Solar Powered Trash Collector and Water Quality Analyser

- A Review of a Few Research Papers and their Comparative Analysis

Presented By: -

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Research Papers taken into consideration -

1. Using a Digital Camera Combined With Fitting Algorithm and T-S Fuzzy Neural Network to Determine the Turbidity in Water

   Source:

   https://ieeexplore.ieee.org/document/8744219

   Authors :

   Sheng Liu - liurise@139.com

   Pingping Cao

   Wenzhu Zhao

   Li Shi

   Hongwen Gao

2. Automated trash collector design

Source:
https://www.researchgate.net/publication/339009377_Automated_trash_collector_design

Authors :

Hirdy Othman - hirdyothman@outlook.com

Mohammad Iskandar Petra - iskandar.petra@ubd.edu.bn

Liyanage Chandratilak De Silva - liyanage.silva@ubd.edu.bn

Wahyu Caesarendra - wahyu.caesarendra@ubd.edu.bn

3. A Review of River Cleaning Robot Using Solar Power

Source:

https://www.journals.resaim.com/ijresm/article/view/29/24

Authors :

Kshitija A. Ingle - kshitijaingle97@gmail.com

Akash G. Bhatkar

Rahul S. Tarmale

Tejashri D. Ingle

Mohan S. Bawaskar

Mangesh J. Nemade

4. A Biological Sensor System Using Computer Vision for Water Quality Monitoring

   Source:

   https://ieeexplore.ieee.org/document/8493502

   Authors :

   En Cheng - chengen@xmu.edu.cn

   Fei Yuan

   Yifan Huang

   Xin Chen

5. Digital Image Processing Techniques for Object Detection From Complex Background Image

   Source:

   https://www.sciencedirect.com/science/article/pii/S1877705812025684

   Authors :

   R. Hussin - shidee@unimap.edu.my

   M. Rizon Juhari

   Ng Wei Kang

   R.C.Ismail

   A.Kamarudin

We analysed all the papers carefully and made a comparative study of the above cited research papers.

Using a Digital Camera Combined With Fitting Algorithm and T-S Fuzzy Neural Network to Determine the Turbidity in Water

1. GOALS:

:- To measure the **water turbidity** with **higher accuracy** than current methods and **efficiently reduce cost.**

2. ABSTRACT:

:- As a direct indicator of water quality, **turbidity** is defined as the **reduction in the transparency** of a liquid sample caused by the **presence of undissolved matter.**

:- Turbidity is also sometimes defined as sedimentological, as a measure of the **fine particulate** material that has a **relatively long suspension time** in the water column, making it both **temporally and physically distinct** from the **relatively rapid settling of coarser sediment**.

Current Trend:

-> all of the turbidity measurement methods are based on the **optical methods** including visual turbidimetry
->based on the **transmitted** and the **scattered** light, and a detection method based on the **transmission-scattering ratio.**

- low accuracy
- rough evaluation

MATHEMATICAL FORMULA 1:

The relationship between the **transmitted light intensity** and turbidity is shown:

$$I_T = I_0 e^{(-kdl)}$$

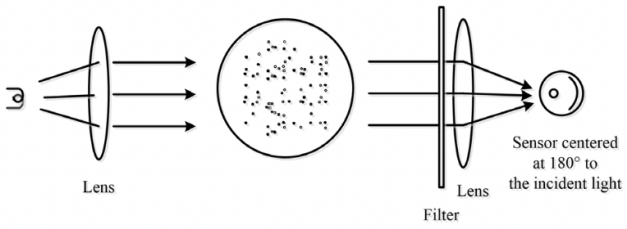


FIGURE 1. **Turbidity measurement principle based on transmission.**

- *IT* is the intensity of the transmitted light
- *I*0 is the intensity of the incident light,
- *k* is the proportional constant,
- ***d* is the solution turbidity**, and
- *l* is the transmission depth.

-> High calibration required for unknown liquids.
-> Error could occur.

MATHEMATICAL FORMULA 2:

The relationship between
the **scattered light intensity** and
the number and volume of particles per unit volume liquid
compliance with **Rayleigh formula:**

$$I_S = kI_0nV^2/\lambda^4$$

- *IS* is the light intensity of scattering,
- *k* is the pro- portional constant,
- *I*0 is the incident light intensity,
- *n* is the number of particles per unit volume in the sample,
- *V* is the volume of particles in the sample, and
- λ is the incident light wavelength

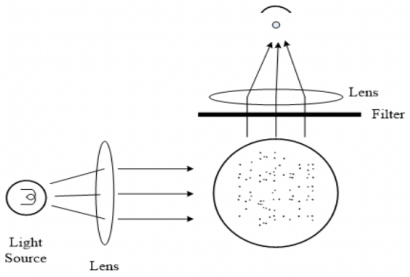


FIGURE 2. **Turbidity measurement principle based on light scattering.**

->For a high turbidity, the scattering in the optical path is very complex, and there are multiple times to scatter.
-> Impossible to accurately determine the relationship between the turbidity and light intensity
-> Hence High Error

3. PROPOSED SOLUTIONS:

Technologies Used for measuring turbidity accurately and efficiently:

- Digital Camera
- Fitting Algorithm
- TS fuzzy neural network

Flow:

->**Digital Camera**
->image of standard solution after a constant light source was passed through the sample
->**RGB** and **LAB** values corresponding to image obtained.

- Turbidity Measuring Device
- Image Processing Software,

  were made based on this.

->**Fitting Algorithm**
-> fitting the turbidity values using color component and color difference
-> standard curves were created

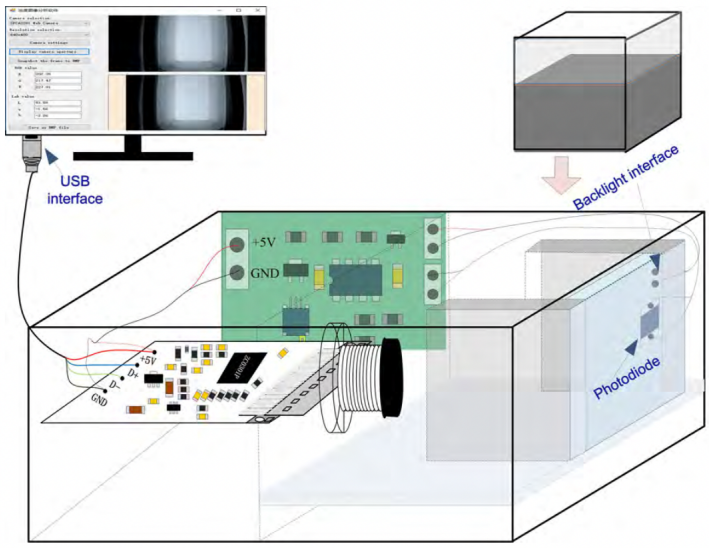
- results were compared with those of turbidimeter.
- accuracy of the fuzzy neural network method is the highest, the measurement error was only ±0.89%,
- accuracy much higher than ordinary turbidimeter

->**Fuzzy Neural Network Prediction Model**
->The RGB values as input.
->standard turbidity values as output.

The T-S fuzzy neural network is a kind of neural network with a **strong adaptive ability**, which can constantly
->modify the **membership function of the fuzzy subset**,
->make the network converge quickly, and
->establish a **non-linear data relationship model.**

4. TESTBED, PLATFORM, TOOLS:

Instrument Design:



a) constant light source circuit
b) a backlight plate :- so that the light is uniform
c) a sample slot and
d) a digital camera

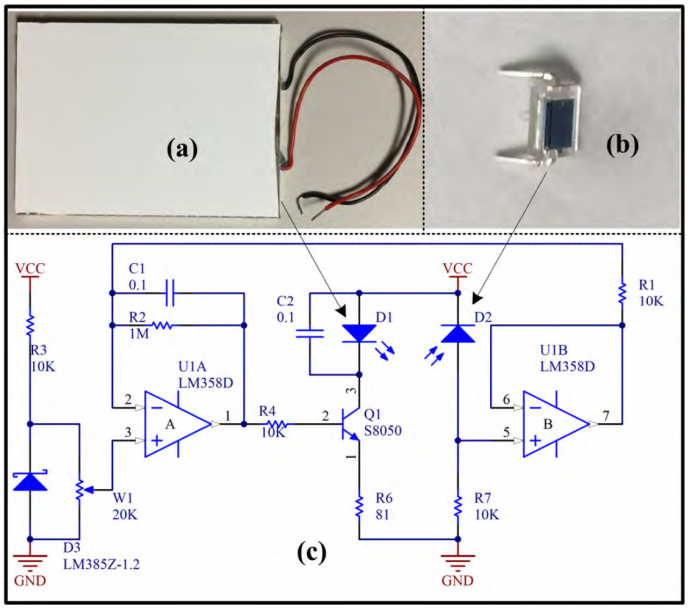
FIGURE 3. **Structure diagram of the turbidity image acquisition device.**

:- The **shading box** seals the sampling area and isolates the external light source, thus avoiding the influence of the external light source on the sampling.

:- When the white light emitted by the backlight plate passes through the turbidity liquid, it absorbs light of a specific wavelength.

