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Analysis of Rain Drop using Image Fusion and Image Segmentation Technique

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Abstract: Rainfall deals with size of drops and amount of water precipitated from cloud in particular time. This method proposes the counting of the processing time, total amount of rainfall per second that is the rainfall rate, total number of rain drops, total volume of raindrops & direction of rainfall. It also represents the rainfall distribution in the graphical form along with the histograms details. In this methodology, the first stage is video acquisition stage in which videos of rainfall are captured by using two slow motion cameras having the same resolution for the identical amount of time. The required results are found out by using the non-sampled contourlet transform(NSCT), energy based image fusion ,a new iterative triclass thresholding technique in image segmentation that is based on Otsu's method. Human appearance would be neglected in this system due to which errors are minimized. The result which we are getting from this system will take very less time with the help of MATLAB. The proposed system is having greater accuracy than the existing methods in many aspects.

Keywords: Non-sampled contourlet transform, Otsu's method, Iterative triclass thresholding, Energy based image fusion.

I. INTRODUCTION

The rain is critical not only to weather, but to life on earth. Rain is necessary for the survival of plants and humans. The most widely used monitoring techniques are rain gauges, weather radar and satellites. These existing methods are used from a decayed to get rainfall data but there are some disadvantages of these methods such as in case of rain gauge there are Wind-induced errors, Evaporation and Wetting Losses, Errors from the Lack of a Windshield.

As in case of tipping bucket rain gauge, there are Calibration Errors and Instrument Errors. Satellite monitoring also getting problems due to the excess of clouds. So to overcome these we introduce a new method for measuring rainfall with the help of image processing for prior rainfall analysis. Image processing is more accurately defined as a means of translation between the human visual system and digital imaging devices.

Image processing may sometimes provide the appropriate analysis tools even if the data have nothing to do with imaging operations relating to the display of images.

In our system, we have taken live videos of rainfall by using two slow motion cameras having the same resolution for the identical amount of time on which the different operations are done to get the total amount of rainfall per second that is the rainfall rate, total number of rain drops, total volume of raindrops & direction of rainfall. As this system has very low cost and the very high accuracy, this might be a future method for the analysis of the rainfall.

II. PROPOSED METHOD

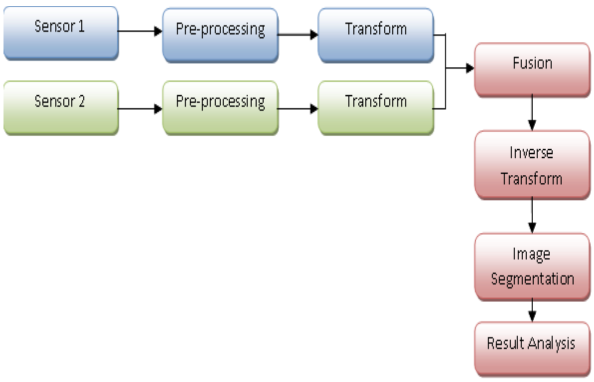

Fig. 1 Proposed algorithm

A. Live Rainfall Data

Rainfall data is captured in the form of videos and then this transferred to the system. For the proper analysis we suggest it should be captured with black background so the amount of external noise is limited and the exact analysis is possible. The cameras should have minimum 1200 fps speed so proper videos can be taken.

B. System

The system requires following specifications:

- Hard Disk: Minimum 500 GB
- Processor: INTEL DUAL CORE or similar
- MATLAB software: version 7.6.*** and above
- Ram: minimum 1 GB

C. Operational Analysis on Data

The operations are as follow:

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- Input videos 1 & 2
- Pre-processing (videos to image conversion ,Rgb2gray, Filtering)
- Non-Subsampled Contourlet Transform (NSCT)
- Fusion (Energy based fusion)
- Inverse Non-Subsampled Contourlet Transform (NSCT)
- Otsu Segmentation (Iterative Triclass Thresholding method)
- Result /Drop Analysis(the total amount of rainfall per second that is the rainfall rate, total number of rain drops , total volume of raindrops & direction of rainfall)

