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Survey on the detection of the fog and its impact on the highway traffic network

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Abstract: This paper provides the survey about the impact of the weather changes (particularly fog) on the highway transport traffic. Considering the general surveys on the road crashes, the deaths caused due to road accidents and fatalities are of 7,400 approximately in an year with 673,000 minor and major injuries. When gone particular about the crashes due to less visibility in the presence of the fog almost 11,600 people die in a year. The data generated due to the weather impact on the transport traffic need to be analyzed to predict the safety of individual on the road during adverse climatic conditions such as fog, high winds etc.

Keywords: Highway transport network, fog detection, road fatalities, grayscale features, histogram, climatic changes, risk index.

I.INTRODUCTION

There are many techniques implemented for analyzing the big data generated due to the transport traffic as a impact of climatic changes, among them few significant techniques are mentioned below:

- The rapid weather change events in a highway network can be detected using a weather station sensor from a weather station.
- The rapid traffic change event on the traffic flow characteristics of a highway network can be detected.
- The correlation among the weather change event and the traffic change event over the given time at a particular place should be analyzed efficiently.

The objective was to come up with the techniques to detect the impact of the weather changes on the traffic conditions in order to reduce the number of transport fatalities. The rapid variations in the weather conditions results in reduce of the visibility, high winds, storms, fog, snow, severe crosswinds and temperature extremes which affect the traffic.

Three vital steps involved are:

- Traffic Message Channel (TMC) is deployed to detect the short-term traffic flow forecasting with already existing algorithms.
- Weather station networks sensors are used to detect the rapid weather changes.
- Statistical impact analysis to analyze the correlation between the weather change event and the traffic change event.

II.RELATED WORKS

In general, algorithms with step by step syntax will be executed or computed with inputs given and produces output after processing. Based on the survey done, in the American and European few sensors are installed in the highway light poles for safety measures. Sensors like remote traffic microwave (RTM) and fog monitoring system (FMS) are installed.

- Remote traffic microwave is used to collect the vehicle based data such as instantaneous speed of individual vehicles, length of each vehicle with the accuracy of 95%.
- Fog monitoring system is installed to detect the weather related data and also visibility data accurately. It senses and collects nearly 21 weather parameters such as dew point, wind speed, soil moisture etc.

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In general, the standard limit of the visibility distance (V_d) is 2000m. The decrease in the visibility can be detected effectively with accuracy.

