Design and Development of System for Water Quality Monitoring

A PROJECT REPORT

Submitted in partial fulfillment of the requirements for the award of degrees of

MASTER OF TECHNOLOGY
In
CONTROL AND INSTRUMENTION ENGINEERING

By
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CERTIFICATE

This is to certify that the project titled **“Design and Development of System for Water Quality Monitoring”** being submitted to the Indian Institute of Technology Madras by **Nenavath Veerendra Naik (EE18M091)**, in partial fulfilment of the requirements for the award of the degrees of **Master of Technology in Electrical Engineering** is a bonafide record of work carried out by **him/her** under my supervision. The contents of this project report, in full or in parts, have not been submitted to any other institute or university for the award of any degree or diploma.

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ABSTRACT

Water is essential to human life and the health of the environment. Water quality is important not only to protect public health, water provides ecosystem habitats, is used for farming, fishing and mining, and contributes to recreation and tourism. Water quality issues influence human and environmental health, so the more we monitor our water the better we will be able to recognize and prevent contamination problems.

Monitoring your water quality by having it tested regularly is an important part of maintaining a safe and reliable source. Testing the water allows a knowledgeable approach to address the specific problems of a water supply. Monitoring helps ensure that the water source is being properly protected from potential contamination, and that an appropriate treatment system is selected and is operating properly. This will assist you in making informed decisions about your water and how you use it, ensure you are using water suitable for your intended agricultural use, ensure that your drinking water is safe, and help determine the effectiveness of your water treatment system. The system can provide useful information regarding hazardous agents and waterborne pathogens contaminants of household drinking water raising awareness and encourage better water-handling. A design is proposed to address such issues. The output specifies the quality of water and turbidity. A prototype of the design has been developed and tested in the laboratory. Test results validate the efficacy of the technique presented.

Such a system can be used at both industrial level as well as household level. Ensuring the user is aware of the type of water by its turbidity is the aim of this project. Since it is cost effective and easy to use such a model can be applied to a larger extent.

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ABBREVIATIONS

NTU Nephelometric Turbidity Unit

UF   Ultra Filtration

JTU   Jackson Turbidity Unit

CHAPTER 1

INTRODUCTION

1.1 MOTIVATION

Nowadays water pollution is one of the biggest fears for the green globalization. In order to make certain the safe supply of the drinking water the quality needs to be monitored. Turbidity is an extremely useful indicator that can capitulate valuable information quickly, relatively cheaply and on an ongoing basis. Measurement of turbidity is applicable in a variety of settings, from low-resource small systems to the large system and sophisticated water treatment plants. This measurement also makes the quality of water in a storage tank be monitored so that the user is aware of the changes in conditions inside the tank and at treatment plant level this system can provide information regarding the water turbidity and subsequent sorting and treatment.

1.2 PROBLEM STATEMENT

Design and Development of an IOT Based Water Quality Monitoring System that could provide reliable information to the user.

1.2.1 OBJECTIVE

To be able to identify and classify samples of different turbidity values so as to facilitate sorting for their respective treatment procedures and quality monitoring.

1.2.2 SCOPE

There can be any kind of intrusion in between treatment plant and end consumers due to various reasons. The system when interfaced with household water tanks it can serve as an entry check to ensure if the incoming water is safe enough for use or if there is any sort of contamination. At the industrial level the system can be utilized for monitoring and sorting purposes as well.

1.2.3 PRINCIPLE

WATER QUALITY IS ANALYSED BASED ON TURBIDITY AS PARAMETER.

The project deals with design and development of an IOT based water quality monitoring system. Its operation is based on the principle that the intensity of the light scattered by the suspended matter is proportional to its concentration.

1.3 NEED FOR SUCH A SYSTEM

This sensor can be used as a part of a low cost sensor network consisting of different types of sensors (pH, temperature, chloride, etc.) to provide water quality information to consumers. Fusing on-line multi sensor measurements, the system can provide useful information regarding hazardous agents and waterborne pathogens contaminants of household drinking water raising awareness and encourage better water-handling.

The system is suitable from a simple household storage tanks to well-built water treatment plants. It provides information about the current health of the water body, whether the water meets the designated use and how it has changed over time. Information gathered can be used to suggest that the water body requires improvement to meet its designated use and lead to actions to protect and restore the health of the water body. In addition, water quality monitoring can help with water pollution detection, discharge of toxic chemicals and contamination in water. One of the reasons for this is unawareness in public and administration and the lack of water quality monitoring system which creates serious health issues. As water is the most important factor for the green globalization it is necessary to protect it and water quality analysis is first step taken in rational development and management of water resources.

1.4 CHALLENGES

The system helps to understand if water supplied is safe for drinking or not in a region. But the system works well under static conditions. When there is continuous flow of water the readings would vary fast enough that the user might not be able to capture the small irregularities in the measurement.

CHAPTER 2

LITERATURE SURVEY

2.1 BACKGROUND

2.1.1 THEORY OF SCATTERING

A directed beam of light remains relatively undisturbed when transmitted through completely pure water, but even the molecules in a pure water will scatter light to a certain degree. Therefore, the solution will have a certain turbidity. In samples holding suspended solids, the manner in which the sample interferes with light transmittance is related to the size, shape and composition of the particles in the solution and to the wavelength (colour) of the incident light.

Effect of size of the particle and wavelength of the incident light on scattering:

a. Large particles scatter long wavelengths of light more effectively than they scatter short wavelengths.

b. Small particles scatter short wavelengths of light more effectively than large particles but have less effect on the scatter of longer wavelengths.

Three main theories are discussed: Rayleigh theory, Mie theory and Geometric optics.

Rayleigh scattering: for particles up to size of 1/10th of the wavelength [1]. Local E field produced by the wave is approximately uniform at every instant. E field produces dipole in a particle, since the E oscillates dipole oscillates and thereby radiating in all directions. When a particle is extremely smaller than the beam of light, the scattering is fairly symmetrical in all directions.

