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Classification of Watermelon using Sound Processing.

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Abstract: ***In a country like India, wide variety of fruits are available. Fruits plays an important role in the health of human beings and naturally health improves, if the quality of the fruit is good. Grading of the watermelon quality helps the consumers and vendors. The proposed work is to classify the watermelons based on the sound. Sound file dataset is created manually by tapping the watermelon and recording the sound. Dataset consist of different types of watermelon. For this, different size, colour and shape of the watermelons are used. Features are extracted from the sound files. Naïve Bayes, SMO and Random Tree classifiers are used for classification. The proposed work has achieved average accuracy of 78.8 %.***

Keywords **: *Watermelon , Sound processing , Fast Fourier Transform (FFT), Naive Bayes, SMO, Random Tree.***

I. INTRODUCTION

Fruit plays a pivotal role in day to day life of humans. Natural fruits are very important to lead a healthy life. There are many varieties of fruits which have vitamins, minerals and fibre. Health improves, if the fruit quality is good and leads a healthy lifestyle. The quality of fruit is very important for consumption. Watermelon is a tropical fruit and its scientific name is Citrullus lanatus which belongs to the family of Cucurbitaceae. It is vine like flowering plant originating in West Africa which is a special kind of berry with a hard rind and no internal division and botanically called as Pepo. Its growth is like a fork/herbal vine. It is larger annual plant with long, weak, trailing, climbing stems with five angled. It requires a lot of sunshine and high temperature of 25°C for optimum growth. Watermelon thrives best in a drained fertile soil of fairly acidic nature. Watermelon contains about 6% of sugar and 92% of water by weight. It is a source of vitamin C. Watermelon rinds, usually a light green or pale of green colour and seeds are classified into 3 varieties: Charleston gray Crimson sweet , Black diamond. Charleston gray watermelons are huge elongated which is named for the greenish gray rind. Crimson sweet are the seeds of the watermelon which are available in summer season. Black diamond is a classic oblong watermelon with black green rind covering bright red, crisp, flavorful flesh [1, 2].

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Watermelon differs from size as smaller and hybrid vines. Watermelons are known for their sweet and juicy interiors. The rind is hard, green and usually striped. The flesh may be pink, red, or yellow. Seedless Watermelons are also available but expensive. The fruit may be round, oval or cylindrical, depending on the variety, and weight of the watermelon varies from 3 to 25kg. As the size of the height and weight differs the farmers differentiate them by male and female. Male watermelons are long elongated with watery taste which has a small penny sized ring, whereas the female watermelons are short and sweet compared to the male watermelon which has larger quarter sized ring. Generally when people go to vendor to buy a watermelon, they blindly buy the fruit without knowing the condition of it. In order to know the condition of the fruit there is a traditional way of testing the fruit whether it is good or bad by tapping the watermelon with our hand in a curved position. Usually the vendors tap the watermelon and predict whether it is good or bad. Based on this the implementation is done to predict whether the watermelon is ripe or not. By tapping on it the fruit vendors can feel the sound of the watermelon and they judge which is good or bad. Vendors say if the water content is more we feel very high sound and say that it's its best fruit and sweet. If the water content is normal and the sound is low, then the watermelon is good but not tasty. If the sound is less, it is presumed that the watermelon is yet to be a ripe fruit. Hence, the proposed work is trying to understand the relation between the sound produced by tapping the watermelon and quality of the watermelon depending on its taste. Hearing or auditory perception is the ability to perceive sound by detecting vibration, changes in the surrounding through time and organ such as ear. In humans, hearing is performed primarily by the auditory system. The mechanical waves/sound waves are known as the vibrations are detected by the ear and transduced/transmitting into nerve impulses that are perceived by the brain .The transmitting sound from ear and hitting into brain is the auditory nerve, so that the human can sense the sound. Sound is a form of energy. This energy can be heard through speech or sound. Sound techniques are used in: medical field, industries, etc.