III. METHODOLOGY

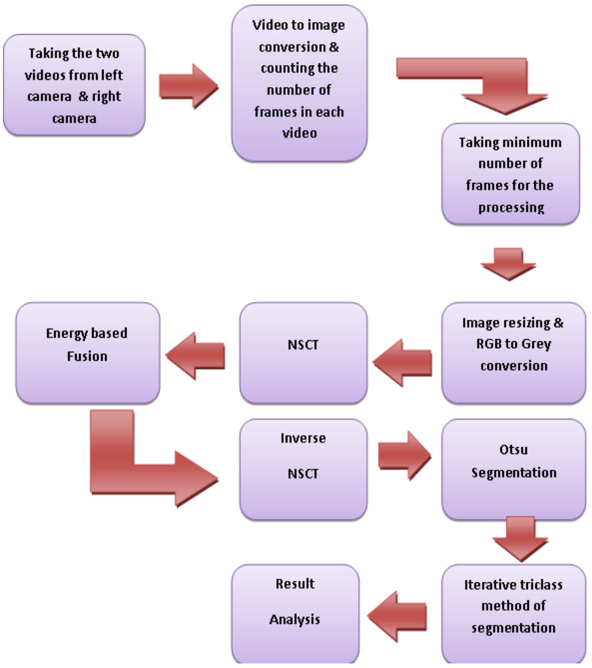

Fig. 2. Operational algorithm

Fig.2 shows the block diagram of Operational Algorithm of system. There are different operations which are done on videos to get result. The given system is having greater accuracy than the existing methods. Where the first stage is video acquisition stage in which videos of rainfall are captured by using a two slow motion cameras having the same resolution for the identical amount of time. After counting the number of frames in both the videos, minimum number of frames have been selected among the two videos & further processing is done for that many number of frames of both the videos. After the resizing and rgb to grey conversion of the images, the non-sampled contourlet transform(NSCT) is used in order to achieve shift invariant technique. The energy based image fusion is performed. In this, the energies of low frequency components & high frequency components of the frames of both the cameras. After comparing the energies , higher pixel values are selected for the image reconstruction. The reconstruction of fused image is done by applying inverse NSCT.A new iterative triclass thresholding technique in image segmentation that is based on Otsu's method is used. This technique iteratively searches for Sub-regions of the image for segmentation, instead of treating the full image as a whole region for processing. Dilation is a process in which the binary image is expanded from its original shape. After thresholding and dilation we get the separate background and foreground objects. In this case, the raindrops are separated from the background .so the next stage is to detection and measuring the volume of raindrops. For this, binarization is used in which, we count the no. of white pixel to measure the size of raindrops. Binary images may contain numerous imperfections. In particular, the binary regions produced by simple thresholding are distorted by noise and texture. Morphological image processing pursues the goals of removing these imperfections by accounting for the form and structure of the image. And by using a MATLAB function named as bounding box we count the total no of raindrops present in the particular frame as well as the direction of rainfall.

A. Video to Image Conversion
If we analyze by using video we first have to convert video into image sequence and then doing operations on this images.

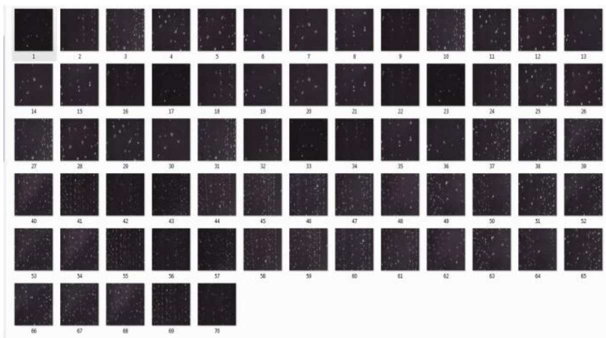

Fig. 3. Frame separation

B. Image Resizing
After we converts image sequence from video. We have to resize our image for further operation. For the further operation we required image with Colum and row size 512*512. we are resizing our image from 2094*1944 to 512*512 it had an advantage that we require less time for analysis and the noise get reduced due to resizing.

C. Non-Subsampled Contourlet Transform (NSCT)
The NSCT is a fully shift-invariant, multiscale, and multidirection expansion that has a fast implementation. The proposed construction leads to a filter-design problem that to the best of our knowledge has not been addressed elsewhere. The design problem is much less constrained than that of contourlets. This enables us to design filters with better frequency selectivity thereby achieving better subband decomposition. Using the mapping approach we provide a framework for filter design that ensures good frequency localization in addition to having a fast implementation through ladders steps. The NSCT has

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proven to be very efficient in image de-noising and image enhancement.