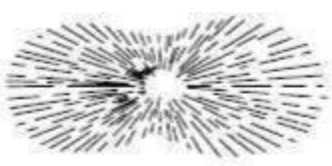

Fig 2.1: scattering by a smaller particles [2]

If the wavelength of light doubles, the scattering efficiency decreases by a factor of 16. Thus, 450-nm wavelength will scatter 16 times more than 900-nm wavelength interacting with the same particle. Light intensity at right angles is half the forward scattered light. When particles size exceeds 10% of the wavelength of light then this theory does not work and Mie theory is applicable.

Mie scattering [1]: Intensity of light is strongly dependent on size of particle than the wavelength. The spatial distribution of scattered light depends on the ratio of particle size to wavelength of incident light. The larger the particle becomes, however, the more light that will be scattered forward. However scattering in this range of particle sizes vary from Rayleigh scattering in several respects: it is roughly independent of wavelength and it is larger in the forward direction than in the reverse direction.

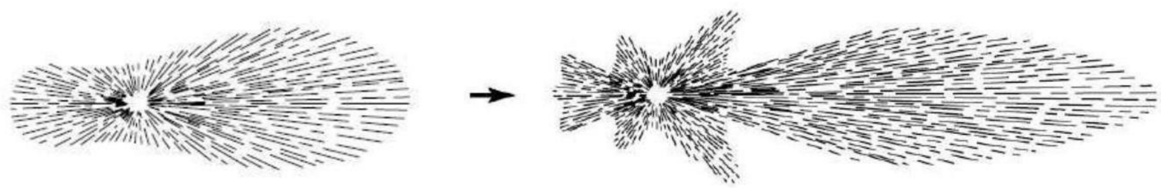

Fig 2.2: scattering by larger particles [2]

As particle sizes increase in parallel to wavelength, light scattered from different points of the sample particle create interference patterns that are additive in the forward direction. This constructive interference results in forward-scattered light of a higher intensity than light scattered in other directions. Hence in larger particles (larger than the wavelength of light) scattering in extremely concentrated in forward direction [3][4]. Therefore placing the receiver at an angle of 90° respect to the emitter will reduce the effect of the particle size. Hence providing sensitivity to a broad range of particle sizes.

Geometric optics theory: otherwise known as ray optics [1], describes the light traversing a medium in terms of a straight path (hence 'ray'). It explains refraction, in which there is a change in direction of a light ray at interface between two regions with differing refractive indices. It also accounts for reflection and absorption, and is best applied in situations where the wavelength of light is much less than the size of the scattering particle.

2.1.2 EXISTING TECHNOLOGIES

The light produced from the interaction of the incident light and the sample volume will be detected by the photo detectors and as a result the electronics signal produced is then converted to a turbidity value. The location of the detector in the turbidimeter varies according to the design configuration of the instrument.

2.2 MONITORING TECHNOLOGIES

It is important to understand that samples with different characteristics such as particle absorption, refractive index, size and size distribution will interact differently with the wavelengths of different light sources. Thus, different turbidity measurement technologies often deliver different results on the same sample volume.

Turbidimeters involve a light source one or more detectors with a specific orientation to one another. The vast number of turbidity monitoring technologies can be categorized by three design criteria [3][4]:

a) The type of incident light source used
b) The detection angle for the scattered light
c) The number of scattered light detectors used.

Three **types of light sources** are commonly used in turbidimeter:
Incandescent, Light emitting diode (LED), and Laser diodes [4].

Incandescent light sources are typically polychromatic with filaments with a colour temperature of 2200 to 3000º Kelvin and emit relatively short wavelengths. These shorter wavelengths will be more effectively scattered by smaller particles. Those methods that are typically compliant to USEPA Method 180.1 or Standard Methods 2130B will utilize an incandescent light source.

Common infrared LEDs(IR) light sources are lower energy emitting light sources when compared to tungsten filament lamps. The most common wavelengths used in turbidity measurements emit 830 – 890nm light that is typically not absorbed by visible colour in the sample, thus eliminating a common error source in most turbidity measurements. The

International Standardization Organization (ISO) method 7027 requires the use of a light source in this range. However, this technology does not provide enough sensitivity to detect ultra-low turbidity changes in membrane effluent water.

Laser-based light sources: A small portion of turbidity measurement techniques will have laser based incident light sources that emit energy at a discrete wavelength. Laser-based light sources are vary sensitive to small changes in turbidity and are often used to monitor filtration performance for clean waters, such industrial processes requiring ultrapure water.

The **detection angle** is formed between the centerline of the incident light beam and the centerline of the detector's receiving angle.

A **90-degree** detection angle is often referred to as the nephelometric detection angle and is the most common detection angle because of its sensitivity to a broad range of particle sizes [4].

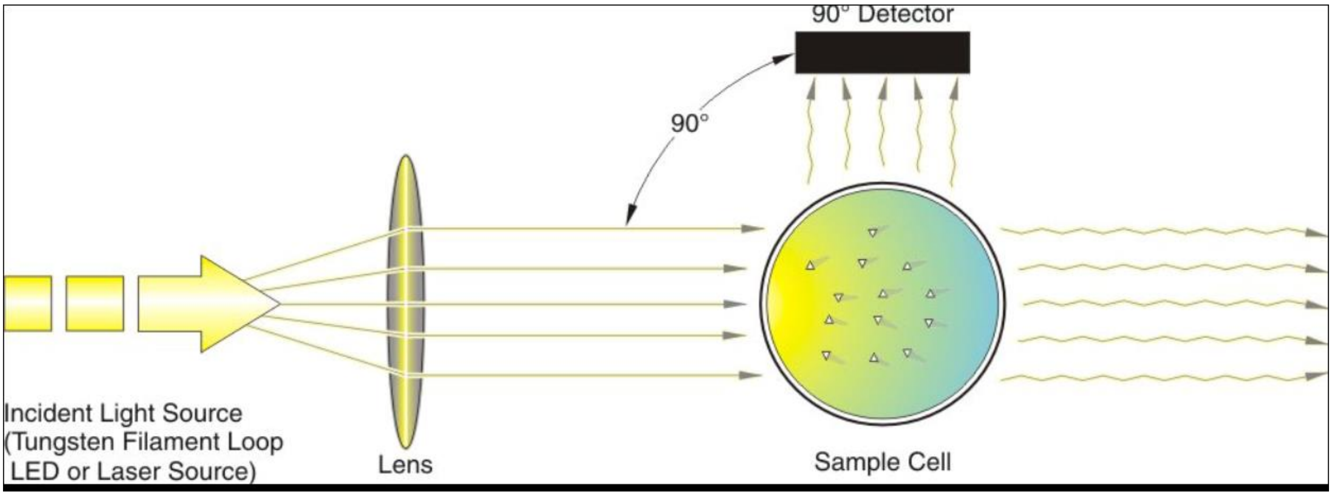

Fig 2.3: optical geometry required for basic nephelometric turbidity measurement [4]

The attenuated detection angle is **180-degrees** relative to the incident light beam so it measures the attenuation of the incident light beam due to both light transmission and absorption.

