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A Real And Accurate Vegetable Seeds Classification Using Image Analysis And Fuzzy Technique

V. S. N. Kumar Devaraju[1], Sirasani Srinivasa Rao[2], V. Subba Ramaiah[3], K. Raghu, K5saikumar[4]

[1]*Asst.Professor, Department of ECE, Mahatma Gandhi Institute of Technology, Hyderabad, Telangana, India. Email:* dvsnkumar_ece@mgit.ac.in
[2]*Associate Professor, Department of ECE, Mahatma Gandhi Institute of Technology, Hyderabad, Telangana, India. Email:* ssrinivasarao_ece@mgit.ac.in
[3]*Assistant Professor, Department of CSE, Mahatma Gandhi Institute of Technology, Hyderabad, Telangana, India. Email:* vsubbaramaiah_cse@mgit.ac.in
[4]*Assistant ProfessorDepartment of ECE,Mahatma Gandhi Institute of Technology, Hyderabad, Telangana, India. Email:* raghukasula@mgit.ac.in
[5]*Research scholar, konerulakshmaiah education foundation, Dept of ECE, Guntur, Hyderabad,* saikumarkayam4@ieee.org

ABSTRACT

Researchers are becoming increasingly interested in computer vision and image processing as a result of its various applications in a number of fields. With this in mind, this paper used fuzzy logic and image processing to perform a study comparing and recognizing two vegetable seeds. Three morphological features were used as rules for the fuzzy inference method after the images were processed. Even though there are only two true values for each characteristic, the fuzzy inference method performed as expected.

I. INTRODUCTION

The nondestructive study of visual quality features in agricultural crops' seeds can be efficiently implemented using computer vision (CV) automation in line with taking, processing, and evaluating pictures[1]. Image processing, also known as digital image processing, refers to the procedures that make up a computer vision system's main and distinguishing tool. The load of the scheme in the procedure is a two-dimensional (2D) image. It produces a better image if a group of significant variables associated with the image is not present [2]. Smart classifiers can remember and perform a variety of tasks, including categorization and sorting [3]. The strategy of image acquisition, preprocessing, and understanding of which fallouts in seed assessment and sorting are all examined in the seed frame. It can provide additional information about seed manufacturing, seed class management, and seed degradation detection [4]. Computer vision and image processing are a cost-effective and nondestructive tool for categorizing and classifying agricultural and food crops during supervision and exchange. The various strategies based on image examination and processing are correlated with the variety of applications in agriculture and food crops. Because of their widespread use in many computer assisted machine vision systems that mechanically review and quantitatively calculate grains, these methods have attracted more interest from researchers, especially in artificial intelligence. The most important procedures

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are data collection, morphological characteristic extraction and illustration, classifier/algorithm selection and information, and classifier testing [12]. A purpose and precision observable method for the approximation of morphological characteristics is provided prior to the analysis of a digital image [13].

Form, height, color, orientation, roundness, dimension, and compactness are all morphological features that can be defined. Manufacturing product analysis, traffic observation, recreation, and medicinal involvement are only a few of them. Apart from that, it has been successfully used in agricultural manufacturing for a variety of tasks, including automated evaluating, reaping, and classifying of products such as grain, fruit, vegetables, and plant sorting [1]. The class of vegetable seeds and the validity of assortment are important considerations in the expanded manufacturing of vegetables [5]. The initial basis for modifying the consistency of the kernels is clarification, propagation, and the absence of any ailments [6]. The inspection and sorting of seeds are important tasks in the agricultural sector. These tasks add to the value of vegetable kernel manufacturing, quality creation, class management, and degradation detection. Experts who manually inspect and verify each seed sample are widely used to carry out these tasks. Agricultural crops, such as grains and vegetable seeds, come in a variety of shapes and sizes [7]. As a result, this lengthy procedure is heavy, exhausting, and time-consuming [6] [8]. Machine vision is a commonly used, controllable, and extremely intelligent technology [9]. A color machine vision system was also used to differentiate between different varieties of seeds and to distinguish one kind of seed from another, as well as to identify damaged kernels in wheat. It was also used to measure the standard of fodder [10].

