Deep Learning for Rice Quality Classification

Nguyen Hong Son and Nguyen Thai-Nghe
Can Tho University
Can Tho city, Vietnam
son.nguyenhong1990@gmail.com, ntnghe@cit.ctu.edu.vn

***Abstract* - Rice is one of the profit export products of Vietnam but how to detect quality of the rice is still difficult. This work proposes an approach for rice quality classification. In this approach, image processing algorithms and machine learning methods were used to recognize and classify two difference categories of rice (whole rice and broken rice) based on the rice's size of the national standard of rice quality evaluation, using Convolutional Neural Network (CNN). Experimental results for 2000 real images give 93.85% accuracy. The system also used Support Vector Machines method with HOG features and k-Nearest Neighbors methods in order to classify and compare the accuracy of those algorithms which show the results of 85.06% and 84.30% accuracy, respectively. These results show that rice quality evaluation and classification could be automatically done using Deep Learning approach.**

Keywords—Rice classification, Deep learning, Convolutional Neural Network, Support Vector Machines, Histogram of Oriented Gradients.

I. INTRODUCTION

Rice recognition and classification through computer vision is a practise topic recently [3][4][5][6]. There were several researches and academic papers relevant in this field using handling and data extraction methods as well as recognition approaches [1][7][9]. For example, Ozan AKI, Aydın Güllü and Erdem Uçar [3] with the method in extraction of 6 properties (perimeter, square, length, thickness of rice, thickness and thinness of bounding box) to get the result of 90,5% accuracy with many difference methods. Harpreet Kaur and Baljit Singh [4] mark the recognize point on rice's border, using SVM method and get the result of 86% in accuracy.

However, those researches are belong to the choosen previous features and seleted by experience of researchers. Besides, with the small size object database like rice, the input database collection is difference from many authors, includes angle shooting, brightness, distance which are data noising effection. Rice is one of the profit export products of Vietnam but how to detect quality of the rice is difficult and research works in this area still has room for improvement.

In this paper, we propose rice classification system bases on computer vision, machine learning and image processing algorithms, in order to recognize and classify two difference categories of rice (whole rice and broken rice) based on rice's size, the national standard of rice quality evaluation, which using CNN. Databases are self-collected images about the rice pattern of Loc Troi 20 breed and captured by 20.7 MP camera of Sony Z1 smartphone. The experimental results in about 2000 images of whole rice and broken rice illustrates the rice recognition and classification with convolutional neural network give 99.16% accuracy on training set and 93.85% accuracy on testing set. The system also used Support Vector Machine method with HOG feature, k-Nearest Neighbors method in order to classify and compare the accuracy of those algorithms, with the results of 85.06% and 84.30% accuracy on testing set respectively. The results shown the capable of using Convolutional Neural Network for rice classification and quality evaluation.

The next parts of this paper was recognized as follows: Part II presents the rice classification system. Part III presents the experimental results. Part IV presents the conclusion and development.

II. RICE RECOGNITION SYSTEM

We propose rice classification system based on computer vision, machine learning and image processing algorithms, in order to recognize and classify two difference categories of rice (whole rice and broken rice) based on rice's size, the national standard of rice quality evaluation, which using CNN as presented in Fig. 1.

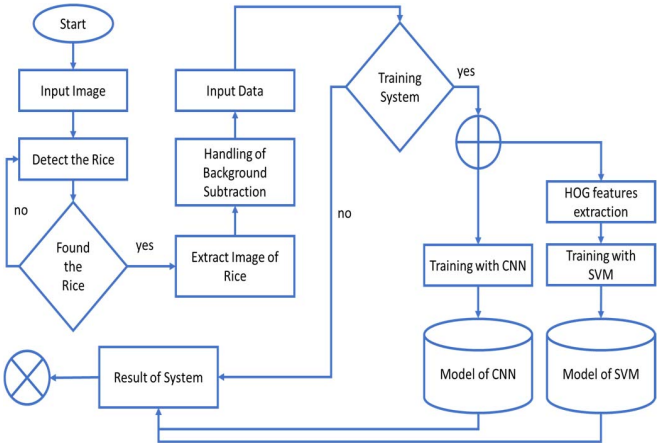

Figure 1. Rice classification system model

A. Preprocessing data

Input images are entered into the system to detect rice objects, only the images which has the rice objects on it will be processed in the next step.

