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Estimation of Rain Drop Analysis Using Image Processing

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Abstract: ***This paper deals with simple algorithm for detection of raindrop size and measuring the total rainfall. In the ERAUIP we are using image and video database from advance slow motion camera for detection of raindrop and measuring the no. of raindrops present in particular frame.in this system image and video database are processed by using image processing and different algorithm are used to extract useful information form the database.in existing methods most of the methods only measure amount of water that reached at the ground .they didn't concern about the drop size and the graphical representation. With the help of ERAUIP method it is possible to count drop size as well as the amount of water reached at the ground. 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.***

Keywords: image processing, raindrop measurement, raindrop analysis, thresholding, rainfall measurement

1. 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 need to measure this rainfall becauseprolonged or heavy rainfall is often the main cause of debris flows and flash floods in rivers and urban areas, and can be a key factor for dam breaks and other types of flash flood. The most widely used monitoring techniques are raingauges, weather radar and satellites. Weather radar networks are typically operated by national meteorological services (nms) together with a core national network of raingauges and other meteorological instrumentation additional raingauges are often operated by river basin management, hydropower, water supply, flood warning and other authorities and as part of community-based flood warning schemes. THERE Are some disadvantages of the existing system to overcome this we introduce a new method for measuring rainfall with the help of image processing for prior rainfall analysis. With the help of this methos we can sindout the raindrop size as well as total rainfall in particular area.Image processing is often viewed as arbitrarily manipulating an image to achieve an aesthetic standard or to support a preferred reality. However, image processing is more accurately defined as a means of translation between the human visual system and digital imaging devices.

There are 3 types of images used in Digital Image Processing. They are
1. Binary Image
2. Gray Scale Image
3. Colour Image

1) Binary Image

A binary image is a digital image that has only two possible values for each pixel. Typically the two colors used for a binary image are black and white though any two colors can be used. The color used for the object(s) in the image is the foreground color while the rest of the image is the background color. Binary images are also called bi-level or two-level. This means that each pixel is stored as a single bit (0 or 1).This name black and white, monochrome or monochromatic are often used for this concept, but may also designate any images that have only one sample per pixel, such as grayscale images Binary images often arise in digital image processing as masks or as the result of certain operations such as segmentation, thresholding, and dithering. Some input/output devices, such as laser printers, fax machines, and bi-level computer displays,
can only handle bi-level images

2) Gray Scale Image

A grayscale Image is digital image is an image in which the value of each pixel is a single sample, that is, it carries only intensity information. Images of this sort,also known as black-and-white, are composedexclusively of shades of gray (0-255), varying from black(0) at the weakest intensity to white(255) at the strongest. Grayscale images are distinct from one-bit black-andwhite images, which in the context of computer imaging are images with only the two colors, black, and white (also called bi-level or binary images). Grayscale images have many shades of gray in between. Grayscale images are also called monochromatic, denoting the absence of any chromatic variation.

3) Colour image

A (digital) color image is a digital image that includes color information for each pixel. Each pixel has a particular value which determines it's appearing color. This value is qualified by three numbers giving the decomposition of the color in the three primary colors Red, Green and Blue. Any color visible to human eye can be represented this way. The decomposition of a colour in the three primary colors is quantified by a number between 0 and 255. For example, white will be coded as R = 255, G = 255, B = 255; black will beknown as (R,G,B) = (0,0,0); and say, bright pink will be :(255,0,255)