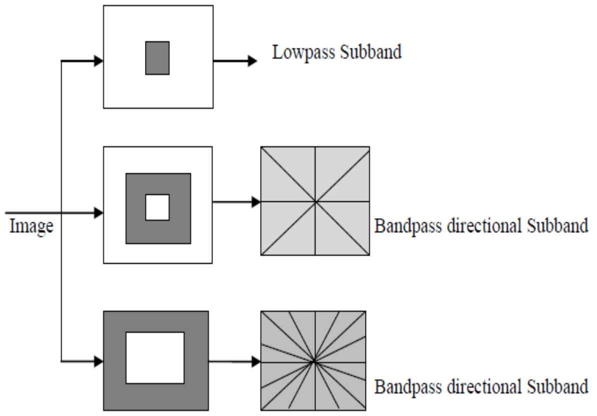

Fig. 4. NSFB structure that implements the NSCT

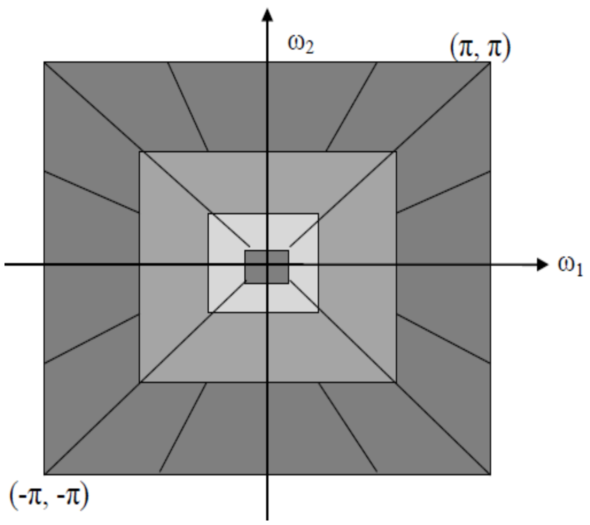

Fig. 5. Ideal frequency partitioning obtained with the proposed structure

A two-dimensional (2-D) filter is represented by its z -transform H(z) where $z = [z_1, z_2]^T$. Evaluated on the unit sphere, a filter is denoted $H(e^{j\omega})$by where $e^{j\omega} = [e^{j\omega_1}, e^{j\omega_2}]^T$. If $m = [m_1, m_2]^T$ is a 2-D vector, then $z^m = z^{m_1}.z^{m_2}$ whereas if M is a 2*2 matrix, then $z^M = [z^{m_1}, z^{m_2}]$ with m_1,m_2 the columns of M. In this ,we often deal with zero-phase 2-D filters. On the unit sphere, such filters can be written as polynomials in $\cos\omega = (\cos\omega_1, \cos\omega_2)^T$. We thus write $F(x_1, x_2)$ for a zero-phase filter in which x_1 and x_2 denote $\cos\omega_1$ and $\cos\omega_2$ respectively.

Fig. 4. displays an overview of the proposed NSCT. The structure consists in a bank of filters that splits the 2-D frequency plane in the subbands illustrated in Fig. 5. Our proposed transform can thus be divided into two shift-invariant parts: a) a nonsubsampled pyramid structure that ensures the multiscale property and b) a nonsubsampled DFB structure that gives directionality.

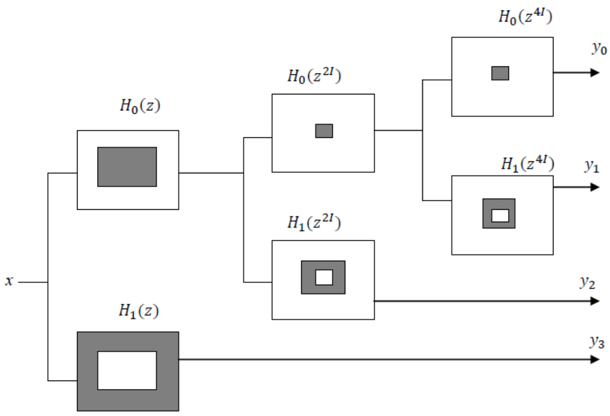

Fig. 6. Three stage pyramid decomposition

The multiscale property of the NSCT is obtained from a shift-invariant filtering structure that achieves a subband decomposition similar to that of the Laplacian pyramid. This is achieved by using two-channel nonsubsampled 2-D filter banks.

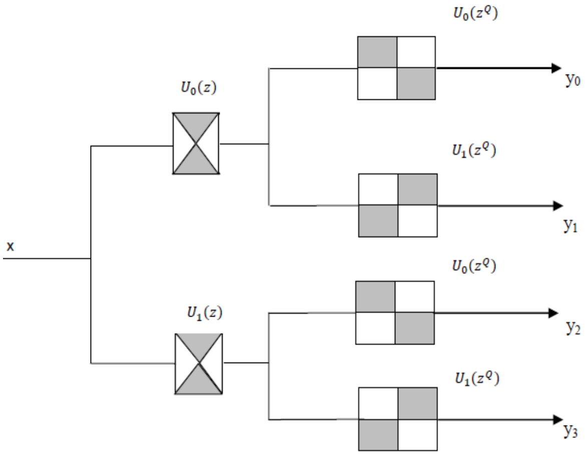

Fig. 7. Filtering structure

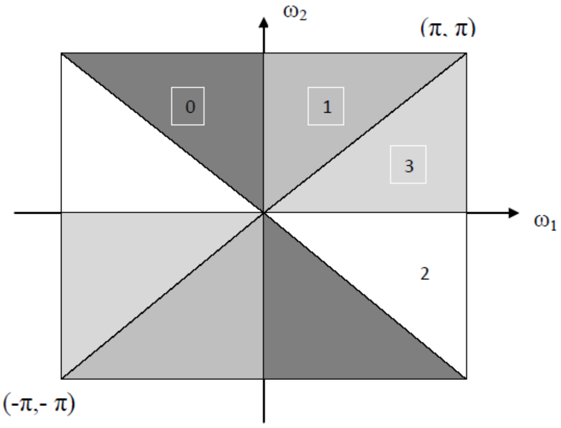

Fig. 8. Corresponding frequency decomposition

The directional filter bank is constructed by combining critically-sampled two-channel fan filter banks and resampling operations. The result is a tree-structured filter bank that splits the 2-D frequency plane into directional

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wedges. A shift-invariant directional expansion is obtained with a nonsubsampled DFB (NSDFB). The NSDFB is constructed by eliminating the downsamplers and upsamplers in the DFB. This is done by switching off the downsamplers/upsamplers in each two-channel filter bank in the DFB tree structure and upsampling the filters accordingly.

