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FEATURE EXTRACTION FROM DIGITIZED IMAGES OF DYE SOLUTIONS AS A MODEL FOR ALGAL BLOOM REMOTE SENSING

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Abstract: Digital images of dye solutions were obtained under controlled conditions to simulate images of algal blooms. The images were dissected and analyzed using RGB color space to determine color features-pigment concentration correlations. The results indicate that the technique may be used in the determination of algal bloom levels / water pigmentation by application of the same analysis to aerial photos of HAB affected bodies of water.

Keywords: color space, remote sensing, RGB, methyl orange, methyl violet

1. INTRODUCTION

Our interest in image analysis is a product of an initiative to develop a simple and practical remote sensing method for algal blooms. It is known that reflectance from the surface of a body of water is a function of water quality i.e. the concentration of suspended or dissolved colored matter (e.g. cyanobacteria) can be determined by color analysis of surface images. (Schowengerdt, R. A., 2007, Ritchie, J. C., Zimba, P. V., Everitt, J. H., 2003)

A very interesting technique in remote sensing involves capturing of images (visible or otherwise) of a subject followed by extraction of "intelligent features". Such features may include color (visible) or reflectances in wavelengths outside the visible range.

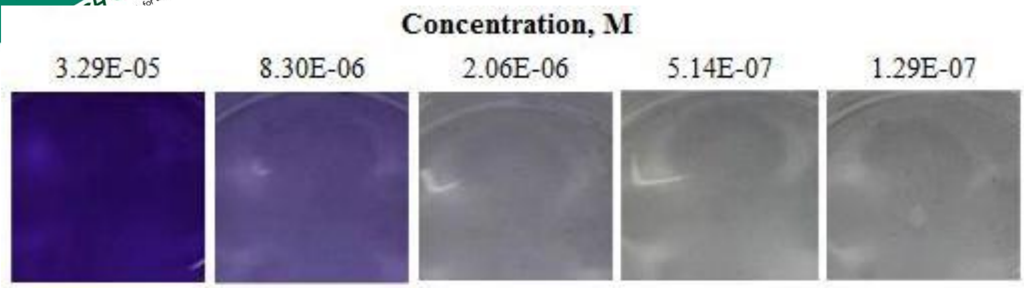
Cloud cover images, for example, can be used to assess precipitation rates. Forest cover images can yield information with regards to the type of vegetation present while images of a body of water may provide useful information on turbidity, algae growth , siltation, etc. (Schowengerdt, R. A., 2007, Ritchie, J. C., Zimba, P. V., Everitt, J. H., 2003, Liu, J. G. & Mason, P. J., 2009)

Image color analysis can be used also to determine solute concentrations in solutions. The most practical method for the determination of acid levels (pH) involve color analysis/comparison. (Schott, J. R.,2007, Bates, R. G., 1973, Myers, R. J., 2010).

In the present work, dye solutions were used to develop a theoretical basis for a proposed algal bloom remote sensing technique.

2. METHODOLOGY

Two dye solutions (Methyl Violet, MV and Methyl Organge, MO) with varying concentration levels were prepared. Images of these solutions in are shown (Figure 1).



(a) Methyl Violet

(b) Methyl Orange Dye

Figure 1. Various concentration levels of the two dye solutions: (a) Methyl Violet and (b) Methyl Orange.

An illustration of the setup is shown in Figure 2. Fluorescent lamps (20 W) were utilized as the light source. A Canon 550D digital camera mounted 12 inches above the surface of the dye solution was used to capture images. The camera settings are as follows: automatic white balance, ISO 400, aperture F8.0, shutter speed 1/20. All the images were captured under these parameters and conditions.

A 100x115 pixel portion from each of the images were cropped and processed using an algorithm running on Matlab to extract color feature in RGB space. The entire process flow is presented in Figure 3.

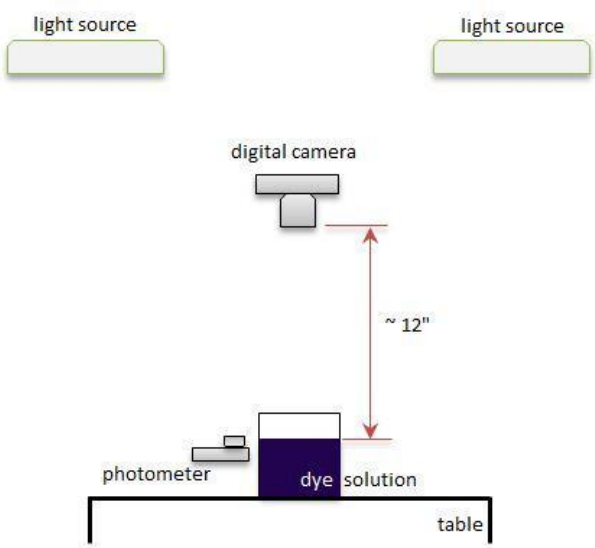


Figure 2. Schematic diagram of the setup.