:- The absorption of the light is reflected in the image by the camera as soon as the light passes through the liquid.

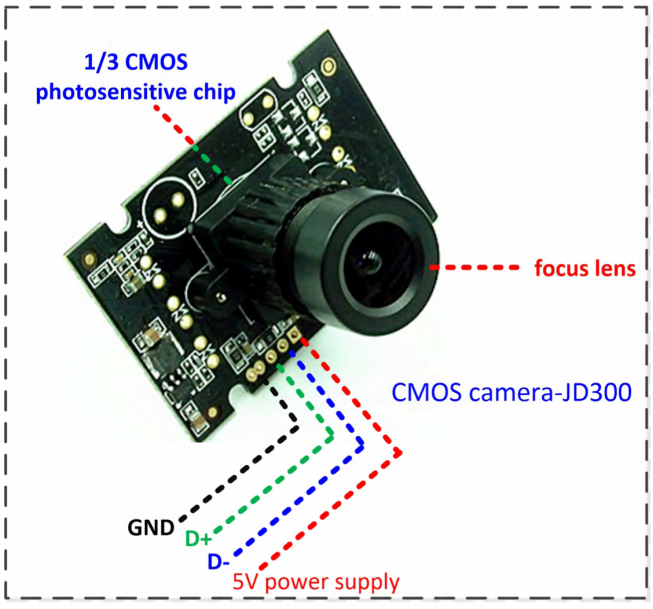
Backlight Circuit:



a) is the overall backlight plate.
b) is the photodiode for detection of light intensity which is marked by D2.
c) is the circuit responsible for maintaining constant light by maintaining a constant controlled current in the backlight plate by detecting light through photodiode D2

FIGURE 4. **Constant light intensity circuit: (a) backlight panel, (b) photodiode, and (c) constant light intensity circuit.**

The Digital Camera:



Needed to disable the

- automatic exposure,
- brightness, and
- white balance adjustment

functions

to ensure the consistency of the parameters throughout the whole measurement process.

FIGURE 5. **Camera PCB details.**

Software Design:

- **open source camera tool development kit and**
- **C# language**

Main function:- obtain the RGB value of the camera image and set the parameters of the camera.

Interface 1:-

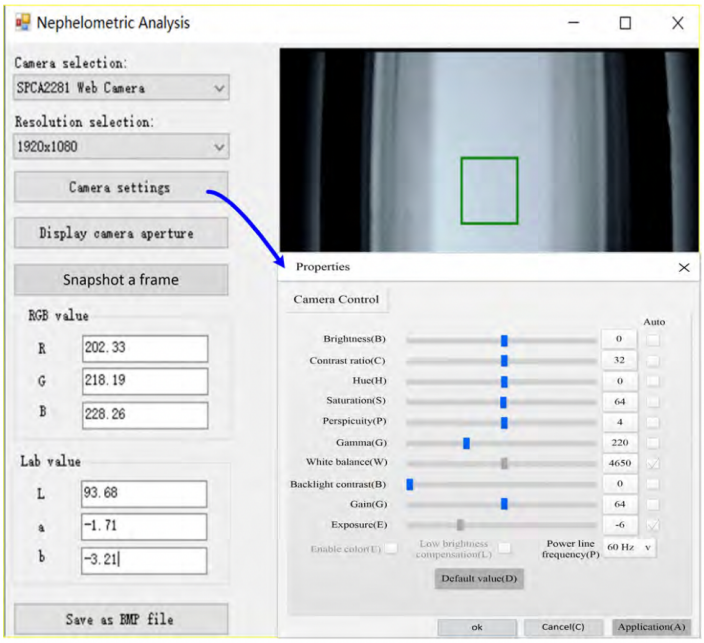


FIGURE 6. **Turbidity image analysis software interface.**

:- A frame image is acquired by the snapshot button.

:- The RGB values of 400 pixels in the central region of the image are read, and then the average RGB values of these pixels are obtained.

:- The camera settings button is used to set up the camera parameters, including the brightness, contrast, hue, saturation, white balance and exposure.

5. PROS AND CONS:

Pros:

Of using a digital camera combined with image method:

- avoids the development of a photoelectric detection circuit, signal-processing circuit, digital-to-analog conversion circuit, and display circuit
- It can also visualize the turbidity measurement process.
- The white balance algorithm of the camera can be used for 0 correction
- The sensitivity of the measurement can be adjusted
- The strong non-linear fitting ability of the neural network can improve the measurement accuracy.

Cons:

- Difficult to measure when the solution has very high turbidity(>1000 NTU), because the travelling of light becomes very difficult.(*Proposal for our project*)

6. ALGORITHM:

A. PREPARATION OF STANDARD SOLUTION

-> 0-1000NTU
-> Made from standard turbidity solutions with 200, 400 and 1000 NTU and distilled water

MATHS 3:
The standard turbidity of liquid is calculated using:

$$c = \frac{c_1 l_1 + c_2 l_2}{l_1 + l_2}$$

where *c*1 and *c*2 are standard turbidity solutions of a known concentration, and *l*1 and *l*2 are the corresponding solution volumes of *c*1 and *c*2.

B. CONVERSION FROM RGB COLOR SPACE TO LAB COLOR SPACE

After obtaining the image of turbidity liquid by digital camera,
the average RGB value of 400 pixels in the central region is accounted for.

- Then conversion of **RGB to XYZ color space** using formulae:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.412453 & 0.3575800 & 0.180423 \\ 0.213671 & 0.715160 & 0.072169 \\ 0.019334 & 0.119193 & 0.950227 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \tag{4}$$

$$\begin{cases} X = \dfrac{X}{255 \times 0.950456} \\ Y = \dfrac{Y}{255} \\ Z = \dfrac{Z}{255 \times 1.088754} \end{cases} \tag{5}$$

- **XYZ to LAB Values** using formulae:

$$\begin{cases} L = 116 f(\dfrac{Y}{100.0}) - 16 \\ a = 500 \left[f(\dfrac{X}{95.047}) - f(\dfrac{Y}{100.0}) \right] \\ b = 500 \left[f(\dfrac{Y}{100.0}) - f(\dfrac{Z}{108.883}) \right] \end{cases}$$

$$f(t) = \begin{cases} t^{\frac{1}{3}} & if\ t > \left(\dfrac{6}{23}\right)^3 \\ \dfrac{1}{3}(\dfrac{29}{6})^2 t + \dfrac{4}{29} & otherwise \end{cases}$$

C. METHOD OF T-S FUZZY NEURAL NETWORK

1) T-S FUZZY NEURAL NETWORK PREDICTION MODEL :

:- fuzzy system i.e **continuous values** unlike discrete boolean.

:- self-adaptive i.e can modify the **membership function** of the fuzzy subset.

:- fuzzy neural networks were established according to the **principles of fuzzy systems.**

:- When the network is initialized, the initial values of the parameters can be determined according to the fuzzy(i.e predefined membership functions) or qualitative knowledge of the system.

2) T-S FUZZY NEURAL NETWORK STRUCTURE :

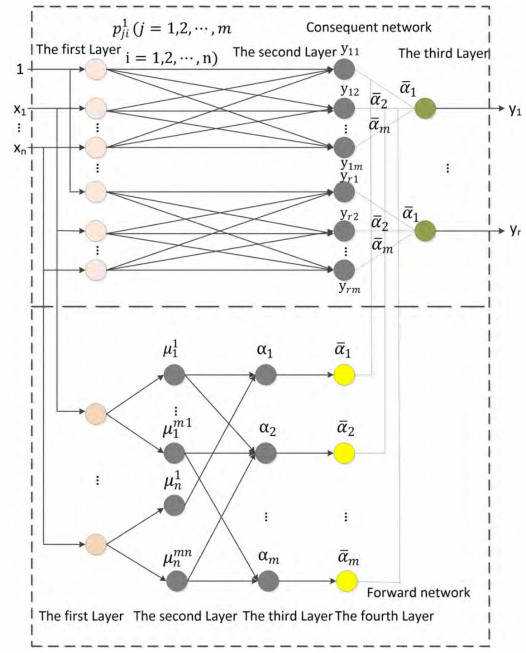


FIGURE 7. Structure of the T-S fuzzy neural network.

1. Forward Network: 4 layers

i. 1st layer :- input layer. No of nodes N1=n.

ii. 2nd layer :- N nodes having some variable value as calculated by **fuzzy membership functions,** belonging to fuzzy subsets, for each input.(x j= x1 to xn)

So, number of nodes are:

$$N_2 = \sum_{i=1}^{n} m_i$$

fuzzy membership function:- to quantitatively represent the turbidity through RGB. which has an exponential relationship.

$$: Y(x) = \mathrm{A}^* \exp\left(\frac{tx}{B}\right) + C$$

similar to gauss function. so a gaussian function can represent the true degree of turbidity through the RGB values.