978-1-7281-4723-9/19/$31.00 ©2019 IEEE
DOI 10.1109/ACOMP.2019.00021

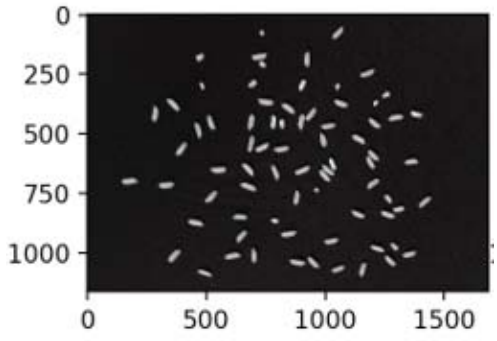

Figure 2. Detection of rice object in input image

After the rice objects is detected, they will be cropped into each object of rice (whole rice and broken rice).

Figure 3. The whole rice (left) and the broken rice

After cropped, those images of each rice object will also contain the background, which will have noise and error, so the background subtraction processing for each image of rice is very necessary. For training model with CNN, background subtraction processing is the important and required step in order to guarantee the ability to work correctly and increases network performance, it will support for training parameters adjustment effectively accurately.

In the first step of this period, the images of rice is added background.

$$\boldsymbol{rect = boundingRect(inputArray, points)}$$

Those images is normalized to create new image which has the original image, keep the content and quality of previous image, the rest part of new image is filled with transparent (shown in Fig. 4).

$$\boldsymbol{squ(rect(w,h)) = \begin{cases} n = h, & w < h \\ n = w, & w \geq h \end{cases}}$$

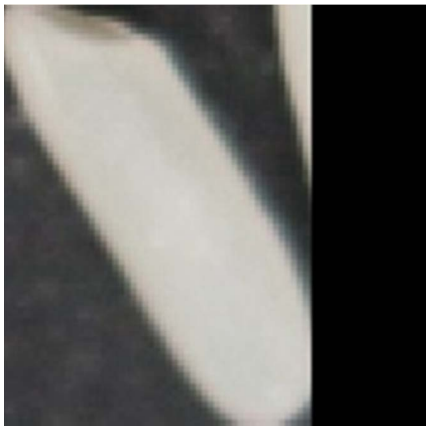

Figure 4. The rice image is cropped and preprocessing in square form

Next, the background will be removed using bitwise algorithms in the first times (OR). The result of this sub-step is the background-removed images basically.

$$\boldsymbol{mask1 = bitwiseOR(squ, inputArray)}$$

After that, using bitwise algorithm in the second times (AND) in order to create the mask layer of object which is done by the corresponding contour layer, this layer will surround the main object as in Fig. 5.

$$\boldsymbol{mask2 = inRange(mask1, lowerColor, upperColor)}$$

Figure 5. The mask is done

Finally, images of rice object which has the same position with the previous image and its background is filled in black background (result in Fig. 6).

$$\boldsymbol{dst = bitwiseAND(squ, mast2)}$$

Figure 6. Last image after preprocessing

After this step, the images contain the rice objects will be used as the input images for training process in CNN.

B. Training with Support Vector Machines algorithm

When the rice objects in the image is detected, the system also using Support Vector Machines to training with HOG feature. Firstly, the rice objects is need to be detected and extracted features using the oriented features – HOG features. The result will return an array of coordinates of the most common features of objects to recognize. Then, those features will be the input data of Support Vector Machines training method. The process is also similar with the training process in Convolutional Neural Network, the training in Support Vector Machine is needed to adjust the parameters for the result optimization. The result of this process will create a training model which will be used to recognize and classify the rice objects in the new images on testing set.

C. Training with Convolutional Neural Network

After preprocessing, the images with the rice objects will be put into the training data of Convolutional Neural Network. The network structure is design in order to create the training model and recognize two types of nature rice: whole rice and broken rice. The training time is quite long and belong to the number of network layers, the number of class in each layer, the object need to recognize and the number of images in the training set. After the first times training, depending on the result of training and the system requirement to adjust the network training parameters in order to optimize the performance of training set and increase the accuracy of testing period.