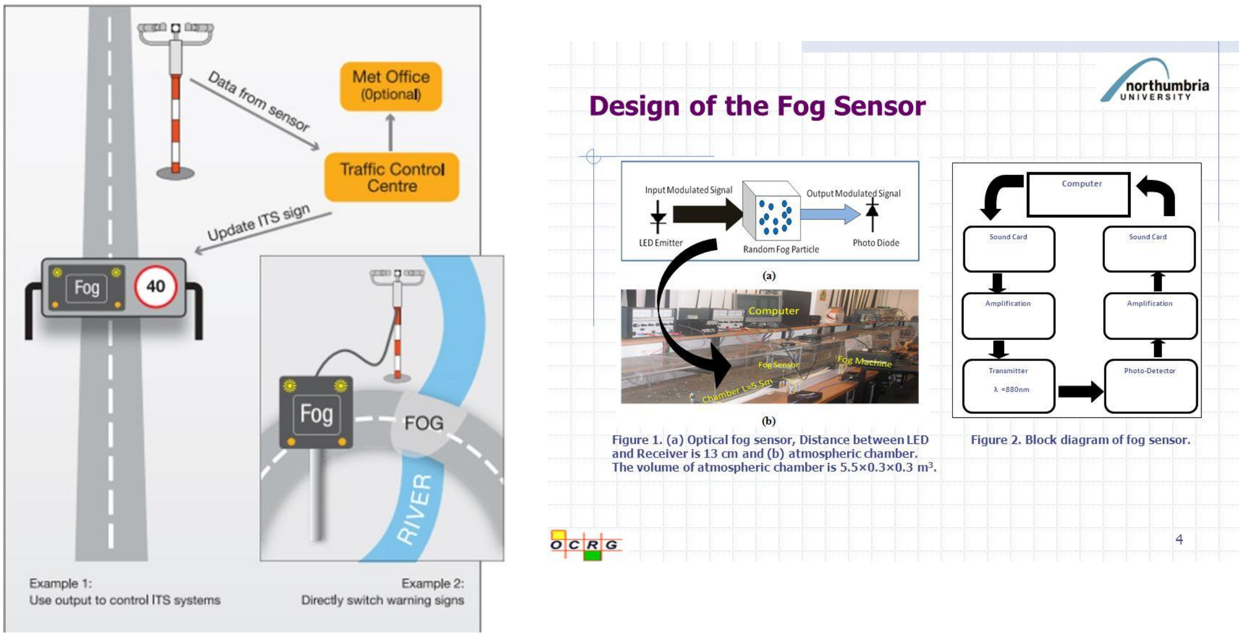

Fig 1: Fog monitoring system sensors installed.

The methods deployed for the detection of the fog condition impact on the highway transport are explained below:

A. Rear-end collision risk index(RCRI):

This method includes the detection of some parameters such are date, time, visibility, speed etc of up to 8 lanes in a highway network. It includes some terminologies such as perception reaction time (PRT), deceleration rate of the leading vehicle (a_l), deceleration rate of the following vehicle (a_f) , speed of leading vehicle (v_l), speed of following vehicle (v_f), clear distance(L), safe stopping time of leading vehicle(SSD_l) and safe stopping time of following vehicle(SSD_f). The flow chart of the rear-end collision risk index:

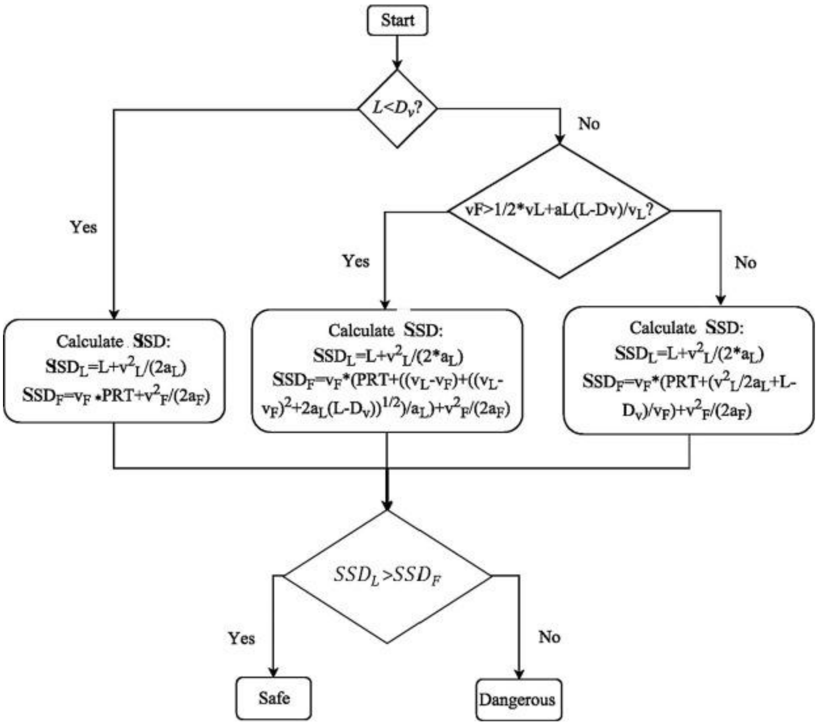

Fig 2: Flow chart of rear-end collision risk index algorithm.

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This algorithm can be used to generate data for single variable change event detection and multi variable change event detection using two hypothesis namely null hypothesis(with no change events) and alternative hypothesis(with change events). These algorithms are flexible enough for 8 lanes. Spatio temporal algorithm is also used for the same reason.

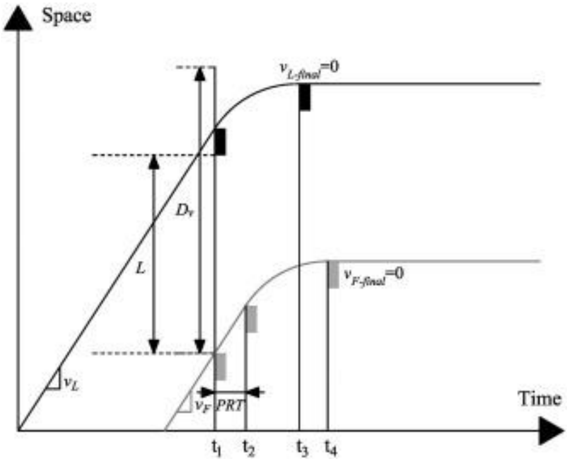

Fig 3: Rear-end collision risk index graph.