Also for accuracy:- sharp shaped membership function is required, hence gauss

$$\mu_{A_j^i} = \exp\left(-\frac{\left(x_j - c_j^i\right)^2}{b_j^i}\right) \quad j = 1, 2, \cdots, n;$$

$$i = 1, 2, , \cdots, k$$

Then, the membership degree is used for the fuzzy calculation, and the fuzzy operators are used as continuous multiplication operators.

$$\omega^i = \mu_{A_j^1}(x_1)^* \mu_{A_j^2}(x_2)^* \cdots^* \mu_{A_j^n}(x_n) \tag{10}$$

Finally, according to Equation (9), the membership function μ_i^j of each input component belonging to the fuzzy set of linguistic variables is calculated:

$$\mu_i^j = \mu_{A_j^i}(x_i) \tag{11}$$

iii. 3rd layer :- grouping together similar fuzzy subsets. (alpha). by matching the preconditions of each fuzzy rule.

$$\alpha_j = min\left\{\mu_1^{(i_1)}, \mu_2^{(i_2)}, \ldots, \mu_n^{(i_n)}\right\} \; or \; \alpha_j = \mu_1^{(i_1)}\mu_2^{(i_2)} \ldots \mu_n^{i_n} \tag{12}$$

they grouped by a simple intersection operation. this in fuzzy as . in boolean.

iv. 4th layer :-

The fourth layer carries out the normalization calculation (Equation (14)), and the number of nodes in this layer $N_4 = N_3 = m$.

$$\overline{\alpha}_j = \frac{\alpha_j}{\sum_{i=1}^{m} \alpha_i} (j = 1, 2, \cdots, m) \tag{14}$$

because the values of alpha j were not relative to each other.

2.Consequent Layer: r sub-networks

i. 1st layer :- inputs. same as forward layer.

ii. 2nd layer :-

calculate the result of each rule; there are m nodes in this layer, and each node represents a rule of the member function being used.

$$y_{ij} = p_{j0}^{i} + p_{j1}^{i} x_1 + \cdots + p_{jn}^{i} x_n$$

iii. 3rd layer :-

The third layer subnetwork is used to calculate the output of the system:y_i.

$$y_i = \sum_{j=1}^{m} \overline{\alpha_j y_{ij}} i = (1, 2, \cdots, r) \tag{16}$$

7. CONCLUSION RELATED WORK- IDEA ON EXPLORATION AND REFERENCES FOR CROSS VERIFICATION:

A. PREDICTION WITH THE T-S FUZZY NEURAL NETWORK PREDICTION MODEL

Now they trained their TS-Fuzzy Neural Network Model a 1000 times.
And the training results are:-

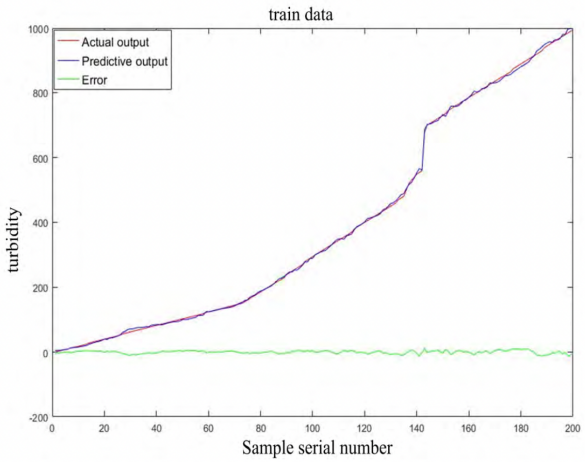


FIGURE 11. Training results of the training data set.

Figure 11 shows that the actual turbidity in the training data is very close to the predicted turbidity. The error fluctuates around 0.

the resulting parameters when applied on test data resulted in:-

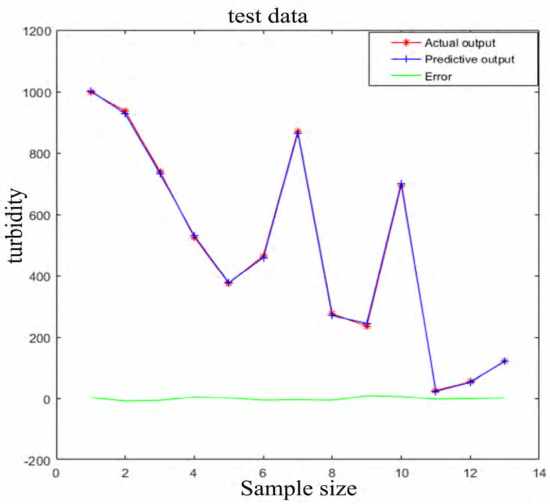


FIGURE 12. Test data set prediction results.

B. THE EFFECT OF DIFFERENT MEMBERSHIP FUNCTIONS ON MEASUREMENT RESULTS:

TABLE 2. Comparison of predicted results of different functions with standard solutions.

Membership function	Standard solution/NTU						Mean error	Std Dev
Standard solution	935	740	375	275	54	120		
Gauss	926.2645	733.5134	376.6235	268.8904	52.6043	121.5525	3.9839	5.2075
Triangular	936.0819	720.1916	372.2178	274.9097	58.9420	120.6265	4.8885	8.4272
Sigmoid	916.3980	719.6590	367.5880	275.4942	57.7116	120.7556	8.5527	11.7567

C. Visual COMPARISON WITH STANDARD SOLUTION

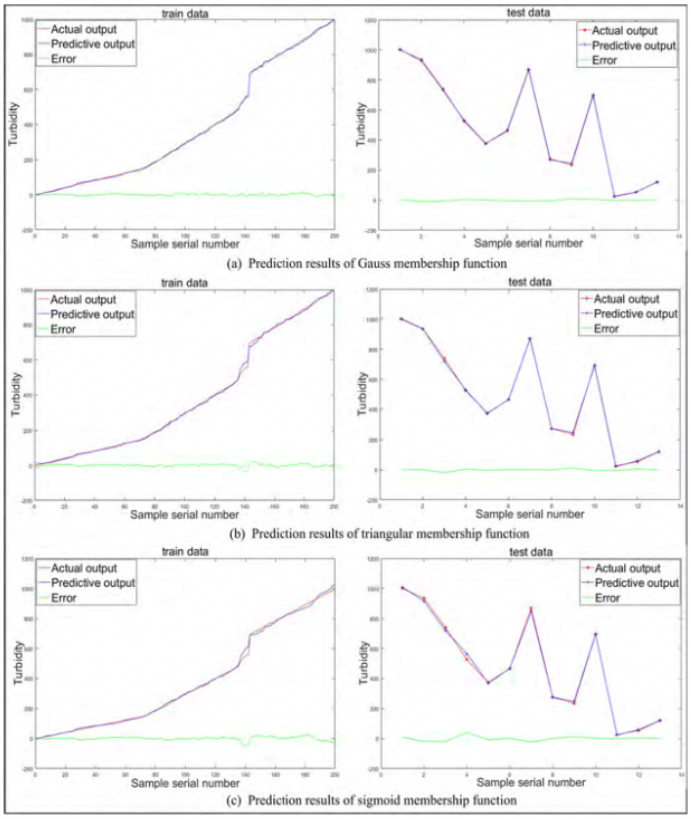


FIGURE 13. Prediction results of different membership functions.

D. DETERMINATION OF ACTUAL WATER SAMPLES

To verify the practicability of the recommended method, **several typical lakes in the Huaibei area** were selected as the water sampling points. The digital camera combined with the T-S fuzzy neural network and the turbidimeter(Model WGZ-1B, produced by Shanghai Xinrui Instrument Com- pany) were used to evaluate the validation samples. **The official error of this turbidimeter was ±5% of the range,** and the range was 0-200 NTU**.**

TABLE 3. Partial test result to standard turbidity solution by different methods.

Methods	Standard solution/NTU						Std Dev
Standard solution	935	740	375	54	275	120	
R curve	927.7845	720.3228	376.0818	62.5512	275.1298	106.1659	10.8394
G curve	928.8493	713.4956	371.1803	56.0059	280.9742	116.8005	11.5820
B curve	929.7736	707.6692	377.1898	52.5030	283.6759	112.8125	14.1807
L curve	908.652	714.64385	396.00627	40.5349	301.39892	112.43649	21.2675
RGB curve	928.9977	713.3206	374.8972	56.2626	280.4484	112.3589	11.8393
Lab curve	931.0958	705.8459	376.0308	53.7672	285.3527	114.8711	14.8119
T-S fnn method	926.2645	733.5134	376.6235	52.6043	268.8904	121.5525	5.2075
Turbidimeter	927.9	735.2	404.3	43.7	304.6	160.5	24.3394

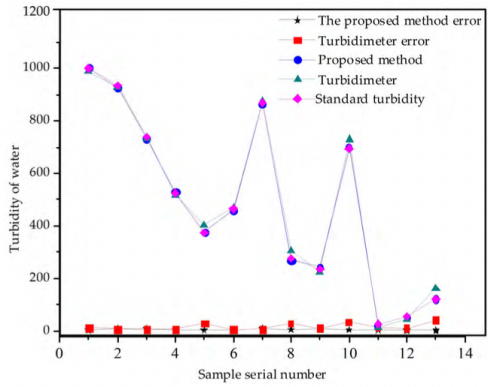


FIGURE 14. Comparison of the results of the turbidimeter with the proposed method.

