RAW CASHEW NUT QUALITY DETECTION BY USING IMAGE PROCESSING

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Abstract: **Currently there is a manual process being used to check the quality of raw cashew nuts. As the raw material is available majorly in the farm and warehouse one quality expert needs to physically travel everywhere to check the quality. Due to this manual process, certain major drawbacks have been evaluated in determining the quality of raw cashews. Research are being carried out to make the entire process automatic by considering different parameters of cashews such as their color, shape, size, moisture content, and many more. Out of various parameters, color and size are the major parameters. This paper addresses the research to design and build a prototype known as a portable raw cashew nut quality detector which will detect the cashew quality using sensors and microcontrollers thereby overcoming the need for special expertise to visit and check the quality of cashew nuts.**

I.INTRODUCTION

Cashew is one of the agricultural commodities which has high demand and high commercial value. After Brazil, India is one of the largest producers and exporters of cashews in the world. Different states in India such as Maharashtra,
Table 1. Cashew production states in India
Kerala, Karnataka, and many others contribute to the production of cashew. (Table 1).
The quality of raw cashew nuts is determined by considering various parameters such as their size, shape, color, moisture content, etc. Depending on these parameters' cashews are segregated into good kernels, premature kernels, bad kernels, and spotted kernels. Each type of kernel (good, bad, premature, spotted) is weighed separately. By using the weight of kernels in the standard outturn formula outturn is

STATE	AREA (ha)	PRODUCTION (tones)	PRODUCTIVITY (kg/ha)
Maharashtra	170000	225000	1500
Kerala	70000	75000	900
Karnataka	107000	60000	320
Goa	55000	30000	700
Tamil Nadu	131000	68000	710
Gujarat	6000	4000	700
Orissa	137000	95000	865

calculated. Depending on this outturn quality of cashew nuts is determined.

At present, the above-mentioned process is carried out manually and requires the assistance of special expertise. As the raw material is available majorly in the farm and warehouse one quality expert needs to physically visit each farm and warehouse to check the quality of kernels. Due to this manual process, many drawbacks are faced in this process such as:
A] Maharashtra ranks first among all the states in producing cashews (Table 1). Due to large production in this state as well as in other states, microwave heat technology is used to avoid the decaying of cashews until special expertise visits the warehouse or farm and determines its quality. But according to the studies carried out it has been observed that the quality of cashews deteriorates if they are exposed to microwave heat for a large period. Thus, if the expertise makes any delay in visiting the warehouse chances of cashew quality degrading are high.
B] Entire quality determination process is carried out by one expertise due to which accuracy of the entire process depends on the capabilities of that particular expertise.
C] In some cases bribing has also been observed.

All these disadvantages can be avoided if automation is introduced in this process and hence there is a scope of experimentation in determining the quality of cashews by using highly accurate sensors and microcontrollers that work with the least human intervention. The introduction of automation in this process will not only avoid the significant disadvantages faced but also make the process easy, cost and time effective.

II.LITERATURE SURVEY

Paper 1: Impact of γ-irradiation and thermal processing on the antigenicity of almond, cashew nut and walnut proteins by M. Su, M. Venkatachalam, S. S. Teuber, K. H. Roux, and S. K. Sathe.

In this paper the author describes the negative impact of thermal processing and γ-irradiation
on the quality of cashews. According to the survey carried out by the food and agricultural department states having large production of cashew use thermal and γ-irradiation for storing the cashews into the warehouse. But it is observed that if the cashews are exposed to γ-irradiation for large period then the quality of cashew is degraded. If these degraded cashews are consumed it can cause serious health issues.

Paper 2: IEEE paper of "KS chiang on 'Quality determination of cashew nuts using moisture content'.

In this paper the author describes the importance of moisture content in determining the quality of raw cashews. If the moisture content is very high, then the possibility of cashew quality degradation is also very high. Thus, moisture is taken out of cashews by using different methods. One of the traditional methods for removing cashew moisture is by exposing them to the heat of sun. Advantage of this method is uniform drying of nuts takes place.

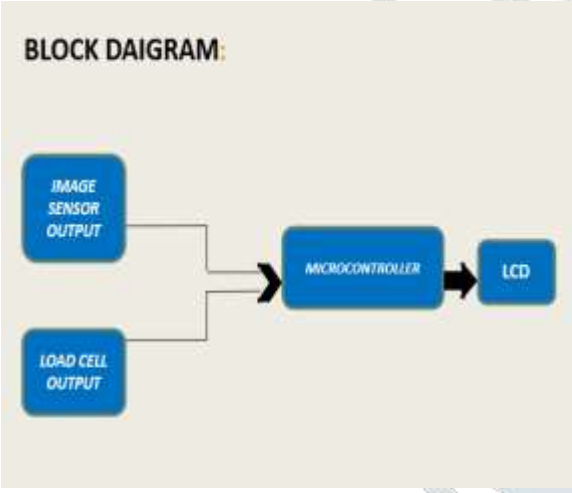
Paper 3: IEEE paper of "S. Karthikeyan, T. Ravi on 'Temperature effect on cashew nuts' TELECON 2010-2010 IEEE Region Conference".