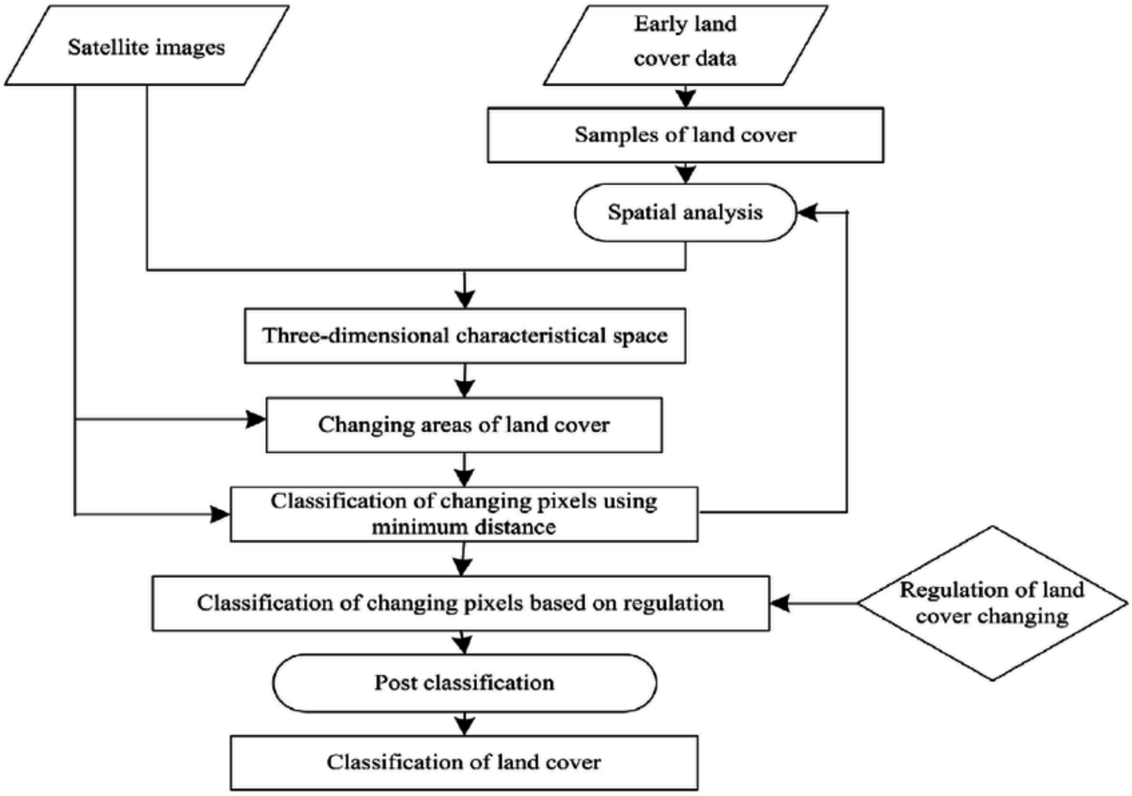

Fig 4: Spatio – temporal algorithm.

B. Grayscale feature:

Grayscale feature is an image processing technique for extraction of a clear image from a foggy background scenario. Gray scale value is the pixels in the image which represents the amount of light. It also provides information about the intensity of the light. The images used here have only two colors namely white and black and an intermediate color gray. The images captured have two components:

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1. Upper portion which is a white sky.
2. Lower part of the road.

In foggy condition, the extraction of the background image should be done in order to see the vehicles or obstacles in the front clearly.

Fog level detection method: Consider a point(x,y) in an image with less visibility. The gray value at the point (x,y) is given as

$B1(x,y) = 1/N_{xy} \sum I_k(x,y) \times V_k(x,y)$

Where,

N_{xy} – Gray accumulation times of pixel point (x,y)

I_k (x, y) – Gray value of pixel at (x,y) in k^{th} image frame.

V_k (x, y) – determines whether to accumulate the gray value of pixel (x ,y) in the image.

