MONITORING AND IDENTIFICATION OF REGION-GROWING MICROALGAE BIOMASS QUANTIFICATION USING DIGITAL IMAGE PROCESSING

Mr. Vinoth Kumar C
Assistant Professor,Dept. of ECE
SSN College of Engineering,Chennai.

Dr. Gopinath K.P
Associate Professor, Dept. of Chemical Engineering
SSN College of Engineering,Chennai.

Akshay Kumar C
Student, Dept. of ECE
SSN College of Engineering,Chennai.

Alaguraj A
Student, Dept. of ECE
SSN College of Engineering,Chennai.

Gunupati Sumadhura
Student, Dept. of ECE
SSN College of Engineering,Chennai.

Harini S
Student, Dept. of ECE
SSN College of Engineering,Chennai.

Abstract— Algal Blooms are one of the reasons for contamination of water and various other environmental issues. So, monitoring these blooms has become an important task these days. A traditional method for finding the concentration of algae are time consuming and requires assistance of skilled professionals. Thus, Digital Image Processing is used where RGB color analysis is done on *Chlorella vulgaris* to find the algae concentration in water. The experiment is carried on by using diluted and concentrated cultures of microalgae to create various concentrations. The Green component varies based on concentration and thus can be used in predicting the amount of algal component present.

Keywords—Eutrophication, Oligotrophic, Mesotrophic , Hypertrophic

I. INTRODUCTION

Microalgae have an important role to play on the ecological environment with various applications in biotechnology process. They are also an integral food source and oxygen producers. As they are very sensitive to environmental changes, they can be used as indicators to analyze the purity of water. Their productivity depends on biomass concentration and thus calculating it has become a prime importance. Therefore, accurate methods which are fast, non-destructive and with high precision are needed to calculate them.

The various concentration samples of *Chlorella vulgaris* are kept in a white box and illuminated continuously at the bottom using light source. A Wi-Fi action camera is used to capture the image of the microalgae samples. The color variation of microalgae represents a significant biomass evaluation. This variation depends on the photosynthetic pigment composition. Color is a useful indicator for both identification of algae and determination of microalgae concentration. RGB model is thus created for direct determination of concentration of algae in the given water sample. Color suspended in the Microalgae can be processed to create a simple and inexpensive method in cultivation of microalgae. This RGB analysis method can also be used for monitoring and controlling algal blooms in the near future.

Eutrophication occurs when a water body has excess nutrients and in turn increase the growth of more plants and algae. Harmful algae can increase disproportionately with eutrophication depending on which nutrients change and in what proportion they do. Algal blooms limit sunlight available to bottom dwelling organisms thus leading to the decrease of dissolved oxygen. Some algal blooms may cause animal mortality by making their way into the food chain. Algae are often used as biological indicators to measure freshwater nutrient levels. Thus RGB model for analyzing the concentration of algae in the water body can be used to measure the Eutrophication levels and save the biodiversity.

Based on the amount of Biological activity present, water bodies can be divided as:

Oligotrophic: It has the least amount of Biological activity and is termed as good quality water which can be used for day-to-day purposes.

Mesotrophic: It has moderate amount of Biological activity and is termed as fair quality water.

Eutrophic and Hypertrophic: These have the highest amount of Biological activity and is called poor quality water which is completely unfit for daily use.

II. MATERIALS AND METHODS

The principal material that is required is microalgae and Chlorella Vulgaris is the algae that is used. An environment is artificially created to support the growth of the algae. Algae concentration is varied in the samples. A white chamber box is used to capture the images of the tubes in which these samples are stored. WI-FI action camera is used to capture and send the images of algae samples through WI-FI.

(A) NOISE AND FILTERS

Noise comes into an image due to the environment conditions in which it is taken or due to any problem in the lens and some other external factors. It is essential to identify the noise present in the image and remove it to obtain better results. There are different types of noises which include Salt and Pepper Noise, Gaussian Noise, Impulse Noise etc. Each of this noise has its own characteristics. If the images with noise are processed, then the results will show a discrepancy. To remove these noises, different Filters are to be used. A particular filter will be suitable for certain noises. Parameters like MSE are calculated and compared to find out the filters that are best in removing a noise. Various filters that are in use are Weiner Filter, Mean Filter, Median Filter, Adaptive Filter and so on.