The study supposes Convolutional Neural Network with the resolution of each input image is 64x64 (pixels), and is organized into 4 layers: {Conv2d -> max_pooling2d} -> {Conv2d -> max_pooling2d} -> {Dense} -> {Dense}

III. EXPERIMENTAL RESULTS

A. Program setting

We set the program to detect rice in image, extracts the features, preprocessing input image of rice by Python programming language, OpenCV library. Comparing the result between the proposed Convolutional Neural Network model and Support Vector Machine model using HOG features, k-Nearest Neighbor (kNN) using HOG features. The program of training and classifying of Convolutional Neural Network is implemented by Python programming language, TensorFlow library. The training and classifying program with SVM-HOG and kNN are also using Python programming language and OpenCV library.

The experiments are run on personal computer, MacBook Pro Operating System (Retina, 13-inch, Early 2015).

B. Preparing database

The experiment is executed on database about 2000 images of rice of two objects: whole rice and broken rice belong to Loc Troi 20 type in An Giang province. Starting training model by detecting the position of rice in images. The images is preprocessed in the square form with 64x64 pixels resolution in order to build rice classification model easily.

The databases are divided into two parts: 60% of the number of image in training set, 20% of the validation set and 20% of the testing set. The number of training step is the division of all images and repeat every 30 cycles.

C. Parameters adjustment

In this paper, we use CNN algorithm to classify rice and adjust Adam algorithm in the model to create parameters. The created parameter Beta1 = 0.9, Beta2 = 0.999, Learning rate = 1e-3.

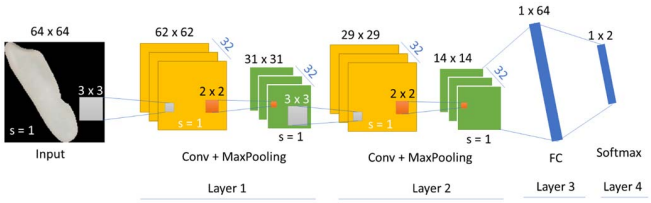

Figure 7. Convolutional Neural Network structure

The method using SVM-HOG model with LibSVM to build the training set. The SVM method with HOG features extraction, using rbf kernel, the optimize parameters is $\gamma=0.2$, $c=1$. We executed the other experiments by adjusting kernels such as rbf, poly, parameter γ, c constraint to find the best results as possible. The best results have parameters C=1000 and gamma=0.001.

The kNN methods with HOG features extraction give the best result with k=1

D. Experimental results

The experiments on 2000 images of whole rice and broken rice using Convolutional Neural Network get 99.16% accuracy on training set and 89.75% accuracy in testing set. The system also uses Support Vector Machine with HOG features, k-Nearest Neighbor in order to classify and compare the accuracy of those algorithms, with the result of 85.06% and 84.30% accuracy on testing set. The results show that we can use Convolutional Neural Network to classify and evaluate rice quality. The experimental results are presented in Table 1 and Fig. 8.

TABLE 1. COMPARING THE EFFECTIVE OF RICE CLASSIFICATION METHODS (WHOLE RICE AND BROKEN RICE)

ID	Methods	Accuracy (%)
2	CNN	89.75
3	SVM-HOG	85.06
4	kNN	84.30

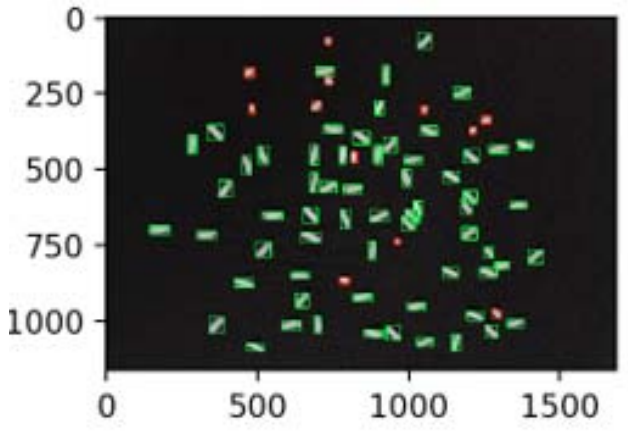

Figure. 8. Results of recognizing and classifying rice

For more details, we randomly get 5 input images with difference numbers of rices and make the recognition. The actual accuracy is calculated based on the number of rice which is recognized by the system and real eyes. Result get 93.85% of accuracy as in Table 2.

For rice quality classification, we used the documents of Brown Rice in 2010 of Ministry of Agriculture and Rural Development, Directorate of Standards, Metrology and Quality Control, Ministry of Science and Technology [8].

