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A Novel Method in Detection of Food Adulteration in Selected Food Items using Digital Image Processing Technology with Digital Camera

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Abstract: Adulteration of food is either adding any substance or subtracting any substance so that the natural quality of food substance is exaggerated. Adulteration of food frauds the consumer and can cause severe danger to health in some cases. In the present scenario, the food substances are subjected to adulteration in order to increase its volume or weight on scale. The aim of this artifact is to create awareness in the consumers and make them to observe some of the common adulterant added in the selected food items. The selected food items are oil, chilli powder, black pepper and milk. However, in food adulteration the quantity of adulterant mixed could not be found out. The advent of the new technology of Digital Image Processing (DIP), releases a new path for analyzing the quantity of adulteration in food items. The images are acquired through digital camera for various adulteration levels. Through normal and present methods small quantities of food adulteration cannot be identified. Texture features are extracted from the adulterated food image. Based on the texture feature values it is determined whether food is adulterated or not and also the quantity of adulterant mixed in the selected food items can be calculated. This is not possible with the present methods. In present methods in order to find the food adulteration, some of the food samples are wasted for testing. This is avoided by means of our proposed method. MATLAB is widely used for the simulation of adulterated food images.

Key words: DIP, adulteration, adulterant, MATLAB, processing, substances

INTRODUCTION

Food is the basic thing that releases energy to live. It satisfies hunger and to help one relish later. But at the end of each day, we are not guaranteed what we eat is pure (Roday, 2002). We may be eating contaminated food and drinks. Due to repeated use of these sources our body becomes completely abnormal with so many diseases caused by illnesses, infections and disorders that affect good health (EMGF, 1954). Food adulteration is an act of purposely belittling the significance of food presented for transaction either by admixture or adding low-grade substances or by eliminating some valuable constituents. It takes into account the deliberate adding or replacement of substance which harmfully affect environment, substance and worth of foods (Christilda *et al.*, 2012). Adulterant means the element which is added to food thereby making the food insecure. If food is contaminated, the food value is reduced or affected by the accumulation of substance which is risky to health. Food is said to be contaminated, if:

- Low-priced materials are added completely or partially
- It brings down its value underneath the average level
- A substance is added which denigrates or rigorously affects it

Adulterated food is unsafe since, it is poisonous and can disturb health and it could remove nutrients essential for proper progress and growth (Shantaiya and Ansari, 2010). Often, food is contaminated by suppliers who are dishonest and who want to make a speedy profit. But deficiencies and enhancing prices, customer demands in diversity of food, absence of consciousness, inattention to products, insignificance and weariness among customers and insufficient implementation of food commandments and food care measures will also lead to food contamination (Rajappan *et al.*, 2010). Some of the common contaminated food items are milk, oil, chilli powder, black pepper and sugar. The contaminants of the above said food items are water, vanaspathi, brick powder, papaya seeds and Soojis, respectively. At present, to find the adulterants in food items the following ways are followed.

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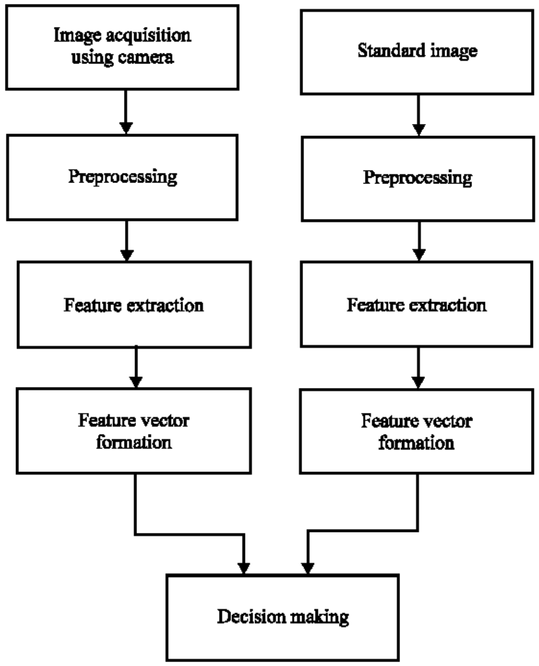

Fig. 1: The image processing flow chart of proposed system

- By using any suitable device which is used to find out the adulterants
- By adding a suitable chemical substance with the food item. This will lead to any color change in the food items
- By means of sieve to separate the adulterant from the adulterated food items (Bligh, 2000)

