ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)
Vol 3, Issue 4, April 2018

Air Pollution Monitoring and Estimation Using Diffusion Process

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Abstract:- **This paper presents a method to monitor and estimate the level of pollution in the environment using diffusion process present in the image processing method. Diffusion process is used to reduce the level of noise present in the images. The percentage of pollution present in the environment is also calculated and the estimation ratio is obtained. Air pollution has become a major issue in the modern world , the reason is industrial emissions and increasing urbanization along with traffic jams and heating/cooling of buildings. Monitoring urban air quality is therefore required by municipalities and by the civil society. Current monitoring systems rely on smoke and exhaust detection system that has been developed for monitoring exhaust gases using far infrared camera which is costly. In this paper, we focus on an alternative or complementary approach, with image processing aiming at obtaining the images from environment and monitoring the pollutants present in the environment using image processing method, along with implementation of the diffusion process to reduce the image noise without removing significant parts of the image content. In image processing the input may be image or video frames. The outputs are also images. Various tasks like classification, feature extraction, recognizing different patterns can be done using image processing method.**

Key Terms-Monitoring, feature extraction, Diffusion process,Estimation Ratio.

1. INTRODUCTION

The main components of the atmosphere are – oxygen (o_2), Carbon dioxide (co_2) for photosynthesis, nitrogen (N_2) for forming products as fertilizers for plants and making the air inert and ozone (O_3)-layer against sun rays. Imbalance in quality causes adverse effects on the living organisms is called air pollution. Air pollution may also be defined as the presence of contaminants which are injurious to human beings, plants and animals(aquatic or terrestrial).The natural air contains trace amounts (about 1 pmm) of gases like methane (CH_4),ammonia (NH_3),sulphur dioxide (SO_2) etc., and variable amounts of dust particles.

Air pollution is a release into the atmosphere of any substance ,e.g., chemicals or airborne particles, which are harmful both to the human and animal health as well as the health of the wider environment.

Air pollution has become a major issue of modern metropolis because of industrial emissions and increasing urbanization along with traffic jams and heating/cooling of buildings. Monitoring urban air quality is therefore required by municipalities and by the civil society. Air pollution affects human health dramatically. According to World Health Organization (WHO), exposure to air pollution is accountable to seven million causalities in 2012.In 2013; the International Agency for Research on Cancer (IARC) classified particulate matter, the main component of outdoor pollution, as carcinogenic for humans. Air pollution has become a major issue of modern metropolis, where the majority of world population lives, and adding industrial emissions to the consequences of an ever denser urbanization. As a consequence, the reduction of pollutant emissions is the main aim of many sustainable development efforts, in particular those of smart cities. The main reason for air quality damage is due to the smoke exhaust from industries, pollution generated by power plants and the smoke exhaust from various vehicles. Industrial revolution made humans to advance further into twenty first century. Due to rapid increase in the industries pollution increased. The other reason for the air pollution is vehicles which emits smokes. These smokes accumulate in the environment and cause a serious effect to human beings, damages the ozone layer. This project focuses on air pollution monitoring through image processing. Polluted images are obtained from the environment. These images are compared with the other image which is pollution free. From those images diffusion process is done and ratio factor is obtained from the images. Proposed system works well for higher noise level, which is one of the advantages of the project. Another advantage is Fair noise illumination analysis.

2. RELATED WORK

Xiaoguang chen, Yaru li, Dongyue li [1] proposed an efficient algorithm in this paper to evaluate the Air Quality Index(AQI) based on image recognition technology. The major advantage is that the proposed algorithm can produce the AQI evaluation with a considerable accuracy of 93.78%

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)
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which is produced by the experimental results .The limitation is the cost of the camera being used.

Pasi Pyykönen, Pertti Peussa, Matti Kutila Kok-Wei Fong [2] proposed the smoke and exhaust detection system that has been developed for monitoring exhaust gases to enforce environmental laws and regulations. The basic idea behind this paper is a camera-based smoke and exhaust detection system that came from the need to detect and identify vehicles with clearly visible exhaust fumes (smoke) in traffic flows. Traditional systems measuring the HSU grade are implemented with mobile units.The major advantage of this paper is detecting the smoke exhaust in any environment.The limitation is the cost of camera.