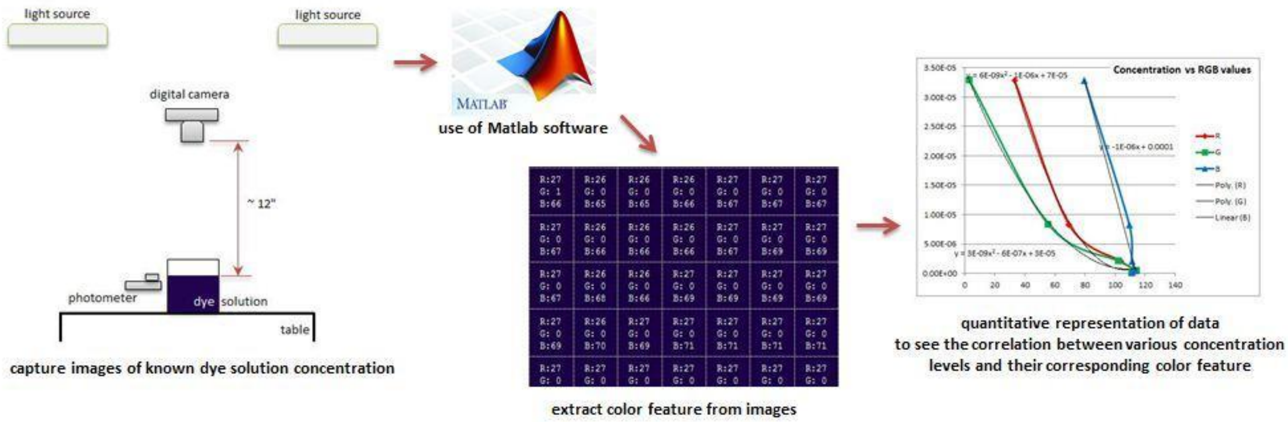


Figure 3. Process flow: from the setup used to color feature extraction of each dye solution.

3. RESULTS AND DISCUSSION

Results are summarized below for the Methyl Violet Dye and Methyl Orange Dye. The concentration levels with their corresponding RGB values are given in Tables 1 and 2.

As expected, RGB values are additive in reproducing color i.e. any combination of the Red, Green, Blue components defines the observed color. Hence, low number RGB combinations correspond to darker/saturated images while (255, 255, 255), maximum RGB number combination correspond to white. Other colors are produced by combinations in between (0,0,0) and this maximum.

The data show that the value of each color component is a function of concentration (Figure 1) and can be fitted into a polynomial or exponential equation.

Table 1. Different concentration levels of the Methyl Violet dye with its corresponding RGB values.

Concentration, M	3.29X10^-5	8.30X10^-6	2.06X0^-6	5.14X10^-7	1.29X10^-7
R	33	69	104	114	111
G	3	56	102	114	111
B	80	109	111	114	111

Table 2. Different concentration levels of the Methyl Orange dye with its corresponding RGB values.

Concentration, M	4.31X10^-5	1.08^10-5	2.70X10-6	6.74X10-7	1.69X10-7
R	115	113	114	117	117
G	52	84	108	118	118
B	7	12	69	105	113