Extensively used in food processing to test automatic ranking, identifying, and investigating products excellence [12] [14]. Various image processing sets of rules are accessed to derive these characteristics from the pictures of the seed sample. This enables the machine vision to be suitable for this type of operation [15]. In this case, the negative effects of temperature, moisture, light, and other factors may change seed morphology [3]. Been generally accepted [11]. These systems rely on computer vision technologies at various levels, which necessitates the use of multiple stages. The aim of this analysis is to use image processing and fuzzy logic to determine if the seed is a cauliflower or a pechay (Chinese cabbage). The MATLAB software will be used to evaluate the image's morphological features as well as the fuzzy inference method. This is to help people who are having trouble recognizing the form of seed because they all look the same to the naked eye.

II. RESEARCH METHOD

2.1 Image Acquisition and Processing

The seeds were obtained from the author's relatives in Aguado, TreceMartires City. A total of 160 seeds were used in this study: 60 pechay seeds and 60 cauliflower seeds were used as training data, and 20 test samples were used for each seed. The photos for the samples were captured with a Canon Power Shot SD1300IS at 12M (4000x3000) resolution and a tripod to avoid any unwanted movement or shaking. To ensure proper lighting for the samples, the camera's flash was switched on for each image. The seeds were arranged in such a way that they would not come into contact with one another, ensuring that the image would have reliable data for processing. For uniformity, the camera's lenses are separated by 8cm for each sample shot. Resizing of images is no longer necessary since the images were taken uniformly. The images of the samples were processed using MA TLAB R2015a, which was mounted in a Lenovo G41 laptop with an AMD A8 quad core processor running at 2.1GHz and 4GB of RAM. This laptop runs on the x64 platform and runs Windows 10 SL. The percentage of image bits, as well as the diversities of dissimilar shades RGB histograms, are then taken into account [16].

2.2 Morphological Feature

The model seeds were dismantled into three morphological structures [17] [18]. Its area, perimeter, and diameter are as follows. MATLAB was used to extract these characteristics. Image processing can be done using MATLAB, which is one of the easiest and most powerful software programs available. Things can be categorized and sorted, defects can be measured, and image processing can be used for a variety of other purposes. In addition, since it can analyze the RGB values for each pixel, this program is a useful tool in digital image processing [12].

2.3 Fuzzy Inference System

In order to distinguish the two seeds, a fuzzy system is used. It is a mathematical scheme that analyses analog input values based on variables with values ranging from 0 to 1. It is capable of creating understandable and user-friendly models of real-world systems [19] [20]. The fuzzy controller is a control mechanism that is used to control a fuzzy logic based system. It comes from a collection of fuzzy rules that represent the system's actions [21] [22]. Figure 1 depicts an example of a fuzzy controller.