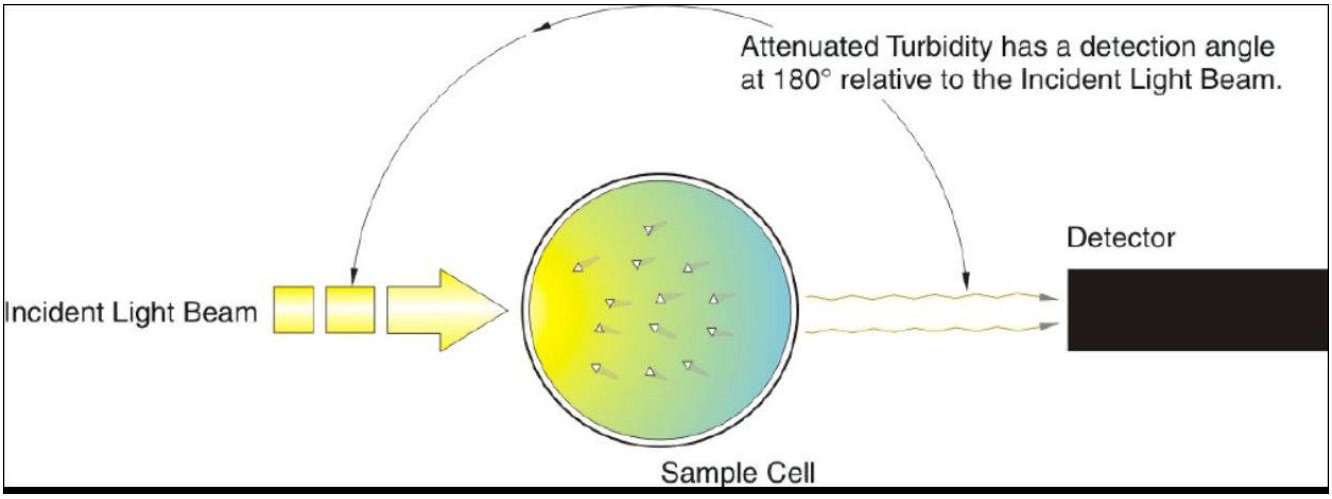

Fig 2.4: optical geometry for attenuated turbidity measurement [4]

The **backscatter detection angle** uses a detector that is geometrically cantered at an angle of between 0- and 45-degrees relative to the directional centerline of the incident light beam. This angle is sensitive to light that is reflected in the direction of the incident light source, which is characteristic of extremely high turbidity samples. The 90° detection angle is considered to be the most sensitive angle to measure scattered light and it is recognized by EPA (Environmental Protection Agency) Method 180.1 [5].

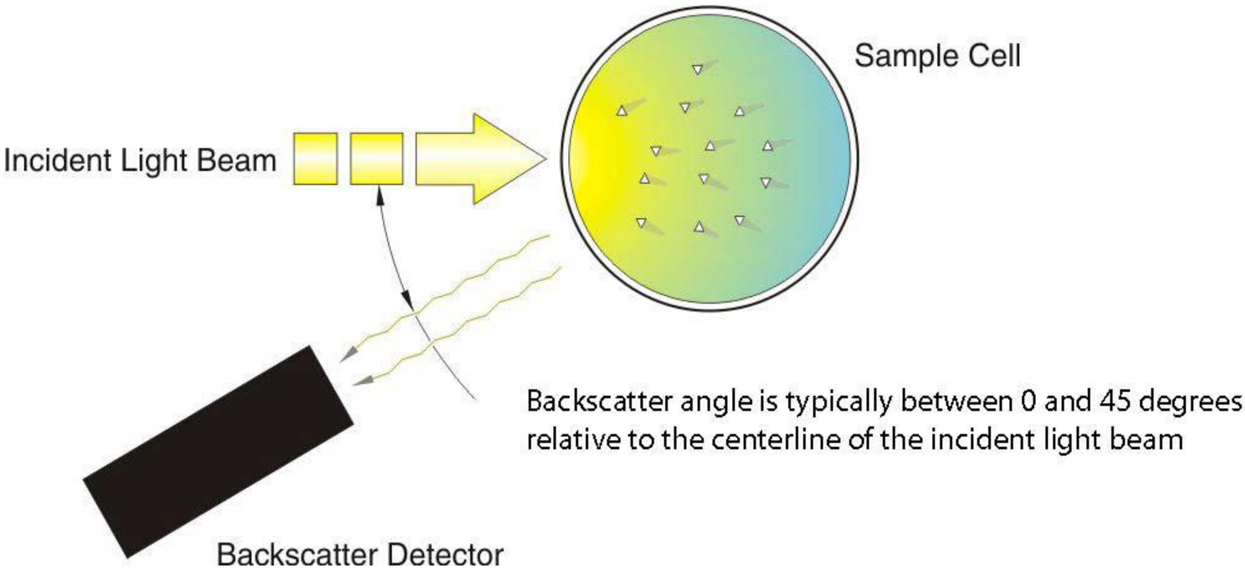

Fig 2.5: backscatter measurement system [4]

Multiple detection angles [4] is ratioing approach will utilize one primary detector, which is typically oriented at a 90 degree angle relative to the incident light beam, and it is often referre to as the primary nephelometric detector. Other detectors will be at various angles including an attenuated, and forward scatter angles. A software algorithm is often used to produce the turbidity measurement from the combination of detectors. These detectors can help compensate for colour interference and in optical changes such as light source degradation.