(B) SHADOW REMOVAL

When taking pictures, another important issue which arises is shadow. A shadow is an area where direct light from a light source cannot reach due to obstruction by an object. The patterns of shadow rely on size of objects and the angles of lighting source. There are disadvantages like loss of information for the surface under the shadows presenting difficulties for image interpretation, image matching, detection and other applications. Shadow removal from respective image can be used for object detection. After the shadows are removed, objects in the images will appear more obviously so that they are recognized correctly. Initially, the channels from the images are separated and pixel values are converted to double data type. A mean filter is applied to these channels. Areas of shadow are identified and the image is converted to binary. The regions with shadow are processed and these images are convolved with the original image to get the final processed image.

(C)BUBBLE REMOVAL

As we are dealing with algae samples, presence of bubbles in the solution is a common problem. Even in the images that are captured, these might appear. Removal of these bubbles is necessary for better results. In this process, first the bubbles are to be identified. Then the identified bubbles are removed using Gaussian filter. The primary purpose of this filter is to smoothen the image. Thus using this filter helps to remove the bubbles.

(D)GUI INTERFACING

GUI (Graphical User Interface) in Matlab is a type of interface that allows user to interact with electronic devices through graphical icons. These icons include radio button, drop-down button, axes, graphs, push-buttons etc.

The images in the test-tube are taken consisting of 5 samples - 0ml algae and 5ml chemical medium, 0.5ml algae and 4.5ml chemical medium, 1ml algae and 4ml chemical medium, 2ml algae and 3ml chemical medium and 3ml algae and 2ml chemical medium. Once these images are loaded into GUI, the region of interest is cropped based on the user's wish. Then the image cropped is pre-processed using shadow removal and bubble removal technique. This enhanced image is also converted to gray scale image. Both these enhanced and gray scale images are then used to calculate the intensity of algae.

Here, based on analysis of the images, only the blue channel varies with the algae intensity. It has been found that, as the intensity of blue channel decreases, the algae content in the mixture containing algae and chemical medium increases and vice-versa. Therefore, we have devised two GUI's of which one helps us to tell about the trophic level of algae and also to predict the intensity of algae by plotting the best fit line. Algae intensity calculation is done using the equation:

$$\text{Blue channel} = \frac{\sum_{i=1}^{a}\sum_{j=1}^{b} img(i,j)}{a+b}$$

Algae Intensity = 255 – blue channel

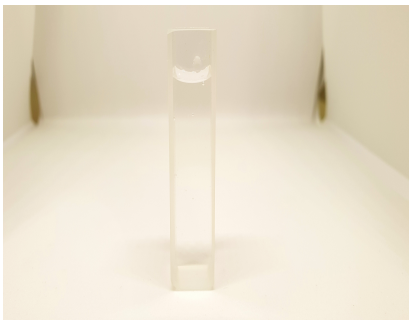
In the first GUI, these values of algae intensity are plotted in a table. Then the best fit line is plotted both for the colored and gray values of algae intensity. This is done by finding out the slope and intercept of the best fit line. This best fit line can also be used to predict the algae intensity given the amount of algae in

chemical medium. Thus, the algae intensity can be used to predict the trophic levels of algae.

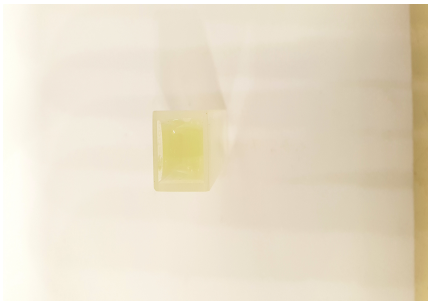
In the second GUI, the enhanced image's algal intensity is compared to check the trophic levels of algae. It is classified as Oligotrophic, Mesotrophic, Eutrophic and Hypertrophic.