2. Rainfall Analysis Methods

Most rain gauges generally measure the precipitation in millimeters. The level of rainfall is sometimes reported as inches or centimeters. Rain gauge amounts are read either manually or by automatic weather station (AWS). The frequency of readings will depend on the requirements of the collection agency. Some countries will supplement the paid weather observer with a network of volunteers to obtain precipitation data (and other types of weather) for sparsely populated areas. In most cases the precipitation is not retained, however some stations do submit rainfall (and snowfall) for testing, which is done to obtain levels of pollutants. Rain gauges have their limitations. Attempting to collect rain data in a hurricane can be nearly impossible and unreliable (even if the equipment survives) due to wind extremes. Also, rain gauges only indicate rainfall in a localized area. For virtually any gauge, drops will stick to the sides or funnel of the collecting device, such that amounts are very slightly underestimated, and those of .01 inches or .25 mm may be recorded as a trace. Another problem encountered is when the temperature is close to or below freezing. Rain may fall on the funnel and ice or snow may collect in the gauge and not permit any subsequent rain to pass through. Rain gauges should be placed in an open area where there are no obstacles, such as buildings or trees, to block the rain. This is also to prevent the water collected on the roofs of buildings or the leaves of trees from dripping into the rain gauge after a rain, resulting in inaccurate readings.

Types of gauges
1) Standard gauge
2) Tipping bucket gauge
3) Weighing rain gauge
4) Optical rain gauge
5) Parsivel-efdisdrometer

Disadvantages of exiting methods :

Wind-induced errors
Since most rain gauges are elevated above the ground, wind eddies form around their orifices which reduces the catch of small rain drops. This problem is known the calculated correction factors are multiplied by the measured daily rainfall values
.

Evaporation and Wetting Losses
These losses are encountered in storage-type non-recording gauges, gauges with small orifices, and gauges recording at long intervals (several days). The magnitude of these losses depends on temperature, humidity, and time between rain and collection of the measurement. Convenience of the modern gauge is a big plus, as is accuracy. Timeliness and added features, such as thermometers and wireless transmission, also make the modern rain gauge particularly useful. The convenience of a modern rain gauge is a clear advantage over a traditional rainwater measuring device.

Calibration Errors
This error is encountered in tipping-bucket rain gauges. These gauges require calibration and adjustment of the tipping mechanism which is mostly done at a fixed small or intermediate rain rate (usually referred to as static calibration)

Instrument Errors
A well-adjusted siphon rain gauge has an accuracy of 0.2 mm for precipitation of up to 20 mm Per hour. A tipping bucket rain gauge has an accuracy of 0.5 mm for precipitation of up to 20 mm per hour, but may have errors of up to 3% for stronger precipitation. In Japan, the minimum Observation unit is 0.5 mm, and precipitation less than this amount is not measured. Errors increase with higher precipitation intensity, and exceed 3% for precipitation of more than 150 mm per hour
.

Errors from the Lack of a Windshield
As the amount of weak precipitation entering the receptacle is reduced by wind, the lack of a windshield causes significant errors.

3. Advance Method For Rain Drop Analysis

Adigital image differs from a photo in that the values are all discrete. Usually they take on only integer values. A digital image can be considered as a large array of discrete dots, each of which has a brightness associated with it. These dots are called picture elements, or more simply pixels. The pixels surrounding a given pixel constitute its neighborhood a neighborhood can be characterized by its shape in the same way as a matrix: we can speak of a 3x3 neighborhood, or of a 5x7 neighborhood.

The ERAUIP system is having maximum accuracy then the existing methods where the first stage is the image acquisition stage in which we are capturing image/video of rainfall by using a slow motion camera.if the image is colour image we have to convert into the gray scale image. This image/video is used as database for further processing. The image/video which we are capturing may containing some sort of noise which can effect in system processing to avoid this we are using image enhancement by using image clustering technique we are discarding noise present in an image .Biclustering mean we are arrange the similar content from image in this case we are divide image in columns and rows. These columns and rows are further divided into the odd and even content. After which the maximum intensity of pixel is counted. This intensity value use to decide the threshold value for the further processing.

Thresholding use to convert gray scale image into binary image. By using thresholding we are differentiating background content with foreground content. With this we are get drops from the background. Now there is need to measure the size of raindrop for which we are using the morphological filtering.in some drops due to noise unfilled areas which filled by using dilation. Now drops are measured and based on this measuring we found maximum and minimum size of drop.

