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Survey on Adulteration in Food Products and Image Processing Techniques used for its Detection

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***Abstract*— Food adulteration is a very common problem that is an issue from ages. The quality of the food is downgraded by adding other ingredients that might be harmful to human health. Adulteration doesn't just mean the addition of an ingredient but it can also be the contamination during storage or distribution of the food item. Nowadays food adulteration is becoming a business. The food items that we consume like the fruits and vegetables are injected with harmful chemicals which are very harmful to human health. This has caused the rising of numerous diseases. This paper is intended to focus on the various image processing techniques administered to detect adulteration in the commonly consumed food products. The food products included in this paper are milk, virgin olive oil, rice granules, almond powder and turmeric powder.**

Keywords*— Food adulteration, Feature extraction, Image processing, ANN, Hyperspectral Images

I. INTRODUCTION

Food safety is a major concern these days due to the growing number of food-borne diseases in the society. Rapid, accurate and automatic detection of food attributes is a practical demand in daily life. Food supply chains have become very complex. At the same time in order to have economic gain organizations are tricking common people by the substitution of adulterants to common food products. In the previous year's many researches have been done to test food quality using various techniques. Traditional methods of food monitoring involves analytical techniques which are time consuming, expensive and require sample destruction. A report published recently says that about 80 percent of premature deaths are due to food as well as water that are contaminated. Use of excessive fertilizers and pesticides is one of the main reasons. The main purpose of adopting this method is to include those specifications that could go unnoticed by naked eye. An emerging technique that has gained popularity in various fields is the Image Processing Technique which helps to find the amount of adulteration in food products. Good digital cameras are used to acquire images and then feature extraction of these images is done. All this is not possible with the olden methods to find adulteration where the samples are used for testing that causes a lot of wastage. Image processing technology gives out a non-destructive and accurate method to calculate and measure the amount of adulterants in a food product. In this research different techniques used for inspecting and for detecting foods quality are discussed. This helps in recognizing the healthiest and best foods that can be released in markets

II. NATURE OF ADULTERANTS

According to the kind of adulterant the processing method can be divided into 3 types:

A. Intended Adulterant
Adulterants such as stone, mineral oil, sand and water. Addition of these kinds of adulterants are harmful for human health.

B. Metallic Adulterant
Metals used in pesticides and cans like arsenic and tin are included in this kind of adulterants. While making food these kinds of adulterants become a part of it

C. Accidental Adulterants-
Adulterants included here are residues of pesticides, accidental dropping of insects, hair, etc. DDT and Pesticides are some of the most common accidental adulterants which exist in plant products.

Testing of these kinds of adulterants is very important so that health issues do not occur cause of consumption of these toxic contaminants [11].

III. LIST OF COMMON FOOD PRODUCTS ADULTERED AND ITS EFFECT ON HUMAN HEALTH

- Turmeric Powder adulterated by adding Kesari dal. Highly Carcinogenic and can cause stomach disorders if taken frequently.
- Mustard Seeds adulterated by adding Argemone seeds. Can affect liver and cause stomach disorders.
- Ice-cream adulterated by adding Washing Powder. an affect liver and cause stomach disorders.
- Black Pepper adulterated by added Papaya seeds. Causes liver related issues.
- Coffee Powder adulterated by adding Tamarind seeds. Causes joint pain and stomach disorders.

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- Sugar adulterated by adding chalk Powder. Very harmful to human health.
- Honey adulterated by adding water or sugar solution. Product quality declines.
- Cloves are mixed with mineral oil which can be very toxic to health.
- Common salt adulterated by adding Chalk Powder. Very harmful to human health.
- Green chilly as well as other green vegetables colored with artificial colors. Harmful to human health.
- Coconut oil adulterated by adding other oils. Mixing different oils is very harmful and can cause heart related problems especially if non-edible oils are mixed.

IV. FEATURE EXTRACTION

When a huge data set is present and when the resouces are to be minimized feature extraction is required. This helps to decrease the data that is redundant. As the data is reduced the machine learns faster and reduces the time needed. First of all to extract the features food segmentation like normalized cuts and contours are done. Scalable Color Descriptor is a histogram descriptor which is based on color [9]. Dominant Color Descriptor is used to show features of object in which just few colors are sufficient to describe the color details. Clustering of colors helps to take few colors and their respective percentages from an area which is segmented in the color space. Next these segments of image are grouped into a food label based on the features that are taken out from that particular segment. Entropy helps to determine signal complexity. Areas having comparable entropies are grouped. Image is broken into smaller images in spatial frequency using Gabor filter. Fractal dimensions are found out for each of the responses. This allows to estimate points in object that can be found in samples of similar objects.

Fig 1. Shows an image from which the specific features are separated out to be processed further.

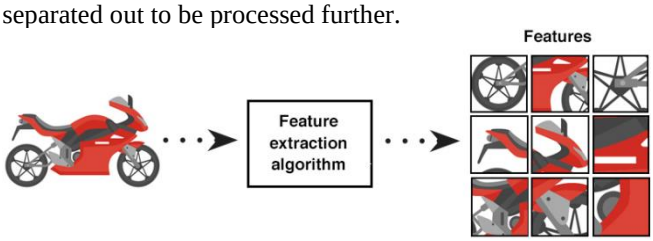

Fig.1. Feature extraction

V. VARIOUS IMAGE PROCESSING TECHNIQUES USED TO DETECT ADULTERATION IN DIFFERENT FOOD PRODUCTS

A. Detection of adulteration in milk using Artificial Neural Network

Milk is a very common food product used in our day to day life [1]. Milk adulteration has been a problem for many years. Some of the usual adulterants used are water, oil, hydrogen peroxide, glucose,urea, etc. note peculiarities. Milk that is adulterated is highly toxic and can be dangerous to human health. Weather conditions can directly impact crop yield. We can make an ANN here by using 2 hidden layers. Various neural networks are trained and the ones which perform best are recorded. The original data that is recorded by experimentation is compared with the result of the ANN model which gives the cow's performance [2]. Also understanding an image using computer vision helps in understanding and reconstructing a 3D image from 2D depending on the features that it has.