E. Using t-test. A method that we learn in statistics. to see 2 hypothesis are similar or diff.

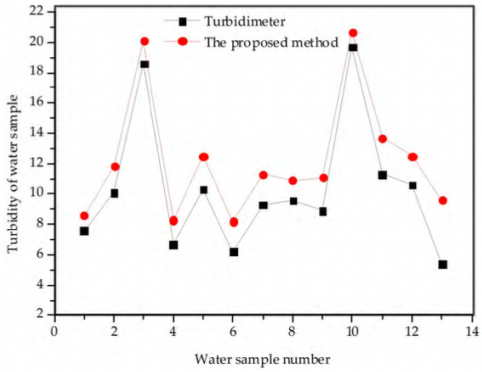


FIGURE 15. Results of the actual water sample measurements using the two approaches.

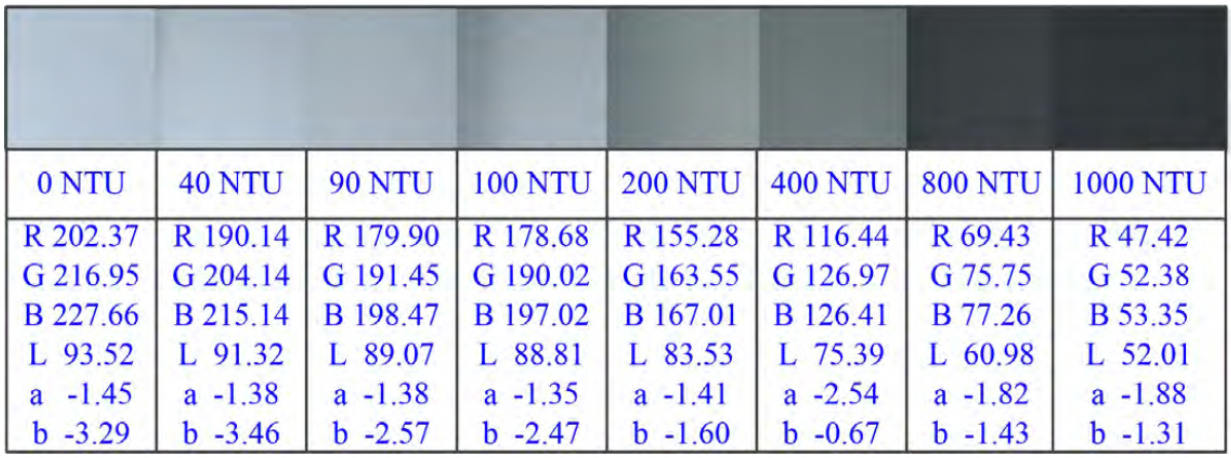
TABLE 5. Independent sample t-test results of the two methods.

	Turbidity
Proposed method	12.3 ±1.109
Turbidimeter	10.6±1.136
t	1.071
p	0.295

Here the p needs to be greater than 0.05 which it is. hence the methods almost coincide and the proposed solution is acceptable.

8. DATA:

The data set used in this research was acquired by **self-made image acquisition equipment** and **turbidity image processing software.**



0 NTU	40 NTU	90 NTU	100 NTU	200 NTU	400 NTU	800 NTU	1000 NTU
R 202.37	R 190.14	R 179.90	R 178.68	R 155.28	R 116.44	R 69.43	R 47.42
G 216.95	G 204.14	G 191.45	G 190.02	G 163.55	G 126.97	G 75.75	G 52.38
B 227.66	B 215.14	B 198.47	B 197.02	B 167.01	B 126.41	B 77.26	B 53.35
L 93.52	L 91.32	L 89.07	L 88.81	L 83.53	L 75.39	L 60.98	L 52.01
a -1.45	a -1.38	a -1.38	a -1.35	a -1.41	a -2.54	a -1.82	a -1.88
b -3.29	b -3.46	b -2.57	b -2.47	b -1.60	b -0.67	b -1.43	b -1.31

FIGURE 9. **Partial standard turbidity solution image.**

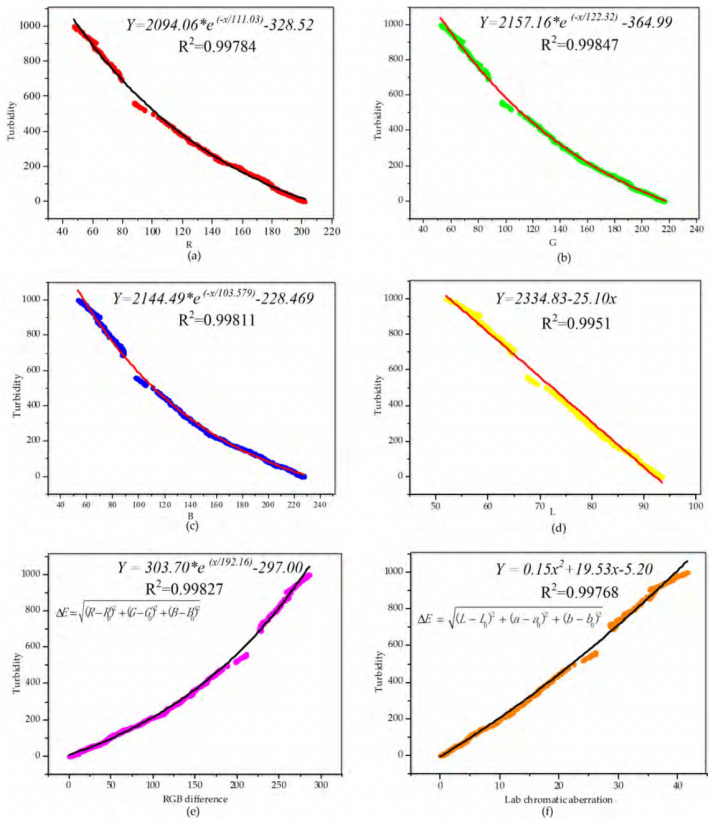


FIGURE 10. **Standard curve of color component to turbidity.**

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10. ANALYTICS:

A. ANALYSIS OF TURBIDITY IMAGE

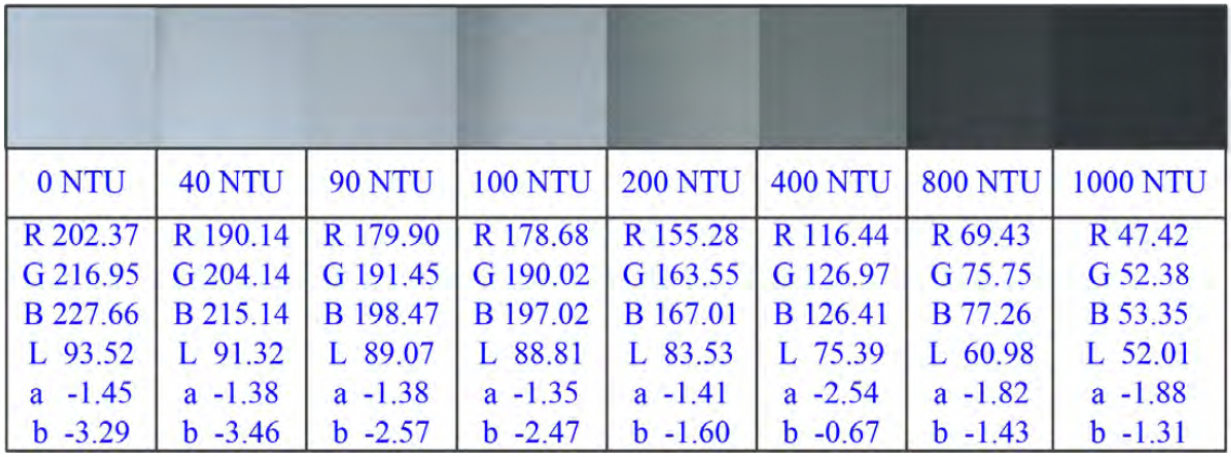


FIGURE 9. Partial standard turbidity solution image.

With the increase of the turbidity, the brightness of the turbidity image decreases gradually, and the RGB value also changes. The variation of the RGB and Lab values of the turbidity images is shown

B. FITTING RESULTS OF TURBIDITY TO COLOR COMPONENT OR COLOR DIFFERENCE

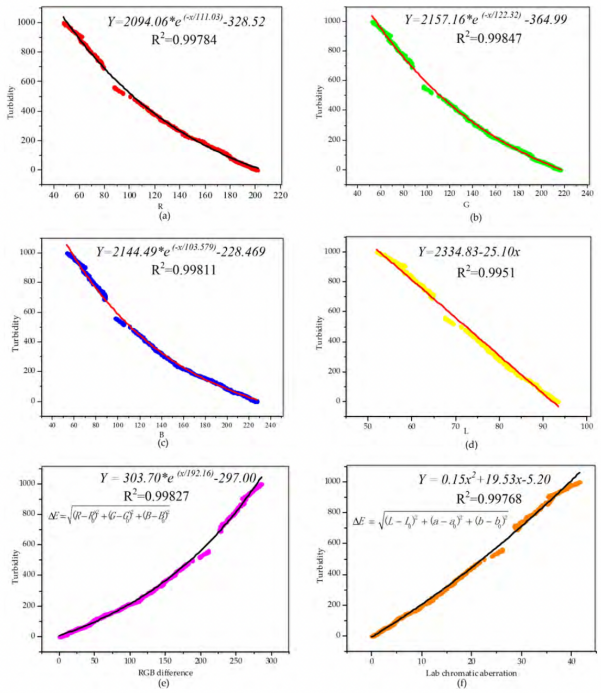


FIGURE 10. Standard curve of color component to turbidity.

