain purity, dimensions and cracks are the main features that decide the grade of the rice and cost. So, the correct assessment of quality of rice is an important task. The analysis of type of grain, grading and assessing the quality attributes are being done manually.

Manual checking process is more complex. It depends on working condition, human factors, rate of cleaning and recovery salvage. The other factors that affect rice quality include addition of impurities viz. stones, damaged seeds and broken granules. The accuracy of manual inspection through human inspectors is less, and so the possibility of mix up of impurities is more. This deteriorates the quality of rice. Also manual checking is tedious as it subjected to the operator concentration and time consuming. Sample testing method makes the testing more costly. In order to overcome these difficulties, image processing based automated classifier systems are designed to test the quality of rice grains.

RELATED WORKS

The quality of food grains play a vital role for healthy life, which is affected by increase in world population and climate change. High quality and safety standards are being entrusted by the governments to maintain healthy life. Manual inspection system is being used for the past few decades. Checking the quality of food and agriculture products through human inspection are problematic and labor concentrated. The system makes a random or sample checking from large batches. This is more time consuming and inconsistent due to lack of trained labors. These lead to huge variations during the analysis and classification of rice grains. Many researchers aimed for automated systems based on image processing techniques. Bhagyashree Mahale & Sapna Korde (2014) utilized edge detection algorithm and analyzed the quality of rice grains through grain size and shape. Morphological features have been used to train the network and their proposed system identified grain type, impurities and assessed the quality accurately.

Megha Sidhagangappa & Kulkarni (2014) developed a mobile application to grade the varieties of jowar using android emulator. This application utilizes MATLAB tool for preprocessing the image, segmentation and feature extraction. Based on the results of these processes, the established system graded the jowars. Convolution Neural Network (CNN) based approach has been presented by David Attokaren et al (2015), to classify the food grains. CNN utilizes the pixels to estimate the score function, using which the features of the images are extracted. This system resulted with an accuracy of 86%. Vidya Patil & Malemath (2015), investigated logic algorithm based model for assessing the quality of rice grains. OpenCV library has been implemented to diagnose and classify externally diseased fruits by Ashwini Awatae (2015). In order to segment the image of the fruits, the system of study used K-means clustering method. Pattern matching and disease classification are assisted by Artificial Neural Network (ANN) techniques. Aran M O et al (2016) proposed a computer based machine vision automated system to pattern and classify the types of cashew nuts. The researchers utilized the features viz. colour, texture, size and shape for grading the grains and Back Propagation Neural Networks (BPN) to classify them. Probabilistic Neural Network (PNN) based grain type identification has been addressed by Poornima Dered & Shanmukhappa Angadi (2016). Color and the geometrical features of the grains are used to classify the type of grains in this system.

In the review carried out by Abhishek Gudipalli et al (2016), machine vision based techniques have been utilized to measure the quality of grains and identifying the adulteration content in them. Rice is the food grain taken up for stud and the rice grains are detected and graded using canny edge detection method. During the year 2017, Depika Sharma & Sharad Sawant determined quality of rice grains through NN classifier. They developed an experimental setup in order to demonstrate the working of their proposed system. Digital image analysis algorithm based on color and morphological features has been developed by Mansi Kulkarni & Soni (2017). In their study, the developed algorithm has been applied to identify variety of rice seeds

planted in Zhejian Province. The aimed algorithm holds good for the application as it resulted better accuracy. In India, Agmark is a standard certification employed for agricultural products. Dipnakar Mandal (2018), estimated the quality of rice as per the present Agmark standards using image processing principles, through MATLAB. The limitations in manual rice grain quality assessment system is its relative grading, time consuming, cost and varying results. These parameters have been addressed by Kucheker & Yerigeri (2018) and they suggested that digital image processing technique will be the suitable solution for the same.

From the aforementioned literature studies, it is evident that quality of rice grains plays an important role in human health. The manual inspection method of assessing the quality of rice grains possess certain drawbacks which include tedious, time consuming, inaccuracy, eye irritation and other health problems which affect the evaluation process. In order to overcome these entire drawbacks image processing based rice grain quality assessment system has been proposed in this research work.