D. A Pan-Sharpening Based on NSCT

Pan-sharpening is conducted as described by the following steps.

- Each original MS_i band is decomposed, using NSCT, in one coarse level and one fine level, whereas the Pan image is decomposed into one coarse level and three fine levels.
- The obtained MS_i coefficients are then upsampled using the bi-linear interpolation algorithm.
- The coarse level of the pan-sharpened MS_i band is the upsampled coarse level of the MS_i band.
- Fine levels 2 and 3 of the pan-sharpened MS_i band are set to fine levels 2 and 3 of the Pan image.
- Fine level 1 of the pan-sharpened MS_i band is obtained by fusing the coefficients of the same level obtained from both the MS_i band and the Pan image. The fusion rule uses the local energy (LE) of each coefficient calculated within a $(2M+1)\times(2N+1)$ a window to generate decision map.
- For the (x,y) position, the LE is given by

$$LE(x,y) = \sum_{i=-M}^{M} \sum_{j=-N}^{N} \left(Fine_{level_{coeff}}(x+i, y+j)\right)^2$$

- This map is used in order to decide whether the Pan coefficient or the MS coefficient will be used
- Finally, the inverse NSCT is performed to provide the pan sharpened images MSi

Left camera image Light camera image Fused image

Fig. 9. Fusion Process

E. Image Segmentation Based on New Iterative Triclass Thresholding Technique

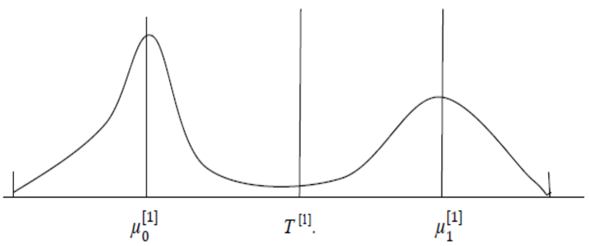

Fig. 10. Otsu's segmentation with iterative triclass thresholding technique

In Image processing, segmentation is often the first step to pre-process images to extract objects of interest for further analysis. The idea of dividing an image's histogram iteratively into three classes as shown in the Fig.10. For an image u, at the first iteration, Otsu's method is applied to find a threshold $T^{[1]}$ where the superscript denotes the number of iteration. We then find and denote the means of the two classes separated by $T^{[1]}$ as $\mu_0^{[1]}$ and $\mu_1^{[1]}$ for the background and foreground, respectively. Then we classify regions whose pixel values are greater than $\mu_1^{[1]}$ as foreground $F^{[1]}$ and regions whose pixel values are less than $\mu_0^{[1]}$ as background $B^{[1]}$. For the remaining pixels u(x, y) such that $\mu_0^{[1]} \le u(x,y) \le \mu_1^{[1]}$ we denote them as the TBD class $\Omega^{[1]}$. So our iterative process assumes that the pixels that are greater than the mean of the "tentatively" determined foreground are the true foreground. Similarly, pixels with values less than μ_0 are for certain the background. But the pixels in the TBD class, which are the ones that typically cause mis-classifications in the standard Otsu's method, are not decided at once and will be further processed. By our definition, we have

$$U = F^{[1]} \cup B^{[1]} \cup \Omega^{[1]}$$

where $\cup$ is the logical union operation. At the second iteration, we apply Otsu's method to find threshold $T^{[2]}$ on region $\Omega^{[1]}$ only. We then calculate the two class means in $\Omega^{[1]}$ separated by $T^{[2]}$ as $\mu_0^{[2]}$ and $\mu_1^{[2]}$. Similarly, the second iteration will generate a new $F^{[2]}$, $B^{[2]}$, and $\Omega^{[2]}$ such that

$$\Omega^{[1]} = F^{[2]} \cup B^{[2]} \cup \Omega^{[2]}$$

where $F^{[2]}$ is defined as the region in $\Omega^{[1]}$ with pixel values greater than $\mu_1^{[2]}$, $B^{[2]}$ as the region in $\Omega^{[1]}$ with pixel values less than $\mu_0^{[2]}$, and $\Omega^{[2]}$ are the new TBD region. The iteration stops when the difference between two consecutive threshold $|T^{[n+1]} - T^{[n]}|$ is less than a preset threshold. At the last iteration [n +1], $\Omega^{[n+1]}$ is separated into two instead of three classes, i.e., foreground $F^{[n+1]}$ is defined as the region of $\Omega^{[n]}$ that is greater than $T^{[n+1]}$ instead of $\mu_1^{[n+1]}$ and background $B^{[n+1]}$ is defined as the regions with pixel value less than $T^{[n+1]}$. The innovation of the new method is to iteratively define the TBD regions to gain a high distance ratio, which will result in better segmentation by applying Otsu's method.