4. Application of Image Processing For Drop Analysis

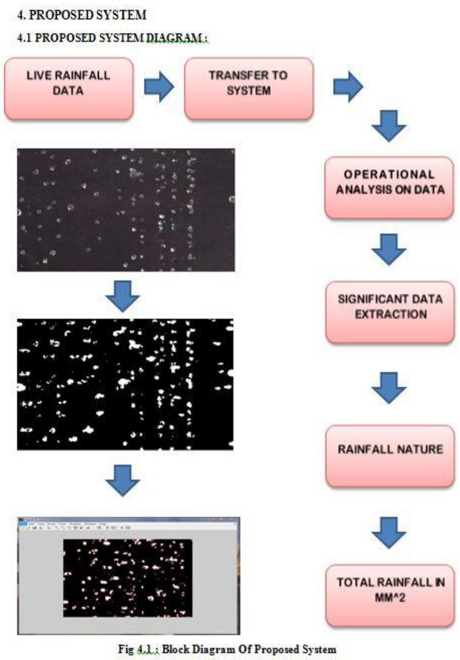


Figure 3.1: Block Diagram of Proposed System

Fig shows the block dia. Of proposed ERAUIP system which containing different stages in which different operations are done on data provided by the camera for analysis of rainfall. There are many factors of the rainfall is measured and represented in the graphical form. The dropsize distribution measurement is the biggest advantage of this system. This system having following stages

Live Rainfall Data:

Rainfall data is captured in the form of image or video 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 camera should have minimum 1200 fps speed so proper image or video can be taken.

System

The system is a computer with minimum 500 GB storage place where all the data is processed and the analysis is done on the data provided by the camera. Analysis is done with the help of MATLAB software in which we can find out the raindrop size and the total rainfall in the particular area in mm^2. With the help of graphical analysis the proper comparison is possible between rainfalls at different time span.

Operational Analysis On Data

With the help of MATLAB different operations are done on data for analysis of rainfall these operations are explained in details in methodology. The operations are as follow:

1. Image resizing
2. RGB image to gray image conversion
3. Biclustering
4. Thresholding
5. Morphological filtering
6. Raindrop counting

Significant Data Extraction:

Rainfall is deals with size of drops and amount of water precipitated from cloud in particular time. so we have to count the total amount of rainfall and the size distribution of the raindrops.

Rainfall Nature

The analysis which we have done on image or video depending on this we have to decide whether the rainfall is heavy moderate or light.

5. Methodology

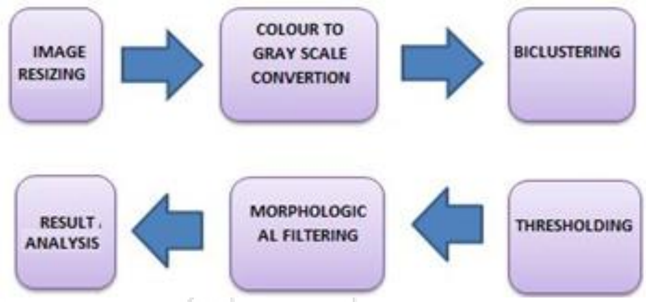


Figure 4.1: Block Diagram of Methodology

Fig shows the block diagram of ERAUIP systems there are different operations are done on image/video to get result.

Image resizing

After converting 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.

Conversion of colour image into gray scale image

The next step of the process is conversion of colour image into gray scale image. Sometimes we have a coloured background so in this case we have to convert it to a grey-level image for further processing.

Biclustering

Biclustering algorithms synchronously cluster both rows and columns. These types of algorithms are applied to gene expression data analysis to find a subset of genes that shows similar behavioral-pattern under a subset of conditions. We used the concept of Gene Expression Data Matrix to detect cancer. It will be working with a R x C data matrix, where each element aij will be a replaced with a real value. In the case of gene expression matrices, aij represents the expression level of gene i under condition j.

Steps Involve in Biclustering

Step one:

Initially we divide image into rows and columns say (r1,c1).

Step two:

We are creating an array of all zeros and then we divide image into even columns and odd columns
Even columns =s1ce
Odd columns = s1co
Then we found mean of these columns.
Output = (s1ce + s1co) / 2
Initially our image having 512 columns by doing biclustering we divide it into 256 even and 256 odd columns so in the output we get mean of this 256 columns.