The above present methods have more disadvantages as:

- In order to check the nature of adulteration some of the food samples are wasted each and every time they are checked (Rajappan *et al*., 2010)
- Exactly, these methods cannot give the exact level or percentage of adulterants in the contaminated food items (Rajappan *et al*., 2010)
- These methods some time give the erroneous result because the methods are manual or done by human being

In our proposed method, the food items are checked for adulteration by using the digital camera as a superior tool (Shapiro and George, 2001) (Fig. 1). The images of adulterated food items are acquired through digital camera and it is being processed with the advent of new technology of digital image processing (Forsyth and Jean, 2003; Christilda *et al*., 2012; Bligh, 2000); Rajappan *et al*., 2010; Shapiro and George, 2001; Sonka *et al*., 2008; Thomso and Rajagopal, 1995). The processing of (extraction of texture features) adulterated food items not only show whether food is adulterated or not but also gives the precise amount of the contamination level.

Novelty statement: In food adulteration system, the quantity of adulterant mixed could not be found out. The advent of new technology of Digital Image Processing (DIP) releases a new path of computer vision based detection of Food Adulteration System (FAS) for analyzing the quantity of adulteration in food items. By this system, we found that whether food is adulterated or not and also the quantity of adulterant mixed in the selected food items are also determined.

MATERIALS AND METHODS

The proposed food adulteration system: Before discussing the proposed food adulteration system, the present methods are presented in order to show how these methods are utilized to detect adulteration in selected food items. The selected food items are milk, oil, black pepper, chilli powder and sugar. The adulterants which are added or mixed with the selected food items are water, vanaspati, papaya seeds, brick powder and sooji, respectively. Detection of adulterants in food by means of the present methods is explained here.

Detection of adulterants in milk: The presence of an adulterant can be found by depositing a dewdrop of milk on a refined sloping surface. The dewdrop of pure milk runs slowly leaving a white path behind it. If it is assorted with water then contaminated milk will follow immediately without a departure mark.

Detection of adulterant in oil: One full teaspoon of oil sample is taken with an identical amount of concerted hydrochloric acid in a stoppered test conduit. A tweak of sugar is added to it. Then, it is shaken for 1 min. Then, it is kept for 5 min. If vanaspati is added or mixed with the oil then there will be a color change in the mixture. This indicates that the sample of oil is adulterated oil. Sometimes, the oil is mixed with edible oil. It is found as follows: 5 mL of specimen in a test pipe is taken. The 5 mL of concerted HCL Acid is added in the combination. Then, it is shaken gently. It is kept for at least 5 min. The color will separate in the upper layer of solution.

Detection of adulterant in black pepper: The adulterant in black pepper is papaya kernels. The papaya kernel can be detached from the pepper by means of their emaciated, elliptical size and their greenish or dark brownish color.

Detection of adulterant in chilli powder: A 5 mg of chilli powder in a cup of water is taken. Dyed water excerpt will show the occurrence of non-natural color. In another way, the adulterant in chilli powder is identified by adding lesser amount of concerted hydro chloric acid to the tiny powder of chilli. After that, it is mixed to the uniformity of glue. Then, the back end of the match stick is dished into the glue and held over the flame. Brick red colored flame will be seen due to the existence of calcium slats in brick powder.

Detection of adulterant in sugar: The adulterated sugar is kept in the bowl consisting of water. Then, it is rinsed properly for 5 min. The sugar is dissolved in water but the adulterant sooji is not dissolved in water.

Problems encountered in the present method: The above tests are used to detect adulteration in the selected food items. The present methods have some problems which are listed as follows:

- These tests are known as quick test which are done manually by human beings. The human intervention will lead to mistakes
- Findings arrived at through these tests lack accuracy
- These tests only give the report whether the particular selected items are adulterated or not
- After testing, the food samples which are taken for test purpose is completely wasted (Roday, 2002)

