Water Quality Estimation using MATLAB in Image Processing Domain

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Abstract**:** *Image processing is the most common way of changing image into a computerized structure and playing out specific tasks to get some helpful data from it .Common water quality measurements include temperature, dissolved oxygen, pH, dissolved oxygen, conductivity, and turbidity and so on. In this paper, a novel water quality estimation using MATLAB in image processing techniques was proposed. Here parameters like pH, dissolved oxygen, turbidity, and nitrate levels are estimated by the system through the analysis of high-resolution images of water samples. The entire experiment was done on 256 * 256 resized image along with grey level conversion. The accuracy and dependability of the system are confirmed by preliminary findings that show a strong correlation between the image-derived metrics and conventional laboratory measurements. From the observation of the results, out of 9 samples 7 samples were successfully gives the valuable results.*

Keywords**:** *pH, Dissolved oxygen measurement, Turbidity measurement, Nitrate measurement*

I. INTRODUCTION

Image processing is a vital field that encompasses techniques for manipulating and analyzing visual images to improve their quality and extract meaningful information. It integrates concepts from computer science, mathematics, and engineering, making it applicable in various domains. Key processes include image enhancement, where adjustments to brightness and contrast improve visual appeal; image restoration, aimed at recovering degraded images; and image segmentation, which divides an image into distinct regions for easier analysis. Additionally, feature extraction identifies important characteristics within images, while image compression reduces file sizes for efficient storage and transmission. Image processing using MATLAB is a common task, and MATLAB provides a rich set of functions and tools for this purpose. Below are some basic steps for image processing in MATLAB, covering reading, displaying, and performing common operations on images .Image processing in MATLAB involves the use of a wide range of functions and tools designed to manipulate and analyze images. MATLAB provides a robust environment for performing tasks such as image enhancement, filtering, segmentation, and feature extraction. The primary tool for image processing in MATLAB is the *Image Processing Toolbox*, which offers a variety of functions to work with 2D and 3D images, including grayscale and color images. Water quality monitoring plays an essential role in safeguarding public health, preserving ecosystems, and ensuring the sustainability of water resources. Accurate and timely measurements of water quality parameters are critical for detecting pollutants and managing water resources effectively. Traditionally, water quality assessment has been conducted through laboratory tests, which are often labor-intensive, time-consuming, and limited in real-time applicability. In contrast, the advent of digital imaging and image processing techniques has opened up new opportunities for efficient, non-invasive, and real-time monitoring of water quality. Leveraging MATLAB, a widely used computational tool, facilitates the development of automated systems for water quality measurement using image processing methodologies. This paper explores the potential of MATLAB-

based image processing for assessing water quality parameters, including turbidity, color, and the presence of contaminants, with an emphasis on automation and real-time applications.

The Smart water quality monitoring system with cost-effective using IoT was proposed using several sensors to measure various parameters such as pH value, the turbidity in the water, level of water in the tank, temperature and humidity of the surrounding atmosphere [1]. A cost effective and efficient IoT based smart water quality monitoring system was proposed which monitors the quality parameters uninterruptedly to the cloud server for further action [2]. The real-time water quality monitoring system installed in River Ganga and results obtained through it for various parameters and the results have also been compared with the standard values [3]. Water Quality Monitoring (WQM) is a cost-effective and efficient system designed to monitor drinking water quality which makes use of Internet of Things (IoT) technology. [4-7]. The proposed system consists of several sensors to measure various parameters such as pH value, the turbidity in the water, level of water in the tank, temperature and humidity of the surrounding atmosphere and the obtained data is sent to the cloud by using IoT based Think Speak application to monitor the quality of the water [8]. Water quality monitoring using MatLab-based image processing and machine learning was presented [9]. Various enhancement technique was used in image processing for the desired future extraction [10 -12]. Image Transformation and Enhancement Techniques were reviewed and analyzed [13].

II. METHODOLOGY

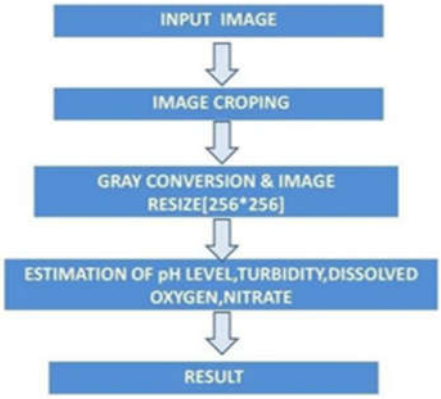

Figure1: Block diagram of water quality measurement using MATLAB

INPUT IMAGE: The input image should be a clear, well-lit photograph of a water sample. Ensure the image captures the water's color and clarity accurately. A consistent background and proper lighting are crucial for reliable analysis.

IMAGE CROP:

The process of selecting and extracting a portion of an image, removing unnecessary parts, and retaining the desired region, Image cropping isolates the water region of interest, reducing noise and improving the accuracy of water quality analysis.

GREY SCALE CONVERSION:

The process of converting a color image to grayscale, reducing the image to various shades of gray.

Grayscale conversion simplifies image processing by reducing color information to intensity levels. It can improve computational efficiency and highlight specific features relevant to water quality analysis.

IMAGE RESIZE:

The Image resizing adjusts the image dimensions to a suitable size for analysis. This can optimize processing time and memory usage, ensuring efficient water quality assessment.

ESTIMATION OF WATER PARAMETERS:

The estimation of water parameters in the physical parameters like ph., turbidity, chemical parameters dissolved oxygen, Nitrate.