Step three:

We are creating an array of all zeros and then we divide image into even row and odd row
Even row =s1re
Odd row = s1ro
Then we found mean of this
Output = (s1re + s1ro) / 2
Initially our image having 512 rows by doing biclustering we divide it into 256 even and 256 odd row so in the output we get mean of this 256 row.

Step four:

Now the output images are ready for the further processing

Thresholding

Threshold is one of the widely methods used for image segmentation. It is useful in discriminating foreground from the background. By selecting an adequate threshold value t, the gray level image can be converted to binary image.
The thresholding operation is a grey value remapping operation *g* defined by:
$g(v) = 255$ if $y > t$
0 if $y < t$

As the input imae is grey scale image we having the pixel values ranging from 0-255 but as in the case binary image we have pixel values 0 and 1(255) so for this we have to apply thresholding . So the procedure for converting grey scale image into binary image is as follows.

Step 1:

Decide fixed threshold value as T he re we take as 25.

Step 2:

Compare each pixel of image with threshold value.
F (m,n) = 255 if f (m,n) > T,
0 IF f (m,n) < T;

Step 3:

Depending upon the result we get black and white distribution of pixels. This way grey scale image converted into binary image. Which is further passed for analysis

Morphological Filtering

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.For this system we are using dilation for region filling. Dilation is the dual of erosion i.e. dilating foreground pixels is equivalent to eroding the background pixels Most implementations of this operator expect the input image to be binary, usually with foreground pixels at pixel value 255, and background pixels at pixel value 0. In our system due to less light some part of drops is not converted into white region so to fill this we use dilation As the dilation fills the area of the drop this will help us to find the proper size of an drops.

Raindrop Detection and Size Measurement

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 size of raindrops so for this we use binarization in which we count the no. of white pixel to measure the size of raindrops. As we have 256*256 JPEG image which can be represented by the summation of white pixels and black pixels.

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)
To calculate no. of white pixels we have another formula.
no. of white pixels p= $\sum_{W=0}^{255}\sum_{H=0}^{255}(f(0))$
Where,
P = number of white pixels (width*height)
1 Pixel = 0.264 mm
After getting no. of white pixel for the particular white drop we have to calculate the actual size of raindrop by using the formula

Size of raindrop = $(\sqrt{p})$ * 0.264 mm^2
Where
P= no. of white pixels

Implementation

Technical Requirement

Software Requirements

Platform: Windows 7
Programming Language: MATLAB Version 7.9.0.529 (R2009b)

Hardware Requirements:

Main processor: Intel Core i3 processor 2.30GHz.
RAM: 4 GB
Hard Disk: 160 GB

6. Result and 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. In ERAUIP we mainly were dealing with two parameter (1) Amount of rainfall and (2) Raindrop size both the parameter is important to get accurate rainfall measurement. 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 measurement techniques with 80-90 % accuracy. The costing of this system is very low only we required a high definition camera which having the ability to captured perfect images and video as these images and videos are the base of this system. So the accuracy of this system is totally depend upon the quality of images and videos.by getting 3d image we can find out the volume of each drop and which helpful to get total rainfall in particular area.

At the end we can conclude that disadvantages of the rain gauge are overcome with the help of this system. This system is having less cost as well as the accuracy of this system is maximum as it have less effect of other climatic condition. The only factor it might be effect is the quality of the image and video which are the base of the system. If we improve the input images accuracy will be maximum Of the system.

7. Future Scope

As we are dealing with 2D image there is certain amount of limitations to get total rainfall in mm. so by using the 3d image this can be possible. Using of slow motion camera we can get 95-99% accurate result from this system. The movement of the rain can be determined but for this more research will be requires. As this system is not tested in storm that type of testing can be done and improvement can be done to get accurate result in storm and tornados.