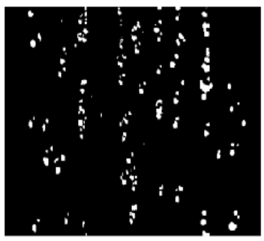

Fig. 11. Iterative segmentation

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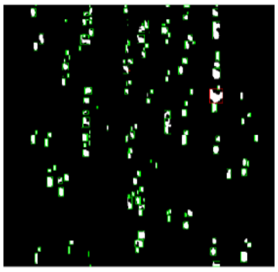


Fig. 12.Segmented image

IV. RESULTS

A. Processing Time

To measure the processing time, the MATLAB commands 'tic' and 'toc' are used. tic starts a stopwatch timer to measure performance. The function records the internal time at execution of the tic command. Display the elapsed time with the toc function. timerVal = tic returns the value of the internal timer at the execution of the tic command, so that you can record time for simultaneous time spans. toc reads the elapsed time from the stopwatch timer started by the tic function. The function reads the internal time at the execution

of the toc command. and displays the elapsed time since the most recent call to the tic function that had no output, in seconds. Elapsed Time = toc returns the elapsed time in a variable.

B. Total Number of Raindrops in Entire Video

To measure total number of raindrops in entire video, the following steps must be carried out

Step 1:

As we have 256*256 JPEG image which can be represented by the summation of white pixels and black pixels.

$$\text{Image, } I = \sum_{W=0}^{255}\sum_{H=0}^{255}(f(0) + f\ (255))$$

Pixels =Width (W) X Height (H) = 256 X 256

f (255) = white pixel (digit 255) f(0) = black pixel (digit 0)

Step 2:

To calculate no. of white pixels we have another formula.

$$\text{no. of white pixels, } \quad p = \sum_{W=0}^{255}\sum_{H=0}^{255}(f(0))$$

Where, P = number of white pixels (width*height)

1 Pixel = 0.264 mm

The above steps are carried out for the all the frames in videos to calculate total number of raindrops in entire video.

C. Total Volume of Rain drop in Entire video

Without droplets of water, most clouds would be transparent.

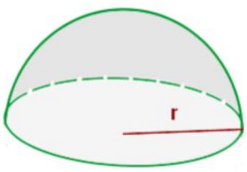


Fig.13. Volume of rain drop measurement

If you were to look inside a cloud you would see droplets of water of many different sizes because droplets constantly grow in size once they are formed. Assume that the droplet is a perfect hemisphere So by using hemisphere volume formula, Rain drop Volume (v), $v = \frac{2}{3}\Pi r^3$

D. Total Rain drop per second

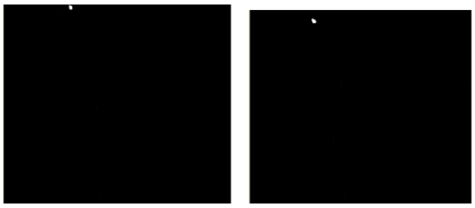
Total rain drop per second is calculated by the following formula

$$\text{Total rain drop per second} = \frac{\text{Total rain drops in entire video}}{\text{total time for which video is taken}}$$

E. Direction Estimation

In order to get the direction of rainfall, we find the same rain drop in sequence of frames, then we find the bounding box of x and y direction for both frames.

- If x direction of both frames approximately same then Rain falling in Vertical direction. For example : $abs(s1(1) - s2(1)) < 4$
- If x direction of both frames are greater then threshold and if difference is in negative value then Rain falling in Right direction For example: $abs(s1(1) - s2(1)) > 4\ \&\ (sign(s1(1) - s2(1)) == -1)$
- If x direction of both frames are greater then threshold and if difference is in positive value then Rain falling in Left direction For example: $abs(s1(1) - s2(1)) > 4\ \&\ (sign(s1(1) - s2(1)) == 1$