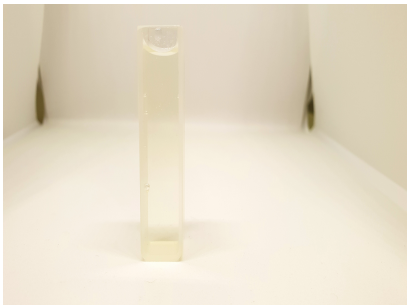
TOP VIEW **FRONT VIEW**

Algae Content - 0 ml

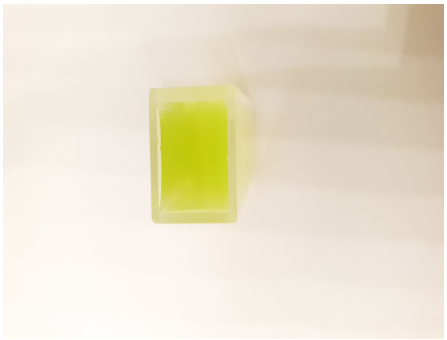


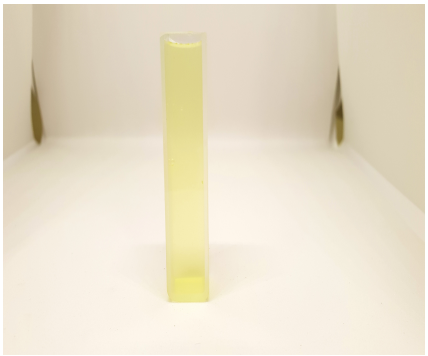
Algae Content – 0.5 ml



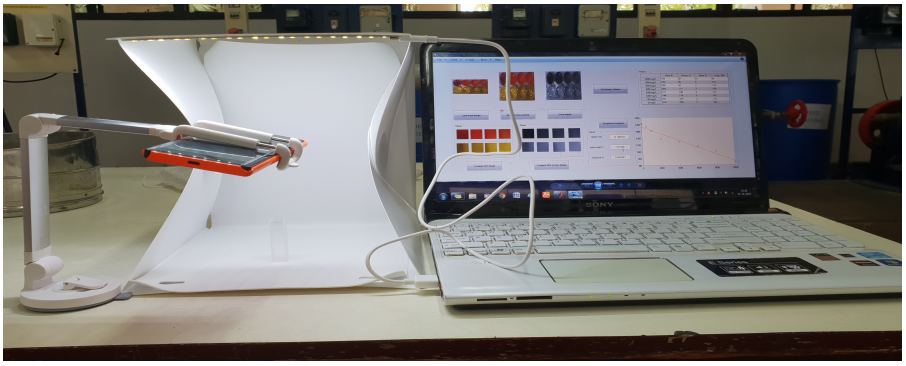


Algae Content - 3 ml

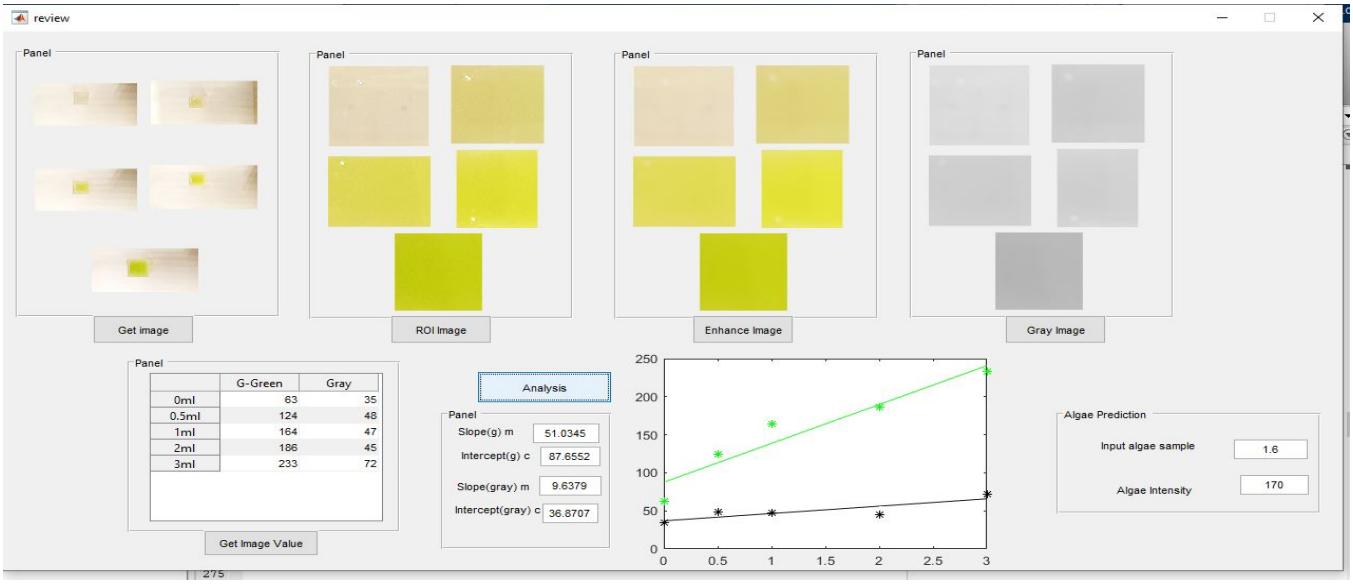




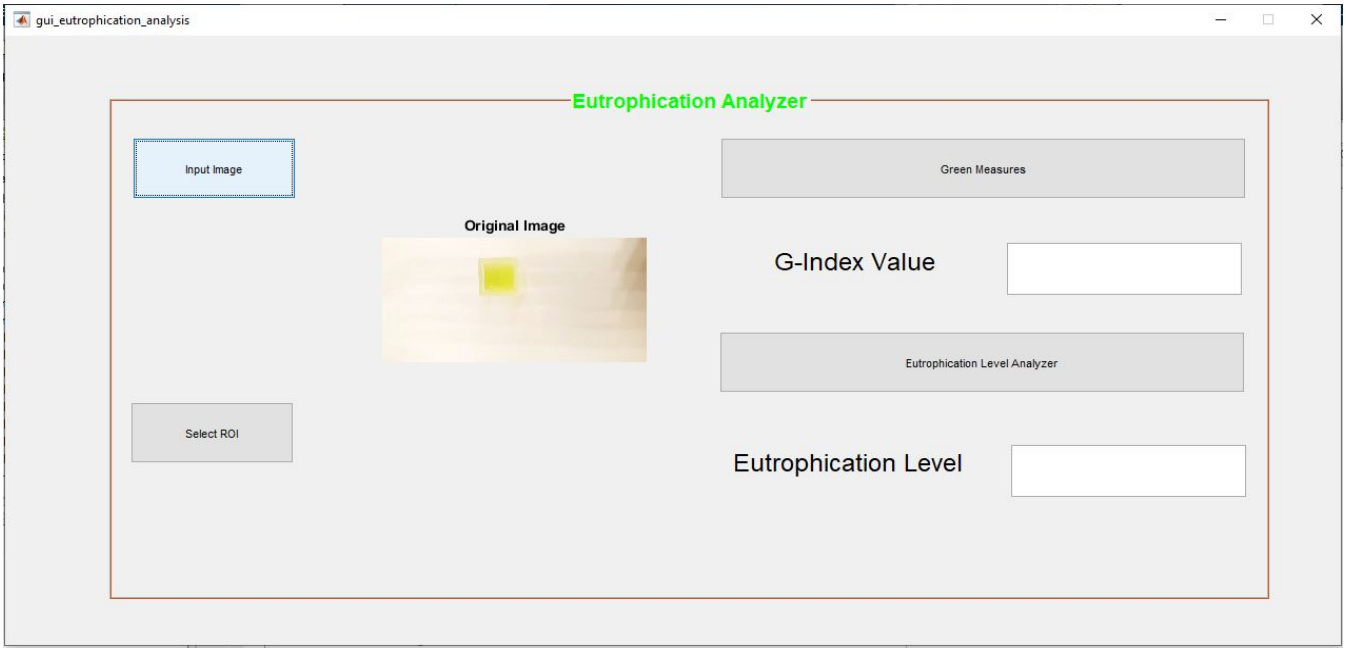
EXPERIMENTAL SETUP

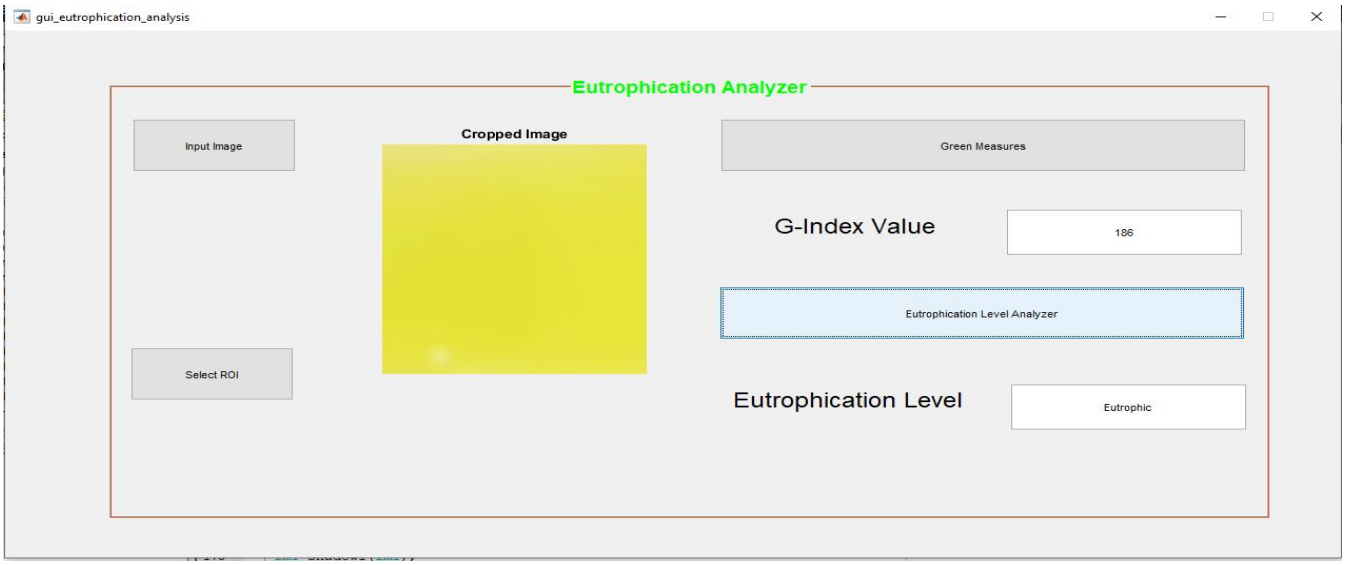


GUI 1



GUI 2





III. RESULTS AND OBSERVATIONS

Thus, given an image of the algae sample, by calculating the intensity of either gray or blue channel, we will be able to find out the content of algae in it. Or given different samples of algae with different concentrations we can