Air Quality Assessment Using Eyes in the Sky

P. Chitra[1], Dr. C. Murukesh[2]
[1,2]*Velammal Engineering College, Ambattur - Red Hills Road, Chennai*

Abstract- **Air quality is a global issue whether from region to region, country to country or continent to continent. This global crisis occurs due to emissions from human activity, sunlight, weather, pollution from far away, wildfires, wind-blown dust etc,. All these factors may change from day to day or hour to hour and this toxic air shortens the life expectancy of the people. To address this issue various global efforts have been taken by many researchers for years. Among one such effort is air quality monitoring using hyper spectral remote sensing. Existing methods monitors' air quality at micro scale level with limited analysis of particulate matter but we propose a novel method which uses an efficient algorithm to predict the air quality in a short span with accurate results.**

Index Terms- HSI (Hyper Spectral Image), PM (Particulate Matter), Emissions.

I. INTRODUCTION

India has the dubious distinction of having 10 out of the 20 most polluted cities in the world. Though we have numerous government air quality monitoring stations in these cities, baring New Delhi (which has 12), are between 1 or 2 stations for a population of 1 to 2 million people. This is woefully inadequate. Further recent study by WHO (World Health Organisation) states that Kanpur, Delhi, Mumbai are the worst polluted city in the country. The PM (Particulate Matter) of Delhi crossed 400 unit grams in cubic meter of air (ug/m3). If the city maintains the prescribed AQI (Air Quality Index) then the life expectancy of the people would be six years more. So we are in a tough situation to handle this global issue as we are increasing our experiments parallel. In spite of various low cost sensors and other measures which are taken already for assessing this air quality, we still lack behind in meeting the accuracy. Using eyes in the sky (satellite) based remote sensing, it is easy to get the accurate and very detailed information about the quality assessment.

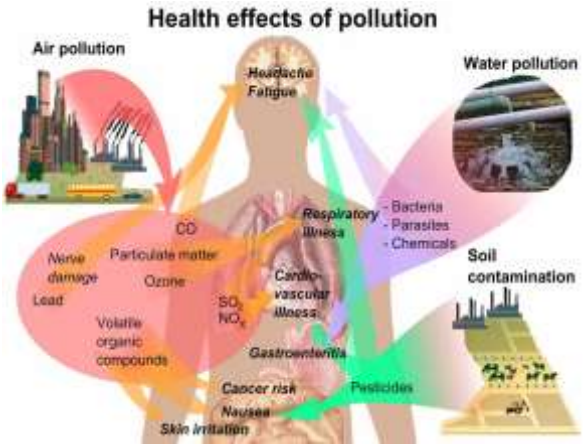

Fig: Health Issues of Pollution

Table – I: Top Global Cities with Worst Air Pollution (previous record)

Country	2014	2010
Bangladesh	169	139
India	*155*	*123*
Pakistan	148	125
Nepal	139	38
China	118	121
Srilanka	69	58

Table - II: PM 10 Levels of Top 10 Megacities (as per august 2018 report)

Mega Cities (urban areas)	PM10 Level	Mega Cities (urban areas)	PM10 Level
Delhi	292	Shanghai	59
Cairo	284	Istanbul	53
Dhaka	147	Mexico	39
Mumbai	104	Saopaulo	28
Beijing	92	Buenos Aires	27

II - HYPER SPECTRAL REMOTE SENSING

A. Remote Sensing:

The process of acquiring data for deriving information about objects or materials (targets) located at the Earth's surface by using sensors mounted on platforms located at a distance from the targets, is called remote sensing. Normally, the

measurements will be in different spectral regions due to interactions between the targets and electromagnetic radiation (EMR). Remote sensing encompasses techniques for obtaining precise information about earth's surface from a distance.

Types of Remote Sensing:

Based on energy sources remote sensing are classified into passive and active. Passive remote sensing makes use of sensors to detect the reflected or emitted electro-magnetic radiation from natural sources and active remote sensing makes use of sensors that detect reflected responses from objects that are irradiated from artificially generated energy sources (Radar). Based on wavelength remote sensing is also divided into Optical and Radar remote sensing. Here the optical wavelength region (0.30-15.0 nm) is mainly used for remote sensing applications and further it is subdivided as Visible (0.38-0.72nm), Near IR (0.72-1.30nm), Middle IR (1.30-3.00nm) and Far IR (7.00-15.0nm) and microwave wavelength region (1mm to 1m).