Dual light source, dual detector measurement technologies use a combination of light sources that are geometrically oriented at 90-degree angles to each other. The detectors are also oriented at 90-degrees to each other and at 90- and 180-degrees to each of the light sources. These different combinations of optical elements provide a turbidity measurement that is compensated for colour, absorption, fouling of the optics, and any optical changes that can occur.

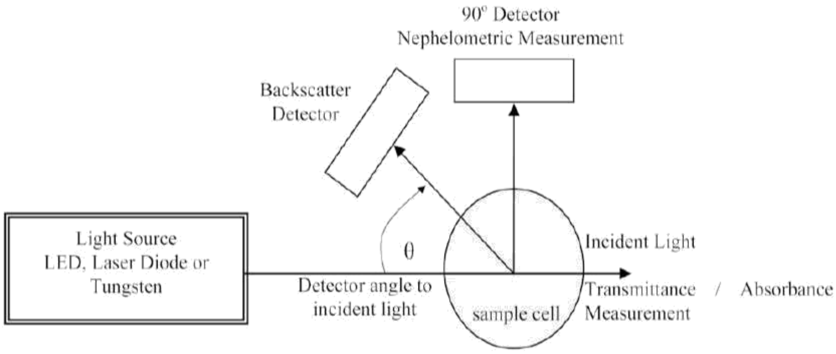

Fig 2.6: configurations for measuring turbidity [6]

Absorbance A = - log (I/Io) = ε * C * L

I = Intensity of incident light, Io = Intensity of transmitted light ε = Molar absorptivity (L/mol/cm), C = Concentration of solution (mol/l) L = Optical path length (cm)

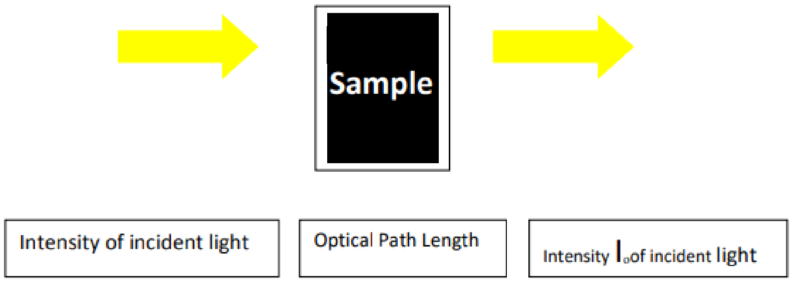

Fig 2.7: configurations for passing light

2.3 METHODS TO MEASURE TURBIDITY

Nephelometry and Turbidimetry [1]

Turbidity is caused by suspended and colloidal particles in water. Particles can be inorganic and organic: clay, silt, mud, silica, rust, calcium carbonate, algae, bacteria, organic material. The particles absorb and scatter light.

In Turbidimetry, light transmitted through the sample is measured.

In Nephelometry, light scattered by suspended particles in a sample is measured. It is more sensitive for very dilute suspensions. The analytical methods employ common electric photometers that can measure light intensity. The turbid meter or nephelometer mainly consists of four parts – light source, optical components (e.g. slit), and sample compartment and a photocell for the measurement of light either transmitted through the sample or scattered from the suspended particles in the sample. The photocell detects light and an electronic amplifier measures the light intensities.

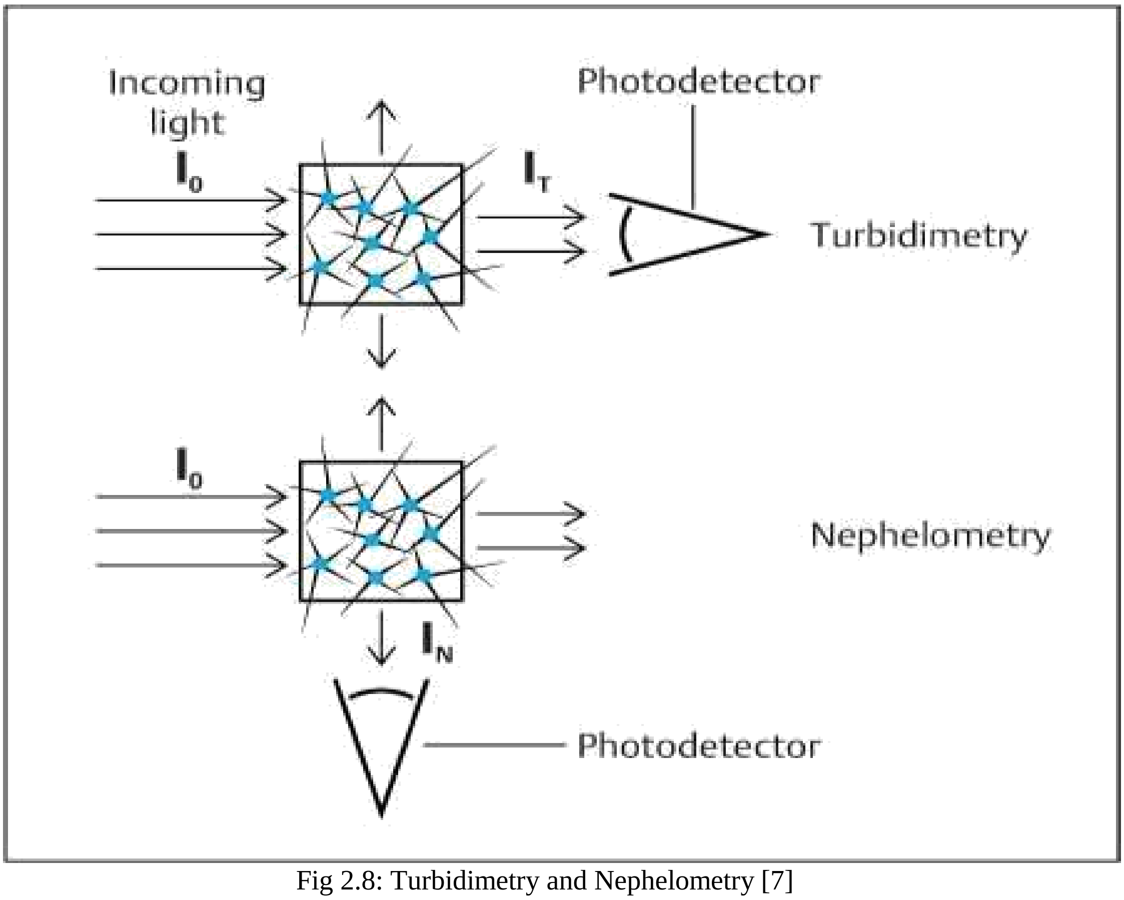

Fig 2.8: Turbidimetry and Nephelometry [7]

2.4 STANDARDS AND UNITS

2.4.1 Turbidity Units

The standard Turbidity unit is called Nephelometric Turbidity Unit (NTU) because of the use of nephelometric method of measurement. The NTU has generally replaced the previous unit of ‘Jackson candle turbidity units (JTU) [8] [13].