In this paper the author describes the effect of various temperature range on color of cashews. According to the study carried out by the author, influence of drying of cashew kernels with test a using superheated steam on product, color change and process energy consumption is simultaneous. Thus, color difference and energy consumption are observed to be a linear function of steam temperature.

II.MATERIAL AND METHOD

As mentioned earlier various parameters are involved in separating cashews into different types. We are considering two parameters those are shape and color of cashews.

Fig1.Block diagram of the prototype



In reference to fig1, two major sensors those are image sensor and a load cell are required to separate cashews into good and bad cashews and weigh them. The microcontroller is required to carry out mathematical calculations and the final outturn and quality are displayed on LCD.

HARDWARE COMPONENTS:

1. Arduino UNO - It is used as a microcontroller board with ATmega328P as a microcontroller in the prototype.

Table 2. Arduino Specifications.

Parameter	Specification
Voltage for operation	5V
Input voltage	7-12V
Digital pins	14
Analogue Pins	6
Flash memory used	32KB
SRAM available	2KB
EEPROM available	1KB
Clock speed	16MHz

2. Pixy Mon version 2-Pixymon version 2 is an image sensor capable of distinguishing objects based on their shape and size as per the requirement. Hence, we have selected pixy Mon version 2 as the image sensor for the prototype.

Table 3. Pixy Mon Specifications.

Parameter	Specification
Voltage	5V
Communication Interface	SPI, I2C, UART, USB.
Software runs on	Windows, Linus
Languages	C, C++ and Python

3. Load cell- 1Kg load cell is used to weigh good and bad cashews. The output of the load cell is analog.

Table 4. Load Cell Specifications.

Parameter	Specification
Load cell package	Linked
Technology used	Strain gauge
Force is determined by	Compression

4. HX711 ADC- As output of load cell is analogue. It is converted into digital by using hx711 analogue to digital converter.

Table 5. HX711 ADC Specifications

Parameter	Specification
Voltage	5V
Number of output pins	2
Oscillator	On-chip
Power on reset	On-chip

5. Liquid crystal display (LCD)-16*2 LCD is used to display all the outputs of microcontroller.

Table 6.LCD Specifications

Parameter	Specification
LCD character	16*2
Columns	16
Rows	2
Duty cycle	1/16
Interfaces	SPI, I2C
Power on rest	On-chip

SOFTWARE USED:

1. Pixy Mon Software-To create a database on the basis of which pixy Mon camera distinguishes between good and bad cashews.

2. Arduino Software-To code Arduino.

Computer Language used:

1. Embedded C language is used for coding microcontrollers.

METHOD

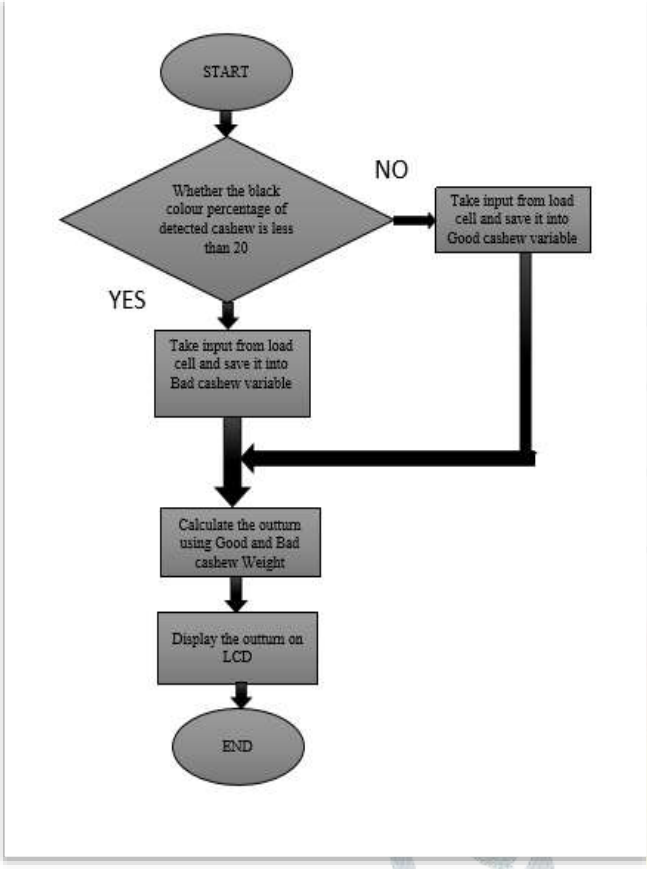
Software implementation:

Database creation---- 50 images of perfect bean-shaped cashews with a black color percentage of less than 20 and 50 images of perfect bean-shaped cashews with black color percentage of more than 20 are used. The total database is of 100 images.