$I_i^1 = ((I_i - I_{min}) * 255) \div (I_{max} – I_{min})$

Where,

I_i^1 – Average gray value after linear sketch at ith row.

I_i – Average gray value at ith row.

Gray value ranges from 0 to 255.

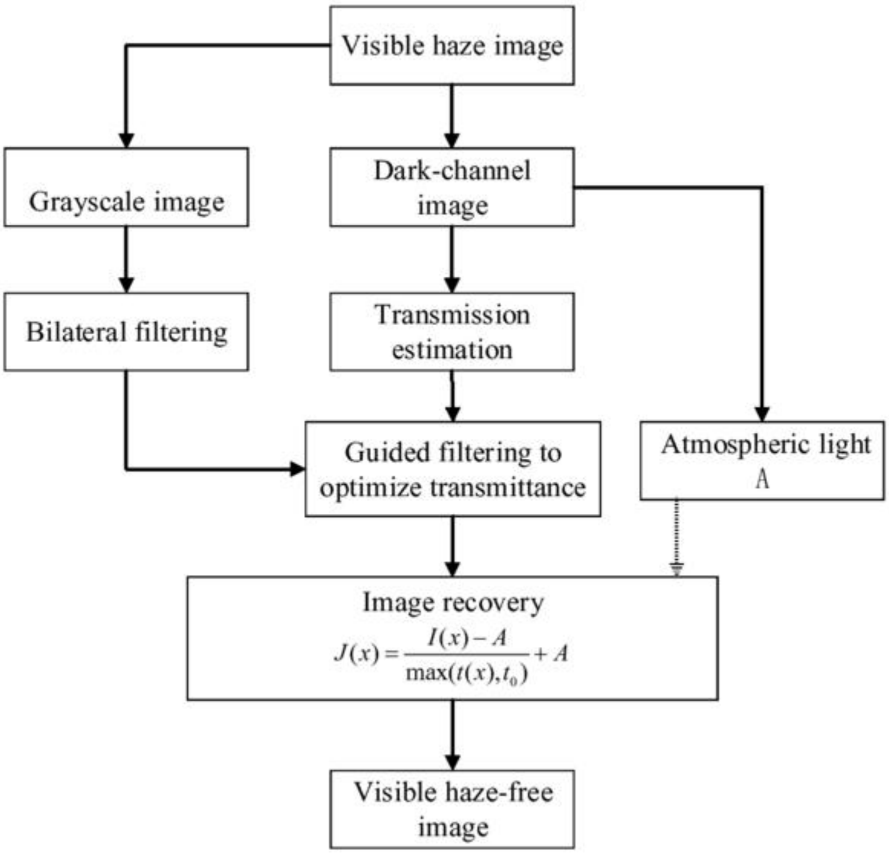

Fig 5: Grayscale Algorithm.

C. HSV Color Histogram:

The distribution of colors in an image is represented in the form of a color histogram. It represents the pixel numbers in which the colors are fixed in color ranges. For monochromatic images, intensity histogram is implemented.

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The HSV histogram code is as follows:

```
close all;
clear all
clc;
I = imread('lavender.jpg');
imshow(I),figure
I = im2double(I);
[index,map] = rgb2ind(I);
pixels = prod(size(index));
hsv = rgb2hsv(map);
h = hsv(:,1);
s = hsv(:,2);
v = hsv(:,3);
%Finds location of black and white pixels
darks = find(v < .2)';
lights = find(s < .05 & v > .85)';
h([darks lights]) = -1;
%Gets the number of all pixels for each color bin
black = length(darks)/pixels;
white = length(lights)/pixels;
red = length(find((h > .9167 | h <= .083) & h ~= -1))/pixels;
yellow = length(find(h > .083 & h <= .25))/pixels;
green = length(find(h > .25 & h <= .4167))/pixels;
cyan = length(find(h > .4167 & h <= .5833))/pixels;
blue = length(find(h > .5833 & h <= .75))/pixels;
magenta = length(find(h > .75 & h <= .9167))/pixels;
%Plots histogram
hold on
fill([0 0 1 1],[0 red red 0],'r')
fill([1 1 2 2],[0 yellow yellow 0],'y')
fill([2 2 3 3],[0 green green 0],'g')
fill([3 3 4 4],[0 cyan cyan 0],'c')
fill([4 4 5 5],[0 blue blue 0],'b')
fill([5 5 6 6],[0 magenta magenta 0],'m')
fill([6 6 7 7],[0 white white 0],'w')
fill([7 7 8 8],[0 black black 0],'k')
axis([0 8 0 1]);
```