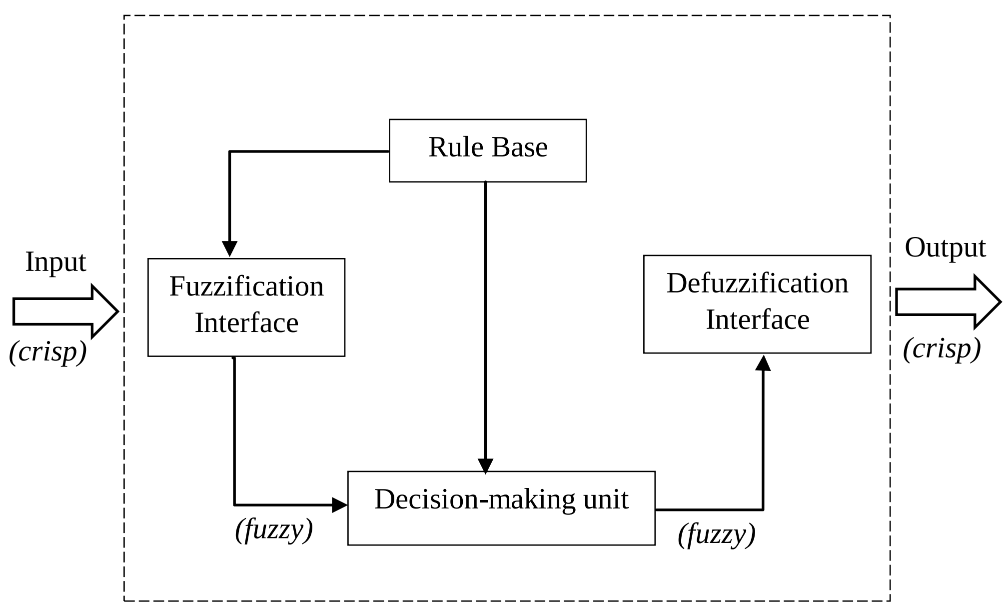

Figure 1. Fuzzy Controller

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The procedure of mapping, provided from input to output by the use of fuzzy logic [23][24], is known as fuzzy inference. Automatic monitoring, computer vision, decision analysis, expert systems, and data classification are some of the notable applications of these systems [25][26][27][28].

In this paper, fuzzy logic was used to classify the type of seed based on morphological data and rules. Since the outputs were constant, a Sugeno form of inference method was used.

III. RESULTS AND ANALYSIS

3. 1 Image Processing

Figure 2 displays an image that was taken in RGB format and went through multiple processes. The first phase involved converting the raw image to grayscale. Figure 3 displays the picture after it was enhanced and converted to black and white. This makes the white areas around the seeds that aren't filled by the seeds white, although the seeds themselves remain white. This makes it easier for the vislabels special function to mark the seeds found in the picture.

Figure 2. Original Image

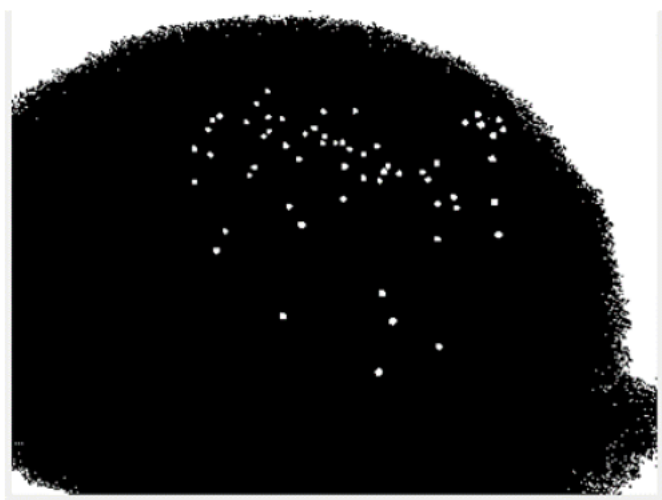

Figure 3. Black and White Image

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3.2 Morphological Feature Analysis

In this paper, three (3) morphological features of the seeds were assessed. This is the field, perimeter, and diameter of the seeds. The holes are first filled after the picture has been converted to black and white. The next step is to use the vislabels function to mark and differentiate the seeds in the picture from the background noise. Figure 4 depicts the image generated with the vislabels feature. Following that, for idx, a range of values is used so that only the seeds are left and most of the noise is removed from the picture, as shown in Figure 5. The minimum and maximum values for the three morphological features of the see ds are shown in Table 1. This table will be included in the fuzzy logic analysis as well.

