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Review on Rain drop detection and removal using k-means clustering and Hough transformation

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Abstract— Raindrops stick to a window glass can considerably destroy the visibility of a scene. Detecting and removing raindrops will benefit in many computer image applications. We presented hybrid approach to detect and remove raindrops and then restore the image back ground in a single image. Proposed framework is based on K-means clustering and hybrid Otsu plus median filter for the efficient retrieval of Rain droplets from the single image. The k-means clustering is used which results in highest correct clustering rate and Hough transform is used to detect and remove the raindrops from single image. We present a complete review on different approach for raindrop detection and removal. The proposed system will gives better results than available approaches for raindrop detection and removal. Results analysis will be performed on the basis of the efficiency and accuracy of the proposed method.

Keywords—Image Clustering, Hough transforms Otsu filter, Median filter, Image segmentation, K-means Algorithm

I. INTRODUCTION

Particularly in rainy seasons, raindrops predictably stick to windscreens, protecting shields and camera lenses. These adherent raindrops occlude and deform some image areas, performances of many applications in the image systems such as tracking, feature detection, stereo correspondence, etc., significantly degraded. This problem generally occurs for vision systems where top-mounted vehicle sensor with no wipers is available and where a hand-held camera is used. Raindrops adhered to a windscreen or window glass can significantly degrade the visibility of a scene .To address this problem, we proposed hybrid algorithm to detect raindrops, remove the raindrops and then restore the image back ground in a single image. This new hybrid algorithm is framed based on Otsu and median filter for the fast retrieval of Rain droplets from the single image. Our research is to implement system which is used for rain drop detection and removal using K-means clustering, hybrid Otsu and median filter and Hough transformation which results in higher correct clustering rate and remove the raindrop from the single image and restore the image with its original background. For that we are planning to implement K-means and hybrid Otsu plus median filter noise removal algorithm, so that image can be pre-processed and the performance is enhanced.

Many papers in research field analyze the presence of adherent raindrops from their local spatial-temporal derivatives [1].Adherent raindrops can have various shapes and finding such adherent raindrops from images can be very problematic. Unlike rainproof Objects, adherent raindrops are transparent, making their appearance and thus depending on the environment the intensity values varies. Due to their proximity they suffer from out-of-focus blur to the camera. Moreover, most raindrops generate dirty look [2]. The following sections are organized as follows. Section II consists of Literature reviews. Section III presents a proposed method of efficient and accurate segmentation procedure of rain drop detection based on K-Means and Hough transforms and rain drop removal using Otsu and median filtering. Final section IV consists of conclusion.

II. RELATED WORK

M.Ramesh Kanthan and Dr.S.Naganandini Sujatha in [1] proposed a hybrid algorithm is mounted in order to find the rain droplets using clustering and shape modelling of raindrops. This new hybrid algorithm is mounted on K-Means clustering and Median filter for retrieval of Rain droplets from the single image. The input image is a color image. To convert image into gray scale, YCBCR color space is used to get the accurate gray component earlier clustering. With the same YCBCR color space approach it is also beneficial to reconstruct the original RGB color image. K-means clustering algorithm is used to perform image clustering. Once clustering process is over, it is added on a per pixel basis by detecting circular raindrops

Using Hough circle transform [3]. This system is advantageous because it is fast compared with alternate droplet identification schemes. The limitation of this method is that K-Means Algorithm is used for clustering results in lower correct clustering rate.

Roser and Geiger in [4] presented Detection Model and Data driven approach. An accurate model has constructed to understand the geometric-photometric properties of a raindrop and image correlation. The definite region on an image is distorted Using raindrop refraction model, thus giving the region an appearance as if a raindrop is present. An adaptive band pass filter is used to hazy images which are based on computing the Difference of Gaussians (DoG) for each pixel. Once above process is over, the regions containing raindrops in the blurred image are greater where raindrops do not exist than the regions containing raindrops in the original image and as raindrops blurring the region that they occlude. Confirmation was performed by placing a model of the raindrop in possible regions and measuring the correlation in their intensity values. The idea is that raindrops are high contrast regions, which are usually texture-less and round, compared to the surrounding regions. This method could be susceptible to high false negative rates. The drawback of this method is Proper classification model is not mentioned which can results in lower correct classification rate.