II. LITERATURE REVIEW

Vivek Venkatesh *et al.*, (2014) worked on estimating the volume of fruits based on its shape. Colour images of the fruits are used for the experiment. The fruits are categorized into spherical, ellipsoid and parabolic shapes and an appropriate analytical model for calculating volume was used for each category. Circular evaluation method,

Elliptical evaluation method, Parabolic evaluation method were implemented. Author claims that they have found the reasonable accuracy [3]. Shah Rizam M.S.B et al,.(2009) study involves in determining and measuring the ripeness and quality of the watermelon in which the texture of skin is captured. A random number of watermelons are taken and filtered using image processing technique of ANN (Artificial Neural Network) which shows the water melon with the ripeness accuracy of 86.51% with 32 hidden units which is applied [4]. Montri Phothisonothai et al.(2016) : The aim of this paper is to find the ripeness of the watermelon. A sample of 20 watermelons were taken for testing. Watermelon's ripeness and the rind texture is found using k-means clustering and Laplacian of Gaussian (LOG) filter. The author shows the result of the watermelon ripeness value varies statistically [5]. Koro Kato (1997). An automatic scheme of identifying the density and the hollowness of the watermelon. A sample of 75 Parnassus queen watermelon were taken for testing. The density is measured by the water displacement method based on the ARCHIMEDES PRINCIPLE. The soluble solids of their inner juice were measured by the standard laboratory re-fractometer method. The author shows that the result as hollowness and the soluble solids of water melon are related to the density of the fruit[6].

A. O. Otunaiya, I. A. Adedeji Adedeji (2014): The aim of this paper is to measure the level of technical efficiency and the determinant of the watermelons productivity in the production system. The sample size of 80 watermelons were taken for testing. Budgetary analysis is also used to examine the cost of the watermelons from the farmers. Quantitative technique is used to determine the technical efficiency. The result from this study shows that the technical efficiency in watermelon production is at the average of 65% [7].

N.Ahmad Syazwan et al., (2012) focused on determining the maturity level of the watermelon. Samples of 45 watermelon were taken to test the ripeness and the images were analysed for the feature extraction. The feature extraction of the RGB (Red, Green and Blue) colour component value results to the yellowish spot which is positioned to provide the highest accuracy rates of 73.33% [8].

Prasanth Thomas and Anita H B (2017) the quality of the coconut is checked using the sound processing technique and the method provides the quality assessment based on audioception. Randomly coconuts were taken and dropped which forms the sound pattern. The sound file dataset is used for the classification and the classifiers used are Sequential Minimal Optimization (SMO), Bagging and Naïve Bayes. The author claims the result as 87.7% [9].

Wei Zeng et al., (2014) study involves in checking the watermelon ripeness whether it is ripen or unripe. By tapping the watermelon sound has been recorded in different cell phones. Mobile analysis and machine learning algorithms are used for testing. By checking the signal, the mobile analysis algorithm will say whether the watermelon is ripe or unripe. The classifiers used in this paper are KNN, support vector machine (SVM) etc. The author claims that the result are accurate as 89% [10].

Seppo Fagerlund (2007) The identification of the bird species using bird sounds and are differentiated in to two different parameters: 1. The Mel – cepstrum parameters 2. Set of low level signals parameters. The decision tree with the SVM classifiers is used to classify both the species with the alternative methods which results in better or equal performance [11]. Chang-Hsing Lee et al., (2008) study involves in classifying birds into different species based on the audio recordings of their sounds. A feature set is derived from the static and dynamic of two dimensional Mel – frequency cepstral. Since there are different types of birds sound the number of representative prototype vector is used to identify the bird species and model selection is developed to determine the optimal mode between Gaussian Mixture Model (GMM) and Vector Quantization (VQ) and results the classification accuracy of 84.06%[12]. Selina Chu et al., (2009) focused on the task of recognizing environmental sound and the context surrounding using an audio sensor. Audio Recognition is used for the collected features including Mel Cepstral Coefficients which describes the spectral shape of the audio. Environmental sounds like chirpings of the insects and the sound of the rain are considered. Empirical feature analysis is used for the audio environment which equal's the pursuit algorithm .The author claims that the features yields to the higher recognition accuracy for the environmental sounds [13]. Febin Antony and Anita H.B (2019) this paper involves in detecting the strangers at home using the sound of the parrots. The sound of the parrots are recorded in 2 ways like the sound when its speaking, and its sound when strangers arrive. The feature extraction is done on the sound file dataset. Naive Bayes classifier is used to classify and results in 72.9% [14]. Arja Selin et al. (2006) describes on recognizing the in harmonic and transient bird sounds efficiently. Each sound has been segmented and arranged into a database and then classified. The author claims the results around 80% of accuracy [15].