Frame 1 Frame 2

Fig. 14. Direction estimation

V. PERFORMANCE

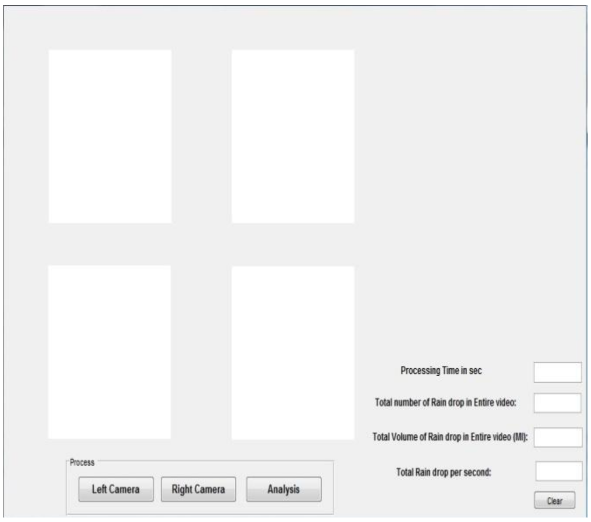


Fig.15. Snapshot of rainfall analysis main GUI

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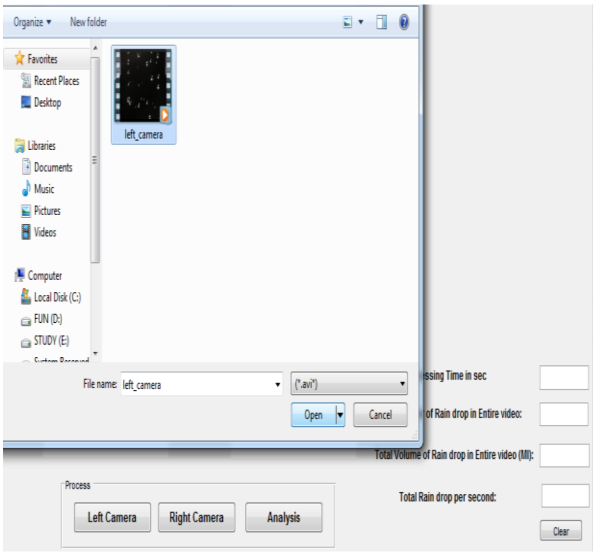

