Review Paper on Physical and Mechanical Properties of Citrus Fruits and Various Techniques used in Fruit Grading System Based on their Sizes

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Abstract

In the economic development of India, agriculture sector plays a key role. For the proper price of any agriculture product, grading according to size is necessary. And it is also value adding technique to the product. To makes the product more attractive and improve its processing qualities uniformity in size is important. At present, size grading of most agricultural products including lemon, garlic, onion, tomato, Orange, mandarin, apple are carried out manually by farmers, agents, whole sellers, retail sellers and customers also. Most of farmers market their products without any grading. Persons engaging in post-harvest crop handling such as collectors, whole sellers, retail sellers, and farmers cannot use high technical and costly grading technique. And also by the local market survey it is found that retail market price of the fruits is significantly varied according to its size. Fruit grading by human is inefficient, labour intensive and errorprone. The automated grading system not only time saving but also minimizes error. Improvement of quality and value addition of agricultural produces has gained higher concern in recent times. There is a great demand for fruits in both local and foreign markets. The study are carried out for the design of a machine which can be used to grade multiple fruits by making adjustments. Machine should be simple to use so it can be operated by any illiterate person also so that farmers can also use it. In this study, the various techniques and mechanisms are studied which are used for grading the various fruits. Also study is carried out on the physical and mechanical properties of various fruits.
Keywords: fruit, grading, sorting, image processing, lemon, onion, garlic

I. INTRODUCTION

in the "Vidarbha" region of Maharashtra, major production of citrus fruits takes place; especially oranges. Maharashtra has gained 2nd rank all over India for production of Sweet Limes. Yet, no any automated garading machines are developed for Indian Breeds of Citrus Family which can grade all the citrus fruits. National Research Centre for Citrus (NRCC) have developed a mechanical sorting machine which sorts' Oranges mechanically size wise, but it doesn't sort the other fruits like amla, lemon. Some research work is carried out for automated gradation of verities of lemon, oranges, mangoes, tomatoes, and vegetables like onion and garlic but no remarkable research work is carried out for Citrus fruits classification especially Indian varieties.
There is a need of Universal fruit grading machine which can be used for grading all circular fruits like Amla, lemon, tomato, Orange, apple and vegetables like garlic, onion as per their size for uniformity. It will be better to use one machine instead separate machines for separate fruits.

By the study of papers mentioned in this review paper, we come to know about the parameters required like physical and mechanical properties of various fruits, variance in diameters, angle of repose, factor of friction between fruits and metals for the design of multiple fruit grading system which can be used for grading of various fruits. Also study is carried out on the various techniques and mechanisms used to grade various fruits. by taking in consideration all these parameters, we can design and develop a multiple fruit grading system which can grade the fruits by changing some adjustments like reposeangle. but machine can grade one variety of fruit at one time.

II. HISTORY

In the market, fruits are available in variety of sizes. If there is no uniformity in their sizes, the seller can not get the good price. It will affect the total chain that are selling fruits like Farmer- agent- distributor- seller- customer. To get the uniformity in fruit sizes, there are various techniques are being used previously like image processing, grading using electrical sensors, manual grading, mechanical grading by various developers.

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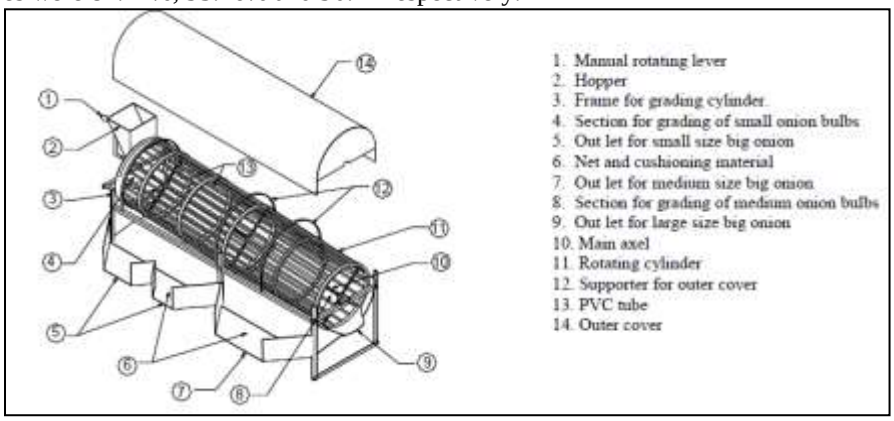
A. *Various techniques and methods of fruit grading:*

*1) "Design, development and evaluation of a**n**Onion grading machine according to size".*