find out the variation in the content of algae with respect to each sample. Once the algae content is determined, the sample can be classified as either Oligotrophic, Mesotrophic or Eutrophic. This classification is based on the trophic levels of algae which we are calculating using the first GUI interface or it is given sometimes.

Hence, this setup is found useful in testing the purity of the water in a simpler and efficient way. Unlike the traditional method this is easier to estimate and is also automated.

IV. REFERENCES

[1] Lin Wei, Kang Su, Siqi Zhu, Hao Yin, Zhen Li, Zhenqiang Chen & Migao Li
(2017): Identification of Microalgae by Hyperspectral Microscopic Imaging System, Spectroscopy
Letters, DOI: 10.1080/00387010.2017.1287094

[2] Sarrafzadeh, M. H. / La, H. J. / Lee, J. Y. / Cho, D. H. / Shin, S. Y. / Kim, W. J. / Oh, H. M. , Microalgae biomass quantification by digital image processing and RGB color analysis, Journal of applied phycology ; 27,1; 205-209.

[3] Sanjeev Kumar et. al. / International Journal of Engineering Science and Technology
Vol. 2(9), 2010, 4482-4486

[4] Junli Wang, Zishi Fu, Hongxia Qiao, Fuxing Liu, Assessment of eutrophication and water quality in the estuarine area of Lake Wuli, Lake Taihu, China, Science of The Total Environment,Volume 650, Part 1,2019,Pages 1392-1402,
ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2018.09.137.