III. RESULTS AND DISCUSSION

The experiment was evaluated on 9 images which were captured BY using cameras and images were detected by Algorithm. They were initially converted into greyscale images and then resized into 256 x 256, resized grayscale face images**.** By using MATLAB code we can measure the water parameters. While image-based methods offer several advantages over traditional techniques, challenges remain in ensuring the robustness of the system. Variations in environmental conditions, such as lighting, turbidity, and water surface reflectance, can affect the quality of captured images.

Figure2: Different types of water samples

To address these challenges, preprocessing techniques such as contrast adjustment, histogram equalization, and noise reduction are often employed to standardize image quality before analysis. MATLAB's extensive set of image enhancement funct33ions aids in minimizing the impact of such factors, ensuring that the water quality measurements are consistent and reliable across diverse conditions.

The different type of and its basics limits is as follows:

1. **MUD WATER:** The water quality of mud water is good and ph level is 6.5-8.5 the turbidity will be 100-500.estimated dissolved oxygen will be 2-5mg/l and the nitrate level is 5-20mg/l.
2. **DETERGENT WATER:** The water quality assessment of detergent water is poor and ph level is 9-11.turbidity will be 50-200.estimated dissolved oxygen will be 1-3 mg/l and nitrate level will be 1-5mg/l.
3. **SALT WATER:** The water quality assessment of Salt water is poor and ph level is 7.9-8.4.turbidity will be 0.5-10estimated dissolved oxygen will be 4-8mg/l and nitrate level will be 0.5-5mg/l.
4. **FLOWING WATER:** The water quality assessment of flowing water is poor and ph level is 6.5-8.5.turbidity will be 5-50estimated dissolved oxygen will be 5-10mg/l and nitrate level will be 0.1-10mg/l.

5. **POND WATER:** The water quality assessment of Pond water is poor and ph level is 6.5-9.0turbidity will be 5-100estimated dissolved oxygen will be 2-10mg/l and nitrate level will be 0.1-10mg/l.
6. **ALGAE WATER:** The water quality assessment of algae water is good and ph level is 7.5-9.5.turbidity will be 50-500estimated dissolved oxygen will be 2-6mg/l and nitrate level will be 0.1-5mg/l.
7. **LAKE WATER:** The water quality assessment of Lake Water is poor and ph level is 6.5-9.0 turbidity will be 1-50estimated dissolved oxygen will be 5-15mg/l and nitrate level will be 0.1-5mg/l.
8. **TAP WATER:** The water quality assessment of Tap water is good and ph level is 6.5-8.5.turbidity will be 0.1-1estimated dissolved oxygen will be 7-10mg/l and nitrate level will be 0.1-5mg/l.
9. **PURE WATER:** The water quality assessment of Pure water is good and ph level is 7.0 .turbidity will be 0.01-0.1 estimated dissolved oxygen will be 8-10mg/l and nitrate level will be <0.1mg/l.

The parameters to measure the water quality is as follows:

1. PH Level: pH is a measure of how acidic/basic water is. The range goes from 0 – 14. The MATLAB function such that pH = (hue_img * 10) - 5; where hue_img represents a matrix containing the hue values of an image. Hue is a color attribute that describes a pure color, such as red, yellow, or blue.

2. Turbidity: Turbidity measures water cloudiness caused by suspended particles. The MATLAB function calculates turbidity by analyzing the intensity of light transmitted through a water sample. Higher turbidity indicates more particles, suggesting poorer water quality. The MATLAB function turbidity = (255 - gli) / 255 * 100; where gli represented mean value of gray scale image.

3. Dissolved Oxygen: Measure of oxygen dissolved in water, essential for aquatic life and the Units are milligrams per liter (mg/L), parts per million (ppm), or percent saturation (%). The MATLAB function represented as Do = (255 – mean (red_img (:))) / 255 * 10; where red_img represents the grey scale image.

4. Estimated Nitrate: It is a common water pollutant, essential for plant growth, but excessive levels harmful to humans and aquatic life. The MATLAB function is given as nitrite = (255 – mean (blue_img (:))) / 255 * 5; where blue image is the blue channel extraction of grey scale image.

Table 1: Water quality estimation of various water samples

SL No.	Type of water sample	Estimated pH level	Estimated Turbidity	Estimated Dissolved Oxygen	Estimated Nitrate
01	Detergent water	7.18	160.72	7.88MG/L	7.28 MG/L
02	Algae water	6.71	84.73	6.91 MG/L	9.75 MG/L
03	Saltwater	7.63	171.65	8.03 MG/L	9.79 MG/L
04	Tap water	6.72	139.69	7.63 MG/L	4.95MG/L
05	Flowing water	7.60	167.12	7.97 MG/L	9.82 MG/L
06	Mud Water	6.62	125.06	7.44 MG/L	5.67 MG/L
07	Lake water	6.98	180.75	8.11MG/L	4.85MG/L
08	Pond Water	6.92	159.59	7.85 MG/L	9.74 MG/L
09	Pure water	7.00	129.03	8.00MG/L	5.00MG/L

IV.CONCLUSION:

This study explored the potential of image processing techniques in MATLAB to estimate water quality parameters. In this work, the visual features and correlated image characteristics with parameters like pH, turbidity, dissolved oxygen, and nitrate were experimented successfully. The various water types, including detergent, algae, salt, tap, flowing, pure, and lake water was evaluated. However, the encountered challenges in obtaining accurate results for highly turbid water samples, such as wastewater and muddy river water was getting proper results. In the future work, will focus on improving accuracy, especially for turbid water, exploring advanced techniques like deep learning, and validating our findings through field studies. Additionally, we will integrate image-based sensors with traditional methods, develop cost-effective systems, and investigate other relevant water parameters.

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