As per our proposed system, digital image processing technology is used. It is an electronic method of detecting Foreign particles in the original food items. In fact, any photograph images (digital images) can be represented in terms of the pixel form (pixel element) which is a numerical value. This is same for the different photograph images of the same item. But it is never same for different food items. Hence, even a small percentage of availability of foreign particles in the original food items will give different numerical values of pixels in the photographed image. This photographed image is processed through computer. The photograph of original food item without adulterant is known as standard image. The photograph of the new food item (with adulterant or without adulterant) under test is known as current image. The standard image and the current image are compared and the difference in pixel values (numerical values) is calculated through computer. Even a very small amount of adulterant or any other foreign particles added to the original item can be easily identified. Figure 1 explains the digital image processing flow chart of detection of food adulteration system. Initially the selected food items such as milk, chilli powder, sugar, black pepper and oil are taken. The photograph images of these selected food items without any adulterants are acquired through digital camera. These photograph images are considered as standard images. An image's character is understood by calculating mean, standard deviation, entropy, smoothness and local tetra pattern. These values are same for any number of photograph images for the same item but it is different for photograph images of different items. Textures features like mean, standard deviation, entropy, smoothness and local tetra pattern are extracted from the standard image. The texture feature vector is formed from the texture feature values. Finally, standard image is stored inside the personal computer in terms of feature vector.

The photograph images of adulterated food items are taken through the digital camera. The same procedure is applied to these images also. These images are considered as current images. Then, the texture feature vector of current images is obtained. The texture feature vector of current image is compared with the texture feature vector of standard image. Based on this comparison decision will be made. The decision will be either the food item is adulterated or not.

The texture feature parameters: The texture feature parameters which are considered for detection of food adulteration in selected food items are mean, standard deviation, entropy, smoothness and texture feature using local tetra pattern. The following paragraphs illustrate these texture features in detail.

Mean: At each trial time the output is a scalar that contains the mean or average value of the R-by-C-by-Q input matrix. In this approach, the block output is always sample based. M = mean (B) returns the average values of the components along various dimensions of an array. If 'B' is a vector, mean (B) returns the average value of B. If 'B' is a matrix, mean (B) extravagances the columns of B as vector, returning a row vector of mean values. If 'B' is a multidimensional array mean (B) extravagances the magnitudes along the first non-singleton dimensions as vector, returning an array of average values.

Standard deviation: At each sample, time the output is a scalar that comprises the standard deviation of the complete input. In this mode, the output is permanently sample based.

Definition: There are two common textbox definitions for the standard deviation S of a data vector X. Syntax:

- S = std (x)
- S = std (x, flag)
- S = std (x, flag, dim)

$$s = \left[\frac{1}{n-1} \sum_{i=1}^{n} \left(x_i - \frac{1}{x} \right)^2 \right]^{\frac{1}{2}}$$

$$s = \left[\frac{1}{n} \sum_{i=1}^{n} \left(x_i - \frac{1}{x} \right)^2 \right]^{\frac{1}{2}}$$

Where:

$$\frac{1}{x} = \frac{1}{n} \sum\nolimits_{i=1}^{n} x_i$$

and 'n' is the number of elements in the sample. The two forms of the equation differ only in n-1 versus 'n' is the divisor. S = std (x), where 'x' is a vector, yields the standard deviation using the above. The result S is the square root of an unbiased estimator of the variance of the population from which x is down as long as x contains independent, identically distributed sampler.

If 'x' is a matrix, std (x) returns a row vector containing the standard deviation of the elements of each column of x.

Entropy: The average information generated from all the pixels is known as entropy:

$$\text{Entropy H} = \sum_{j=1}^{i-1} p_j \log_2 P_j \frac{\text{Bits}}{\text{Message}}$$

Entropy is maximum when the pixels are uniformly distributed. In various science/engineering applications such as image analysis, speech recognition and time delay estimation which is useful to estimate the differential entropy of a system.

Smoothness: The noise reduction and distorting or altering can be done by means of smoothing filters. Normally, distortion is done in pre-processing steps. After the pre-processing steps, removal of minor particulars from large image and connecting of small gaps in lines and curves has been made. By distorting with a linear filter and by nonlinear filter, noise lessening can be achieved types:

- Low pass spatial filtering
- Median filtering

Local tetra pattern: Texture analysis has been extensively used in computer and machine vision due to its potential in extracting the prominent features. It is proposed that based on the route of pixels using horizontal and vertical derivatives, a second order Local Tetra Pattern (LTrP) is determined. The procedures which are followed to find adulteration in various food items are explained as follows:

- The standard image is loaded and it is converted into gray scale
- The first-order derivatives in horizontal and vertical axis are applied
- The direction for every pixel is calculated
- Based on the direction of the center pixel, the patterns are divided into four parts
- The tetra patterns are calculated and are separated into three binary patterns
- The magnitudes of center pixels are calculated
- The binary patterns are constructed
- The feature value (using local tetra pattern) of standard image is constructed and is stored in computer
- The feature value of current image is found by using the above said procedures
- The current image is compared with the standard image in the computer
- If both images match there is no adulteration
- If both images do not match, adulteration is confirmed

RESULTS AND DISCUSSION

Model of equipment and methodology used: Model of equipment which is used to test the adulteration in food items are canon digital camera, Intel dual core based industrial computer in which MATLAB Software tool is loaded for simulation purpose. While taking the photograph of food items, the image characters are not affected due to the changes in external light intensity, changes in temperature, during thunder and rainy season with high humidity. Texture is a feature that is quite difficult to describe and subjected to the difference of human perception and it is hard to be extracted by segmentation because segmentation is unable to extract the whole texture. The set of features computed are the texture descriptors. The following text descriptors are used. They are:

- Mean
- Standard deviation
- Entropy
- Smoothness
- Texture feature using local tetra pattern

These descriptors have mainly been used to decide on the number of uniform or textured or coarse blocks in the image. To detect and find adulteration in the selected food items the following algorithm is used:

- Store the standard image in terms of its feature vector
- Read the current input image
- Convert color image into gray scale image
- Calculate the current image feature vector as mean, standard deviation, entropy

Smoothness and texture feature using local tetra pattern:

- Compare the difference between current image features and the features of the standard image
- If both images match, the selected food item is said to be a non-adulterated food item
- If both images do not match, the selected food item is said to be an adulterated food item

Detection of food adulteration in milk: To increase the income and also to increase the quantity it is mixed with water. So, there is a necessity of finding this adulterant in milk product. It is usual to add water in milk to increase the quantity to make more profit. That is why, water is considered as adulterant in milk. In this context, it is mentioned that it is not always bad to add water in milk. For example, it is essential to dilute milk when feeding an infant. But it should not be done by the seller. It should be done by the consumer (mother). Also, it is appreciated that adding iodine in table salt is to avoid thyroid gland problems. And adding chicory to coffee powder for making coffee is felt necessary. Our technology depicts the adulteration in any food items. Usually adulteration is considered as bad except the cases cited above. The amount of added adulterant is calculated to know the cheating which is done by the seller. Water is generally added to milk. Adding whey or urine is also to increase the quantity of milk. This can also be tested through our method but unfortunately the scope of this study deals only with the identification of the amount of foreign particle to original food item not the type of foreign particle. In present digital world, we have state of art technology namely digital image processing (using software algorithms) which is replacing all the existing methods. We also intend to replace the old method of using lactometer to find the adulterants in milk. Different photographs (digital camera image) are taken with different levels of adulterant content of the milk. These different adulteration levels in the milk photographs are stored inside the computer in terms of its texture feature vector and database is created with the experimental setup values. The pure milk image is stored as standard image inside the computer. In the actual environment in the milk unit, digital images are taken using digital camera (web camera) and forwarded to the PC. These images are compared with the stored standard image (pure milk) in

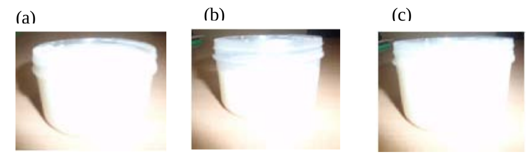

Fig. 2: a) Test environments to determine adulteration in milk; b) Pure milk (standard image; c) Impure milk (current image 1) and d Impure milk (current image 2)

Table 1: Texture based feature vectors for different images

	Texture based feature vector				
Type of images	Mean	SD	Entropy	Smoothness	Local tetra pattern
Standard image	0.9309	0.1648	4.2672	0.0264	374
Current image 1	0.9221	0.1625	4.2538	0.0257	319
Current image 2	0.9218	0.1607	3.6425	0.0252	264

Adulterant level in current image 1 and 2: 09.3, 11.9%

the PC using suitable algorithm. When a particular incoming image matches with the stored image (pure milk), milk is not adulterated and so no action need be taken. When a particular incoming image does not match with the stored image (pure milk), milk is adulterated. The test environment is shown in Fig. 2. Table 1 elucidates the texture based feature vectors for different images. The performance of the system is same for different adulterants like whey, urine, etc. In our system, two samples with two different levels of adulteration quantity are checked through two different photograph images. While checking, the different parameters of the photograph images (digital images) are compared. It is possible that one parameter of the standard image may be closer or even very closer to the parameter adulterated image (current image). But the other remaining parameters will definitely be different. This helps to calculate the quantity of adulterant.

