IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 10, October 2015.
www.ijiset.com
ISSN 2348 – 7968

A Simple Approach for Efficient Detection and Estimation of drops during the Rainfall

Kolli. Harsha Vardhan Reddy[1] Shaik. Mahaboob Basha[2] Jogi. Srinivasulu[3]

[1]Post Graduate Student, Department of ECE, Priyadarshini College of Engineering and Technology, Nellore, Andhra Pradesh, India

[2]Professor and Head of the Department of ECE, Priyadarshini College of Engineering and Technology, Nellore, Andhra Pradesh, India

[3]Assistant Professor, Department of ECE, Priyadarshini College of Engineering and Technology, Nellore, Andhra Pradesh, India

Abstract

The advanced driver assistance systems (ADAS) are the systems to provide for automate the technologies in automobiles. These systems are malfunctioned in bad weather conditions. Mostly in rain these devices are failing for detection of objects in a scene and sometimes this phenomenon leads to damage electronic devices. The protection of ADAS is possible to make alert from rain before it turns to show adverse effects. We consider such conditions, we presented a novel strategy to detect raindrops and estimation of rainfall captured through camera mounted in the vehicle. This approach works on the principle of intensity of raindrops in a scene. The core idea for this strategy is to detect raindrops efficiently and to improve accuracy of detection at the same time as raining. The results are executed through MATLAB.

Keywords: *advanced driver assistance systems, intensity, estimation of rainfall*

1. Introduction

The usages of advance driver assistance systems and outdoor surveillances, vehicle in-front cameras etc, are vastly spreads in our daily life. Such systems are utilized for different purposes i.e. for security and data collection. These electronics are adversely functioned /damaged in bad weather conditions i.e. while falling of rain and snow. It results the degraded frames being captured by inevitably adhered raindrops.

These adhered raindrops occlude the captured scenes. While usage of such frames for analysis is being difficult to track objects, detection etc. in such conditions we need an alert while raining to protect the outdoor furniture and electronic appliances. Based on such task many approaches are up fronted.

Identifying the rain is quite difficult by the reason of transparency of rain drops. Raindrops are adverse due to refraction, reflection in environment such as sun light and nature colours.

To address such problems, we analyze the appearance of raindrops on a transparent screen. It is clear the adhered raindrops is like a concave lenses. It may reflects the environment such as light and intense of colours.

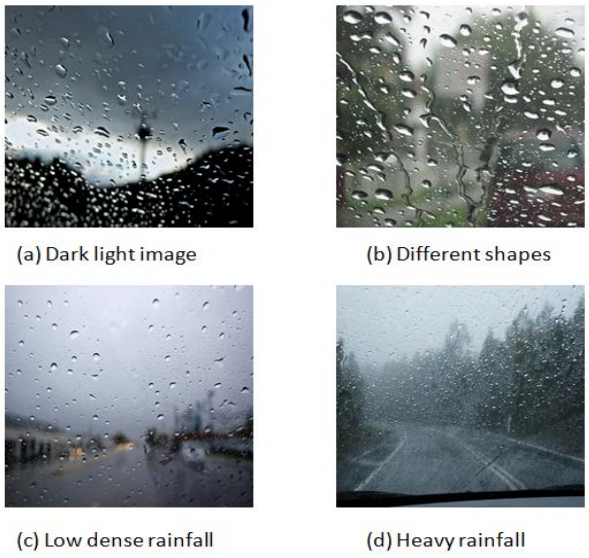


Fig.1 (a - d) The appearance of raindrops with dark intensity, different shapes, and density of rainfall (low and heavy).

Consequently, the motion of raindrops is downwards such motion is to be mutual to other drops. However, it is such condition doesn't allow the perfect detection and removal. Such basic idea leads to the detection of rainfall based on a transparent screen.

2. Origin of the work

The adverse weather conditions such as fall of rain and snow. While such conditions the captured frames is almost degrades the scene. Based on this term several researchers are conducted several projects to overcome such conditions from late 90's. the most active researchers are Narasimhan and nayar. They written several study theses

ISSN 2348 – 7968

based on bad weather conditions. They describes rain and its vision with a clean study [1] also the detail study of shape and behavioural description of raindrop is explained in the photometric model of raindrop[12]. The vision in rain [11] and the difficulties faces while raining are clearly shown their researches.

3. Proposed Methodology and Architecture

The raindrops are complex in nature. While raining these raindrops are occluded the scene through vehicle cameras, windshields, surveillances and may chances to damage the outdoor electronics and furniture like peripherals. Such issues are occurs while raining. It may overcome through these issues is possible on pre-alert while raining.