[5] Elham M. Ali, Hanan M. Khairy, Environmental assessment of drainage water impacts on water quality and eutrophication level of Lake Idku, Egypt, Environmental Pollution, Volume 216, 2016, Pages 437-449, ISSN 0269-7491, https://doi.org/10.1016/j.envpol.2016.05.064.

[6] Hamed A. El-Serehy, Hala S. Abdallah, Fahad A. Al-Misned, Saleh A. Al-Farraj, Khaled A. Al-Rasheid, Assessing water quality and classifying trophic status for scientifically based managing the water resources of the Lake Timsah, the lake with salinity stratification along the Suez Canal, Saudi Journal of Biological Sciences,
Volume 25, Issue 7,2018, Pages 1247-1256, ISSN 1319-562X, https://doi.org/10.1016/j.sjbs.2018.05.022.

[7] I. Kagalou, E. Papastergiadou, I. Leonardos, Long term changes in the eutrophication process in a shallow Mediterranean lake ecosystem of W. Greece: Response after the reduction of external load, Journal of Environmental Management, Volume 87, Issue 3, 2008, Pages 497-506, ISSN 0301-4797,
https://doi.org/10.1016/j.jenvman.2007.01.039.

[8] AL-Fahdawi, A.A.H., Rabee, A.M. & Al-Hirmizy, S.M. Environ Monit Assess (2015) 187: 367. https://doi.org/10.1007/s10661-015-4607-2.

[9] Markogianni, Vasso & Dimitriou, Elias & Karaouzas, Ioannis. (2014). Water quality monitoring and assessment of an urban Mediterranean lake facilitated by remote sensing applications. Environmental monitoring and assessment. 186. 10.1007/s10661-014-3755-0.

[10] Wenqiang Zhang, Xin Jin, Dong Liu, Chao Lang, Baoqing Shan, Temporal and spatial variation of nitrogen and phosphorus and eutrophication assessment for a typical arid river — Fuyang River in northern China, Journal of Environmental Sciences, Volume 55, 2017, Pages 41-48, ISSN 1001-0742, https://doi.org/10.1016/j.jes.2016.07.004.

[11] Jingbo Guo, Chongjun Zhang, Guochen Zheng, Jie Xue, Lanhe Zhang, The establishment of season-specific eutrophication assessment standards for a water-supply reservoir located in Northeast China based on chlorophyll-a levels, Ecological Indicators, Volume 85, 2018, Pages 11-20, ISSN 1470-160X, https://doi.org/10.1016/j.ecolind.2017.09.056.

[12] Bachisio Mario Padedda, Nicola Sechi, Giuseppina Grazia Lai, Maria Antonietta Mariani, Silvia Pulina, Marco Sarria, Cecilia Teodora Satta, Tomasa Virdis, Paola Buscarinu, Antonella Lugliè, Consequences of eutrophication in the management of water resources in Mediterranean reservoirs: A case study of Lake Cedrino (Sardinia, Italy),
Global Ecology and Conservation, Volume 12, 2017, Pages 21-35, ISSN 2351-9894,
https://doi.org/10.1016/j.gecco.2017.08.004.

[13] Kenia Dias Pessoa, Willian Toito Suarez, Marina Ferreira dos Reis, Mathews de Oliveira Krambeck Franco, Renata Pereira Lopes Moreira, Vagner Bezerra dos Santos , A digital image method of spot tests for determination of copper in sugar cane spirits, Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy (2017),
doi: 10.1016/j.saa.2017.05.072

[14] Marina A. Dominguez, María E. Centurión, Application of digital images to determine color in honey samples from Argentina, Microchemical Journal, Volume 118, 2015, Pages 110-114, ISSN 0026-265X,
https://doi.org/10.1016/j.microc.2014.08.002.

[15] V. R. P. Borges, M. C. F. d. Oliveira, T. G. Silva, A. A. H. Vieira and B. Hamann, "Region Growing for Segmenting Green Microalgae Images," in *IEEE/ACM Transactions on Computational Biology and Bioinformatics*, vol. 15, no. 1, pp. 257-270, 1 Jan.-Feb. 2018. doi: 10.1109/TCBB.2016.2615606.