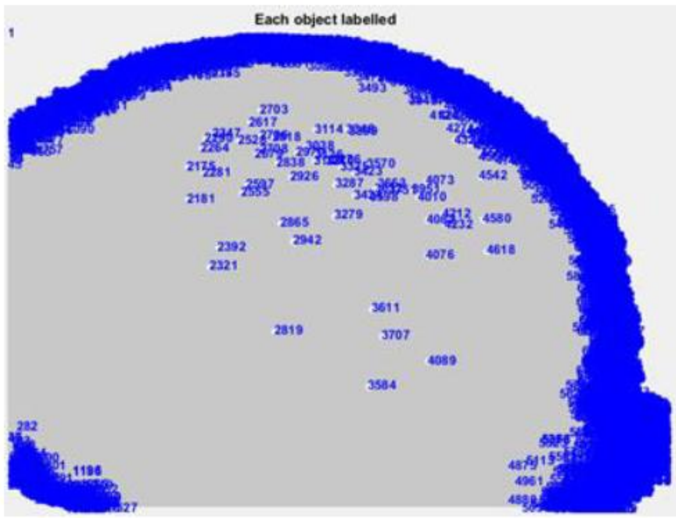

Figure 4. Labeled Image

Figure 5. Output Image

TABLE 1

MORPHOLOGICAL FEATURES RANGES

Type	Area	Perimeter	Diameter
Petchay (Chinese Cabbage)	702 to 1616	93.106 to 163.031	29.88 to 48.38
Cauliflower	800 to 3050	103 to 220	33 to 57

The sets of morphological features served as the foundation for these laws. The rules were set such that the output would be the same as when all three values are true as long as there are two (2) true values for the features. In the fuzzy inference method, the minimum value rule was applied. The fuzzy logic design is shown in Figure 6. The morphological features are seen to be one of the three inputs. Since the output should be constant, Sugeno type inference was used. Figure 7 displays the rule viewer, which indicates that there are fourteen rules in all. The performance changes as we adjust the values of the three inputs. Pechay = 0 and cauliflower = 1 were assigned to the outputs. In order to obtain the results, the values should be rounded to the nearest whole number. Pechay is defined as output values less than 0.5, while cauliflower is defined as output values greater than 0.5.