III. METHODOLOGY

Data Collection and Pre-Processing:

At present, the standard database for watermelon sounds are not available. Hence, in the present study we created our own database for watermelon sounds**.** To record the sound, a sample of watermelons were collected from different vendors at different places with varying in size, height, weight, shape and water content. The sound was recorded by tapping it by hand and wood. For 1 watermelon fruit sound consist of 4 audio files. 2 sound files by the tap of hand by 2 different people and 2 files by the tap of wood. So totally we have 200 sound files.

Table1: Data Collection

Item	Varieties	Total number	Description
Watermelon	Citrullus Lanatus (50 samples)	200 audio files	Each sample of sound has 2 types. 1. By the tap of hand. 2. By the tap of wood.

While recording the sound the constraints used are:

- The environment was made noise free.
- The watermelon was taken in the left hand and tap.
- The tapping was done with same height and angle.

The sound is recorded at 100kbit/s -45MB/h. This was the constant constraint throughout the entire recording procedure.

Table 2: Grading of watermelon

Quality/Grading	No of melon.
1.GOOD	13
2. BEST	10
3.BETTER	05
4.MEDIUM	12
5.TASTELESS	10
Total	50

Fig 1 Grading of the melon

Table 2 and fig 1 shows the grading of the watermelon. Grading of the watermelon is done based on the colour, stripes ,yellow spot, sound and taste of the watermelon .By seeing the stripes in the watermelon and the yellow spots we can classify them. A better way to pick the watermelon is by tapping it than picking it randomly. The grading is done by the testing the sound , the difference between the stripes, the colour and the yellow spot of the watermelon.

The database consists of a dataset of the recording. It consists of both good and bad watermelon sound. All the Good, better and best watermelon are taken as quality 1 watermelon and medium and tasteless are taken as quality 2 watermelon as per table 2. There are 28 quality 1 watermelon and 22 quality 2 watermelon totally 50. They are differentiated by tasting the watermelon manually.

Once the recording is completed the files are taken for cropping .Cropping is done to choose a single tap of the sound which gives a perfect sound of the tap. It is done using the Audacity.

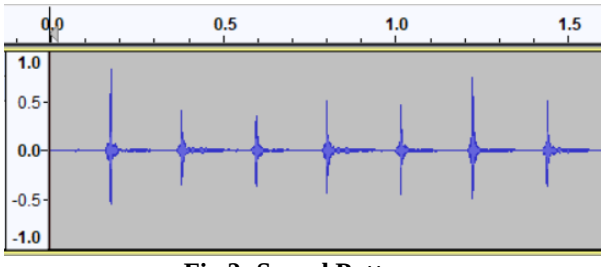

Fig 2: Sound Pattern

Fig.2 depicts the sound pattern represent in the recorded file. For cropping, open the recorded audio file in Audacity. The required region of the audio file is cropped and resaved in an .mp3 format which will be used for classification

IV. FEATURE EXTRACTION

The cropped sound signal is considered for the feature extraction. There are a number of features which are been extracted. A brief description of the features are given below:

1. Crest Factor:

Crest factor is the difference between the peaks and the RMS value of the signal .It is a factor which is used in an audio signal

$$Q = 20*\log_{10}(maxval/s);$$

2. Autocorrelation:

It is used to compare a signal with the time delayed version.If it is a periodic Signal then we can correlate with the time-delay in an integer number of periods.

$$RT = (1-N)/Fs;$$

3. FFT:

FFT is performed on the signal. The resultant of the process gives us a spectrum which is represented by complex values. The real part of these complex values is considered and Standard deviation is performed. The mean of the real values is considered.