2.4.2 Typical Turbidity Values for different waters

Drinking water quality standards are determined according to World Health Organization [9] guidelines for drinking-water quality as well as other relevant organizations (i.e. EU, USEPA). These organizations set the standards for drinking water quality parameters and indicate which microbiological, chemical and indicator parameters must be monitored and tested regularly in order to protect the health of the consumers and to make sure the water is healthy and clean.

Type of water	NTU
Very bad water (Rainy season)	20 and above
Bad water	10 to 20
Tap water	1 to 10
Drinking water	1 or less

Table 2.1: Types of water and their turbidity

A Turbidity of 1 NTU for drinking water is accepted and above 5 NTU consumer acceptance decreases [10]. Turbidity may change during sample transit and storage.

2.5 WATER QUALITY ANALYSIS AND MONITORING

Theofanis P. Lambrou and Christos G. Panayiotou in the paper ,"A Low-Cost System for Real Time Monitoring and Assessment of Potable Water Quality at Consumer Sites"[11] discussed of the design of a low cost water quality monitoring system. Based on selected parameters a sensor array is developed along with several microsystems for analog signal conditioning, processing and remote presentation of data. Finally, an algorithm for fusing on-line multi sensor measurements is developed to assess the water contamination risk. Such implementation is suitable for large deployments enabling a sensor network approach for providing spatiotemporally rich data to water consumers, water companies and authorities.

Divya Bhardwaj and Neetu Verma in their journal,"Research Paper on Analysing impact of Various Parameters on Water Quality Index"[12] mentioned about various parameters such as pH, electrical conductivity, turbidity and dissolved oxygen that effect the water quality index. Apart from discussing the effect of such parameters on water quality, the specifications for these parameters to be suitable for agricultural needs, industrial use, aquatic organisms and drinking purposes are also studied in order to provide quality information regarding the water available.

Óscar Sampedro, José Ramón Salgueiro in the article titled,"Turbidimeter and RGB sensor for remote measurements in an aquatic medium" [13] proposed a design of turbidimeter with nephelometer method to analyse the quality of water over a time period. The calibration for temperature, turbidity (to relate signal output to turbidity scale) and RGB (to relate output signal to the colour of the sample). The turbidimeter was tested during two months offshore in a bay of north western Spain obtaining a periodic turbidity daily signal from the water. On the other hand, the RGB sensor pointed out that the marine suspended particles were primarily green. These data demonstrated that the apparatus detected the dial vertical migration of phytoplankton.

2.6 GOVERNMENT OBSERVATION

TABLE-2.6.1: TECHNOLOGIES AVAILABLE

Available Technologies	Parameters Measured	Applications
UV Spectrophotometry (Single wavelength)	COD, BOD	Fresh Water analysis with constant matrix in water source
UV-Vis Spectrophotometry 40 wavelength	COD, BOD, TSS	Fresh Water & Waste Water analysis with Constant matrix in water source
UV-Visible Spectrophotometry (Single Beam)	COD, BOD, TSS	Fresh Water & Waste Water analysis without interference check and compensation
UV-Vis Spectrophotometry (Double beam with entire spectrum scanning)	COD, BOD, TSS	Fresh water to Waste water analysis Interference check for colour and turbidity and compensation.
Combines Combustion Catalytic Oxidation at 680°C and NDIR Method	TOC (Co-relation with BOD & COD)	Fresh Water and Waste Water analysis
UV Persulfate NDIR Detector	TOC (Co-relation with BOD & COD)	Fresh Water and Waste Water analysis
Persulfate Oxidation at 116-130degC NDIR Detector	TOC (Co-relation with BOD & COD)	Fresh Water and Waste Water analysis
Persulfate Oxidation at 116-130degC NDIR Detector	COD	Fresh Water and Waste Water analysis
Measuring COD using Potassium dichromate(K2Cr2O7) + Calorimetric	COD	Fresh Water and Waste Water analysis
Measuring COD using Potassium dichromate(K2Cr2O7) + Potentiometric Titration	pH	Fresh Water and Waste Water analysis
Electrode /Potentiometric method	TSS	Fresh Water and Waste Water analysis
Nephelometry Method	TSS	Fresh Water & Less turbid water analysis

Colorimetric (645-655nm)	NH3	Process stream & Waste Water analysis. Turbidity interference is there which can be overcome
Ion Selective Electrode method With temp correction	NH3	Process stream & Waste Water analysis. Turbidity interference is there which can be overcome
UV Absorbance or Multiple Wavelength UV Absorbance Spectrophotometers (200- 450nm)	NH3	Process stream & Waste Water analysis. Turbidity interference is there which can be overcome
Colorimetric method Reaction of Cr-VI with diphenyl carbazide in acid solution	Chromium	Fresh Water & Waste Water analysis.
Voltammetry (Anodic Stripping Voltammetry)	Chromium	Fresh Water analysis.
Dual Beam UV-Visible Spectrophotometry	Chromium Hexavalent and Trivalent	Fresh water & waste water analysis.
Voltammetry (Anodic Stripping Voltammetry)	Arsenic	Fresh Water analysis.

TABLE-2.6.2: SUITABILITY OF TECHNOLOGIES FOR DIFFERENT MATRICES

Available Technologies	Parameters Measured	Application	Limitations
UV Spectrophotometry (Single/two/four wavelengths)	COD, BOD	Fresh Water analysis with constant matrix	Suitable for fresh water and not for waste water analysis. Interference of colour & high turbidity. Suitable for stable matrix. Single bond organic compounds are not measured
UV-Vis Spectrophotometry 40 wavelength	COD, BOD, TSS	Fresh Water & Waste Water analysis with constant matrix	Many organic compounds are unattended due to lesser scanning of UV spectra.