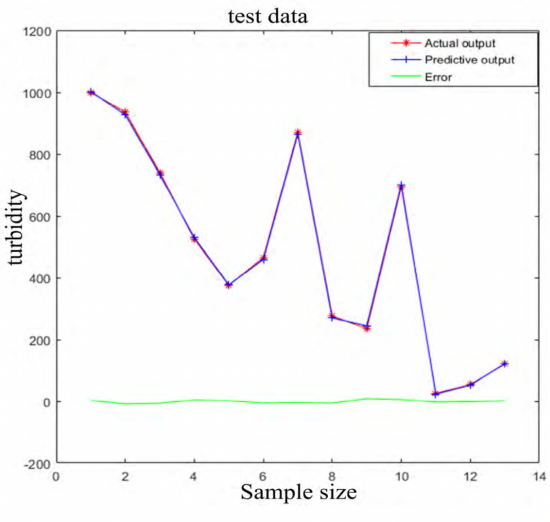
They have given here the standard curves that get recorded against turbidity for cross verification.
a, b, c :- **Non linear variation (decrease)** of RGB color components respectively with increase in turbidity.
d:- **Linear decrease** of brightness.
e and f :- the RGB color difference and Lab colors' difference V.S. the turbidity.

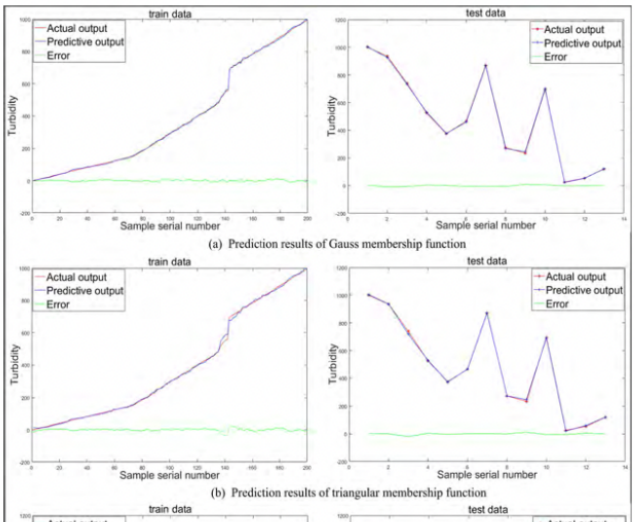
11. USER INTERFACE-TO TAKE INPUT OR SHOW THE RESULTS IN USER FRIENDLY MANNER:

The user is communicated properly through graphs for better process visualisation.

PERFORMANCE MEASURES: METRICS RESULTS- NUMBERS, TABLES, GRAPHS:.

The accuracy of the fuzzy neural network and the fitting algorithm is higher than that of the turbidimeter, the measurement error was only ±0.89%.





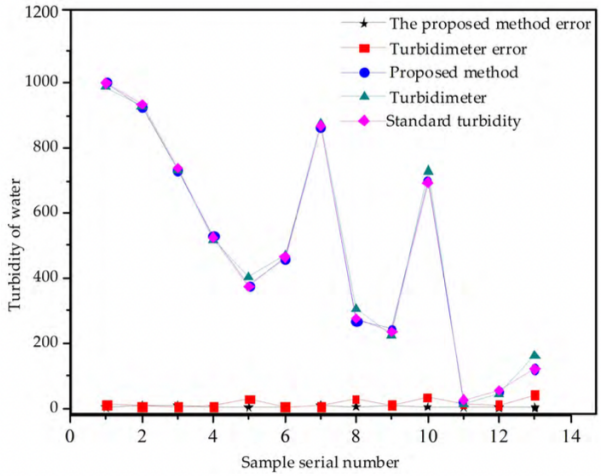


FIGURE 14. **Comparison of the results of the turbidimeter with the proposed method.**

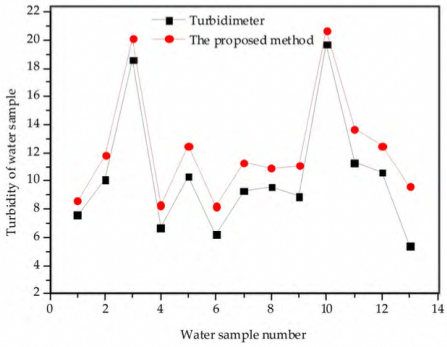


FIGURE 15. **Results of the actual water sample measurements using the two approaches.**

Future Work:

COMPARING WITH THE LATEST IMAGE METHODS FOR TURBIDITY MEASUREMENT

1.

- A turbidity measurement method for natural water based on **Hydrocolor** was proposed [23], which is based on **radiometric measurements instead of image color.**
- **24% less precision** to that of a portable turbidimeter.
- Compared with our method, this method provided a **simple and low cost** method for measuring the reflectance and water quality, but the **accuracy is low for the HydroColor's ability to measure.**

2.

- Automatically Effluent samples are imaged.
- The **light absorption characteristic** is highlighted as a **function of fluid depth.**
- **Computer vision processing techniques** are used to **quantify** this characteristic.
- The system has the advantage of **easy repetition, and implementing** such a system would lead to a **reduction in manpower** requirements, **improve wastewater monitoring frequency.**
- However, when measuring **turbidity**, the system **needs to be calibrated** to produce comparable turbidity values, and the **accuracy is not guaranteed.**

AUTOMATED TRASH COLLECTOR DESIGN

GOALS :

The objective of this paper is to study, analyse and investigate the main contributor of plastic pollution which has become the world's major infamous problem nowadays, and to explain the platform design which aims to help in reducing the issue of floating trash.

ABSTRACT :

This study shall include the methodology; classification of trash cleaning systems as well as the efforts to tackle this problem.

As for this paper, the proposed design will be focusing on a dynamic system which is fully autonomous. The model is a multi-functional design which incorporates different types of sensors(image, pH) .

This paper also emphasizes the novelty and uniqueness of the proposed design as compared to existing ones; in terms of architecture and its functionality.

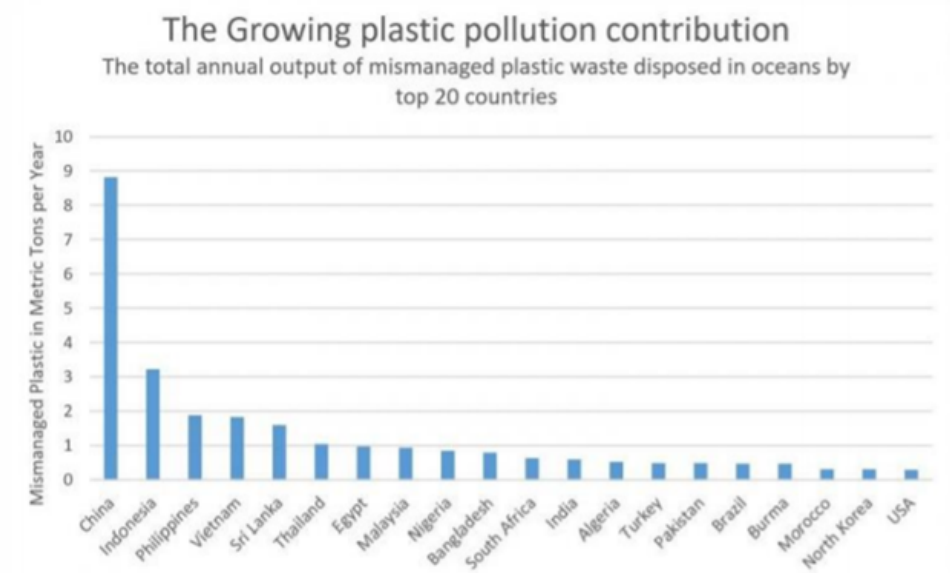
STATISTICS :

- Annually, more than 2 million tonnes of plastics have been tossed to the water body and eventually washed away to the sea.
- Case studies -

  Pollution case in Guangxi province of China. This happened in September 2016 where a quarter size of a whole shipment loaded with household garbage was dumped into the river. After some reports were made, an instant action had been made by the local department of environmental protection by launching an emergency water quality monitoring of the river. The Guangxi Environmental monitoring centre handled the case and had also conducted a thorough investigation.

- Another case study was taken from reference [8], where synthetic material such as the disposal of plastic has been seen as a threat to the surrounding and its widespread throughout the environment has caused the destruction of Anthropocene; an act of

human activities which has an influence on the environmental impact hence the future of the earth system.



