

Image Processing Based Sorting Application for Quinoa

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ABSTRACT: The report presents the recent development and application of image analysis and computer vision system in quality evaluation of products in the field of agriculture. Computer vision is a rapid, consistent and objective inspection technique, which has expanded into many diverse industries. Its speed and accuracy satisfy ever increasing production and quality requirements, hence aiding in the development of totally automated processes. The requirements and recent developments of hardware and software for machine vision systems are discussed, with emphases on monochrome imaging, colour imaging and multispectral imaging for modern grading and sorting systems. Future trends of machine vision technology applications are discussed.

Key Words: Image thresholding, Image filtering, Image labelling, kNN classifier, custom function distance

1. INTRODUCTION:

Quality investigation of sustenance and horticultural deliver are difficult and labour intensive. All the while, with expanded desires for nourishment results of high calibre and security guidelines, the requirement for precise, quick and target quality assurance of these attributes in sustenance items keeps on developing. Be that as it may, these operations for the most part in India are manual which is exorbitant and untrustworthy in light of the fact that human choice in distinguishing quality components, for example, appearance, enhance, supplement, surface, and so on., is conflicting, subjective and moderate. Machine vision gives one contrasting option to a mechanized, non-dangerous and financially savvy procedure to finish these prerequisites. This assessment approach in view of picture examination and handling has found an assortment of various applications in the sustenance business. Significant research has highlighted its potential for the investigation and evaluating of foods grown from the ground, grain quality and trademark examination.

1.1 Introduction to Image Processing:

• Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a sort of flag preparing in which info is a picture and yield might be picture or qualities/highlights related with that picture. These days, picture preparing is among quickly developing advancements. It shapes centre

research zone inside designing and software engineering disciplines as well.

• In imaging science, image processing is preparing of pictures utilizing numerical operations by utilizing any type of flag handling for which the information is a picture, a progression of pictures, or a video, for example, a photo or video outline, the yield of picture handling might be either a picture or an arrangement of attributes or parameters identified with the picture.

• Image processing basically includes the following three steps:

1. Importing the image via image acquisition tools;
2. Analyzing and manipulating the image;
3. Output in which result can be altered image or report that is based on image analysis.

• There are two types of methods used for image processing namely, analogue and digital image processing. Analogue image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. Digital image processing techniques help in manipulation of the digital images by using computers. The three general phases that all types of data have to undergo while using digital technique are pre-processing, enhancement, and display, information extraction.

• In image processing, a process is done on the image thorough some functions in order to get desirable output.

• Nowadays image processing, artificial intelligence and machine vision are the most popular field for the automation and control process.

• There are many in built functions in OpenCV which are used for image processing. Like Geometric Transformation, Image Threshold, Smoothing images, Morphological Transformation, Image Gradient, and Histogram etc.

1.2 Objectives:

Separation of seeds by size, shape or length is a process performed in the industry to ensure a premium quality of the end product. Today, an organization needing these sorts of sorting need must use no less than two unique

gadgets. Besides, the sorting exactness of current innovations is to such an extent that a ton of item is squandered alongside the reject. Now and again, this may not be essential but rather in others, where the item esteem is high, this may prompt reliable budgetary misfortunes. Shading highlight is the most essential parameter in arrangement and sorting of grains. So as to complete picture handling and to remove helpful elements of caught pictures by machine vision a profoundly effective calculation was produced and actualized in Visual condition. The calculation comprised of foundation division, grains determination and highlight extraction. The main objectives of processing the grains are:

- To remove the husk that is present on the raw grains
- To avoid germination
- To remove the pericarp, present on the grains that contains saponins which are constitute the bitter layer on the grains

1.3 Parameters that need to be considered:

- Perimeter
- Area
- Centroid
- Major-axis length
- Minor-axis length
- Eccentricity
- Metric value

1.4 Challenges & Limitations:

The challenges are as follows:

1. Measurement of size, shape, and length in only one pass
2. Reject only the unwanted product
3. Increase productivity of several percentage points
4. Perform several sorting tasks with one machine
5. Possibility to add colour sorting

The limitations are as follows:

1. High capital costs for installing sorter(s)
2. High operation costs
3. Difficulties to maintain the sorting machines
4. Requirements for feed preparations
5. Low efficiency for special use
6. Existence of too much fines in feed
7. Deposit size
8. Complexity of the sorting process in comparison with other pre-concentrating methods

2. METHODOLOGY:

Below is an image that determines the basic methodology of a quality measurement process that is used in large scale industries where quality

measurement is the foremost priority. The image has different parts and the function of each part is explained below:

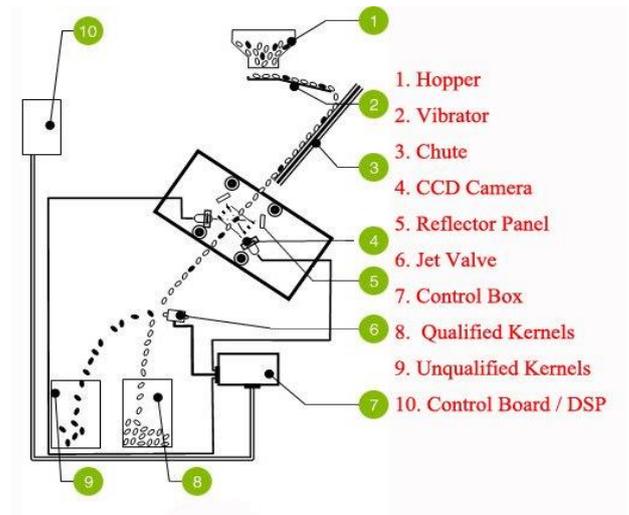


Figure-1: BASIC GRAIN SORTER

1.HOPPER: the function of the hopper is to store quinoa kernels and pour it down onto the conveyor/chute. It helps in the falling of the kernels uniformly.

2.VIBRATOR: a vibrator aligns the kernels in a systematic manner thereby making the kernels fall one by one and not in a bundle/group.

3.CHUTE: it is a non-friction, non-sticky and a smooth inclined surface on which the kernels move one by one steadily.

4.CCD CAMERA: the main aim of the camera is to get a clear image of a single kernel. This image is sent to the control box for further processing. The image taken should be of a single quinoa at a time.

5.REFLECTOR PANEL: these panels improve the quality of the image as they reflect the images of the kernel from both sides thereby giving negligible scope for the camera to get a distorted or blurred image.

6.JET VALVE: jet valve is an important component of this whole process. As per the instruction/command given by the control box, it discards the unqualified kernels through an air push.

7.CONTROL BOX: it contains the main algorithm/code that is used for the processing of the quinoa kernels. As per the image obtained from the camera, it compares the parameters of the received image with the defined parameters and accordingly gives a command to the jet valve whether to discard the kernel or accept it.

8.QUALIFIED KERNELS: these are the kernels that are considered “ideal” as per defined by the user.

9. UNQUALIFIED KERNELS: these are the discarded kernels that are “not ideal” and do not fulfil the parameters that are defined by the user.

10. CONTROL BOARD/DSP: this is the master board of the whole process. It contains the on/off switches as well as the reset button. The whole process is supervised using this board.

3. ALGORITHM

The basic idea of the image processing of the kernels is to get as clear an image as possible so that while we perform the various image processing functions on the image, it does not affect the results. Thus the basic idea of any image processing based quality measurement is to get the most efficient results. We have performed various steps in order to achieve most efficient results possible. The steps are highlighted below one by one:

STEP 1:

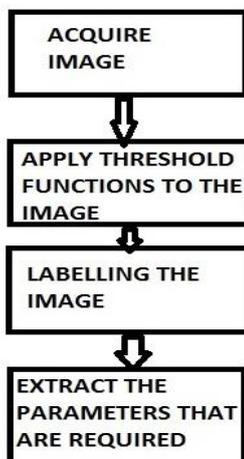


Figure-2: STEP 1 FLOWCHART

1. Acquiring the image has to be the most basic step of the whole process. The image of the kernel has to be obtained in order to carry on with further processing.

2. Applying threshold functions is a must before carrying out with the function implementation. This step erases the other particles that are of no use and only focuses on the kernels that are captured in the image and that are of use to us in order to go further with the processing.

3. Labelling the image helps us in the viewing of the results. The results of the various parameters that are to be determined can be easily determined by looking at the label of the objects that are present on the image. The image contains a number of kernels. Now, to get every parameter of each kernel, we need to label each kernel so that there is no confusion as to which parameter is of which kernel.

4. After the labelling has been done, the parameters need to be extracted for each kernel. Parameters are necessary as we need to compare them with the “ideal parameters” in order to differentiate the kernels.

STEP 2:

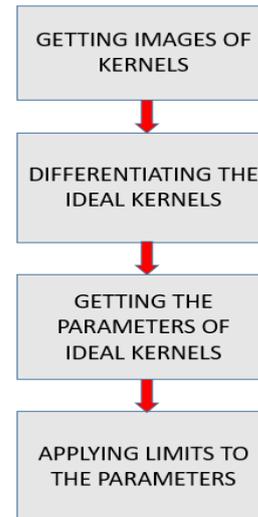


Figure-1: STEP 2 FLOWCHART

1. We need to get the hard/soft copies of the images of the kernels.

2. By looking at each of the kernel we will be able to tell whether the kernel is an ideal one or not. By looking at the shape and size of the kernel we can tell that. Usually, ideal quinoa kernels are round in shape and are large (comparatively).