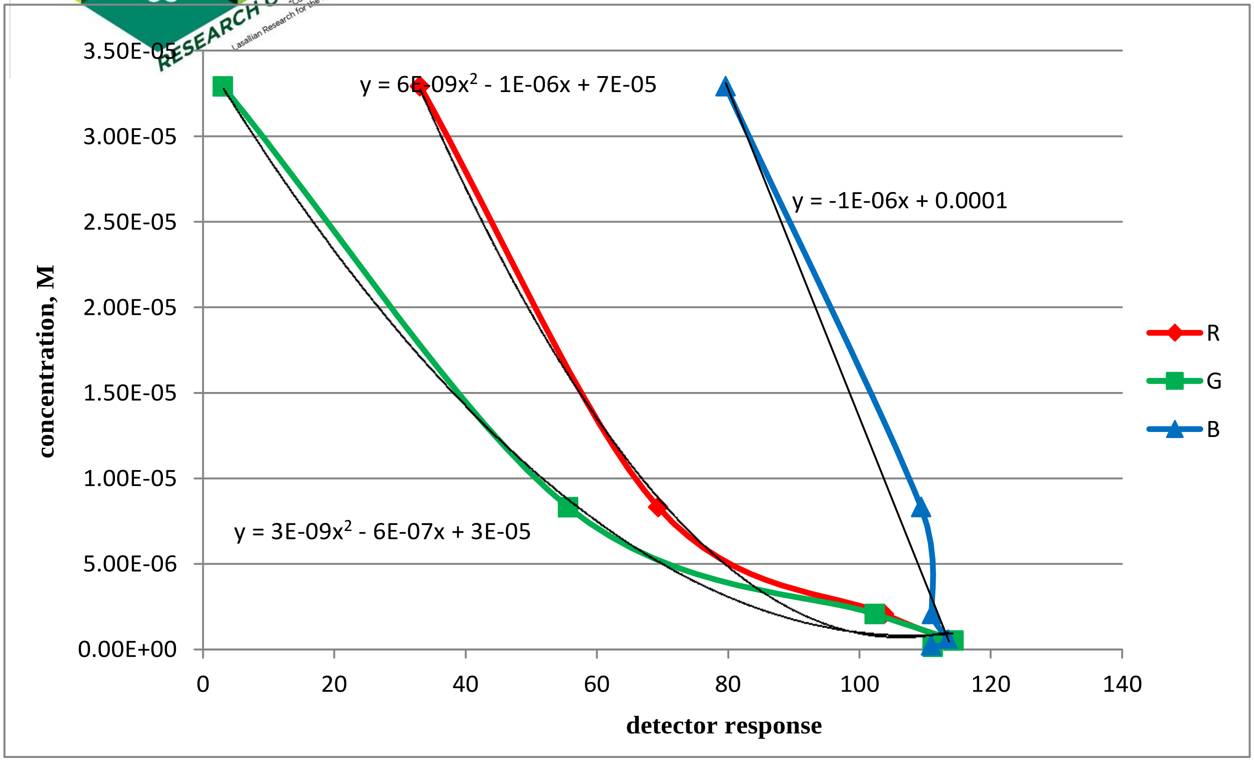


Figure 4. Concentration vs. RGB values from Methyl Violet

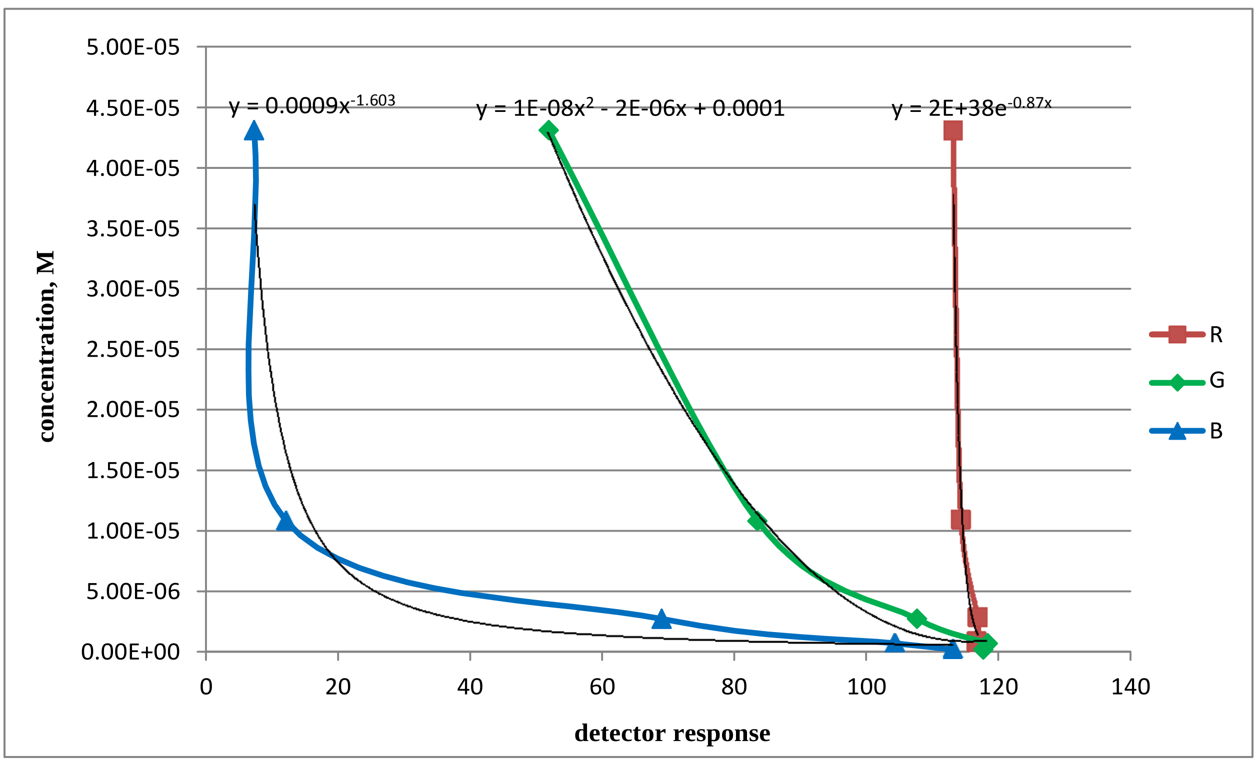


Figure 5. Concentration levels vs. RGB values from Methyl Orange

Correlation between Concentration and RGB values are shown in Figures 4 and 5. Best fit curves (polynomial or exponential) were overlayed on the graphs to see the relationship of each R, G, and B curves given the concentration levels in each dye.

4. CONCLUSION

Simple CCD sensor equipped digital cameras can be used to capture images that can be dissected to generate the corresponding RGB color space combinations. These RGB color space value combinations provide a simple technique to determine dye/colored solute concentrations.

5. REFERENCES

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