PROPOSED METHODOLOGY

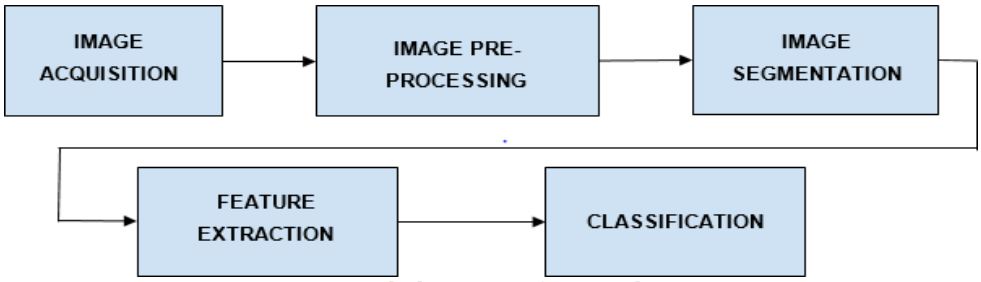


Figure 3.1: Block Diagram of Proposed System

The block diagram of the proposed automated rice quality assessment system is portrayed in Figure 3.1. The system includes image acquisition, pre-processing, segmentation, morphological feature extraction viz. geometrical structure & shape and classification process. In order to classify the rice grains ANN and SVM based algorithms have been used in this research work.

Image Acquisition

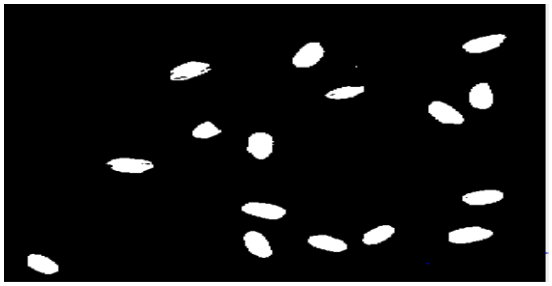
The image of the rice grains are acquired through high quality camera sensor system. The minimum prescribed pixel to be used is 8 MB, as it determines the quality of fine grains of rice and the overall efficiency of the system. Sample images of rice granules are captured and stored for training and testing purposes. Figure 3.2 (a) shows the sample rice grain image.

Figure 3.2 (a): Sample Rice Grain

Image Pre-Processing

Image pre-processing is the phenomenon where the images are resized, contrast of the images are adjusted as in Figure 3.2 (b) and the image is converted into gray scale, as in Figure 3.2 (c) and finally into black and white as shown in Figure 3.2 (d). These processes help to remove the unwanted distortions, noise and blur in the image, resulting in enhanced quality image, suitable for further processing.

(b) **(c)**



(d)

Figure 3.2: Pre-Processed Images

Image Segmentation

Segmenting the image into several parts assist to locate the objects and boundaries in an image. The objects and its boundaries are located by assigning labels to each pixel with similar characteristics. Once the image is pre-processed, the Region Of Interest (ROI) is segmented out from the image. Figure 3.3 depicts the segmented image.

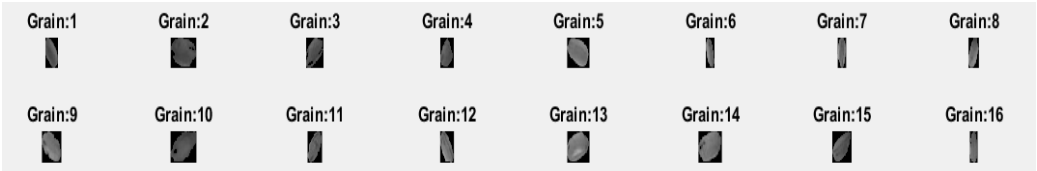


Figure 3.3: Segmented Rice Grains

3.4 Feature Extraction

Features define the behavior of an image which in turn affects the storage space occupied, classification efficiency and time consumption. The features of rice image include geometrical features viz. area, perimeter, major and minor axes and morphological features viz. mean values of Red, Green and Blue. These features are extracted and stored as knowledge base for training and testing purposes during classification process. Based on these features the rice variety and its types are identified. Figure 3.4 depicts the kernel of the rice grain showing the features.