Le Quy Don , Hanoi [3] this article presents study on application of remote sensing technique to evaluate air pollution on the mining area of QuangNinh province, the northeastern coast of Vietnam, using multispectral image LANDSAT 5 TM. The advantage of this article is that the obtained results showed that the API index is an effective tool for air quality assessment and management.The limitation is the remote sensing method which is a difficult method to obtain the results early.

S. N. Palve, P.D. Nemade and S.D. Ghude[4] this paper aims to investigate possible impact of air pollutants over the climate change on Indian subcontinent using remote sensing method. The major advantage of the paper is the study of Satellite derived column aerosol optical depth (AOD) in a cost effective way, to monitor and study aerosols distribution and effects over a long time period.Whereas,the major limitation is the topography.

3.EXISTING SYSTEM

Existing system [1] studies the smoke and exhaust detection system that has been developed for monitoring exhaust gases to enforce environmental laws and regulations. In many highly populated countries the Hart ridge Smoke Unit(HSU) grade is used to impose penalties. In many cases, HSU values above 50 are leading to legal actions.

The idea of a mobile camera-based system was to speed up smoky vehicle selection from a traffic flow. In a traditional system, the police authority monitors traffic flow visually and selects vehicles for more detailed HSU measurement. Our solution automates smoky vehicle selection from the traffic flow by selecting and identifying vehicles that produce smoke that is clearly visible to the human eye. When the system detects a smoky vehicle it delivers results to a stationary HSU measuring unit for further analysis.

Existing system [1] proposes a method that adopts two cameras, a far infrared camera and a high-resolution visible wavelength camera, as a detection system for smoky vehicle detection. The far infrared camera is used for detecting the vehicle exhaust fumes. This information is fused with visible spectrum information from the high-resolution camera. An algorithm evaluates if the identified vehicles are causing visible exhaust smoke. If smoke is detected, the system stores evidence for further actions. The first prototype version of the system needed an automatic adaptation procedure in order to calibrate far infrared and high-resolution images together. Mechanically, the system can be set up quickly in the chosen roadside location.

A developed prototype system is one step towards future tools for authorities to automatically detect and classify vehicles emitting smoke. If a permanent set-up is desired, the system can be installed on a lamp post, beneath an overhead bridge or on other similar structures.

Figure 1.User interface for smoke detection and analysis system.

3.1. Devices and Software

The idea of the smoke detection system is to look at vehicles from two possible angles: above or the roadside to see the rear of the vehicle and along the ground to detect possible smoke coming from underneath the vehicle. The installation makes it possible to monitor two lanes simultaneously. Naturally, the camera locations have to be chosen so that a large vehicle cannot completely obscure a smaller vehicle or its exhaust gases.

Each camera pair consists of a camera for visible wavelengths and a thermal camera. The camera views are calibrated so that when the thermal camera detects a hot spot, its location in the visible wavelength camera view can be calculated. The thermal camera is used to detect potential

ISSN (Online) 2456 -1304

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exhaust pipe locations, after which a developed smoke detection algorithm can be applied to the visible wavelength camera image to analyse the area around the potential pipe location.

3.2. SDAS Algorithm

The key idea of the study was to investigate a means to detect and identify smoke-exhausting vehicles from the traffic flow. For this purpose, we need to implement smoke detection analysis software (SDAS) that includes an algorithm for image processing. The algorithm is based on image analysis from thermal and visible wavelength cameras.Detection of exhaust pipe locations is the starting point for recognition of exhaust smoke with the with the thermal camera. As a result, the smoke search is carried out only in the limited area of the corresponding visible wavelength camera image around the exhaust pipe location. For each exhaust pipe, the algorithm generates one or more rectangular ROI (Region Of Interest) areas, from which the existence of smoke is analysed. The image is then categorized into three classes based on the detected smokiness level (HSU values).

Fig. 2.An example of smoke detection on a small road section with HSU>90

For practical implementation reasons, the smoke detection problem was solved in two parts. The first was the collection of image material using a thermal camera and a visible wavelength camera, which had the same field of view. All the images was stored in digital form. The second and more important part was to analyse the collected image material and detect smoky vehicles from it.The main disadvantage of the existing system is that Thermal camera and the far infra red camera used are very costly. Hence, it is difficult to implement using these cameras.In the proposed system the camera system is been eliminated and the reference images are taken for monitoring the pollution level.