B. Detection of adulteration in Virgin Olive Oil

Virgin Olive Oil is a very healthy ingredient which is added in making food [3]. It helps in preventing various heart diseases and other chronic disorders. Usually olive oil is mixed with other cheaper oils which cannot be identified or noticed by the naked eye. Image Processing can be used to identify the amount of adulteration of each component. Various images of combined samples of the oil are captured. CIELab color is used to identify the presence of adulterants and it gives predictions [4]. An advantage of this technique is that it doesn't use very complex formulas or is not time consuming and so the code can be easily covered from MATLAB to mobile.

C. Detection of adulteration in Rice Granules

In the olden days food grains were passed through filters or other mechanical means for the need of grading [5]. But those methods were time consuming and difficult. In order to use a noncontact method Digital Imaging technique is useful. It also helps to reduce the time required and improve the performance. In this image processing technique firstly an image is captured using a camera. Gaussian filters are used to reduce the noise which helps in producing smoother images. Then Histogram equalization of the image is done [6].This helps in giving better information about the image. Next image segmentation is done by edge and region segmentation [14]. Next edge detection is done. Finally feature extraction is done which gives the quantitative information.

This data which is acquired is used in Neural networks systems for detecting and grading the rice grains. Fig. 2. shows the simple flowchart of the adulteration detection technique used in rice grain.

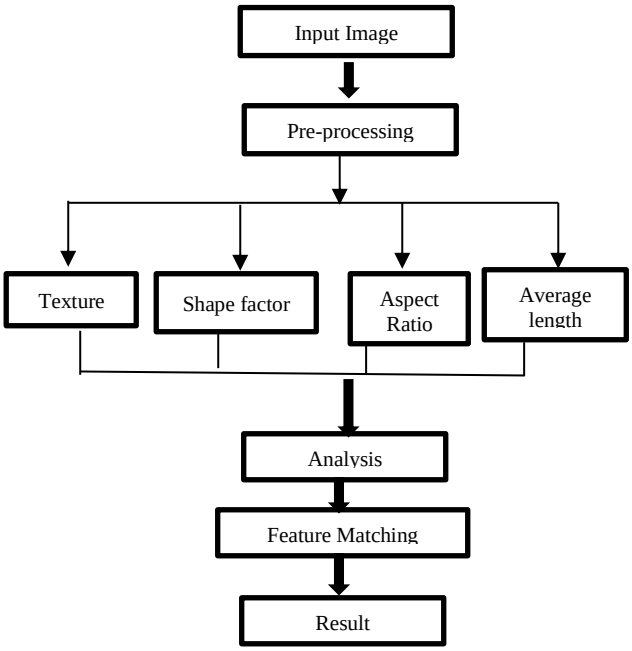

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Fig.2. Flow Chart to find adulteration in rice grain

D. Detection of adulteration in Almond Powder

In this detection method we use the Hyper Spectral Imaging System which is a non-destructive method. Here an imaging system scans the samples. Then these hyperspectral images are translated to relative reflectance intensities [7]. Without changing the conditions the same system can be changed. Next spectral extraction is done after which the resultant data is analyzed. A classifier called DD-SIMCA Classifier is used here to find any amount of adulteration in the almond powder. This model helps in determining the adulterants with greater accuracy. A map which shows the composition of each of the concentration is made. So here we have combined hyper spectral imaging along with various chemometric models to test adulterated almond powder samples.

E. Detection of adulteration in Turmeric Powder

Here multispectral imaging system is used to find the amount of adulteration in turmeric powder. Different samples of adulterated turmeric powder are captured. Noise which is present while doing Analog to digital conversion is removed using different filters [10]. Principal Component analysis is done on the data which changes the correlated variable to uncorrelated variable. Multivariate Gaussian distribution is performed which models the probability density functions of each of the adulterations[8].This kind of a multispectral imaging system has many advantages like low cost, it has non-destructive components used to find the level of adulteration[15].

F. Detection of adulteration in Salmon with Water

Salmon is a food product that is considered very good for human body containing nutrients and unsaturated fatty acids [12]. This can help to remove the cholesterol in human blood which helps to prevent heart related diseases. As salmon industry is growing increasingly the adulteration has also increased. A technique has been used to detect salmon adulteration which is a nondestructive method known as hyperspectral imaging technology. Firstly salmon samples are taken and hyperspectral imaging is done in wavelength of 390–1050 nm. In wavelength of 400-1000nm six component images are taken and six principal-component images of the hyperspectral images are taken out. Out of these, 3 characteristic wavelength are taken depending on weight coefficients of the features of image. The spectral details along with the color features are taken as input to the model. This gives out an SOM model which combines spectral details and color features [13].

VI. CONCLUSION

Adulteration of food products have increased over the years and has become a common problem that affects human health. Lab procedures used to check food quality was once taken as the only option but is not feasible to check every time We can see that from the long history of detecting adulterants the methods adopted to find adulteration have also increased and it needs non-destructive techniques. It has become increasingly needed and important to find new accurate and rapid methods to assess the quality of food products. Image processing methods have become effective and helps to eliminate the manual intervention as well as increases accuracy and performance of the industries. Future work would be to improve the efficiency of the proposed methods to get more accurate results. As the issue of adulteration is increasing over the years we can expect new easy to use, reliable, cheaper and environment friendly methods from the field of image processing very soon.

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