Figure 3.4 Rice Grain Kernel

Classification

Classification is the approach by which images are grouped into different classes based on the features extracted from them. In this research work, ANN and SVM classifier algorithms have been used to classify the rice grains and the results have been compared.

ANN Based Classification

ANN classification system is inspired by biological nervous system which composes of multiple nodes, emulating biological neurons of human brain. The nodes or neurons are connected and interact with each other. The nodes accept the input data, process them and transform them to other neurons as output through the link. Each link will have its own weightage, which could be modified. The output at each node is processed through the weight. The layer in between the input and output is called as hidden layer, which performs computations on weighted inputs and produce the net input. The net input is then applied with activation function to produce the actual output. The number of hidden layer is usually one or can be 2/3 of the sum of input and output nodes. During passing form input to output layer, the network randomly adds some weight and the result is passed to the successive nodes. The final output is compared with the target. If unmatched, it propagates backwards and alter the weights until the output is matched with the target. Figure 3.5 portrays the ANN architecture.

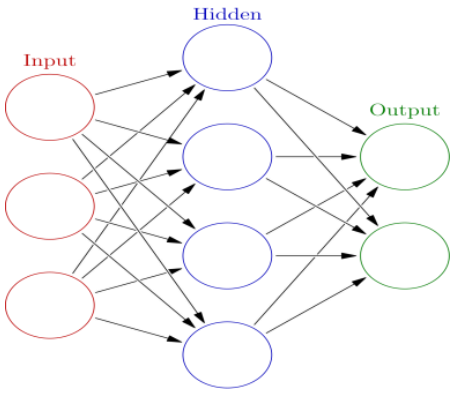


Figure 3.5 ANN Architecture

SVM Based Classification

Support Vector Machine can be employed for classification and regression purposes. It is a supervised learning method. It utilizes, support vector which are the data points of data set nearest to the hyper plane. If the data set is removed, it alters the position of the dividing hyper plan. Figure 3.6 illustrates Support Vectors and hyper plane. The distance between the hyper plane and nearest data point from either set is called as margin. The objective is to choose a hyper plane with highest margin in a training set, such that a new data is being classified correctly. Once the features are extracted from the images, the inputs are labeled as predictors and outputs as response.

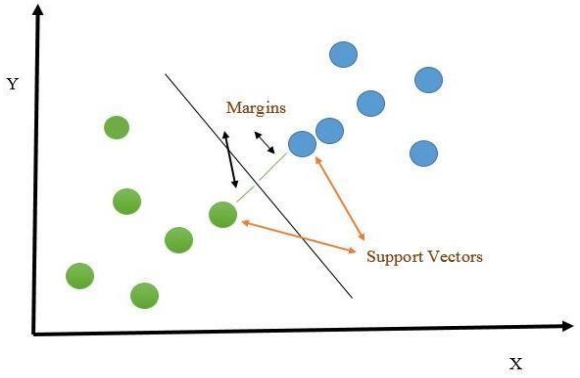


Figure 3.6: Support Vectors

EXPERIMENTAL ANALYSIS AND RESULTS

The process flow proposed automated rice grain quality assessment system based on ANN and SVM has been depicted in Figure 4.1.