4. PROPOSED SYSTEM

The main objective is to monitor the air pollution present in the environment. Image processing is used to detect the pollution in the atmosphere. Binary segmentation algorithm is used to segment the input image. With the help of the input images the pollution is monitored and the ratio factor and the diffusion process are obtained. Mean filter is used to improve the image quality. In existing system, various images of the environment at different levels of smoke emission from vehicles using far infrared camera and a high resolution visible wavelength camera are obtained. These input images are pre-processed. Various Grey level images are obtained for different ranges of HSU. Density analysis of pixel is done using brightness ratio test. Finally, the noise is estimated. The key idea of the existing system was to investigate a means to identify smoke-exhausting vehicles from the traffic flow. For this purpose, we need to implement smoke detection analysis software (SDAS) that includes an algorithm for image processing. The algorithm is based on image analysis from thermal and visible wavelength cameras.

Thus, the proposed system obtains the images from the environment and monitors the pollution through diffusion process present in the image processing method. The amount of pollution in the environment is obtained from the dialog box which displays the pollution level in the environment and the percentage of pollution is finally displayed in the Command window.Various steps have been followed to obtain the pollution level in the environment. The various steps involved are obtaining the input image, pre-processing of the input image and edge detection using canny operator.Diffusion process is the major step used to obtain the level of pollution.

A.INPUT IMAGE

Input image is the image which is taken from the real time. The image obtained is used to monitor the pollution in the environment. The input image is obtained from the traffic or the road. It is not possible to obtain a satellite image.Fig.1 shows the input image.

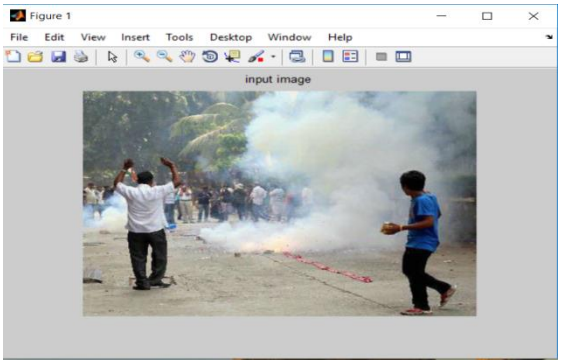

Fig. 3. Input image

B.PRE-PROCESSING

Image pre-processing is the next step after obtaining the input image. The important aim of pre processing is to

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)
Vol 3, Issue 4, April 2018

improve the standard of the image which will be processed for recognition. The pre-processing step is important to convert a colour image to gray scale as shown in Fig. 2 .There are certain enhancement techniques such as contrast Stretching, Noise filtering and histogram modification.

In this method of pre-processing we use noise filtering method. Noise filtering is used for filtering the unwanted or unnecessary information from an image. It is also used to remove various types of noises from the images. There are various types of filters being used such as low pass, high pass, mean and median filter. But in this paper we are using mean filter.

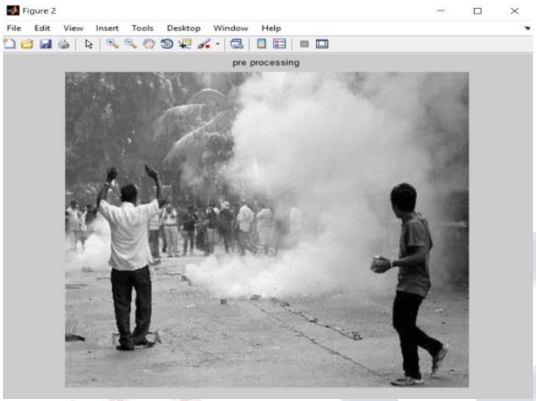

Fig. 4.Pre processing

C.EDGE DETECTION

Edges are the change of intensity or boundaries between different textures. Edge can be defined as the discontinuity in image intensity from one pixel to another. Canny edge detector is being used in edge detection which is an edge detection operator that uses a multi-stage algorithm to detect wide range of edges in images. The Canny algorithm is adaptable to different types of environment. Recognition of edges is done with the help of the important parameter. Edge detection is used to detect the edges and obtain the noise free image where the important details are displayed.

