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A Study on Detection of Seed Borne Disease using Fourier and Wavelet Transform

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***Abstract*: For the past twenty years, technology has been well improved by the invention of digital computing devices. Digital image processing is the Combination of computing algorithms to analyze and manipulate digitized image to improve the quality of image according to the user application. The main techniques used for machine vision are Image Acquisition, Image Pre-processing, Image Enhancement either by spatial (or) frequency domain, Image Segmentation and Feature Extraction. After that, the digitized objects in the converted Image are visualized (or) statistically reported and classified based on some classifiers. Development of Digital Image Processing has been exponentially increased in various fields especially in the field of Agriculture. In every field there are detection phase to eliminate any damaged and unwanted information. Like-wise in Agricultural field, One of the main difficulties Cultivators face is Disease infected seeds because Non-fertile (or) Non-vigor seeds can lead to demand in Cropping and Consuming. So Detection and Identification is taken on seed lot for non-entry purpose in cropping. After capturing the image from seed lot, the image is converted from one time domain to frequency domain. For that step many transformation techniques were used. In this study, Fourier Transform and Wavelet Transform techniques are applied for detecting the seed borne disease and compare the accuracy of the results produced by both the techniques for better and fast Prediction.**

***Keywords*: Fourier Transform, Wavelet Transform, Seed Borne Disease.**

1. Introduction

Digital processing of images has been in live from many years ago. Traditional steps involved in Digital Image Processing are Image Acquisition which is the first process. Real time moment is captured by electronic (or) digital devices. It is also a Problematic Domain because the 2-D images which is taken from any time and space. So the images can have Noise (unwanted information), Distortion, Low (or) High Illumination. Acquired image is converted from time domain to frequency domain for manageable processing of that image.RGB Image is converted to grayscale for easier computation. High –pass (sharpening), Low-pass (Blurring) filters and selection of thresholds are used to get suitable result for analysing the image. Next is Image Pre-processing, which may have dynamic effect on the quality of feature extraction [1].Information contained in the image is extracted. Extracted information are classified and clustered according to the features family given to that specific Identification application. Example: Texture, color, size. In Agricultural field, One of the main difficulties Cultivators face is Disease infected plants, leaf and seed. Particularly seeds because Non-fertile (or) Non-vigor seeds can lead to demand in Cropping and Consuming. Seed borne Disease were caused by pathogenic organisms which lives in and residue of soil surface which disrupts the uptake and translocation of water and nutrients from soil. Pathogens infects the seeds during post and pre-emergence phase (Germination). These infection of disease causes seedling death (or) seed infertile. So Detection and Identification is taken on agricultural lots for non-entry purpose in cropping.

2. Image transform

Images can be analyzed and represented in either spatial or frequency domain. In spatial domain, operations of images are directs on the individual pixels composing on that image by convolution and correlation methods but in spatial domain analyzing the images are difficult because some convolution operation can be of higher computational cost and process are complex. So that images are transformed from spatial to frequency for easier computation and better analyzing of the Image. While transforming a 2-D image, the result should be a matrix that has the same size as the image before transforming. So each transformation methodologies has forward and inverse transforms where forward transform is analyzing stage and Inverse transform is synthesizing stage.

3. Existing image transformations

A. Fourier transform

Fourier transform is known to decompose image as two components: sinus and cosines which is called sinusoidal functions. Fourier Transform can convert the given image from spatial to frequency domain. For a discrete function Discrete Fourier Transform is applied by summation of finite number of sinus and cosines functions can give an approximation of the image function.

Forward Fourier Transform: Analysis Equation

$$F(u,v) = 1/MN \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) e^{-j2\pi(\frac{ux}{M}+\frac{vy}{N})}$$

Inverse Fourier Transform: Synthesis Equation

$$F(x,y) = \sum_{u=0}^{M-1}\sum_{v=0}^{N-1} f(u,v)e^{j2\pi(\frac{ux}{M}+\frac{vy}{N})}$$

B. Walsh transform

Walsh Transform is a set of Ortho-normal square-wave function to represent frequency components of given image. Walsh functions are real that they take only two values which are either +1 or -1.

Forward equation:

$$F(u,v) = 1/N \sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\prod_{i=0}^{p-1}(-1)^{b_i(x)b_{p-1-i}(u)+b_i(n)b_{p-1-i}(v)}$$

Inverse equation:

$$F(x,y) = 1/N \sum_{u=0}^{N-1}\sum_{v=0}^{N-1} f(u,v)\prod_{i=0}^{p-1}(-1)^{b_i(u)b_{p-1-i}(x)+b_i(v)b_{p-1-i}(y)}$$

C. Hadamard transform

HT is symmetric and non-sinusoidal function. It consists of a projection onto a set of square waves. The HT coefficients are all +1 or -1(addition and subtraction operations) called sequence components. It does not require any multiplication or division operations. Hadamard matrices are easily constructed for $N=2^n$ if $H = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$.