Willson et al. [5] worked on Sensor/Lens Dust Removal. They gave a detailed analysis on the imagery model with dust adhered to the lens. Dust blocks light reflected from objects and reflect light coming from the environment. In this paper they have presented an optics-based model that simulates the size and optical density of image manufactured article produced by dust particles. The image artifact size is determined by the size of the lens aperture and not the size of the particle, while the artifact's optical density is determined by the ratio of the particle and aperture areas. They also showed how the model has been used to evaluate the effect of dust on two machine vision algorithms used on the 2003 Mars Exploration Rovers.

Zhou and Lin in [6] propose method to detect and remove small dark dust artifact. They proposed a depth estimation framework using calibrated images captured under general camera motion and lens parameter variations. Kurihata et al. [7] and later Eigen et al. [8] approach the problem through machine learning. A weather recognition method uses a subspace method to judge rainy weather by detecting raindrops on the windshield. "Eigen drops" represent the principal components extracted from raindrop images in the learning stage. Then the method detects raindrops by template matching.

Montero-Martinez et al.in [9], demonstrate that a non-negligible fraction of drops have an anomalously large fall velocity owing to their diameter, the ratio between the observed, and expected speeds being all the more large that the drop diameter is small. While these authors attribute this 'anomaly' to breakup between colliding drops, authors showed on the basis of detailed laboratory experiments that it can be fully accounted for by a scenario which has effectively represented the distribution of drops sizes in rainfall, namely the spontaneous breakup of large drops [10]. Such scenario makes estimates that fraction of drops in rainfall should have a velocity approximately 2.5 times larger than their equilibrium fall velocity given their size, consistent with measurements. The trajectories of the busted drop fragments and the distribution of the norm of their velocity at bursting are determined. The average fragment velocity induced by bursting is found to be much smaller that the velocity of the initial mother drop. In addition to that the fraction of drops affected by the velocity 'anomaly' is estimated [10].

Shaodi You and Robby T. Tan in [16] presented the method that automatically detect and removes the sticky raindrop. The core idea is exploit the local spatio-temporal results of raindrops. It develops not only a video completion technique, but also the information behind some unclear areas of raindrops. The limitation of this method is that it does not work with highly dynamic raindrops.

Shaodi You and Rei Kawakami proposed a method that automatically detects and eliminates sticky raindrops. They use long range trajectories to determine the motion and presence features of raindrops locally along the trajectories. Author Conducted both quantitative and qualitative evaluation to measure the accuracy of detection and removal method. The disadvantage of this method is that it does not work with dynamic raindrops and improving the computation time [15].

III. METHODOLOGY

The proposed approach is shown in figure. The input image is a color image. To perform clustering input image should be in gray scale form. So the YCBCR color space is used to convert image into gray scale form. YCBCR gives accurate gray component. It will also useful to reconstruct the original RGB color image once raindrop detection and removal process is over. The RGB color space and YCbCr color space is related with following formula:

$$Y = (75R + 150G + 29B) / 256 \quad (1)$$
$$Cb = (-44R - 87G + 131B) / 256 + 128 \quad (2)$$
$$Cr = (130R - 110G - 21B) / 256 - 128 \quad (3)$$

Where R, G, B represents the R-channel, G-channel, and B-channel of original image respectively. Once Binarization is performed we will move towards noise removal. For noise removal we will use Otsu and median filter in combination to remove the noise from single image. After noise removal we perform clustering using k-means clustering algorithm. Then after we used Hough circle transform to detect and remove the raindrops from the single image. Once we detect and remove the raindrop from the image, we will get the output image means the image with its original background. After that we analyse the result by using accuracy, precision and recall.

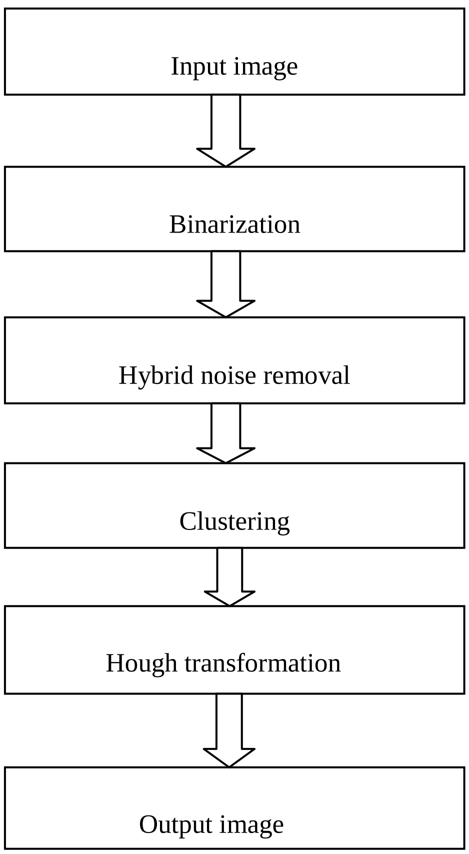

Figure1. Proposed approach.