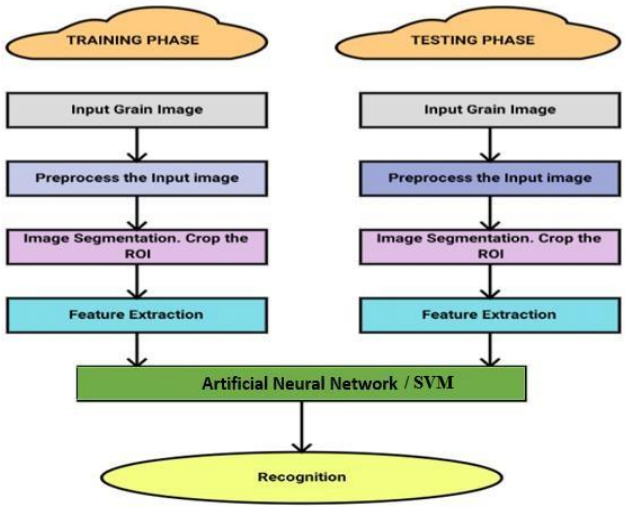
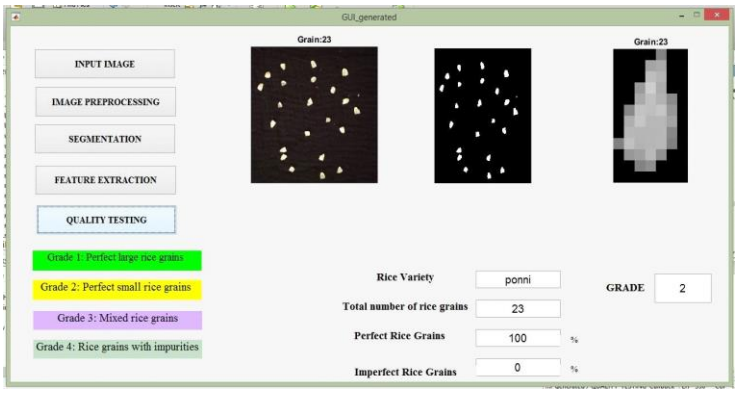


Figure 4.1: Process Flow Chart

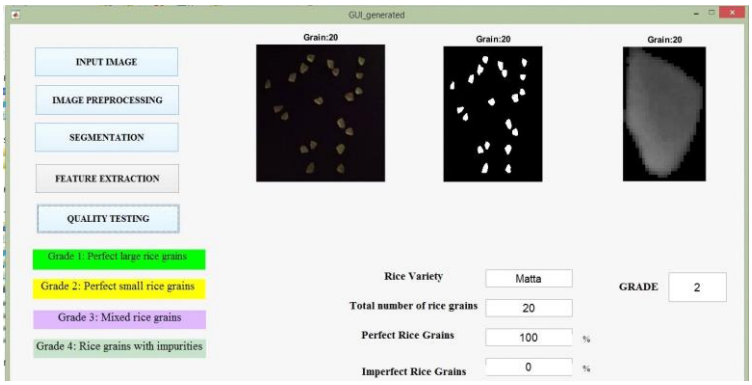
Two commonly used rice varieties are taken up for study viz. Matta and Ponni. They are classified into four grades as given in Table 1. The Mean values of RGB of different images are used to classify the rice as Ponni and Matta rice. Test results are depicted in Figure 4.2. (a) for Ponni variety and Figure 4.2 (b) for Matta rice. The geometrical features are used to grade the rice grains as grade 1, grade 2, grade 3 & grade 4. The results are shown in Figure 4.2 (c) for grade 1, 4.2 (d) for grade 2 and 4.2 (e) grade 4.

Table 1: Grade of Rice Grains

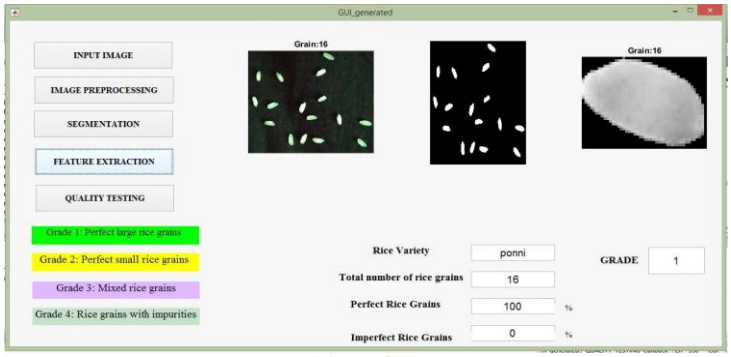
Grade	*Type*
1	*Perfect large rice grains*
2	*Perfect small rice grains*
3	*Imperfect (Mixed) rice grains*
4	*Rice grains with impurities*