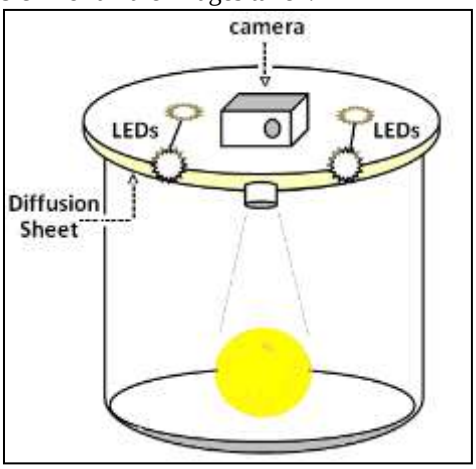
The study is carried about the onion grading machine. It comprizes of grading cylinder made by PVC tubes (diameter 20mm), iron circle, feeding hopper and supporting frame. Front portion of the feeding hopper was adjustable. Grading cylinder made of two segments with four outlets. First segment was longer compared to second and it consist two outlets used for separation of small onion bulbs which are having diameter less than 4cm. Second segment consist one outlet used for separation of medium size onions bulbs whose diameterlies between 4cm and 6cm and larger onion bulbs having diameter more than 6cm were collected from the outlet located at the end of the grading cylinder. Lengths of the first segmentis 150cm and that of second segment is 100cm. Outlets are fabricated by Soft wire mesh and also PVC tubes were wrapped by rubber for providing the cushioning effect so that the mechanical damaged for onion bulbs can be prevented. A lever /handle is given for manual operation and also electric motor can be coupled by using pulley and belt mechanism ifmechanical operation is required. Three different inclined angles i.e. 2o,3oand 4o against horizontal axis and rotational speeds of 10, 15 and 20 rpm of grading cylinder are given.For the highest performance, Combination of rotational speed of 15 rpm and 3o inclined angle against horizontal axis of grading cylinder is reported.The maximum grading efficiency of 3 grades werepositioned close to 15rpm and3o inclined angle of the gradingcylinderagainst horizontal axis adjustments. Maximum grading efficiencyof three grades was obtained under 14.45rpm and 2.990 inclined angle of grading cylinder.

The maximum capacity of the grader under optimum operation conditions was 630 Kg/hr and grading efficiency of small, medium and large grades were 84.47%, 93.46% and 90.14 respectively.



2) "Orange Sorting by Applying Pattern Recognition on Colour Image"

In this paper, the study is carried about sorting of oranges.colour imageof orange fruit is the input to the system designed. It is found that the Source of light, Intensity of light, background, distance from Camera, and Camera settings etcaffect the images of a same object. An imaging chamber is so designed as to maintain the consistency in all the fruit samples. A white colour cylindrical plastic box is used as imaging chamber. Base of the box is coated with white paper, to reduce reflections from the base. The inner surface of the box is coated with light reflexive material. For the source of light inside the imaging boxLEDs mounted on the top are used. For constant light intensity inside the box,UPS power supply is used to avoid voltage fluctuations which measured 430 Lux using digital Lux meter. Light intensity used follows Hunter Labs standard of diffused day light. Camera used is DSC 2000 Sony Camera in VGA mode (640 X 480), with light setting in auto mode, flash off & imaging angle is 0º. Distance of a fruit from the camera is 18 cm for all the images taken.



3) "Development of a lemon sorting system based on colour and size"

This method also uses the image processingmethod for sorting of lemon. The input to the machine is given by capturing image of lemon. Sorting accorting to size is done by comparing the volume of the standard feeded image and captured image. Volume is

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compared by removing the background of captured image. fruit image is devided into number of distinct sectors and volume of the fruit can be estimated. During the sorting stage, the online images of fruit passing in frontof cameras were captured and HSI colour values and their estimatedvolumes were determined. By comparing the information duringsorting phase with the available information in the database, thefinal grade of passing fruits was determined. The fruit was gradedas class one if its volume and color (Hue) were bigger than volumeand color thresholds determined in calibration stage. The fruit wasgraded as class Two if its volume was bigger than threshold volumeand its color was less than the threshold colordetermined incalibration stage. Finally fruit was graded as class Three if itsvolume was less than the threshold volume. At the final stage ofalgorithm, fruit's centre of gravity was calculated to be later used forautomatic sorting through phenematic mechanism.The number of pixels in the foreground (fruit) has to be scaled inorder to convert (map) the total number of pixels into a real volumevalue. The constants C (scale factor of volume) of C = 2.35*10-4were obtained after rationing the real and measured volume of aperfect sphere. The C is eventually used to convert unit's ofmeasurement from pixels to cm3.