			Suitable for stable matrix. Any matrix change would require revalidation of factor. Sample pumping limitation.
UV-Visible Spectrophotometry (Single Beam)	COD, BOD, TSS	Fresh Water & Waste Water analysis.	Interference due to colour & high turbidity affects the analysis. Reference beam compensation not available. Suitable for stable matrix. Any matrix change would require revalidation of factor.
UV-Vis Spectrophotometry (Double beam with entire spectrum scanning)	COD, BOD, TSS	Fresh Water & Waste Water analysis.	Interference of colour & turbidity is compensated in visible spectrum. Any matrix change would require revalidation of factor
Combines Combustion Catalytic Oxidation at 680°C and NDIR Method	TOC (Co-relation with BOD & COD)	Fresh Water & Waste Water analysis.	-Carrier gases required -Continuous High power requirement -For Analyser: Infrastructure is required -More than 10-15 minutes sampling frequency. -Only TOC can be measured. -Any matrix change requires fresh correlation to COD & BOD

UV Persulfate NDIR Detector	TOC (Co-relation with BOD & COD)	Fresh Water & Waste Water analysis.	-Carrier gases required -Continuous High power requirement -Analyser: Infrastructure required. -More than 10-15 minutes sampling frequency. -Only TOC can be measured. Any matrix change requires fresh correlation to COD & BOD.
Per sulphate Oxidation at 116- 130degC NDIR Detector	TOC (Co-relation with BOD & COD)	Fresh Water & Waste Water analysis.	Applicable for moderate polluted effluent. -Carrier gases required -Analyser: Infrastructure required Any matrix change requires fresh correlation to COD & BOD
Measuring COD using Potassium dichromate(K2Cr2O7) + Calorimetric	COD	Fresh Water & Waste Water analysis.	Discharge of hazardous chemicals
Measuring COD using Potassium dichromate(K2Cr2O7) + Potentiometric Titration	COD	Fresh Water & Waste Water analysis.	-Auto feeding of reagents -Discharge of chemical --One sample takes about 30 min. -Sample measured during change of matrix
Electrode /Potentiometric method	pH	Fresh Water & Waste Water analysis.	--Electrode life

Scattered Light Method (IR)	TSS	Fresh Water & Waste Water analysis.	--
Nephelometry Method T	TSS	Fresh Water & Less turbid analysis.	Fresh Water analysis with Low turbidity
Colorimetric (645-655nm)	NH3	Fresh Water & Waste Water analysis.	Turbidity interference is there which can be overcome. 3-15 min cycle time
Ion Selective Electrode method With temp correction	NH3	Fresh Water & Waste Water analysis.	Interference from Potassium. Requires additional measurement of potassium for compensation.
UV Absorbance or Multiple Wavelength UV Absorbance Spectrophotometers (200-450nm)	NH3	Fresh Water & Waste Water analysis.	Turbidity interference is there which can be overcome.
Colorimetric method Reaction of Cr-VI with diphenyl carbazide in acid solution	Chromium	Fresh Water & Waste Water analysis.	Experience in Indian condition is not available
Voltammetry (Anodic Stripping Voltammetry)	Chromium	Fresh Water analysis.	Experience in Indian condition is not available.
Dual Beam UV-Visible Spectrophotometry	Chromium Hexavalent and Trivalent in full spectrum	Fresh water & waste water analysis.	Experience in Indian condition is not available
Voltammetry (Anodic Stripping Voltammetry)	Arsenic	Fresh Water analysis.	Experience in Indian condition is not available

CHAPTER 3

EXPERIMENTAL SET UP

The circuit is designed using near infrared laser source with peak emission wavelength at 650 nm.

3.1 SYSTEM ARCHITECTURE

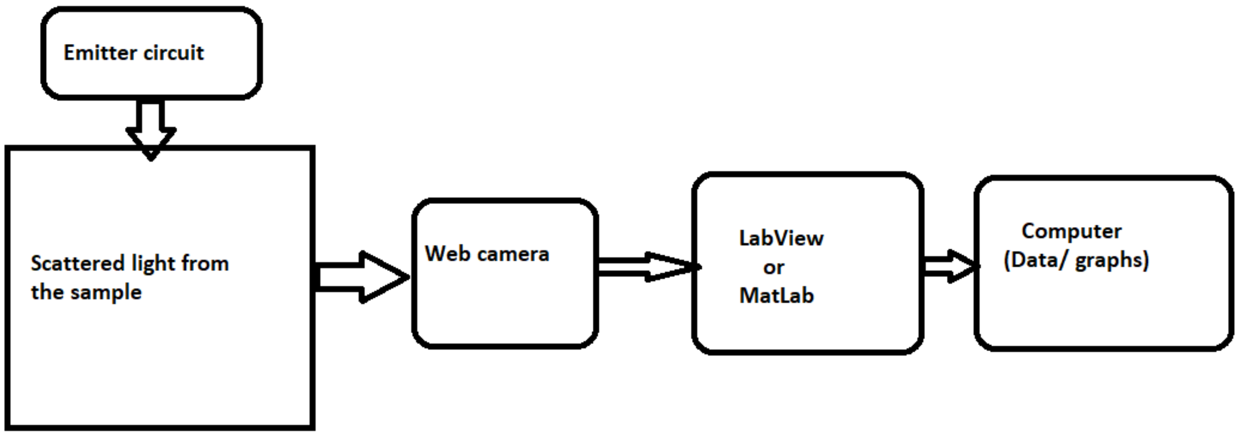

Fig 3.1: system architecture

The light comes from emitter circuit and is scattered by the sample present in the tube. The scattered light is captured by the Webcam which processed in LabView / MatLab gives the value and appropriate data graph.

3.2 WORKING OF THE MODEL

The light emitted from the laser passed through the sample. The scattered light from the particles inside the sample responsible for the turbidity is then captured by the WebCam and extracted RGB values through Labview. Thereafter the results can be shown in the computer.