Detection of food contamination in oil: The main aim of contaminating any food item of good quality is to enhance the quantity. For example, water is the adulterant in milk. Similarly, vanaspathi is the adulterant in palm oil. In the present days, the adulterant in milk is tested with lactometer. The adulterant in the palm oil is tested by adding a chemical substance. The presence of adulterant in the oil is found by means of any color alteration in the vanaspathi.

However, the quantity of adulterant which is mixed with the food item could not be found out. The advanced technology of digital image processing offers excellent ways for examining the quantity of adulterant in the oil. For different adulteration levels, the image was taken

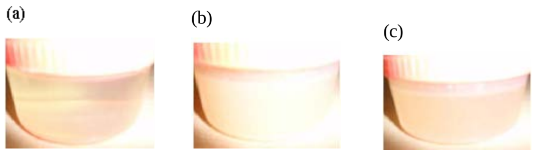

Fig. 3: The experimental setup to determine the, adulteration in oil: a) Pure oil; b) Impure oil 1 and Impure oil 2

Table 2: Texture based feature vectors for different images

	Texture based feature vector				
Type of images	Mean	SD	Entropy	Smoothness	Local tetra pattern
Standard image	0.8723	1.620	6.3062	0.0256	313
Current image 1	1.0790	2.003	7.7970	0.0317	387
Current image 2	1.1110	2.064	8.0350	0.0326	399

Percentage of adulterant in impure oil 1 and 2: 3.6, 27.4%

through digital cameras. Normal eye cannot identify small quantity of adulteration. Photographs are taken through digital cameras of different levels of adulterant in the pure oil. These impure oil images are stored inside the computer as an experimental setup in terms of its texture features. In the normal checkup the oil photograph without adulteration (pure oil) is taken and is compared with the already stored image inside the PC in terms of its texture features. When pure oil image does not match with the impure oil image it indicates that there is some quantity of adulterant in the pure oil. Even for small amount of adulterant which is added to the pure oil can be easily found. The experimental setup is as shown in Fig. 3. Table 2 discloses the texture based feature vectors for pure and impure oil images. The percentage of adulterant in impure oil is different as compared with the percentage of adulterant in milk because the amount of adulterant (vanaspathi) added to pure oil is completely different from the amount of adulterant (water) added to the pure milk. That is the quantities of adulterants added to respective food items are entirely different. It is noted that any particular image variable or image character or image feature value does not decide the adulterant. This value differs for different types of adulterant but final percentage of adulterant will be the same for the same quantity of different adulterants.

Detection of food corruption in pepper: Black pepper is a blossoming plant in the family of piperaceae which is cultured for its fruit. It is usually desiccated and used as a flavor and excitement. When the peppercorn fruit is desiccated, then it is approximately 5 mm in diameter which is dark red when fully developed. Peppercorns and the ground pepper obtained from them may be designated simply as pepper or more exactly as black pepper which is prepared by desiccating immature fruit. And also green pepper and white pepper are available. Desiccated ground pepper has been used as a medication. Black pepper is the world's most exported spice. Normally, black pepper is adulterated by adding the papaya seeds.

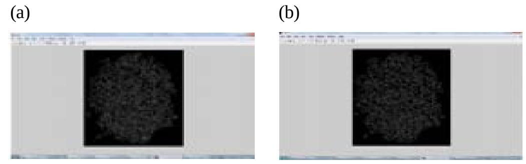

Fig. 4: Canny edges of current images: a) Canny edges of current image and Canny edges of current image 1

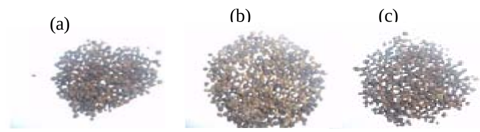

Fig. 5: The experimental setup to find the adulteration in black pepper: a) Standard image; b) Current image 1 (contaminated image) and Current image 2 (contaminated image)