B. Hyper Spectral Image:

HSI helps to obtain the spectrum of each pixel which further can be used for identifying, detecting and finding the objects. The two commonly used HSI are Push broom scanners and snapshot. Push broom scanner reads the images with respect to time and snapshot generates the image in an instant.

HSI is used by wide variety of applications for identification and monitoring of land cover, land use, disaster, urban, forestry, rural, water bodies, mineralogy, agricultural, eye care, food processing, surveillance, physics, astronomy, chemical imaging, environment, vegetation, snow grain size studies, aerial sensing recycling, etc,.

C. Hyper spectral remote sensing:

Hyper spectral remote sensing plays a vital role in monitoring of environment as it gives more precise and quick analysis when compared to field sampling. HSI now evolved as an alternative to traditional sensor based gas detection methods. It facilitates to solve the issues related to conventional methods and field sampling.

Atmospheric Model Parameters for computations:

1-air temperature
2-water vapour
3-precipitation
4-earth radiation (solar irradiance)
5-air pressure
6-upper air temperature
7-surface radiation
8-composition of CO_2, NOx, SOx, O_3
9-wind speed and direction & other hazadours gases
10-other green house gases, aerosal properties

III - METHODOLOGY

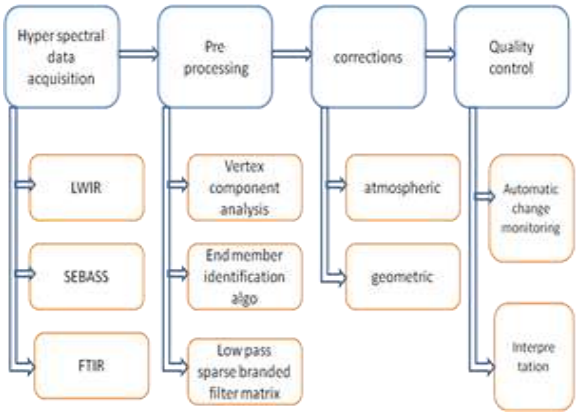

fig: Work Flow of The Hyper Spectral Air Monitoring System

The quality of hyper spectral data is inspected by evaluating three different quality issues:

1) Quality of data pre-processing
2) Quality of atmospheric correction
3) Signal-to-noise ratio estimation

Pre-processing of hyper spectral data consists of radiometric correction, geo rectification and geo referencing. The sensor operator takes care of the radiometric calibration before the flight and radiometric correction after the flight. The next quality is evaluated for geometric errors in the data, which is found by studying straight lines, for example roads, in the imagery. The next evaluation is quality of atmospheric correction, it is evaluated using REF and PIF targets.

The steps followed for assessing the air quality is as follows:

1-Hyper spectral monitoring system
2-Integration with environmental data

Here we propose a hyper spectral monitoring system for most polluted cities of our country. The system is based upon hyper spectral airborne campaigns. For any process acquiring data is the initial step and it is

followed by well documented data processing producing accurate and reliable information of the environment around the polluted area.

The change detection is done using several different methods. Different types of environmental changes are detected using methods most suitable for the case. Hyper spectral imaging enables to monitor several key observables representing environmental state. Automatic change detection can produce information on the location, type and magnitude of the change. The automated change detection is followed by expert interpretation of the change. The expert interpretation defines the biological meaning of the detected change

Results of these studies can be integrated with results from the hyper spectral monitoring system. Results from the hyper spectral monitoring system can be validated using other environmental data. Results can also be used as training data for hyper spectral classification methods. Integration can be used both ways. Hyper spectral data can be used to assess if the spatial coverage of studies based on sampling is adequate.

IV- CONCLUSION

The WHO reported said 14 of world's 15 most polluted cities were in India which includes Delhi, Kanpur and Varanasi. In this report a review on hyper spectral remote sensing techniques and applications have been presented. A brief introduction on general remote sensing principles is followed by detailed review on hyper spectral applications. Then a proposal for hyper spectral monitoring system for the polluted site is presented. Based on the review presented in this report it can be concluded that hyper spectral remote sensing is very promising technique in the monitoring of nuclear fuel repository site.

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