Based on such task, we improved a method to get alert from rain. In the process to detecting raindrops describes at step by step method.

3.1 Raindrops detection

Adhered Raindrops on a windshield glass are transparent. These drops are reflected the nature of light and colour. Normally detection of each drops of rain is quite difficult. These difficulties lead different ideas for researchers to develop projects. Minded on such aspects we moved to the detection of raindrops.

Detecting raindrops based on its intensity of raindrop on a transparent screen. The process of detection is described as in different stages followed by one by one as shown below.

3.2 Prewitt operator

This is one of the operators used as a edge detector. It calculates the gradient of the image intensity at each point. This calculates 3x3 kernel and convolves with the changes in the image i.e horizontal and vertical measures.

$$P_x(i,j) = \begin{bmatrix} -1 & 0 & +1 \\ -1 & 0 & +1 \\ -1 & 0 & +1 \end{bmatrix} * A$$

$$P_y(i,j) = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ +1 & +1 & +1 \end{bmatrix} * A$$

Where $p_x(i,j)$ – measuring of horizontal edge with the convolution of original frame A. $p_y(i,j)$ –measuring of vertical edge with the convolution of original image A.

3.3 Morphological operation

Morphological operations are dilation and erosion etc. But here dilation is performed to obtained image from the edge detector. Dilation is defined the similarity of binary values in the image with maximum operator. Erosion is also similar to values with minimum operator.

3.4 Dilation

This operator is one in the morphological process. It works to “brightening” in binary image. The mathematical representation of the dilation is expressed as follows:

$$D(A, B) = \max_B\{A\}$$

Where, A – source image and B –is the Morphological background image with binary values.

3.5 Erosion

The one of the operator used in morphological processing defining with similar to dilation. It defines with minimum operator applied on binary values. It also works to “brighten” or “smoothen” image with binary values.

Mathematical representation of erosion is expressed as follows:

$$D(A, B) = \min_B\{A\}$$

Where, A – source image and B –is the Morphological background image with binary values.

3.6 Region filling

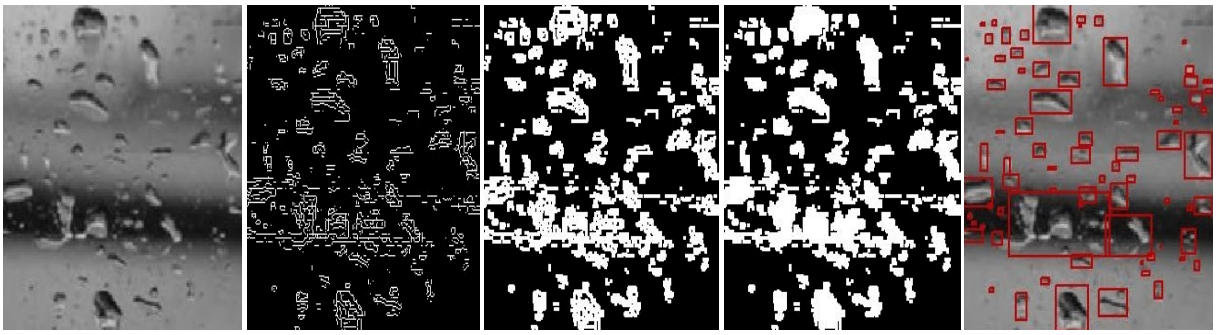
The dilated image after edge detection has some dark pixels. It misleads the detection of exact region of raindrops. The term *imfill* is “brighter” the dark pixels in the region. The region of dark pixels in the binary is removed or replaced.

Mathematically it is expressed as follows:

$$X_k = (X_k{-}1 \oplus B) \cap A^c{}_k = 1, 2, 3, \ldots$$

where $X_0 = p$ and B is the cross-shaped structuring element. The process exit at kth iteration if $X_k = X_{k-1}$. The union of X_k and A contains the original boundary (A) and all the pixels within it labelled as 1.

ISSN 2348 – 7968



(a) Test input (b) Prewitt (c) Dilated (d) Fill holes (e) Feature extraction

Fig. 2 Images using different operators

3.7 Feature extraction

Feature extraction is major for processing raindrops and shows clear information of raindrops. This method Extract features from binary image using measuring terms of perimeter, regional properties and its statistics. Based on such parameters like boundaries represents exact areas to be degraded in a scene and extremity of raindrops are clearly estimated.

The density of raindrops in the frame is estimated through acquiring the above statistics. Such measurements are clearly represents the raindrops without any error.

The tested algorithm used to complete the process as follows.