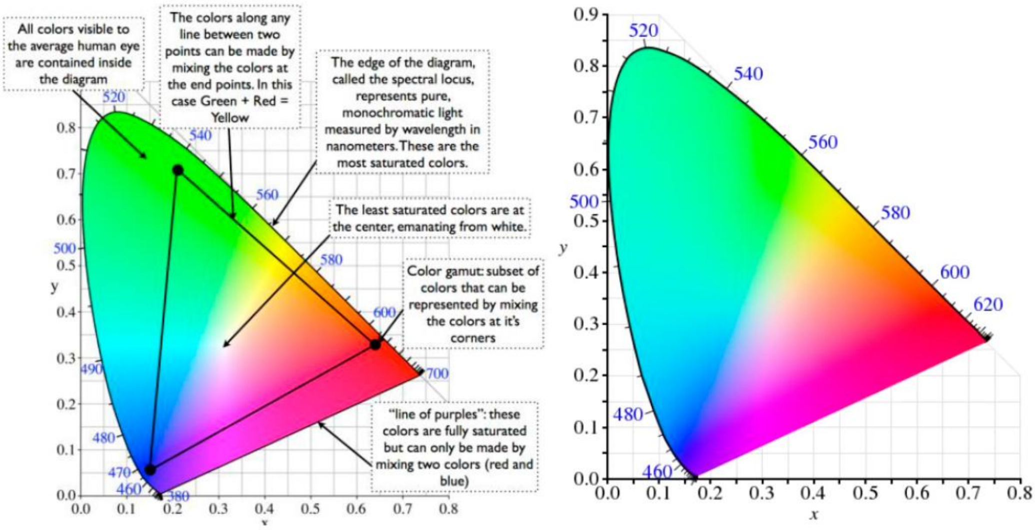

Fig 6: HSV Color Histogram.

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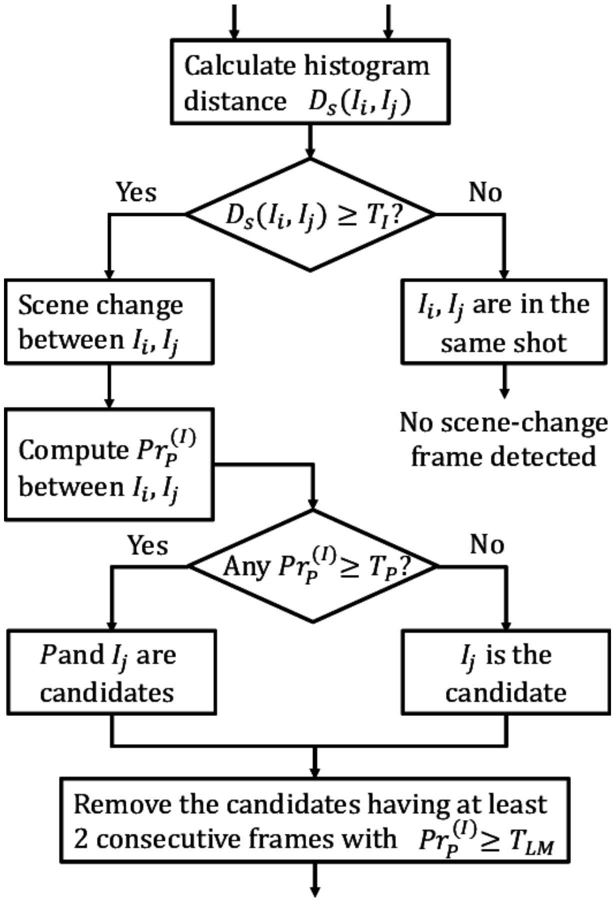

Fig 7: HSV Color Histogram algorithm flowchart.

III.CONCLUSION AND FUTURE WORK

The main objective of the paper is to reduce the number of highway fatalities by implementing the already existing techniques to increase the visibility distances in the foggy climate. There are many techniques developed for this purpose and few of the most effective among them are discussed in the paper. In future, we would be working on increasing the efficiency of such algorithms and analyze the data generated.

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