- A recent study has been conducted according to [8] that in 2010, there was an estimation between 4.8 and 12.7 million tonnes of land-based plastic which was not properly managed and mishandled had been insinuated to the oceans.
- The accumulation of large scales of marine plastic was the result of aftereffect of the wind flow, the currents of the ocean as well as the thermohaline circulation (a flow of heat fluxes and freshwater across the sea surface).
- Plastic could host very harmful viruses, microbial communities and bloom species which are also known as "Plastisphere". Regardless of the little size of the plastic, every particle has the ability to convey living organisms and to re-disseminate destructive substances which may alter ecosystem composition and its functionality as well as changing their genetic diversity.
- 79,000 tonnes of plastics were found on the sea water surface. Based on the two studies made on the same reference, the size of the plastics had increased four times since 2014.
- It has been said that, there is also a distinct increase in the mass of the plastic; the sea water is getting denser with floating plastics and debris but there is no indication of extending the surface area.

PROS AND CONS :

1. Simply needs one person to control the drone
2. Economically viable.
3. Limited reach
4. Too big to be powered by resources like the sun

FUTURE IMPROVEMENTS :

- In terms of material wise, carbon fibre is recommended as compared to galvanized iron and mild steel for manufacturing of the frame. Beside this, the frame will be lighter and easier to be assembled and disassembled.

- Foldable solar panels can be equipped for the means of emergency purposes.

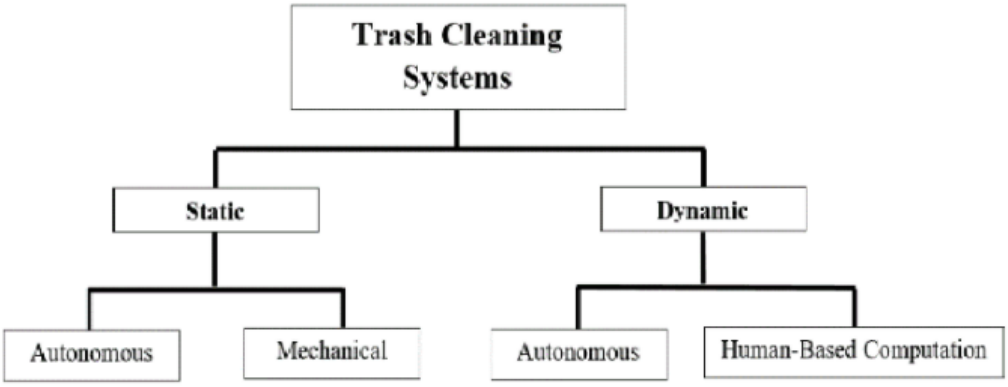
- Rechargeable spare batteries can be used to supply the power while the drained batteries are recharging.

- The use of Raspberry Pi is more desirable for artificial intelligence purposes.

- Global Positioning System (GPS) can be adopted for this proposed design as it can be used to locate the exact position of the rubbish. It is favourable to use a remote controller with a camera installed on the robot for the ease of directions.

EFFORTS TO TACKLE PROBLEM :

The trash systems can be divided into the following categories :



According to references, static system can be defined as a state that does not move or stationary while on the other hand, dynamic system is a state that can move in all directions.

There are efforts currently being executed by several countries in order to reduce and overcome this plastic pollution. There are also several methods introduced to tackle this problem.

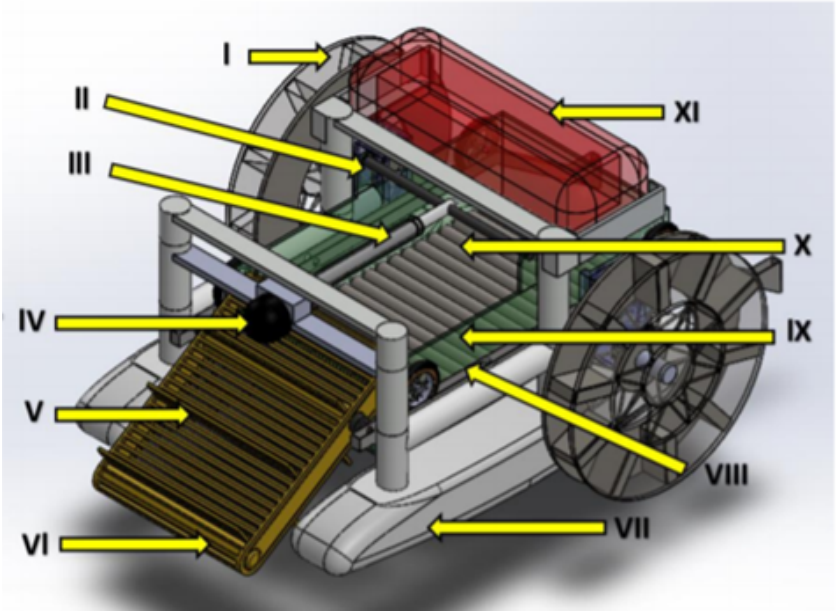
Some are using mechanical and partial robotics. And some of them are integrated systems.

The table below contains several examples of static and dynamic models for the trash cleaning systems.

Trash Cleaning System		
Method	**Region**	**Description**
Static - Autonomous		
Automatic trash removal system	India	It is powered by solar. The trash are collected by conveyor and the test field taken for testing were the canals and local water bodies [25].
Static - Mechanical		
Solar-powered water wheel	United State	It is powered by harnessing the energy from river current. Variety of trash were collected using conveyor and it took place in Baltimore's inner harbour [26, 27].
Dynamic - Autonomous		
Ocean clean-up project	Great Pacific Garbage Patch	It is floating barriers with 600 meters in length. It moves towards the pacific garbage with the help of natural current system and ocean's gyres [28].
Waste shark	Netherlands	It is a small aquatic drone used to collect floating trash near the Rotterdam port by patrolling around the river without oversight of human [29].
SeaVax	United Kingdom	It is a robotic vessel used to patrol the trash in the sea over a long distance. A remote command is used to guide towards the known gyre of plastic and then collected [30].
Automatic trash collection boat	China	An initiative to collect different kinds of trash including plastics, debris and construction waste [19].
Dynamic – Human-based Computation		
Buddy catamaran	United Kingdom	It is designed for cleaning marine debris as well as waterways maintenance especially marinas and harbours [31].
Trash skimmers	New York	It is a skimmer boat used for cleaning trash on both fresh and salty water surface with a low profile configuration for under lower obstruction. Able to retrieve both large and small objects by using the front conveyor [32].
Floating trash skimmer	India	It is a skimmer boat used for collecting trash and aquatic weed [33].
TrashCat	Malaysia	This skimmer boat is used to remove the floating trash and debris along the Klang River [20, 21].
Harvester	Thailand	A skimmer boat used to drag up waste mainly composed of aqua weeds and other types of debris along the Chao Phraya River [22].
Skimmer boat	Philippines	The boat is semi-mechanized and it scoop up the garbage from the water surface at Manila Bay [34, 35].
Trash robot	Chicago	It was designed with two functions; autonomous and human-based computation. It can also be controlled by using web browsing with camera installed enabling users to know their directions [36].
Ro-boat	India	It is a cleaning robot purposely created for Yamuna and Ganga River. This robot is capable of detecting pollutant such as metals, plastics and water chemical as well as ability to completely submerge under water to collect trash on the river bed [37].

PROPOSED SOLUTIONS :

The size of this robotic model is 7 feet long and 5 feet in width.



No	Part(s)	Function(s)
I	Wheel	Each wheel will be driven by a single DC motor with high torque. Both wheels are used to maneuver the directions.
II	Motor	It is a 24V DC motor with 2600 rpm. Sufficient enough to move the robotic vessel. It is a water proof motor.
III	Actuator	It is a 12V linear actuator. This actuator will be used to push the storage backward once it is fully loaded with rubbish.
IV	Sensor	It will be equipped with image sensor. Once the rubbish is detected by the image sensor, the conveyor will be activated and the rubbish will be picked up by the metallic arm.
V	Metallic arm (Hooker)	This metallic arm is used to hook a huge and heavy rubbish such as plastic bottles.
VI	Conveyor belt	The conveyor belt is used to pick-up and transfer the collected rubbish to the storage.
VII	Surf board	The surf board acts as a floating platform for the robotic vessel. The surface area and the thickness of the surf board are sufficient enough to accommodate up to 50-70 kilograms.
VIII	Run way platform	The designated run ways are used to ease the movement of storage when it is pushed backward by the actuator.
IX	Storage	The storage is used to keep the collected rubbish.
X	Rolling cylinder	Once the rubbish is collected and stored in the storage, all the cylinders will be activated and rolled to make sure the rubbish occupies the empty spaces as well as to level the rubbish at the same height. The rolling cylinder is driven by a single 12V DC motor. It is a water proof motor.
XI	Compartment	All the electrical components will be kept here and it is a water proof compartment.

Apart from collecting rubbish, this robotic is also equipped with sufficient multiple sensors all around the upper frame.

Among the uses of the sensors include to activate and deactivate the conveyor in the presence of the rubbish, to avoid or to dodge any obstacles that might hit the robotic vessel, to turn to any directions as well as to check the pH and quality of the water.

Once the sensor has detected the storage is fully loaded with rubbish, it will return to the starting point and the storage will be pushed backward by actuator using designated runways.