3.8 Algorithm

Extract region properties

Find the labelled components using bwlabel.

Check the statistics of labels using stats.

```
for i = 1:length(raindropstats)
  each drop represents in a rectangle box
end
if  numofdrops <100
        (‘less rainfall’);
else if numofdrops >100
        (‘medium rainfall’);
else if numofdrops >300
        (‘heavy rainfall”);
end
```

Analysis of rainfall based on the counted raindrops on the windshield captured through vehicle mounted camera and it scheme represents in a manner. The process for detecting raindrops and estimation of rainfall are categorized with step by step description.

The utilization of frames for spotting raindrops and recognize rainfall by applying of different methods is notified as in detail manner.

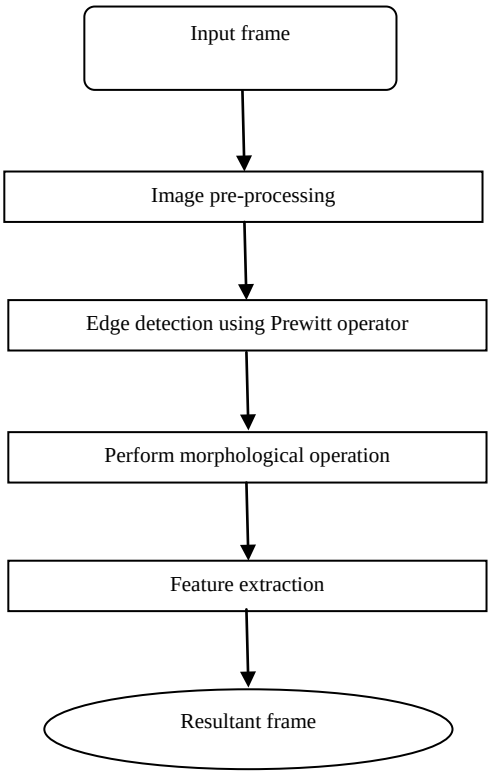


Fig. 3 The overall process for detection described as step-by-step.

ISSN 2348 – 7968

Density of rainfall estimates through the raindrops appeared on a transparent screen.

In our process of testing, the samples values taken to estimate rainfall i.e raindrops is less than 100 for less rainfall, greater than 100 for moderate/medium rainfall, and greater than 300 for heavy rainfall.

4. Simulation Results and Analysis

The simulated images obtained in the work are explained below.

a b
Fig. 4 c d: All images shown at left side are input images.
d e

After being processed the Resultant images are shown at right side.

4.1. Estimation of Rainfall

The estimation of rainfall is based on raindrops detected on a windshield. The sample values assigned to estimate rainfall to follows.

Figure 4(a) - the experimental result for this frame has detected 510 raindrops in that frame. As per the value, the rain is heavy rain
Figure4(b) 8 - 289 drops detected. Based on the value rainfall is medium rainfall.
Figure 4(d) 10 - 210 drops detected. Based on the value the rainfall is medium rain.

After the execution of improved method .the detection of raindrops and its resultant frames are obtained successfully. The test images and their results is shown in the above figure 4(e).

5. Conclusions

This project is developed for benefiting to controlling the damages occurring from rain. This strategy allows to detecting rain through the method of edge detection based on intensity of adhered raindrops on a transparent screen. The added advantage of this strategy also measuring the density of rainfall based on the number of raindrops detected in the frames captured from the advance driver assistance systems (ADAS). The core idea is to develop this project for improve the accuracy of detection for alert while raining.
The strategy is tested and executed successfully using MATLAB.

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Authors

Kolli.Harsha Vardhan Reddy has received his B.Tech degree in Electronics and communication engineering from A.C.T College of Engineering, nelvoy in 2012 which is affiliated to Anna University and currently he is pursuing his M.Tech specialization in Digital Electronics and Communication Systems in Priyadarshini College of Engineering & Technology, Nellore which is affiliated to JNTUA.

Dr. Shaik. Mahaboob Basha working as Professor and Head of the Department of Electronics and Communication Engineering in Priyadarshini College of Engineering and Technology, Nellore. He has done his PhD from J.N.T.University, Hyderabad.He is the member of Engineering Professional bodies like IEEE, IE(I),ACM and ISOI . He has published 16 papers in reputed International and National journals and conferences.

Jogi Srinivasulu, working as assistant professor of the Department of Electronics and Communication Engineering in Priyadarshini College of Engineering and Technology,Nellore. He has published 4 papers in reputed International and National journals and conferences He qualified NET june-2013 and he has also qualified GATE march-2015.