Table 3: Texture based feature vectors for different images

	Texture based feature vector				
Type of images	Mean	SD	Entropy	Smoothness	Local tetra pattern
Standard image 1	0.760(1)	0.2460	6.0821	0.0571	301
Current image 1	0.801(1)	0.2593	6.4099	0.0602	317
Current image 2	0.891(5)	0.2885	7.1340	0.0671	353

The quantity of adulterant in adulterated black pepper image 1 and 2: 5.4, 17.3%

This type of adulteration has been done to increase the quantity of the food item and to earn more profit. The technology used for finding adulteration in black pepper is based on digital image processing. By means of a digital camera (web camera) photograph (digital images) of the black pepper without contamination is taken. This image is considered as standard image. This standard image is stored inside the computer as in terms of texture based feature vector. The digital camera will take photograph of current images after adding the adulterant with the black pepper and forward these images to the computer for further processing. The canny edge detector is applied to the current images.

Figure 4 shows the images after the application of canny edge detector to current images 1 and 2. From Fig. 4 it is understood that the elliptical shape edges indicate the papaya seed and cylindrical edges denote the black pepper. Figure 5 shows the practical arrangement for detecting the adulteration in pepper. Table 3 reveals the texture based feature vectors for standard and current images.

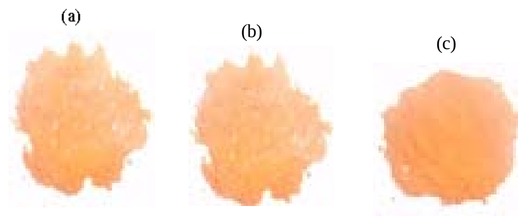

Fig. 6: The various current images and standard image: a) Standard image; b) Current image 1 and Current image 2

Table 4: Texture based feature vectors for different images

Type of images	Texture based feature vector Mean	SD	Entropy	Smoothness	Local tetra pattern
Standard image	0.8566	0.2275	5.2610	0.0492	290
Current image 1	0.9559	0.2539	5.8707	0.0549	324
Current image 2	1.0260	0.2725	6.3010	0.0589	347

Adulterant level in current image 1 and 2: 11.6, 19.8%

Detection of food corruption in chilli powder: Chili powder is a spice which is hot-tasting prepared from ground dried red chillies or with other spices also. When it is added with other flavors it is known as chili powder mixture.

The chilli is otherwise known as red chili peppers. It is vital to avoid adulteration in chilli powder. Normally brick powder is added to chilli powder. When the brick powder is added to chilli powder, it is very injurious to health. So, it is essential to identify the adulteration in chilli powder. For that DIP technique is suggested here. The chilli powder image without any adulteration is stored inside the computer as standard image in terms of its texture feature values. After adding various quantity of brick powder to chilli powder, the photograph of these images are taken through the digital camera and these images are stored as current images. In order to identify the adulterated chilli powder, the red color is separated from the current image by applying segmentation in the current images. After the segmentation, the chilli powder and the brick powder are separated by its color. Red color indicates chilli powder and orange color indicates brick powder. Figure 6 shows the various current images and standard images, respectively. Table 4 demonstrates texture feature values of current and standard images.

Detection of food corruption in sugar: Sugar is nothing but sweet crystalline substance. This substance is obtained from various plants like sugar cane and sugar beet. It essentially consists of sucrose. In food and drink, sugar is used as a sweetener. To earn more revenue, sugar is contaminated with sooji. We can examine the adulteration in sugar by means of new technology known as digital image processing. To determine the adulteration in sugar, first inside the PC pure form of sugar image is stored as standard image in terms of texture based feature vector. Subsequently, the adulterated sugar image is taken through digital camera. Now, the current image is compared with the standard image through a suitable algorithm. When the current image of sugar matches with the standard image, the current image is said to be non-adulterated sugar. If the current image does not match with the standard image then the current image is said to be adulterated sugar. The practical arrangement for detection of food corruption in sugar is shown below. Figure 7 displays the experimental set up to identify adulteration in sugar. Table 5 and 6 illuminates the texture based feature vectors for the different images.