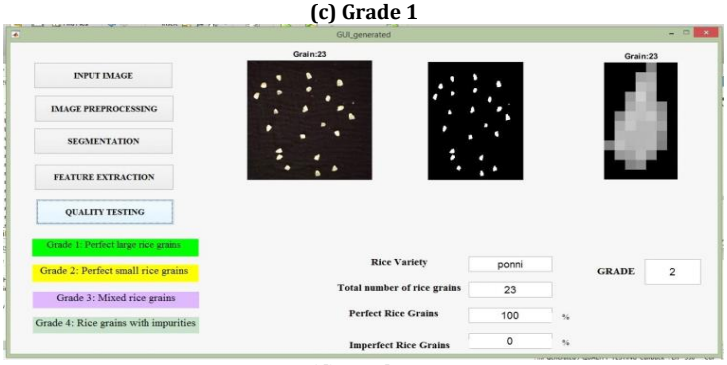
(a) Ponni Rice



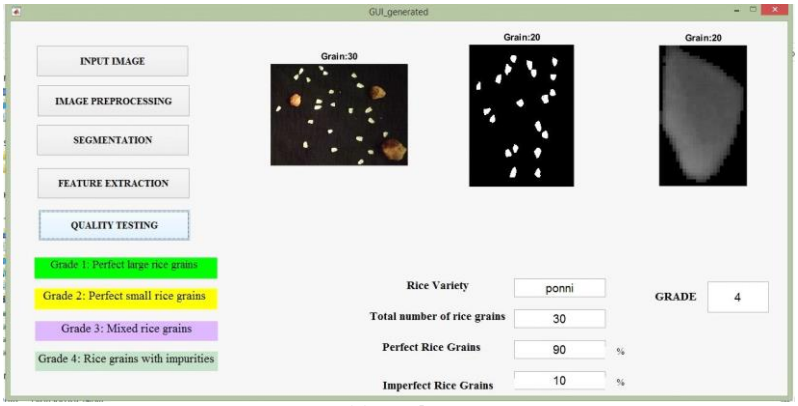
(b) Matta Rice



(c) Grade 1



(d) Grade 2



(e) Grade 4

Figure 4.2: Test Results for Rice Variety and Grades

Results of ANN Classifier

The rice grains classification system are carried out using nntool box of MATLAB. Seven data set has been used in NN classifier system. Figure 4.3 shows the ANN framework used in this research work. 7 features have been considered as inputs, whereas the rice quality and variety have been considered as outputs. This model has 48 hidden layers, as to achieve highest accuracy level. The results of the NN classifier have been depicted in Figure 4.4.