Forward equation

$$H(u,v) = 1/N \sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)(-1)^{\sum_{i=0}^{n-1} b_i(x)b_i(u)+b_i(y)b_i(v)}$$

Inverse equation

$$f(x,y) = 1/N \sum_{u=0}^{N-1}\sum_{v=0}^{N-1} H(u,v)(-1)^{\sum_{i=0}^{n-1} b_i(u)b_i(x)+b_i(v)b_i(y)}$$

D. Hough Transform

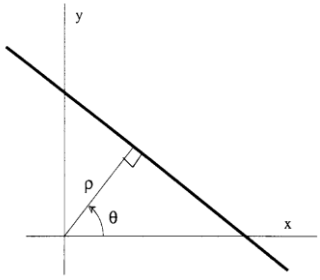

Fig. 1. Normal parameter for a line

Hough transform is basically used for detecting linear figure points in parametric space from a discrete image by using parameter. Parametric space is a representation of define straight lines in spatial plane. A data point in the source space maps onto data points in the destination space.

The equation of a line corresponding to this geometry

$$\rho = y\,sin\theta + x\cos\theta.$$

Where angle θ of its normal and its algebraic distance ρ from the origin

E. Discrete cosine transform [DCT]

Discrete Cosine Transform is real –valued discrete sinusoidal family which contains set of basis vectors that are sampled cosine functions. DCT converts signals into elementary frequency components. It express a finite sequence of data points in terms of sum of cosine function oscillating at different frequencies which is used as one of the Image compression techniques.

Forward Equation

$$F(k,l) = \propto(k) \propto(l) \sum_{m=0}^{N-1}\sum_{n=0}^{N-1} f(m,n)\cos\left[\frac{(2m+1)\pi k}{2N}\right]\cos\left[\frac{(2n+1)\pi l}{2N}\right]$$

Inverse Equation

$$F(m,n) = \sum_{k=0}^{N-1}\sum_{l=0}^{N-1} \propto(k) \propto(l) f(k,l)\cos\left[\frac{(2m+1)\pi k}{2N}\right]\cos\left[\frac{(2n+1)\pi l}{2N}\right]$$

F. Radon transform

Radon transform is an integration of mathematical transform used for detecting horizontal and vertical lines in the given 2-D image. A mapping can be approached from two points of view (i.e) radial distance towards origin will take the radial line perpendicular for the line join by a point to origin in all direction. So that data point in the destination space is obtained from the data in the source space.

Forward transform

$$R(\rho,\theta) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \mathrm{f(x,y)}\delta(\rho - \mathrm{x}\cos\theta - \mathrm{y}\sin\theta)\mathrm{dx\,dy}$$

Inverse Transform

$$f(x,y) = (\frac{1}{2\pi^2})\int_0^{\pi}\int_{-\infty}^{\infty} \frac{\left(\frac{\partial}{\partial s}\right)R(\rho,\theta)}{x\,cos\theta + y\sin\theta - s}\,dsd\theta$$

G. Wavelet transform

Wavelet Transform the images from spatial domain to wavelet domain. A Wavelet is a vibration that decays quickly. The wavelet domain represents wavelet coefficient of the images. The wavelet decomposition is performed by passing the image into series of low pass and high pass filters. The various filter bands are produced and each band producing images of different resolution levels and orientations. These sub bands are then combined using inverse wavelet transform.

Forward Transform

$$W_\Psi^i(j,m,n) = 1/\sqrt{MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)\Psi_{j,m,n}^i(x,y)$$

Where **i** = {H, V, D}.

Inverse Transform

$$f(x,y) = 1/\sqrt{MN} \sum_{i=H,V,D} \sum_{j=j_0}^{\infty} \sum_{m} \sum_{n} W_{\Psi}^{i}(j,m,n)\Psi_{j,m,n}^{i}(x,y)$$

Table 1
Application domain

S. No.	Image Transform name	Application Domain
A.	Fourier Transform	Image Filtering, Reconstruction, Compression
B.	Walsh Transform	Speech Recognition
C.	Hadamard Transform	Image recognition
D.	Hough Transform	Detection of lines in images.
E.	Discrete cosine Transform	Image Compression
F.	Radon Transform	Image Matching
G.	Wavelet Transform	Image Restoration, Compression, De-noising.

4. Proposed methodology

In this Proposal, the study is planned to compare the application of Fourier Transform and Wavelet Transformation techniques for analyzing the image taken from the given training data sets. In analyzing stage, Fourier Transform and Wavelet transform used as low pass filter, high pass filter, band-pass filter and sub-band pass filter. After that the filtered image is segmented and classified. The Performance of Fourier and Wavelet Transform is measured by performance analysis with parameters like PSNR (Peak Signal to Noise Ratio), MSE (Mean Square Error), CR (Compression Ratio), SC(Structural Content). In recent days SSIM is used for better performance evaluation. With that the calculated values measured from thetraining image datasets is used for identification of seed borne disease images from the agricultural lots, so that the percentage of detection can be statistically reported. Comparing the Fourier and Wavelet Transform is measured by the below parameters in Table 2.

Table 2
Parameters

Parameters	Description
PSNR	Calculates peak signals between two images, which gives the rational quality measurements between original and transformed image.
MSE	Represents cumulative squared intensity ratio between reference image and transformed image.
SC	Determine ratio between two images by built-in various small image patches.
CR	Calculates ratio between compressed and uncompressed image data size.
SSIM	Quantifies the quality of image compression and it is full reference non-cognitive metric.

5. Conclusion

This study had described about the combination of digital image processing techniques in agricultural fields. Seed borne disease which are formed from seeds, vegetables, fruits etc. can be detected before cultivation by using image transformation methods. Comparison of the application of Fourier and Wavelet transforms can be used for identification of seed borne disease images from the agricultural lots, so that the percentage of detection can be statistically reported, by that we can get the featured information from the image for further detection of seed borne disease in agricultural lots.

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