Digital Analytical Study toward Air Pollution Effect Upon an Absorption Spectrum for Different Color Pigments

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ABSTRACT

In urban centers, particulate matter and gaseous emissions as pollutant emissions from industries and auto exhausts are responsible for rising discomfort, increasing airway diseases and deterioration of artistic and cultural patrimony. The presented paper concerns with such topic; smoke effect inside a system designed for this purpose. In such system, a burning incense is used as a source for smoke emission to study its effect upon the absorption spectrum for an ink with different pigments. Results show an evidence to the concept of wavelength absorption/reflectance attitude for an ink; ink absorbs the appropriate wavelengths to give rise the required color. The latter evidence is true for all colors except for white/black pigments. The later pigments have identical curved lines for Red, Green, and Blue bands with a trough (high reflectivity)/peak (high absorption) respectively.

INTRODUCTION

In recent years, an attention has been focused on the local environmental problems such as noises, red tides, air pollution and water clarity which obstructed the comfortable human lives [1]. The air that a human breathe is a mixture of gases, small solid and liquid particles. Some substances come from natural sources while others are caused by human activities such as our use of motor vehicles, domestic activities, power generation and industry. These substances are called air pollutants and can be either particles, liquids or gaseous [2]. Air pollutants can cause a variety of health problems including breathing problems, lung damage, bronchitis, cancer, and nervous system damage. Air pollution can also irritate the eyes, nose, throat, and reduce resistance to flu and other illnesses. Air pollution causes haze, smog, reduces
visibility, dirties, damages buildings, other landmarks, and harms trees, lakes and animals [3].

The air pollutants can be classified as primary or secondary pollutants. The primary air pollutants are harmful chemicals which directly enter the air due to natural events and human activities. A secondary air pollutant is a harmful chemical produced in the air due to chemical reaction between two or more components [4].

Y. S. Cheng, et al. in 1995 found that aerosols produced from burning an incense are similar to other aerosols formed by condensation like environmental tobacco smoke found indoors. They estimated the incense aerosol generation rate as a function of time and the aerosol removal rate constant [5]. J. Hagedorn and M. D’Zumra found a model for color constancy with fog which can be described by the suggested model that takes into considerations the shift in color and change in contrast [6]. The researchers in [7] made a comparison between a model of a typical gas flare with experimental one obtained from other flare in Petroleum Company in industrial City of Nigeria. They studied the parameters that affected on the dispersion pattern of pollutants.

It is well-known that the spatial variation of an incident radiance in the direction of the captured devise from the scene can be represented digitally by using a camera [8] and computers are indispensable for the analysis of image amounts of data for tasks that require complex computation, or for extraction a quantitative information [9]. Image analysis combines techniques that compute statistics and measurements based on the gray-level intensities of the image pixels [10]. "Spectral operations" can analyze the distribution of color, gray scale values, or black and white in an image. The most important spectral operation is "Mean Gray Scale Intensity" that can be described as follows [11]:

**MEAN GRAY SCALE INTENSITY**

The mean grayscale value of an image is considered the simplest image analysis method which can be expressed as in the following relation:

$$\mu = \bar{g} = \frac{1}{n} \sum_{i=1}^{n} g_i \quad .........(1)$$

Where $n$ is the number of pixels and $g_i$ is the grayscale values of the pixels in the image segment [12,13].

**THE DESIGNING SYSTEM**

The building system consists of a wooden rectangle box with dimensions 120, 40, 60 cm, colored scene (chart with eight different colors) illuminated by a white LED light located in the middle of the upper box's side as shown in Fig.(1). The interior smoke had been obtained from burning an incense inside such system. Images have been selected in a sequential frames through equally time periods from the captured video
which falls into 18.37 min. The used camera is a Sony-Cyber shot with 16.2 Mega Pixel, 5X optical zoom, optical steady shot DSC-WX30.

RESULTS AND DISCUSSION
In any color manufacturing or printing process, the appearance of pigments depends on the natures of the light falling on them [14]. The process of mixing colors may be classified into two different types; additive and subtractive. The first one applies to light combination beams while the subtractive one applies to paints, pigments dyes, or, filters when they combined [15]. Figure (2) shows some of the selected images starting from clean air case and ending with smoke-disappear one passing through the case of full-smoke. In order to analyse such images to see smoke behavior though the whole process, the mean estimator had been calculated for a rectangle selected box from each image's colors (i.e. White, Yellow, Cyan, Green, Magenta, Red, Blue, and Black) by using Matlab R2014a and which be presented in Fig.(3).

![Fig.(1) Designing System](image1)

![Fig.(2) Some of selected images at different time periods](image2)
According to [16,17], "the ink absorption spectrum consists of a curved line with peaks and troughs", so, Figure (3) illustrates such spectrum for an ink with different colors. Red, Green, and Blue ink pigments reflects R, G, and B wavelengths strongly with troughs curved lines respectively and absorbs the complementary colors with a peak curved lines respectively; Green and Blue bands for red-ink, Blue and Red for green-ink, Green and Red bands for blue-ink, respectively which can be distinguished in Figs.(3f,d,g). In the same way, Cyan (C), reflects blue band and absorbs green and red as in Fig.(3c), Yellow (Y) reflects green wavelength and absorbs red and blue bands which can be seen in Fig.(3b), Magenta (M) color reflects red wavelength and absorbs blue and green bands expressed clearly in Fig.(3e). Noting that for CYM colors, the complementary wavelength is the lowest curve. Otherwise, the principle of selectivity absorption/reflection for pigments isn't true for all, the White and Black color of an ink reflects/absorbs Red, Green, and Blue bands strongly in the same strength as a curved line with a trough/peak respectively that can be seen in Figs.(3a,h).

**CONCLUSION**

A variety of health problems can occur by air pollutants. Such pollutants will harm the comfort for both humans and animals in addition to the damage that could be resulted for plants and materials. Results verify the principle of subtractive color mixing in which each colorant transmits two thirds of the visible spectrum and absorbs one third in such that the complementary band is the lowest curve. A strong absorption spectrum with identical strength bands resulted in the case of white and black pigments with trough/peak curved lines respectively.

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