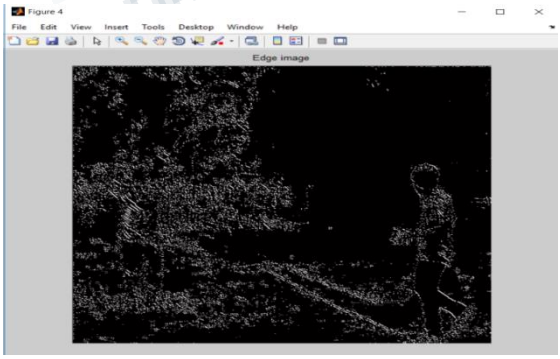

Fig. 5. Edge Detection

D.DIFFUSION PROCESS AND ESTIMATION RATIO

Diffusion process is been proposed by the Perona and Malik algorithm. It avoids the blurring and localization problem. It is an Anisotrophic diffusion method. The scale space is being displayed with the 3-D image as shown in Fig.6.The Estimation ratio is determined to indicate the pollution using a series of formula to estimate the pollution in the graph. This Estimation ratio is displayed in the form of decimals in the command window. The percentage of pollution is also displayed in the command window as shown in Fig7.Finally Fig.8 shows the Dialog box representing the level of pollution as less or more level of pollution.

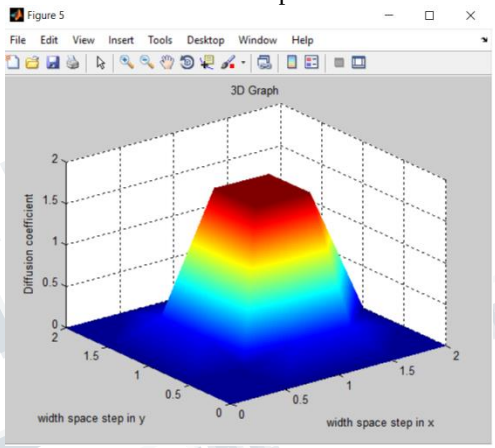

Fig 6. Graph displaying the diffusion coefficient in 3-D

Fig .7.Command window displaying the Estimation ratio and the percentage of Pollution

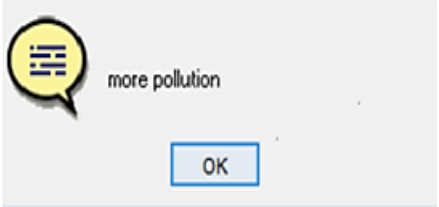

Fig.8.Dialog box to represent pollution level

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)
Vol 3, Issue 4, April 2018

POLLUTION LEVEL	ESTIMATION RATIO	PERCENTAGE OF POLLUTION
LESS POLLUTION	1.0696	32
MORE POLLUTION	1.5848	84

Table 1. Table representing the estimation ratio and percentage of pollution

5. METHODOLOGY

The input images are the images which are obtained from the real time such as the polluted industrial area, traffic area and also pollution free area. Image pre-processing is a vital step in any image analyzing system. Pre-processing of an image is used to improve the image quality of the input image. The colour image is being converted to gray scale image using the pre-processing step. Edge detection is the next step in the process. Canny Edge detection is being used in the edge detection method. Partitioning the images into small frames in order to obtain a clarity regarding the frame which has the smoke content. Diffusion process is used to remove unwanted noises (such as trees) and enhance the image quality to show only the smoky or polluted area. Estimation ratio is being obtained for the image from the graph. Percentage of pollution is also being displayed in the command window.

6. CONCLUSION

Pollution is one of the major problem which causes severe problems to the human health as well as the environment in which we live. The objective of the project is to monitor the pollution using image processing method. This objective is fulfilled by obtaining the percentage of pollution using diffusion process as key method present in the image processing. Plotting of the diffusion coefficient is also done and the result is displayed in the form of 3D Graph. Finally the percentage of pollution is also displayed. Thus air pollution monitoring and estimation is done using diffusion process present in the image processing method.

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