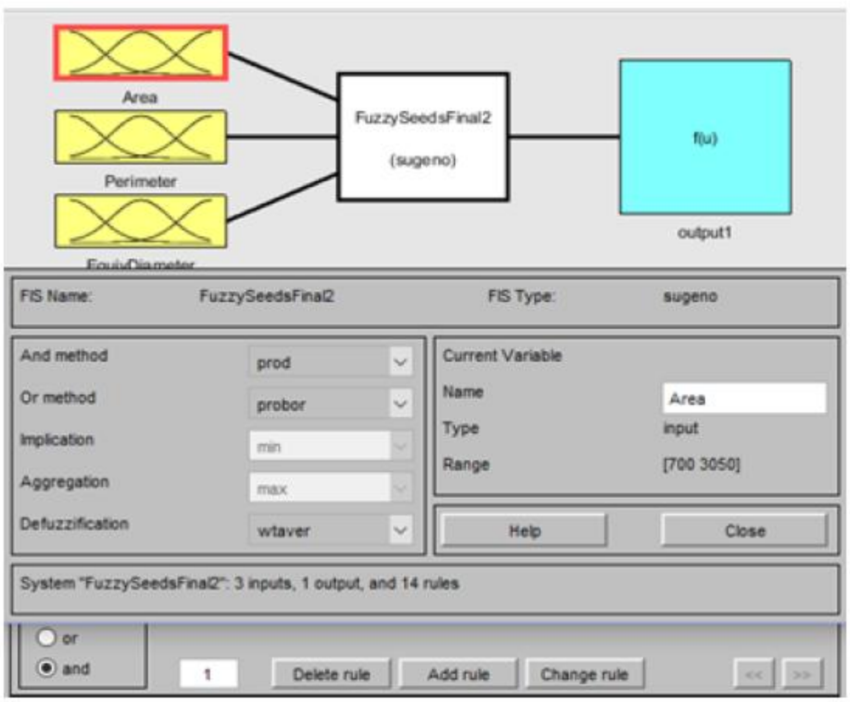

Figure 6. Fuzzy Design

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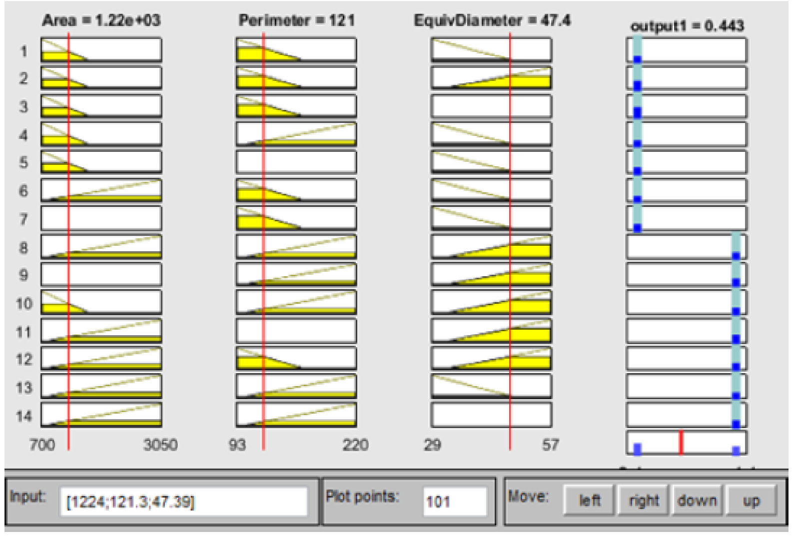

Figure 7. Rule Viewer

The performance surface plots are shown in Figure 8. Patola has the largest variety, since all of the combinations in the X and Y axes result in patola occupying the majority of the plots.

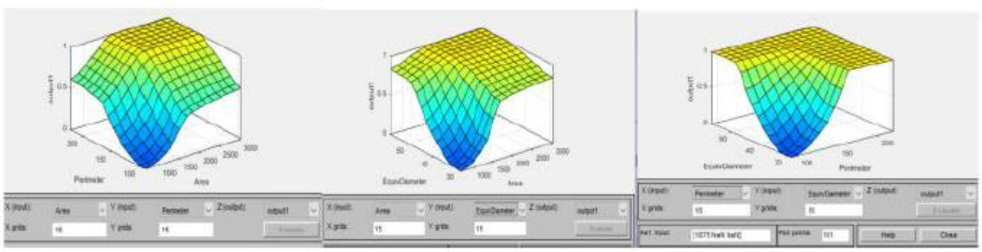

Figure 8. Surface Plots

The results of evaluating 20 samples of each form of seed are shown in Table 2. This was accomplished by copying the test data from MS Excel into Notepad and properly formatting it so that it could be pasted into the MATLAB rule viewer with ease. With pechay seeds, 100 percent accuracy was achieved, but with cauliflower seeds, only 65 percent accuracy was achieved. With 40 samples combined, this results in a precision of 82.5 percent.

TABLE 2

FUZZY TESTING RESULTS

Type	No. of Success	No. of Fail	Accuracy (%)
Pechay	20	0	100
Cauliflower	13	7	65

IV. CONCLUSION

The use of image processing and fuzzy logic to evaluate the form of seed is accurate and has much fewer errors, according to this paper. While traditional seed classification methods are still very successful, machine vision-based methods can improve accuracy even more. When the samples were combined, this paper achieved its goal with an accuracy of 82.5 percent. While the fuzzy logic results at the pechay test sample were more reliable, this is marginally lower than the results obtained using the K Nearest Neighbor classifier, which yielded an accuracy of 85 percent. Since the scope of this analysis is very limited to just two types of vegetable seeds, it could be enhanced by using more samples and varieties of vegetable seeds. Future researchers could choose to use a broader range of seeds and morphological characteristics with less overlaps.

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