Fig. 16.Snapshot of video 1 selection from database

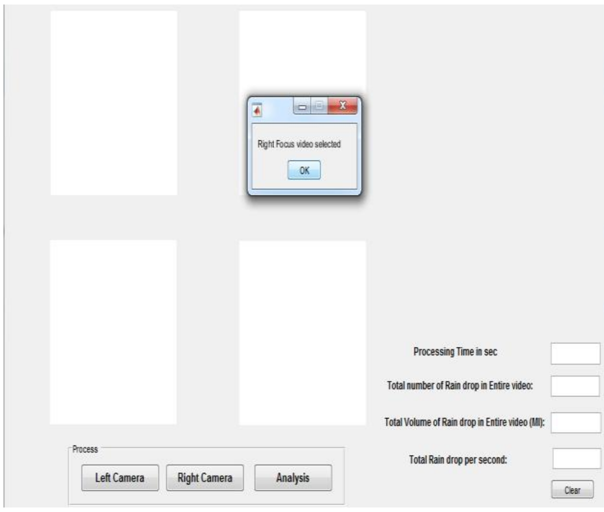

Fig.19. Snapshot of video 2 selection from database

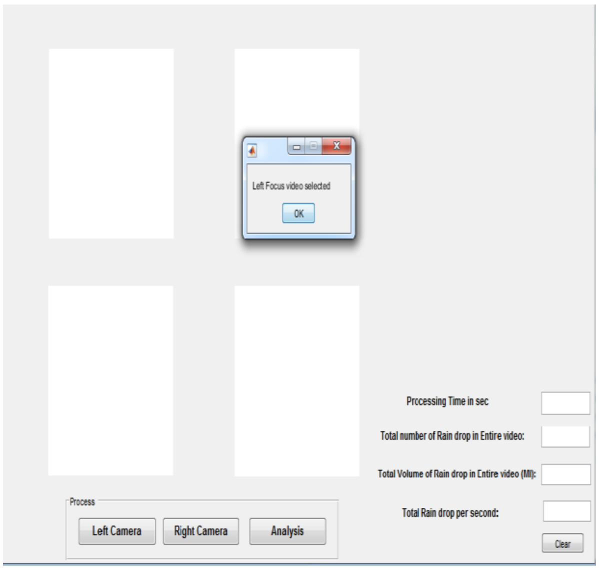

Fig.17. Snapshot of video 1 selection from database

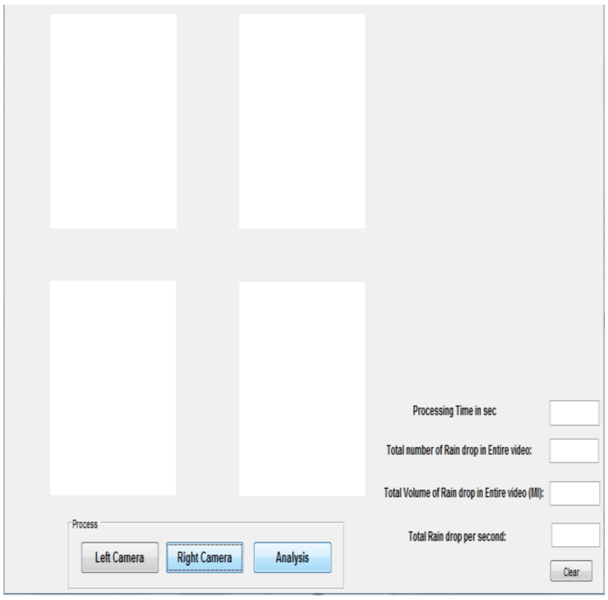

Fig. 20. Snapshot of beginning of analysis

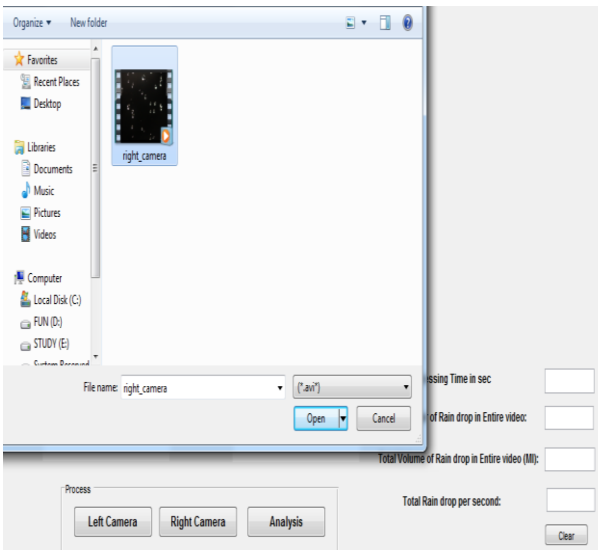

Fig.18. Snapshot of video 2 selection from database

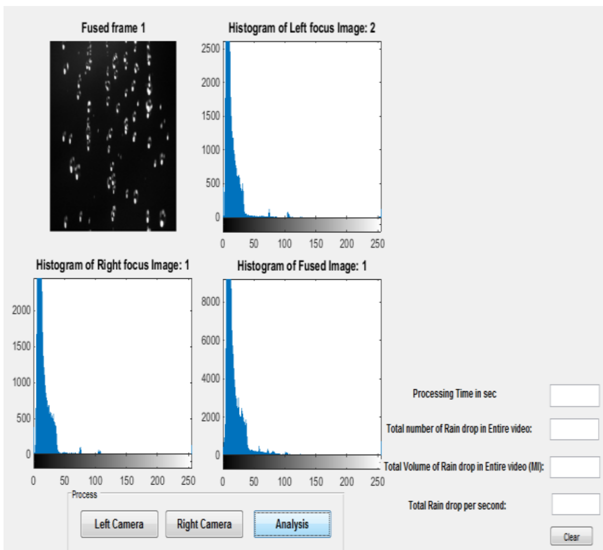

Fig. 21. Snapshot of frame fusion and segmentation

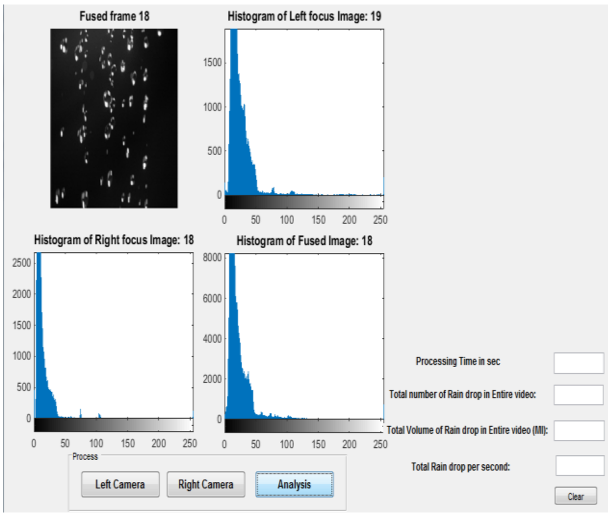

Fig. 22 Snapshot of frame fusion and segmentation

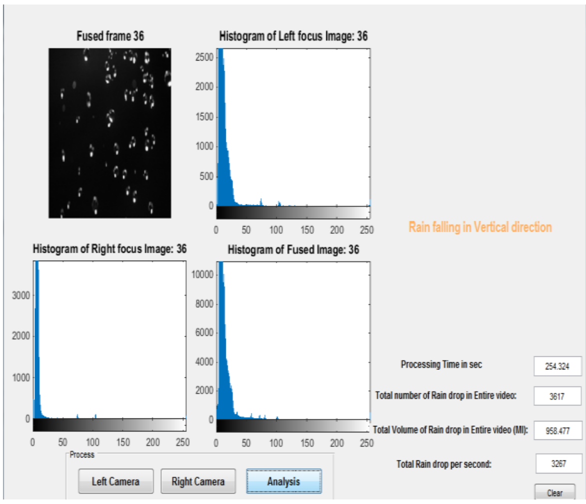

Fig. 23. Snapshot of completion of frame fusion and segmentation

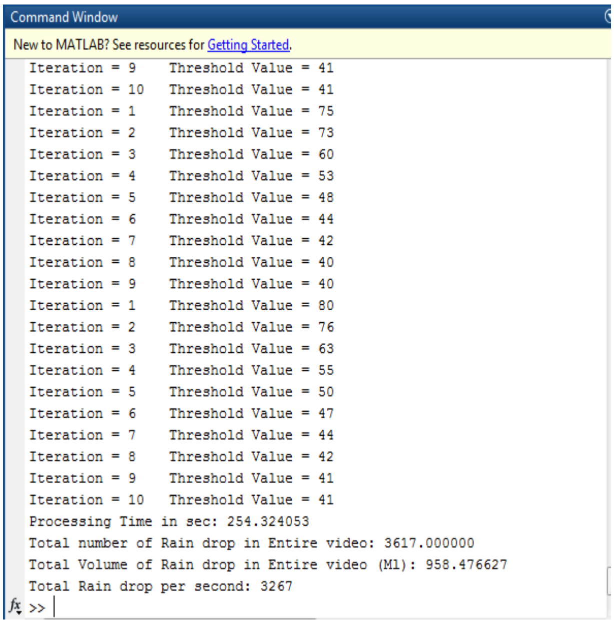

Fig.24. Snapshot of result analysis

VI. CONCLUSION

Rainfall measurement is the global need to get accurate information of the amount of rain is fallen in a particular area for the safety purpose of the people as well as the crop management for the farmers. We mainly are dealing with the parameters (1) the rainfall rate (2) total number of rain drops (3) total volume of raindrops & (4)direction of rainfall all the parameter are important to get accurate rainfall analysis. This system use image processing as processing tool and having numerous amounts of advantages over the rain gauge and other measuring instruments also the errors due to human interpretation is get nullified due to very less amount of human interference. This method may be the future of the rainfall analysis techniques with 90-95 % accuracy.

The costing of this system is very low only we required a high definition camera which having the ability to captured perfect video camera as these videos are the base of this system. So the accuracy of this system is totally depend upon the quality of videos captured. By using two cameras ,we find out the volume of rain drops and which helpful to get total rainfall in particular area.

VII. FUTURE SCOPE

In this system, We only consider the one layer of the rain further research will be possible by taking multiple layers of raindrops. As this system is not tested in storm so that type of testing can be done and improvement can be done to get accurate result in storm and tornados.