TABLE 2. REAL PRACTICE RESULTS IN RICE CLASSIFICATION.

ID	Number of rices	#Whole-rice predicted	#Real whole-rice	#Broken rice predicted	#Real Broken-rice
1	75	61	62	14	13
2	90	35	43	55	47
3	27	15	17	12	10
4	25	19	19	6	6
5	27	15	15	12	12

TABLE 3. TABLE OF QUALITY REQUIREMENTS OF FLIP RICE

	% whole rice >=	% broken rice <=
Whole rice 100% type A	80%	4%
Whole rice 100% type B	80%	4,5%
5% broken rice	75%	7%
10% broken rice	70%	12%
15% broken rice	65%	17%

Based on documents in Table 3, we can calculate the ratio quality of the rice in Table 4.

TABLE 4. RICE RATIO CLASSIFICATION

Image ID	#Rices	#Predicted whole-rice	Whole-rice ratio (%)
1	75	61	85.9
2	90	35	63.9
3	27	15	66.3
4	25	19	84.5
5	27	15	66.1

From these experiemtal results we can see that given a random images of rice by randomly sampling 100 gram of rices (or more, based on the legal documents), we can use deep learning approach to detect the quality of the rices. This is very helpful for rice exporting as well as determining rice price.

IV. CONCLUSION

This work proposes an approach for rice quality classification. In this approach, image processing algorithms and machine learning methods were used to recognize and classify two difference categories of rice (whole rice and broken rice). The experimental results for 2000 images of whole rice and broken rice illustrates that the proposed approach work well.

We are planning to provide more experimental results on the bigger databases, apply more classes to recognize and identify, compare the performance of the proposed model with other methods, improve classification model in order to classify more categories of rice.

V. ACKNOWLEDGEMENT

This study is funded in part by the Can Tho University Improvement Project VN14-P6, supported by a Japanese ODA loan. We would like to thank Mr. Tram Vu Kiet for conducting experiments.

VI. REFERENCES

[1] Monika Dubey and Prof. Lokesh Singh, "Automatic Emotion Recognition Using Facial Expression: A Review," IRJET, vol. 3, no. 2, 2016.

[2] Nishant Hariprasad Pandey, Dr. Preeti Bajaj and Shubhangi Giripunje, "Design and Implementation of Real Time Facial Emotion Recognition System," International Journal of Science and Engineering Research, vol. 4, no. 11, 2013.

[3] Ozan AKI, Aydın Güllü and Erdem Uçar, "Classification of Rice Grains Using Image Processing and Machine Learning Techniques," International Scientific Conference, 20-21 Nov 2015.

[4] Harpreet Kaur and Baljit Singh, "Classification and Grading Rice Using Multiclass SVM," International Journal of Scientific and Research Publication, vol. III, no. 4, April 2013.

[5] Zhengjun, Qiu Jian Chen, Yiying Zhao, Susu Zhu, Yong He and Chu Zhang, "Variety Identification of Single Rice Seed Using Hyperspectral Imaging Combined with Convolutional Neural Network," 31 Jan 2018.

[6] Kasan Herath, "Rice Grains Classification Using Image Precessing Technics," International Journal of Scientific and Engineering Reseach, pp. 10-14, Feb 2017.

[7] Navneet Dalal and Bill Triggs, "Histograms of Oriented Gradients for Human Detection," IEEE Conference on Computer Vision and Pattern Recognition, INRIA Rhone-Alps, 655 avenue de l'Europe, Montbonnot 38334, France, 2005.

[8] vanbanphapluat.co, "Tiêu chuẩn Việt Nam TCVN8372:2010," Tiêu chuẩn quốc gia TCVN 8372:2010 về Gạo trắng – Xác định tỷ lệ trắng trong, trắng bạc và độ trắng bạc, 1 Jan 2017. [Online]. Available: https://vanbanphapluat.co/tcvn-8372-2010-gao-trang-xac-dinh-ty-le-trang-trong-trang-bac-va-do-trang-bac. [Accessed 29 Oct 2018].

[9] Nguyen Thai-Nghe and Nguyen Chi-Ngon. 2014. An Approach for Building an Intelligent Parking Support System. In Proceedings of the Fifth Symposium on Information and Communication Technology (SoICT '14). ACM, New York, NY, USA. pp. 192-201. ISBN: 978-1-4503-2930-9.