The provided compartment on the upper frame is used to keep the electrical components such as micro-controller and batteries.

Another privilege of this robotic, it has been architecture to withstand fresh and salty water.

CONCLUSION :

The aim of the study was to investigate the main contributor to plastic pollution. It was found that the main sources of plastic pollution were mainly caused by a huge dump of garbage as well as the result of tourism activities.

With the new proposed design, it could help to scale down the amount of plastic wastes.

A REVIEW OF RIVER CLEANING ROBOT USING SOLAR POWER

GOALS :

This paper presents an Arduino based totally River Cleaning Robot. It is a robot which floats on the water and the energy is supplied from a 12V battery.
The purpose of the project is to reduce the manpower, time intake for cleaning the river.

ABSTRACT :

The world today faces a major garbage crisis, the product from rapid economic growth, overcrowding, poor urban planning, and corrosive corruption. Lakes are an important feature of the Earth landscape. They are mostly valuable ecosystems and provide a variety of goods and offerings to humankind.
This paper presents an Arduino based totally River Cleaning Robot which floats on the water.

STATISTICS :

The numbers of water bodies are declining rapidly due to the cause of water pollution. For instance ,at the start of 1960s Bangalore had 262 lakes, now the handiest 10 hold water.

Similarly, in 2001, 137 lakes had been listed in Ahmedabad city, and over 65 were reported being built over.

In Delhi in 2010-11 to test the adjustments in three water bodies in closing 10 years the fame of forty four lakes was ascertained and it was located that 21 out 44 lakes had gone dry because of fast urbanization and falling water tables.

PROS :

I. Through the use of our drone we are able to acquire many floating wastes like plastic bottles, bags, plants

II. Assists in reducing the water pollution to a positive extent

III. Protection to human lives supplied

IV. Simply needs one person to control the drone.

V. Economically viable.

CONS :

I. Project makes only for small lakes.

II. Instructional guide to be considered before using the designed model.

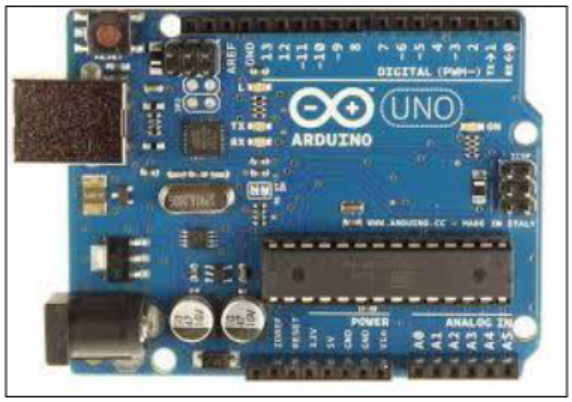
III. Works on a bluetooth module so has limited reach.

FUTURE IMPROVEMENTS :

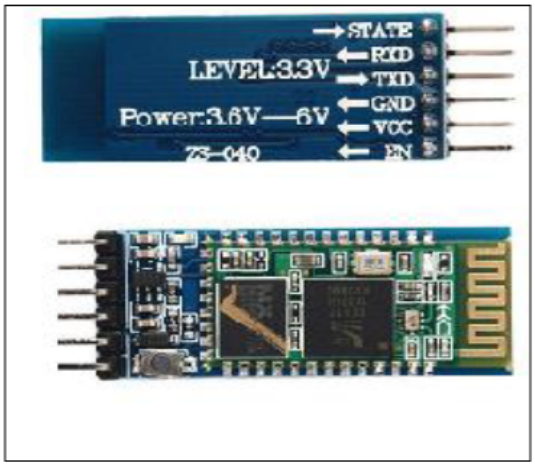
- The product can be used for plenty of other functions in the future.
- It can be changed to throw existence jackets for the duration of rescue operations. This can be finished by fixing suitable propellers with better motor rpms.
- We can also replace batteries with solar panels and make it completely work on solar energy.
- With some modification in its size and ability, it can be used in large lakes and rivers like Ganga.

TESTBED, PLATFORM, TOOLS :

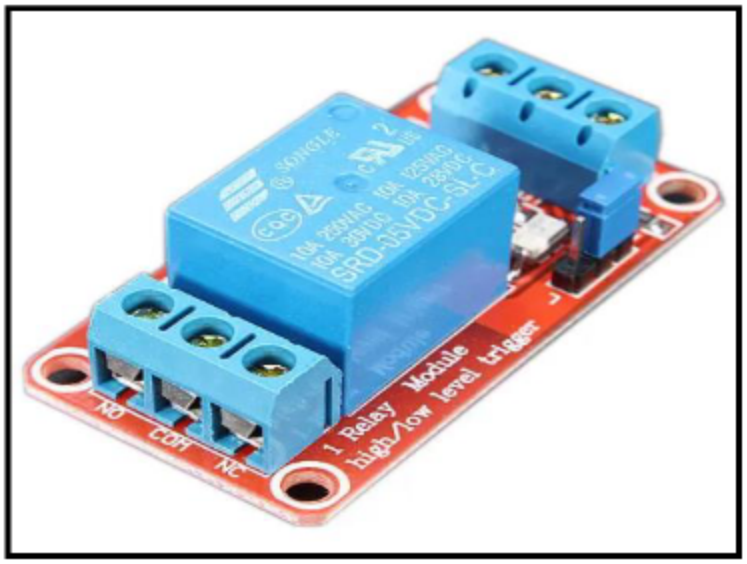
1. Arduino Uno



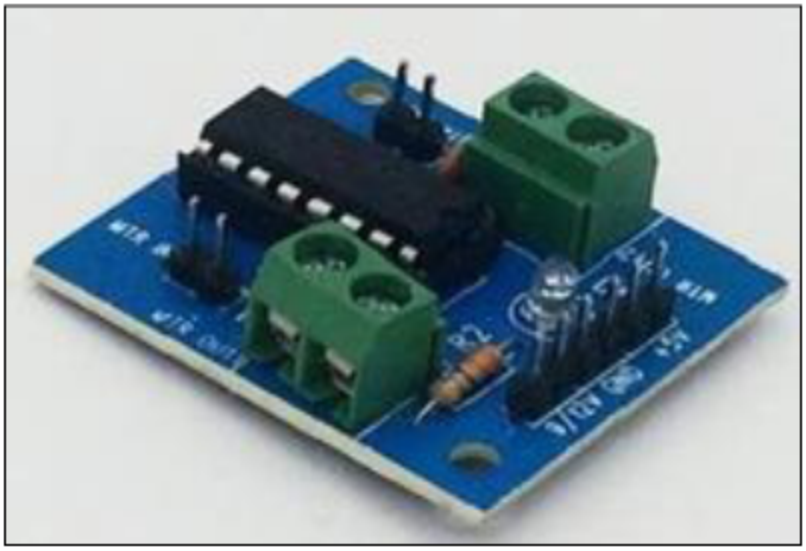
2. Bluetooth module(bluetooth module hc-05; master/slave module.)



3. Solar panel
4. Battery
5. Relay



6. DC motors
7. Motor drive

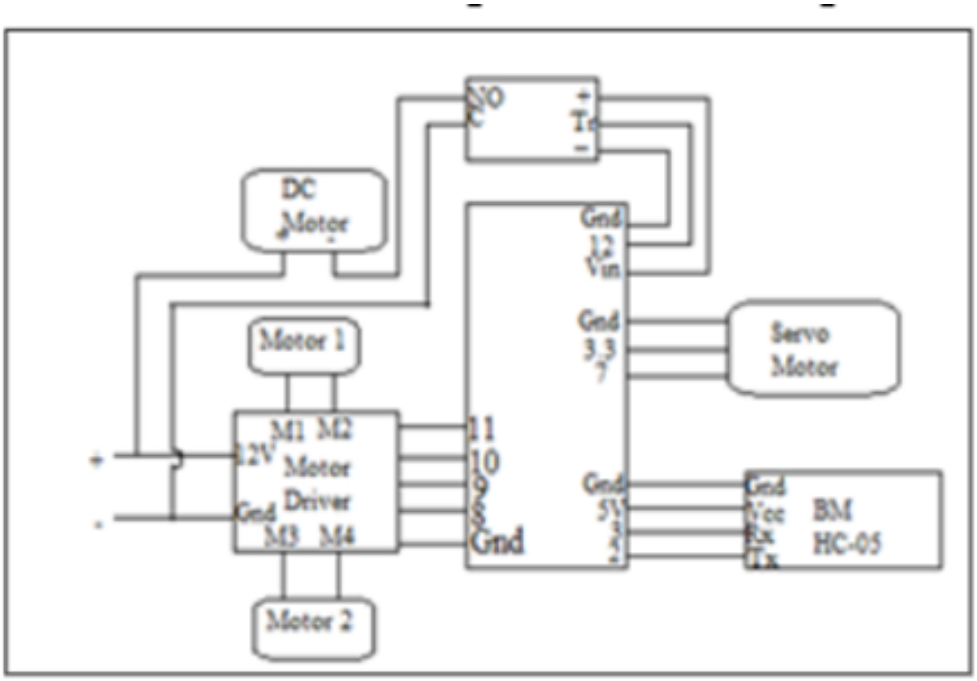


8. Conveyor belt
9. BO motor

10. Servo motor

PROPOSED SOLUTION :

The block diagram of the model looks like -



ALGORITHM :

The main aim of this device is to boost waste debris from the water floor and dispose of it in the tray.