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I express sincere gratitude to my Project guide **Prof. P.A. Ghonge,** who in spite of their busy schedule has been a tremendous and outstanding guide. I am also thankful to my family members for the encouragement and support that they have extended. This acknowledgement is a humble attempt to earnestly thanks to all who are directly or indirectly involved in the completion of this report.

REFERENCES

[1] "Estimation Of Droplet Analysis" by Prof.P.A.Ghonge And Mr.Sameer Sawant in Mumbai University 2014
[2] "Droplet size measurement for liquid spray using digital image analysis technique" by N.Lad A.Aroussi And M.F.Muhamad Said
[3] "An Automatic Method Based on Image Processing for Measurements of Drop Size Distribution from Agricultural Sprinklers" By Paulo Estevão Cruvinel ,Edson Roberto Minatel ,Marcos Luiz Mucheroni ,Sidney Rosa Vieira ,Silvio Crestana
[4] "Image Fusion Method based on Non-Subsampled Contourlet Transform" by Hui Liu School of Science, Jiangxi University of Science and Technology, 341000 Ganzhou, China December 2012
[5] "A New Iterative Triclass Thresholding Technique in Image Segmentation" by Hongmin Cai, Zhong Yang, Xinhua Cao, Member, IEEE, Weiming Xia, and Xiaoyin Xu
[6] "A Pan-Sharpening Based on the Non-Subsampled Contourlet Transform: Application to Worldview-2 Imagery by Miloud Chikr El-Mezouar, Kidiyo Kpalma, Nasreddine Taleb, and Joseph Ronsin

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ISSN (Print) 2319 5940

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[7] "The Nonsubsampled Contourlet Transform: Theory, Design, and Applications" by Arthur L. da Cunha, Jianping Zhou, Member, IEEE, and Minh N. Do, Member, IEEE
[8] **"**An Image Processing Algorithm for Detection and Tracking of Aerial Vehicles" Sungwook Cho, Sungsik Huh, Hyong Sik Choi and David Hyunchul Shim, Member, IEEE
[9] Wikipedia (http://en.wikipedia.org/wiki/Rain_gauge)
[10] **"**Analysis of Raindrop Size Distribution Characteristics in Malaysia for Rain Attenuation Prediction " H.Y. Lam , Din.J, L Luini , A. D.Panagopoulos , C.Capsoni
[11] "Improving Rainfall Measurement Accuracy in Spaceborne Rain Radar over Sea" F.Capolino, G. Biffi Gentili, L.Facheris, M.Gherardelli, D. Giuli IEEE-International Conference On Advances In Engineering, 1995 0-7803-2567-2195
[12] "Analysis And Synthesis Of Raindrop Size Distribution Time Series From Disdrometer Data" Mario Montopoli, Frank Silvio Marzano, Senior Member, IEEE, And Gianfranco Vulpiani,Ieee Transactions On Geoscience And Remote Sensing, Vol. 46, No. 2, February 2014

BIOGRAPHIES

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