4. Dynamic Range:

Dynamic range is the ratio between thelargest and the smallest values of the quantity. It can be used in the context of signal like sound and light. It can be measured in ratio or base-10 or the base-2 logarithmic values of the difference between the largest and the smallest vales of the signal .

$$D= 20*\log10(maxval/min(abs(nonzeros(x))));$$

V. CLASSIFIERS

Weka tool is used for classification. In the proposed system Naïve Bayes, SMO and Random Tree classifiers are tried for classification. Naïve Bayes gives a good accuracy when compared to the SMO and Random Tree classifier.

VI. ALGORITHM

The algorithm below defines the entire step by step process involved in feature extraction from the recorded sound signal.

Input: Sound Signal

Output: Feature vector

Method:

Step 1: Isolate the required region and crop it out.

Step 2: Apply an FFT on the audio signal.

-Standard deviation of the real part of the FFT signal.

-Mean of the real part of the FFT signal.

-Absolute value of FFT mean and standard deviation.

Step 3: Extract the following features,

- Maximum Value
- Minimum Value
- RMS(Standard Deviation)
- Mean
- Dynamic Range
- Crest Factor
- Autocorrelation

Total number of features extracted are 10.
Step 4: Store extracted feature vector in a database

VII. RESULT ANALYSIS

The table describes the result analysis with respect to different classifiers. The Naive Bayes,
SMO and Random Tree classifiers used for classification.

Table 3:Result Analysis

Classifiers	Percentage
1.Naive Bayes	78.8%
2.SMO	70%
3.Random Tree	75.5%

The Good, better and best watermelon are taken as quality 1 watermelon. Medium and tasteless are taken as quality 2 watermelon. According to table 2, we have 28 good and 22 bad watermelons.
Sound file dataset consist of 200 files. Total number of 112 sound files are created from quality 1 watermelons. Similarly 88 sound files are created from quality 2 watermelons.
1. Navie Bayes

5. Table 3.1: Confusion matrix

	Quality 1	Quality 2
Quality 1	45	14
Quality 2	5	26

2. SMO

Table 3.2: Confusion matrix

	Quality 1	Quality 2
Quality 1	30	7
Quality 2	20	33

3. Random Tree

Table 3.3: Confusion matrix

	Quality 1	Quality 2
Quality 1	28	20
Quality 2	2	40

VIII. CONCLUSION

The proposed methodology used the concept of audioception. This concept can be applied when the consumer wants to select the good watermelon by tapping the watermelon instead of depending on the vendors. Using the tap sound of the watermelon, people can classify them into the good or bad category. In the proposed work audacity is used to crop the recorded sound. Features are extracted from the cropped sound files. Classification is done using Weka tool. The average accuracy rate obtained is 78.8%. The classification accuracy can be improved by increasing the size of the dataset and removing the background noise

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AUTHORS PROFILE

Pavadharini T is currently pursuing her Master's Degree in Computer Science at CHRIST (Deemed to be University), Bengaluru, India. As a part of her current curriculum requirements, she is also a Software Intern working at Clear trip Private Ltd. Her job profile is software testing in automation. She completed her under graduation in the year 2018. She has worked on projects like Rent the Unused, Robotic Process Automation. For building these projects, HTML, MySQL, Java, Python, Robot Framework and Visual Basic tools are used. Her research interests are mainly focus on the field of Machine Learning and Sound Processing.

Anita H. B. is presently working as an Associate Professor in Department of Computer Science, CHRIST (Deemed to be University), Bengaluru, India. She has more than 15 years of teaching experience at various institutions. She has received her PhD degree in 2014 at Gulbarga University, Department of Computer Sciences, Gulbarga, Karnataka, India. Her main research interests are Digital Image Processing, Deep learning, Sound Processing, Machine learning, Medical Image Processing and Signal Processing. Her research contribution is in the classification of images using spatial and frequency domain features. She also supervises research projects. Currently, she is guiding Mphil and PhD students.

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