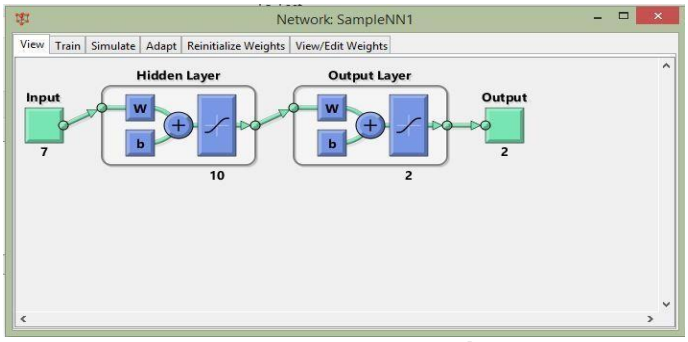
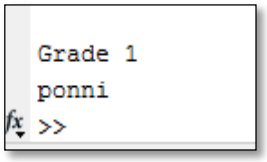
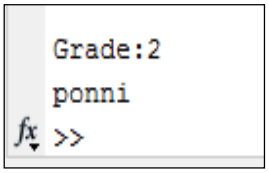
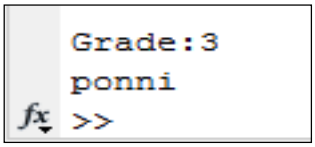
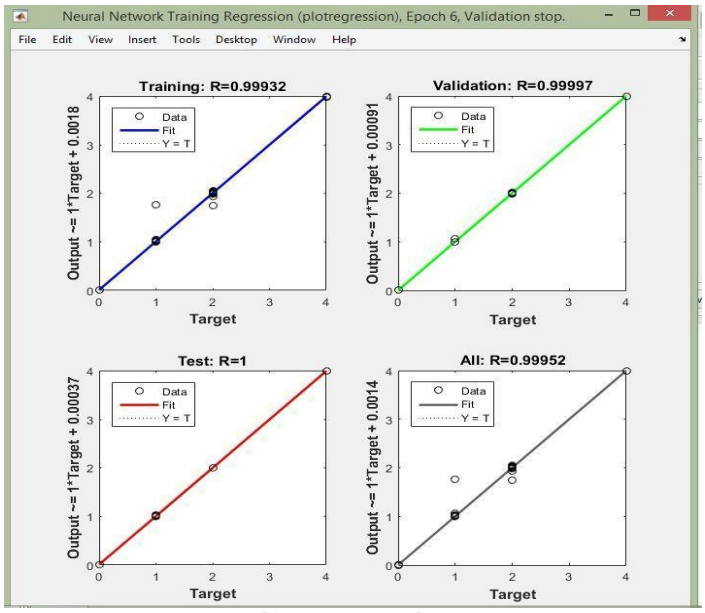


Figure 4.3: ANN Framework

INPUT IMAGE	OUTPUT
	
	
	

(a) Variety and Grade of Rice Grains



(b) Regression Plots

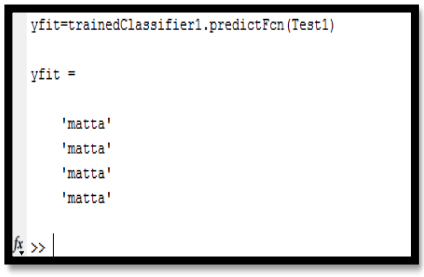
Figure 4.4: Results of ANN Classifier

Results of SVM Classifier

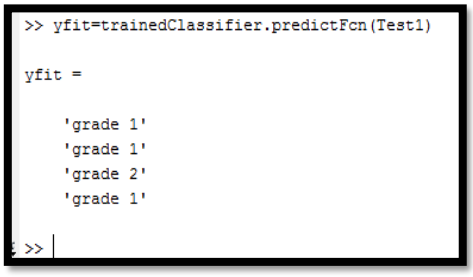
The features extracted are tabulated and utilized in MATLAB to train the classification learner and SVM trainer. The features like major & minor axes, area, perimeter and mean RGB are considered as predictors and rice variety & grade are responses. Figure 4.5 depicts the input test data and results of SVM classifier.

Area	Perimeter	MajorAxis	MinorAxis	MeanR	MeanG	MeanB
428	127.039	42.13192327	14.51272387	15.048	8.1333	12.8241
713	100.674	42.16829761	21.75631096	15.048	8.1333	12.8241
692	94.677	35.71486629	24.84381539	15.048	8.1333	12.8241
900	296.289	54.19479984	34.25243423	15.048	8.1333	12.8241