A. Otsu and Median filter

Otsu method is one of the eldest methods in image segmentation. According to its probabilistic implementation it is treated as a statistical method. It must be stated that the Otsu method is one of the best automatic thresholding methods. The basic principle in Otsu method is to split the image into two classes which are the substances and the background. The automatic threshold is obtained through finding the maximum difference between the two classes. Otsu is a type of global thresholding assortment method, which is widely used because of its simplicity and effectiveness. Otsu algorithm can obtain acceptable segmentation result when it is applied to noisy images

Median filtering is one of the best methods which are used to suppress Salt & Peppers noise which is called impulse noise. Median filter has established an effective technique to suppress impulse noise while preservative signal changes. The central pixel in a (k × k) window with the median of the pixels inside that window is replaced by classical median filter. The central location of the pixels after arranging these pixels in ascending order is called as the median. As an example, in a 5×5 window we pick up the thirteenth value in the ordered pixels after ascending arrangement. Median filter aims to change noisy pixels in such a way to be look like its nearby neighbours. Median filtering eliminates noise without blurring edges when the window size is small, but it also makes rooftop edges tabularize. The disadvantage of median filter is that high blurring in the image when large window size is implemented. Due to that we used median filter and Otsu noise removal in combination.

B. k-means clustering algorithm

1. Set the no of cluster K
2. Randomly assign K items from the list to K initial Cluster
3. Do
   a. Use the membership function to calculate difference between the item and the center.
   b. Assign the item to the cluster whose centroid is the most similar to the item intensity.
   c. Recalculate the centroid s whose cluster change because of the item removal or item adding
4. End while convergence achieved.

C. Hough Transformation

The Hough transform is a technique which is used to isolate features of a particular shape within an image. Because it requires that the desired features be specified in some parametric form, the classical Hough transform is most commonly used for the detection of regular curves such as lines, circles, ellipses, etc. A generalized Hough transform can be employed in applications where a simple analytic description of a feature(s) is not possible. Due to the computational complexity of the generalized Hough algorithm, we restrict the main focus of this discussion to the classical Hough transform. Despite its domain restrictions, the classical Hough transform retains many applications, as most manufactured parts contain feature boundaries which can be described by regular curves. The main advantage of the Hough transform technique is that it is tolerant of gaps in feature boundary descriptions and it is relatively unaffected by image noise. The Hough technique is particularly useful for computing a global description of a feature(s), given local measurements. We can use Hough transform to detect other features with analytical descriptions. For instance, in the case of circles, the parametric equation is

$$(x-a)^2 + (y-b)^2 = r^2 \quad (4)$$

Where a and b are the coordinates of the center of the circle and r is the radius. In this case, the computational complication of the algorithm initiates to increase. We research with the Hough circle detector on raindrop image. One way of reducing the computation required to perform the Hough transform is to make use of gradient.

Figure 2.Raindrops

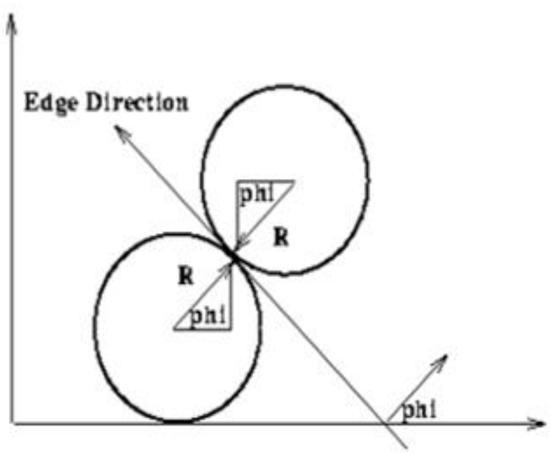

Figure.3.Hough circle detector

IV. CONCLUSION AND FUTURE SCOPE

In this paper we have presented a comprehensive review on raindrop detection and removal using k-means and Hough transformation. The k-means clustering algorithm results in highest correct clustering rate. Otsu and median filter noise removal algorithm, to remove the noise from image which is transformed by Hough transformation to get more filtered image with greater performance and to make resultant image more blur free. The future scope is all these basic functions can be derived from color gradient functional. These techniques can be further protracted to detect the other features of the detected regions which are useful for the image diagnosis. The future focus of this system is the resultant blurriness has to be removed.

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