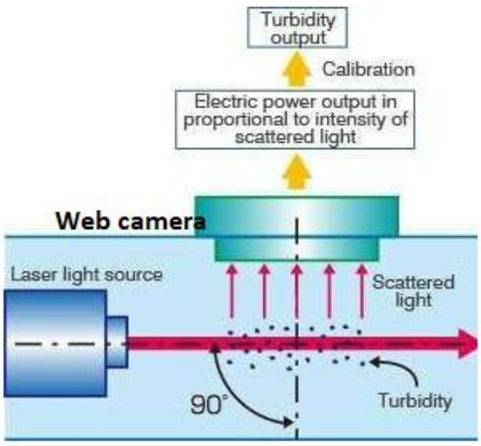

Fig 3.2: working of the model [3]

Unlike the commercially available turbidity meters, which are relatively expensive and bulky, the proposed device is small-sized, low power, table-top set up(presently), lightweight, easy to use and inexpensive. Laboratory tests of the device have yielded satisfactory repeatability and precision.

3.3 LABVIEW MODULE

The light comes from emitter circuit and is scattered by the sample present in the tube. The scattering light captured by Webcam and its processed through the image acquisition. By using vision assistant to get the RGB matrix values and the matrix values converted to an array that represent the suspended particles presented in the sample its gives turbidity values.

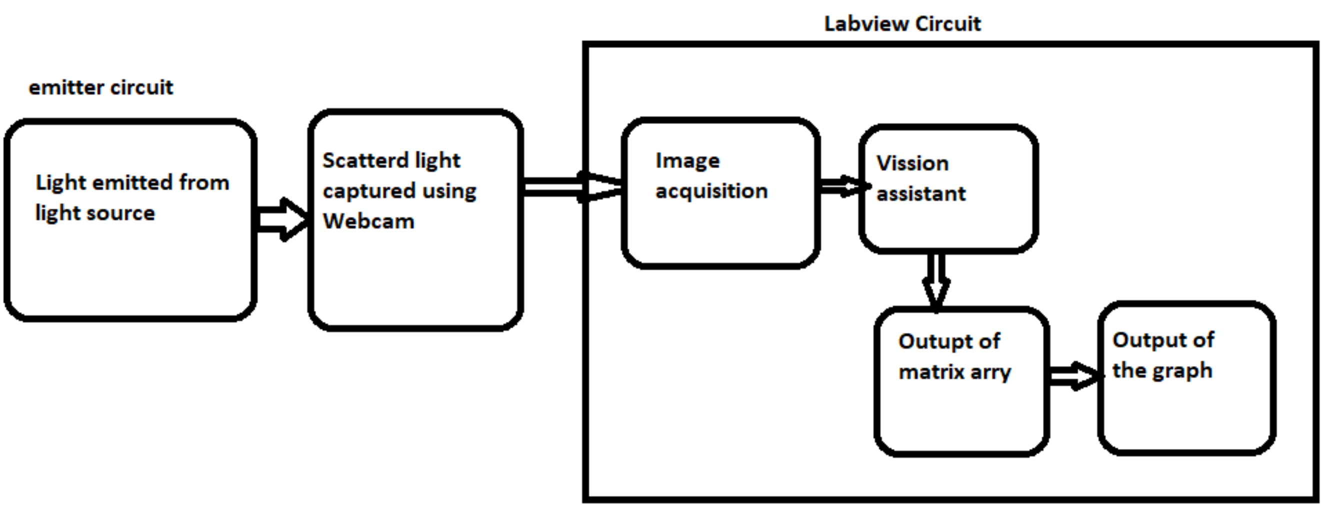

Fig 3.3: configuration of Labview circuit model

Image acquisition: is the recreation of digitally encoded representation of the visual characteristics of an object, such as a physical scene or the interior structure of an object.

Vision assistant: is extract a colour plane (RGB colour) from an image and it gives array values of an intensity of colour in the image.

Output of matrix or graph: It shows array output of the intensity of colour in the image.

3.4 MATLAB MODULE

The scattering light captured by Webcam and open an image path file in Matlab to get the RGB matrix values. And then open the matrix values in Microsoft excel to get the RGB values it gives the turbidity value of suspended particles in the sample.

Fig 3.4: experimental setup

Fig 3.5: test tube with pure water

Fig 3.6: test tube with colour added water

CHAPTER 4

READINGS AND RESULTS

4.1 OUTPUT

Scattering intensity of particles decrease from top to bottom of test tube.