3. Once we are able to differentiate the kernels, we apply the code to find the various parameters of the kernels. From the result we will be able to obtain the area, eccentricity, major axis length, etc... of the ideal kernels. Thus now, we have the parameters of the ideal kernels with which we need to compare the parameters of the other kernels in order to process the quality of the kernels.

4. Now we have all the parameters of the ideal kernels. We will find here that the kernels that are branded ideal by us will not have the same/similar values of the various parameters. Thus we can set a higher limit and a lower limit of each and every parameter and then say that any kernel that has the values of all of its parameters between the higher and lower limit set by us, will be considered ideal.

STEP 3:

The final step is to run the final code that includes the filtering of the kernels which are ideal. The code contains the limits of the ideal kernels and also marks the

centroid of all the ideal kernels with round black dot thereby differentiating the ideal kernels from the others. When we run the final code, the kernels that are ideal have their centroids marked with a black dot.

4. OUR RESULTS:

We have implemented the kNN classifier technique. kNN stands for k-nearest neighbour classification. It is a nearest-neighbour classification object, where both distance metric ("nearest") and number of neighbours can be altered. The object classifies new observations using the predict method. The object contains the data used for training, so can compute re-substitution predictions.

This kind of classifier is based on distance prediction. There are various kinds of distances that are used for classification. They are:

1. Euclidean Distance
2. Standard Euclidean Distance
3. Mahalanobis Distance
4. City Block Metric Distance
5. Minkowski Distance
6. Chebychev Distance
7. Cosine Distance
8. Correlation Distance
9. Custom Function Distance

We have used a custom function distance in our code in order to find the best suitable parameters for an ideal kernel. The function we have used is:

$$D = ((D_o - \max)^2 + (D_o - \min)^2)^{0.5}$$

Where D_o = distance/value of the object

Max = maximum value determined from our filtering

Min = minimum value determined from our filtering

Using this function, we will be able to get the values of D of all the objects present on the image. Thus for every kernel and its every parameter, we will have a value of D. The least value will be considered as the most ideal as it will be considered to have the least deviation.

Nearest neighbour classifiers typically have good prediction accuracy in low dimensions, but that might not be the case when we are dealing with high dimensions. They have fast fitting speed, and the prediction speed is inversely proportional to the dimension of a system, i.e., fast for low dimensions (<10), but slow for high dimensions (>20). They use large amount of memory space and are difficult to decipher/interpret.

Different arrays of different parameters are formed that contain the 'D' values of different objects present on the

image. Suppose there are 30 objects on the image, as in the case above, then a 1x30 array will be formed for every parameter and the value of D for every object will be stored in the array. In the result window, we have displayed the minimum value of each parameter. This value is the best suitable value for each parameter of an ideal kernel. An ideal kernel must have these values.

4.1 Computation time:

Computation time is a must for any program. This time helps in the placing of components in a physical model. Suppose a particular program takes 10 seconds to run, then the action that has to be taken must be provided within a time the object reaches the next stage where the action needs to be taken. Thus if we know the computation time, we can place the command components at a distance accordingly. We have listed below various computation times for different programs that we have used for quinoa kernel processing.

- **Labelling process:** 4.304176 seconds
- **Displaying the values of parameters process:** 3.860674 seconds
- **Final code that marks the centroid with a black dot and filters the ideal kernel:** 6.393 seconds

Thus by knowing how much time each process takes, we can determine the placement of the camera and other components. This will make the process error free and more efficient. There will be no confusion within the process and smooth working of the whole process will be determined.

5. FUTURE ASPECTS:

Grain is one of the most important foods in the world both as a source of nutrition and income. Determination of grain type and quality is a crucial aspect at every stage of grain post-harvest handling. Traditional manual analysis and sorting of grains has a numerous disadvantages and limitations. Thus, a systematic process that ensures the safe and efficient quality measurement of food grains is necessary. Thus an automated tool will objectively evaluate the various factors that affect the grains and will provide results accordingly. The automated grain sorting process will provide an efficient as well as an effective method to sort grains and will make grain sorting and quality measurement time-saving and efficient. Thus, such a system will be of great use in the future provided it is applied with utmost care.

6. CONCLUSION:

This report presents the recent developments in computer vision system in the field of agricultural and food products. The adoption of this emerging technology

in sorting and grading of fruits and vegetables will be of immense benefit to this country. Some of the other associated benefits include more efficient operation, production of more consistent product quality, greater product stability and safety. Computer vision systems have been used increasingly in industry for inspection and evaluation purposes as they can provide rapid, economic, hygienic, consistent and objective assessment. However, difficulties still exist, evident from the relatively slow commercial uptake of computer vision technology in all sectors. Even though adequately efficient and accurate algorithms have been produced, processing speeds still fail to meet modern manufacturing requirements. With few exceptions, research in this field has dealt with trials on a laboratory scales and hence it needs more focused and detailed study.

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