Perfect bean-shape helps the sensor to recognize whether the placed object is cashew or not and color percentage helps in separating detected cashews into good and bad cashews. (Fig.2)

Fig2.Database creation using pixy Mon software

Arduino algorithm.



Flowchart of algorithm of Arduino code.

Hardware implementation:

1. First step involves measuring the weight of cashew nuts and counting the number of cashews in that particular amount of weight. Generally, one kg of cashew nuts is selected for sampling. After selecting the samples cashews are deshelled and dry the cashews for testing purposes. (Fig.3)

Fig3.Weighing of cashew samples.

2. Step two involves separating the cashews into good cashews and bad cashews from the sample (1kg). With the help of an image sensor, the portable device detects good and bad cashews. Pixy Mon sensor determines whether the placed object is cashew or not depending upon its shape and further separate them into good and bad cashews depending on their color. This separation is done by taking created database as the reference.

3. The output of pixy Mon is given to the Arduino. Depending upon the input from pixy Mon the Arduino takes input from the load cell (weight sensor-1kg) which will give the weight of determining good or bad cashews. Weight of good cashew is stored into good cashew variable and bad cashew into bad cashew variable. By using these inputs Arduino calculates the outturn using the outturn formula given below

OUTTERN = (% Of useful kernels /100) *weight of nuts bag (generally 80) *(1/0.45359)

where, N - Number of nuts in 1 kg

W1 - Weight of a sample

W2 – Weight of good kernels

Outturn with respect to 80kg nuts is obtained for the productivity rate. Hence the weight of nut bags is generally considered as 80. Based on this outturn quality of the cashew is determined.

Table 7. Outturn range chart

Out-turn range	**Quality of cashew nuts**
48-53 lbs.	Excellent
43-48 lbs.	Good
Less than 43	Poor

By referring outturn chart quality of cashew is displayed. (Table7)

6.All the information whether the placed object is cashew or not further it is good or bad and the final outturn in lbs.(pounds) as well as quality of cashews are displayed on LCD (Liquid Crystal Display-16*2.

III.RESULTAND DISCUSSIONS

Results:

1. The pixy Mon separates the cashew into good and bad cashews by using the database. The performance efficiency of the pixy Mon is given by its accuracy. Accuracy is calculated as the number of cashews successfully detected by pixy Mon to that of total number of cashews. The sensor is capable of detecting eighty out of hundred cashews. Hence its accuracy is 80 %.

The separated cashew information is given to Arduino by interfacing pixy Mon with Arduino using SPI protocol so that it can take further inputs from load cell for the weight of particular cashews. (Fig.5 and Fig.6)

Fig5. Good cashews detected by pixy Mon

Fig6.Bad cashews detected by pixy Mon

2. Arduino takes input from load cell. This output which is the weight of particular cashew is displayed on LCD. (Fig.7)

Fig7.Load cell output displayed.

3. After taking weight from load cell Arduino calculates the outturn using formula and displays it on LCD so that we can determine quality of cashew using outturn chart. Outturn is always displayed in pounds. (Table 2) (Fig.7) Time required for the entire process is half hour.

Fig8.Outturn Displayed.

Discussion:

All the significant steps such as detecting cashews, separating them, and calculating outturn are carried out by sensors and microcontrollers with the least human help. Due to which the need for special expertise to physically visit the warehouse or farm to detect the quality of cashews is overthrown. The time required to carry out this process manually takes one full day or it can take months as the entire process depends on the expertise to physically visit the warehouse. But by using the automated prototype the entire process is done within a half-hour. Thus, if the time required to detect the quality of raw cashews by the manual and automated process is compared it is clear that a significant amount of time is reduced if the automated process is adapted. Thus, the degradation of cashew quality due to the microwave heat technique used for storing cashews can also be avoided.

The cost for appointing a quality person with good technical knowledge is quite high as compared to the prototype. This is because the quality person will charge every time, he visits the warehouse or farm but if the prototype is purchased, it can be used several times. As the prototype is portable it is also possible to share it between a group of farmers and use it as and when required. Further, the prototype is very user-friendly and hence can be used by the farmers without any difficulties. Thus, the efficiency of the entire process is improved by adopting automation.

IV.CONCLUSION

The need for any skilled person to determine the quality of cashews is overthrown as the prototype requires no human interference. The accuracy of the prototype is very high as compared to manual process as human errors are avoided due to which the yield of the entire process is increased. The solution is easy to implement and the whole system is non-destructive and scalable. The prototype is cost-effective as an investment is one time. The overall time of the process is also reduced. Hence, we can say that the prototype is compact, simple, maintenance-friendly, affordable, reliable, and easy to use.

By considering the advantages of the proposed automated solution an automated prototype is one of the best alternatives for the ongoing manual quality detection process of raw cashews.

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