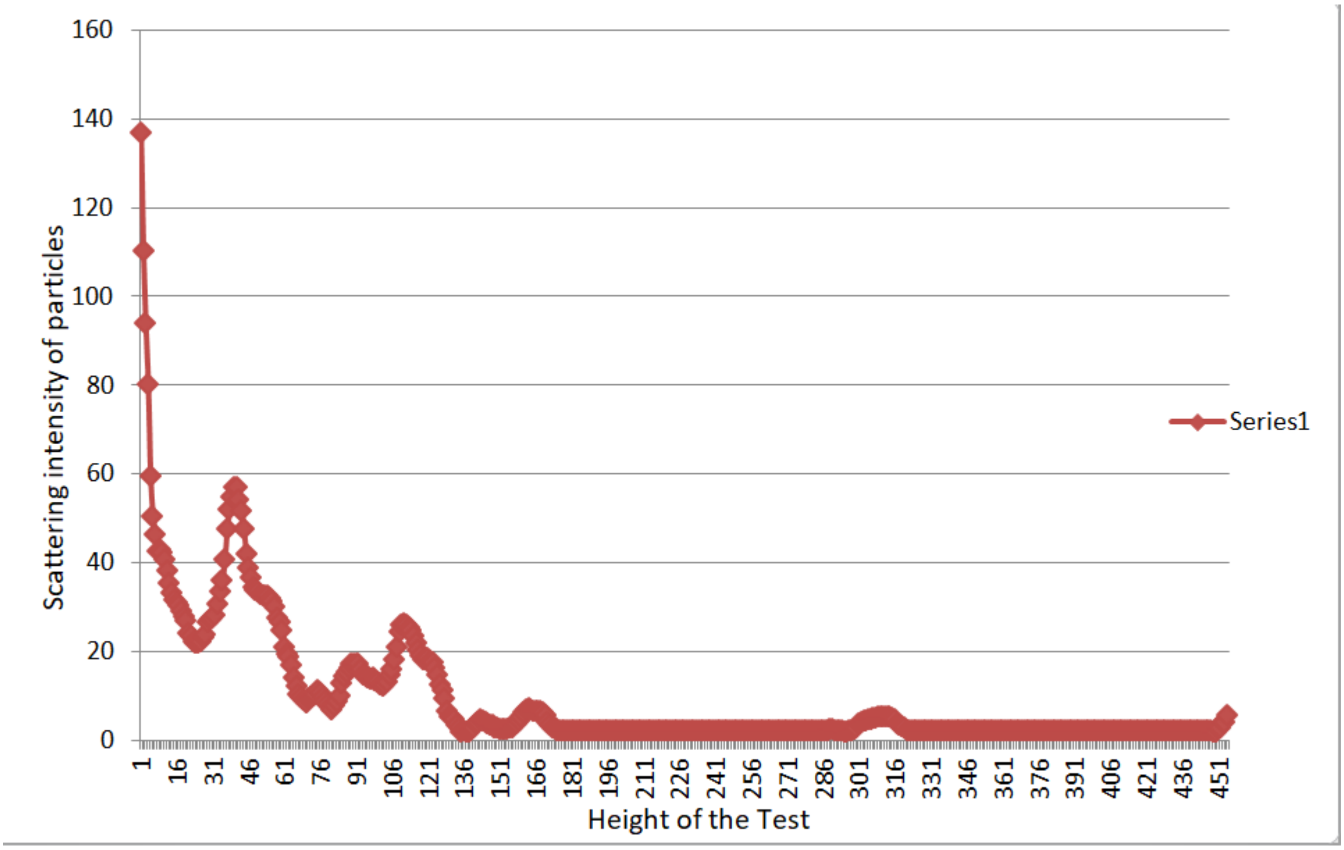

Fig 4.1: output of the pure water

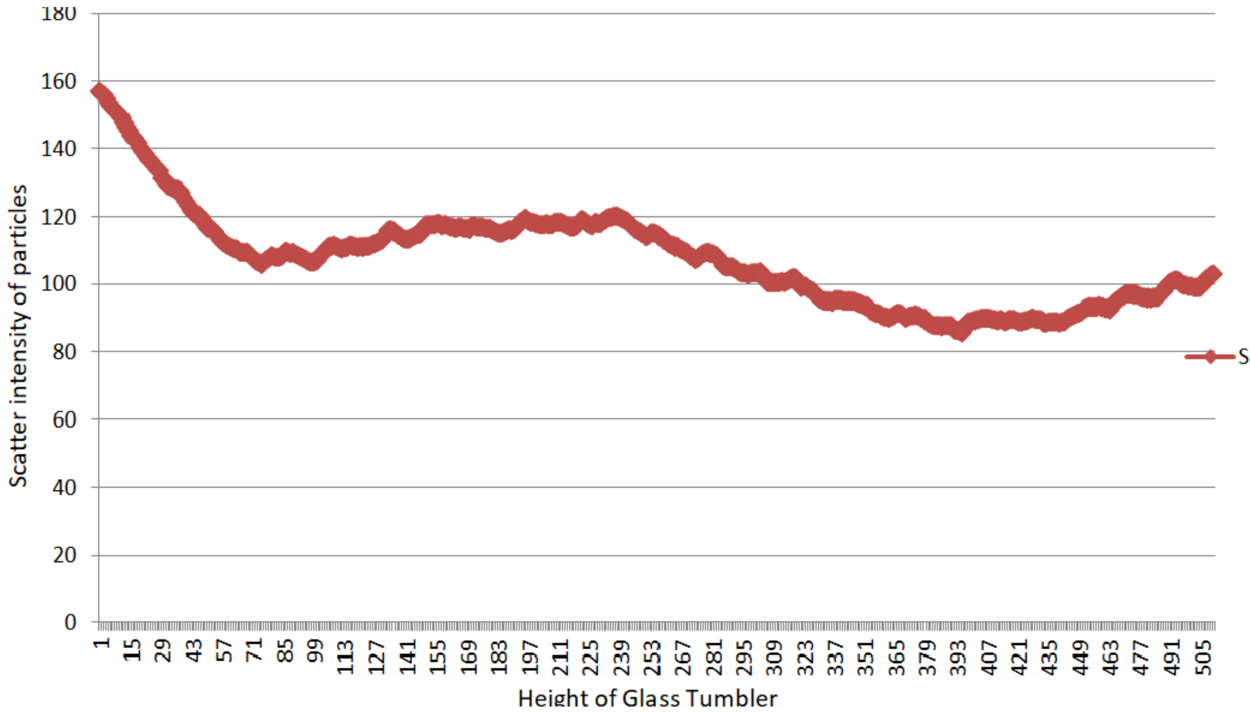

Fig 4.2: output of the colour added water

CHAPTER 5

CONCLUSION

5.1 CONCLUSION

The samples using the nephelometric method were successfully distinguished into different classes and the turbidity of the samples were predicted. The construction materials are easily obtainable. This system can be used as a part of a low cost network to provide water quality information to consumers. If installed at the consumer end will provide water quality information to the user both at industrial and household levels.

Further, the model can be made to transmit the readings to a remote server so that the user can have access to them from anywhere and anytime. It would be extremely useful, if a real-time turbidity monitoring system could be installed to act as a type of "early warning system" for possible potable water quality deterioration at homes. For such a system to be implementable though, turbidity systems that are cheap, easy to install and use, and could have capabilities of sending information to a central data logging and processing facility would be essential. Apart from considering turbidity alone as parameter to assess the water quality, alongside various other parameters like pH, electrical conductivity, dissolved oxygen etc., can also be included.

The paper distinguished between Matlab or Labview by its operation. Labview gives the real time value data.

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APPENDIX

Matlab code for programming:

```
%display one channel only
Clear all;
A=imread('file-name.jpg');
r=A( : , : ,1 );
g=A( : , : , 2);
b=A( : , : , 3);
```

Note:

Sir, I couldn't asses or logging Labview software due to License expired. So I couldn't send the Labview result file.