(a) Predictors

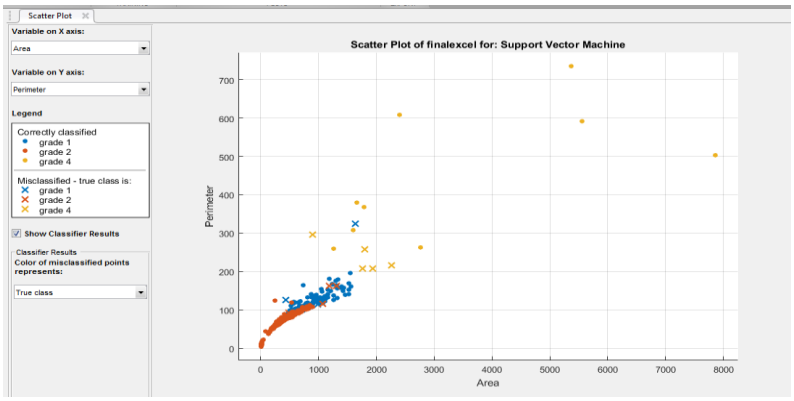


(i) Variety

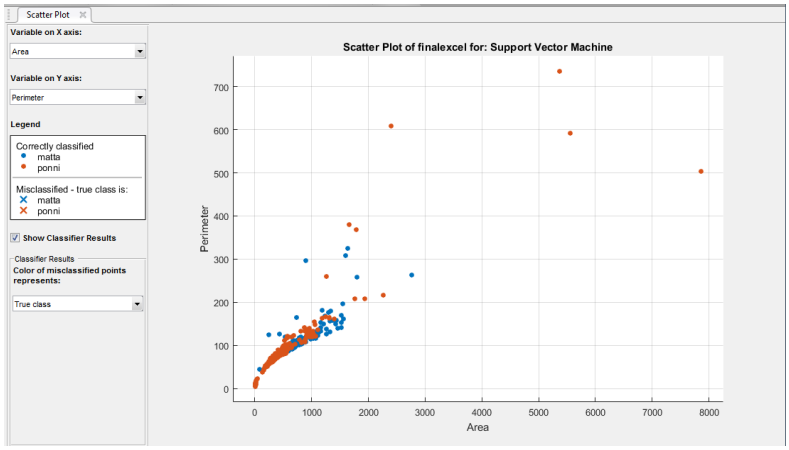


(ii) Grade

(b) Classification



(c) Scatter Plot with quality as response



(d) Scatter Plot with grade as response

Figure 4.5: Results of SVM Classifier

COMPARATIVE ANALYSIS

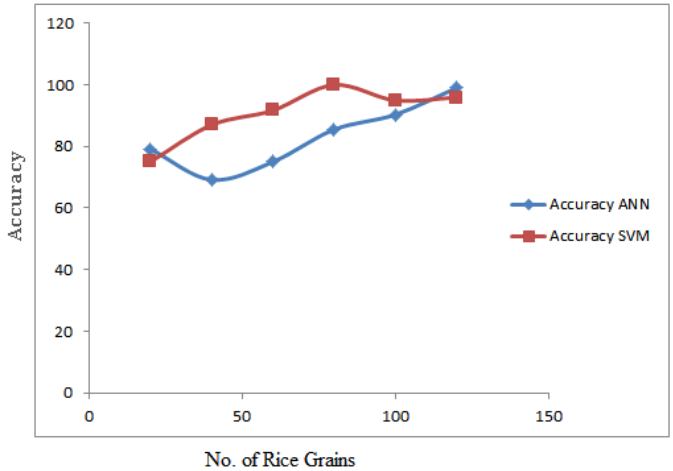


Figure 5.1: Comparative Analysis

A comparative analysis has been made between ANN and SVM Classifier algorithms on the samples of rice grains. Figure 5.1 portrays the comparative analysis of accuracy level resulted from both the classifiers and other parameters have been tabulated in Table 2.

Table 2: Comparison between Results of ANN and SVM Classifiers

Classifier	Performance	Accuracy	Classification	Time consumption for training
SVM	Very high	High	One type of classification at a time	low
NN	High	Less	More than one type of classification at a time	high

CONCLUSION

Consumers of today are very conscious about the quality of food grains. In order to ensure the quality of rice grains, an automated rice grain quality assessment system based on ANN and SVM classifiers has been addresses in this research work. Two types of rice grains viz. Ponni and Matta are taken up for study. The proposed system identified and classified the rice grains based on their morphological and geometrical features. The experimental analysis showed that the proposed ANN classifier has an overall accuracy of 83%, whereas SVM resulted in 91%. On the other hand, when the other parameters are considered, such that the computational time and parallel processing (classifying more than one samples at a time), the performance of SVM is far better than its counterpart. The reasons may be due to imbalance training ratio. It is concluded that the proposed system can effectively classify the type of rice grains.

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