4) "Modelling physical properties of lemon fruits for separation and classification"

To avoid the physical and mechanical damage to the fruit due to collision of fruit with matal and to decide the exact variance between sizes of fruits, it is necessary to study the physical properties of fruits. To study the physical properties of lemon, two different varieties of lemon i.e. seedless lisbon and frost eureka are taken. The which are very similar inappearance but different in interior quality.

For measurement of physical properties three mutually perpendicular axes were specified,major, intermediate and minor and projected area PA were measured from images taken by camera in a light controlled condition. the captured images were transmitted to computer and processed in ImageJVer 1.46d software.along with diameter, mass, volume and some othe physicalproperties were calculated. These properties are mentioned in following table.

Property	*SeedlessLisbon*		*Frost Eureka*	
	Max	*Min*	*Max*	*min*
Major Dia (mm)	*62.85*	*49.31*	*70.18*	*58.44*
Intermediate Dia. (mm)	*57.42*	*43.33*	*59.26*	*46.35*
Minor Dia. (mm)	*55.32*	*42.60*	*58.32*	*45.54*
Geometric Mean Dia. (mm)	*58.45*	*45.30*	*62.13*	*49.84*
Mass (g)	*106.62*	*48.97*	*122.28*	*62.24*
Actual Volume (cm^3)	*106.43*	*48.63*	*126.32*	*63.37*

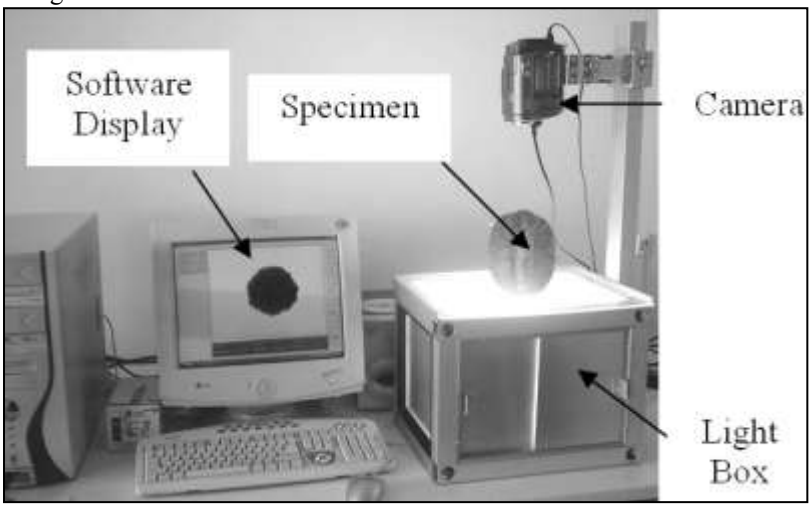
5) "Physical properties of Orange"

The physical specifications of oranges like mass volume and specific gravity are highly important in sizing system. Parameters measured through sizing system are dimensions i.e. lengh, width and height,surface area and weight.

To study the physical properties three varieties according to sizes were taken. Small, medium and large each of 50 samples are taken.

To determine the physical properties of orange, image processing technique is used. Light emitting chamber is so designed as to emit light from behind the fruit.The equipment set comprises of three sections i.e. light source, diffuser and camera holding stand.The function of the light source is to emit the light to the bottom section of diffuser.The diffuser diffuses light at its owen level.

The image captured from camera is transfered to capture card.The card changes the imae from analog form to digital one. The digitized image is transmitted to the imageprocessing window by computer software. Theeuipment set captures three orthogonalimages from which we can determine the dimensions of the fruit through the display window. The following image shows the set of image capturing.



The following table shows some physical properties of oranges that are calculated by using this technique.

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Dependant variety	*Subset*	*Large size*	*Medium size*	*Small size*
Major Diameter (mm)	*1* *2* *3*	*90.40*	*84.06*	*77.93*
Intermediate Diameter (mm)	*1* *2* *3*	*85.03*	*77.39*	*70.62*
Minor Diameter (mm)	*1* *2* *3*	*84.39*	*75.54*	*69.15*
Bulk Density ($g\ cm^{-3}$)	*1* *2* *3*	*0.36*	*0.43*	*0.44*
Fruit Density ($g\ cm^{-3}$)	*1* *2* *3*	*0.99*	*1.01*	*1.04*
Fruit Volume (cm^3)	*1* *2* *3*	*268.28*	*217.82*	*168.19*
Fruit Mass (g)	*1* *2* *3*	*277.53*	*215.38*	*159.76*

III. CONCLUSION

Our focus is tostudy various techniques and methods used for the grading of the fruits according to their size. In the above mentioned papers, the image capturing technique is mainly used which needs camra and computer. The image capturing technique uses the components which increases the initial cost & maintenance cost. It also needs technically trained person. By using physical and mechanical properties of various fruits, we can determine the suitable material for grading machine.

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