8. Performance

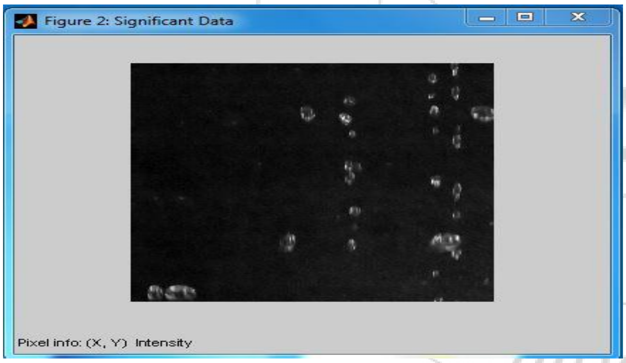


Figure 7.1: Input Data

Figure 7.2: Thresholding

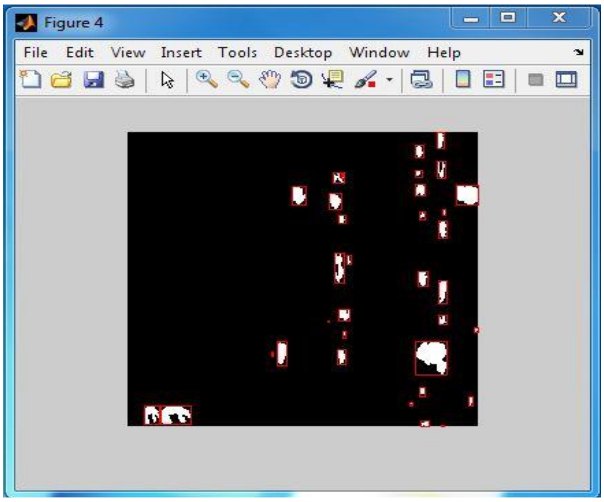


Figure 7.3: Raindrop Counting

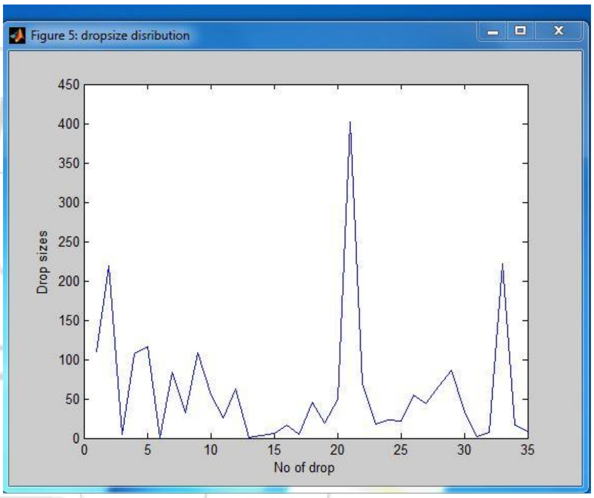
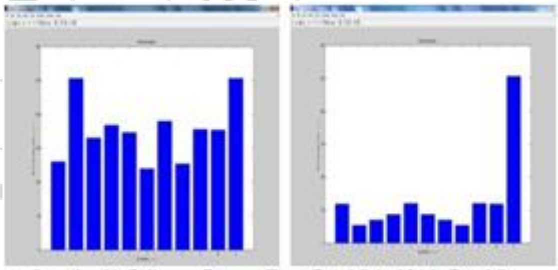
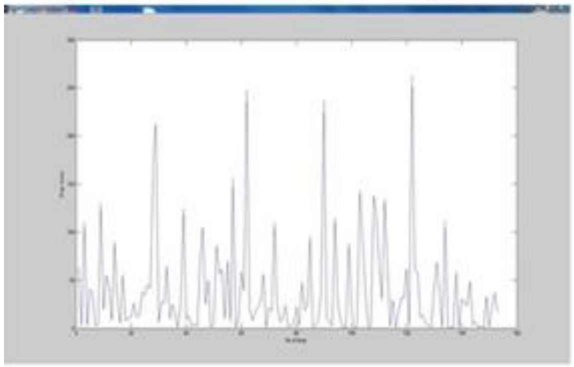


Figure 7.4: Raindrop Size Analysis



Snapshot 12: Difference Between Heavy Rainfall And Light Rainfall



Snapshot 13: Drop size Distribution In Particular Frame Using Image Analysis

Figure 7.5: Raindrop Analysis

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