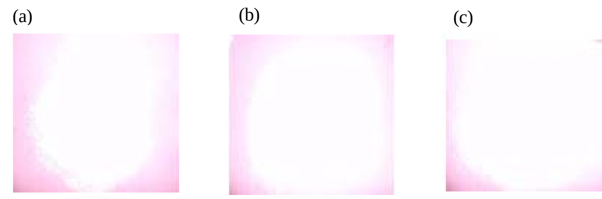

Fig. 7: The various current images and standard image

Table 5: Texture based feature vectors for different images

Type of images	Texture based feature vector Mean	SD	Entropy	Smoothness	Local tetra pattern
Standard image	0.9913	0.02810	2.2120	0.0787	295
Current image 1	1.1040	0.03130	2.4640	0.0877	328
Current image 2	1.1690	0.0.0323	2.6100	0.0929	348

Percentage of adulterant in sugar image 1 and 2: 11.4, 18.01%

Table 6: Performance of proposed method

Parameters	Present method	Proposed method
Responsive time	60-120 sec	45 msec
Accuracy	85%	98%
Adulterant Percentage	Not found	Able to find
Decision making	Sometimes wrong	Always correct
Operation	Manual	Fully automated
Error	Normal error (Due to human)	Error free
Cost	Low	High

Determination of adulterant level in selected food items: The adulterant level in selected food item is determined by how far the texture based feature values of current image are deviated from the texture feature values of standard image. For example, the quantity of adulterant is calculated for milk food item which is explained as follows.

The percentage of adulterant in original milk food item is given by the following equations (percentage of adulterant in food item due to mean+percentage of adulterant in food item due to standard deviation+percentage of adulterant in food item due to entropy+percentage of adulterant in food item due to smoothness+percentage of adulterant in food item due to local tetra pattern)/No. of parameters. Here, the number of parameters are five (i.e., mean, standard deviation, entropy, smoothness and local tetra pattern). The percentage of adulterant in impure milk (current image 1) due to mean = (mean value in current image 1-mean value in standard image)/mean value in standard image)×100. The percentage of adulterant in impure milk (current image 2) due to mean = (mean value in current image 2-mean value in standard image)/mean value in standard image)×100. Similarly, the percentage of adulterant in impure milk (current image 1) due to standard deviation = (standard deviation value in current image 1-standard deviation value in standard Image)/standard deviation value in standard image×100.

The percentage of adulterant in impure milk (current image 2) due to standard deviation = (standard deviation value in current image 2-standard deviation value in standard image)/standard deviation value in standard image)×100. The percentage of adulterant in impure milk (current image 1) due to entropy = (entropy value in current image 1-entropy value in standard image)/entropy value in standard image)×100.

The percentage of adulterant in impure milk (current image 2) due to entropy = (entropy value in current image 2-entropy value in standard image)/entropy value in standard image)×100. The percentage of adulterant in impure milk (current image 1) due to smoothness (smoothness value in current image 1-smoothness value in standard image)/smoothness value in standard image×100.

The percentage of adulterant in impure milk (current image 2) due to smoothness = (smoothness value in current image 2-smoothness value in standard image)/smoothness value in standard image)×100. The percentage of adulterant in impure milk (current image 1) due to local tetra pattern = (local tetra pattern value in current image 1-local tetra pattern value in standard image)/local tetra pattern value in standard image)×100.

The percentage of adulterant in impure milk (current image 2) due to local tetra pattern = (local tetra pattern value in current image 2-local tetra pattern value in standard image)/local tetra pattern value in standard image)×100.

After that, the percentage of adulterant in original milk food item is given by the following equation (per centage of adulterant in food item due to mean+percentage of adulterant in food item due to standard deviation+percentage of adulterant in food item due to entropy+percentage of adulterant in food item due to smoothness+percentage of adulterant in food item due to local tetra pattern)/No. fparameters. Here, the number of parameters are five (i.e., mean, standard deviation, entropy, smoothness and local tetra pattern).

CONCLUSION

The new interesting solution of digital image processing based determination of adulteration in selected food items is obtained. Not only finding adulteration in food item but also calculating the quantity of adulterantin the food item is possible with this new technique. These methods which are used in this adulteration detection system are found to be smart by the food corporation sector in all countries. Proposed for finding adulteration levels in the selected food items, the study gives the original architecture and methodology. It gives possibilities in analysis of concert of food product. The subsequent Table 6 displays the concert of proposed method with existing methods with respect to various parameters. This study proposes ways of finding food adulteration is found in some of the selected food items like sugar, black pepper, chilli powder, oil and milk. This can be further extended to all the food items which are utilized by the food corporation sectors by all government.

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