It consists of an association of conveyor that's region on the shaft of the motor. Due to rotation of the motor, conveyor circles. As the conveyor is moved, it accumulates water debris, waste garbage and plastics from water bodies.

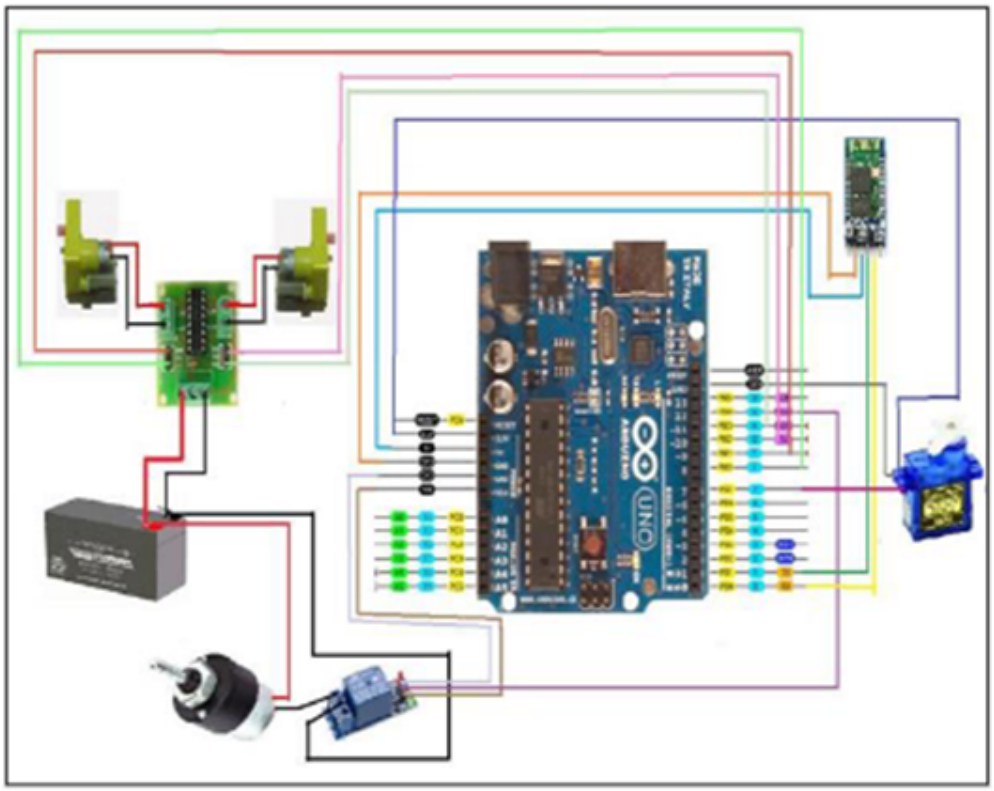
As the device is located inside the water the waste particles in water will get lifted and it acts in upward direction. As the waste debris reaches the upper intense position it will get dropped inside the tray. Hence this can result in cleansing of water surfaces and a safe series of waste particles from water.

Propeller is used to power the machine at the river and run with the assistance of a PMDC motor. By the usage of this four bar mechanism; it rotated at a particular attitude meant to gather the garbage for the version.

The fins are connected with a rod with the assist hook out of doors of the boat. The flowing of water from fins collects the floating stable waste. After collecting stable waste between fins all the waste is transferred into the last section by way of lifting the fins with the help of Servo Motor. Fins hanging from one factor and another point is connected with metal twine and metal wire is connected with Servo motor.

Defined herein, with the aid of a solid waste series system for gathering solid waste in a body of flowing water that has a flotation platform adapted to being securely placed in and floating on the water, a solid waste series phase set up on the platform having, two rods attached to and lengthening outward from the upstream give up of the platform used to connect the fins with boat. This segment can be connected with boat usage of hooks.

The circuit diagram would look like :



USER INTERFACE :

Uses bluetooth modules to be operated by the user. Right here the android app (**Bluetooth Terminal HC-05**) is designed for sending serial data to the bluetooth module when the sure button is pressed. The bluetooth module at the other end gets hold of the data and sends it to the Arduino via the TX pin of the bluetooth module (RX pin of arduino). The code fed to arduino tests the received data and compares. If received data is 1 the led turns on indicating that the module has entered the command mode. The connection is indicated by blinking the LED twice in 1 second.

CONCLUSION :

We are able to conclude that it is an innovative technique of minimizing manual stress and therefore very much reliably stabilizing inside the river. The project executed via us made an impressive task inside the environmental purpose and it is very useful for the small scale works.

The outcomes of robot performance were found that the robot arm and the conveyor belt can collect the garbage from the river for ex. glass bottles, plastic waste, etc. at the surface of the river.

A Biological Sensor System Using Computer Vision for Water Quality Monitoring

Goal

To improve the existing monitoring system and combine computer image processing technologies with water quality monitoring to improve the applicability, accuracy and reliability of the system, specially solving the illumination, white balance problems.

ABSTRACT

- Most studies use biological monitoring methods to monitor water pollutants, such as pesticides, heavy metals, and organic pollutants.
- Few methods consider the influence of illumination and complex background in the monitoring environment, and the characteristics parameters extracted in the systems are single.
- the results of using shallow neural networks for water quality classification are often not ideal.

PROPOSED SOLUTIONS:

- We design a water quality monitoring system combined with the computer image processing technology and use computer vision to analyze the **fish behavior** in real-time for monitoring the existence or not of water pollution.
- Since fish are sensitive to the water environment, they are often used to evaluate the comprehensive toxic substances of single or multiple pollutants as important indicator organisms in water quality testing.
- For the illumination problem, we use the no-reference quality assessment algorithm based on natural scene statistics for contrast distortion images to evaluate the video and configure the lighting conditions of the monitoring environment.
- We use background modelling to eliminate the influence of complex background on the moving target detection and the foreground is extracted using the saliency detection algorithm.
- The saliency detection algorithm (Seg) based on the saliency metric and the conditional random field model is utilized to detect the moving target of the fish group.
- multi-dimensional feature parameters are used to quantify the indicators, including movement velocity, rotation angle, spatial standard deviation, and body color which characterize the behavior changes of the fish.

- Finally, the classification model based on neural network is used to classify the feature parameters data of the fish behavior in different water quality environments.
- In this paper, red zebra fish is used as the indicator organism and copper sulfate solution is used as the toxic pollutant to simulate the water pollution.

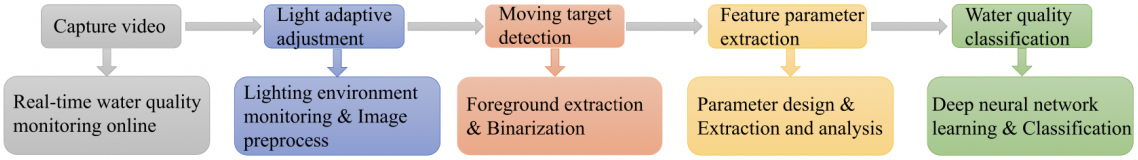
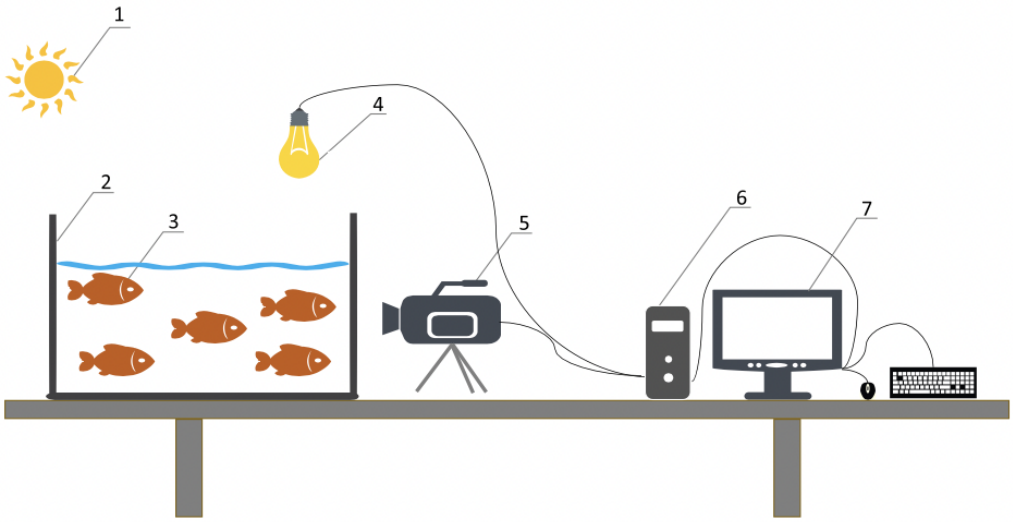


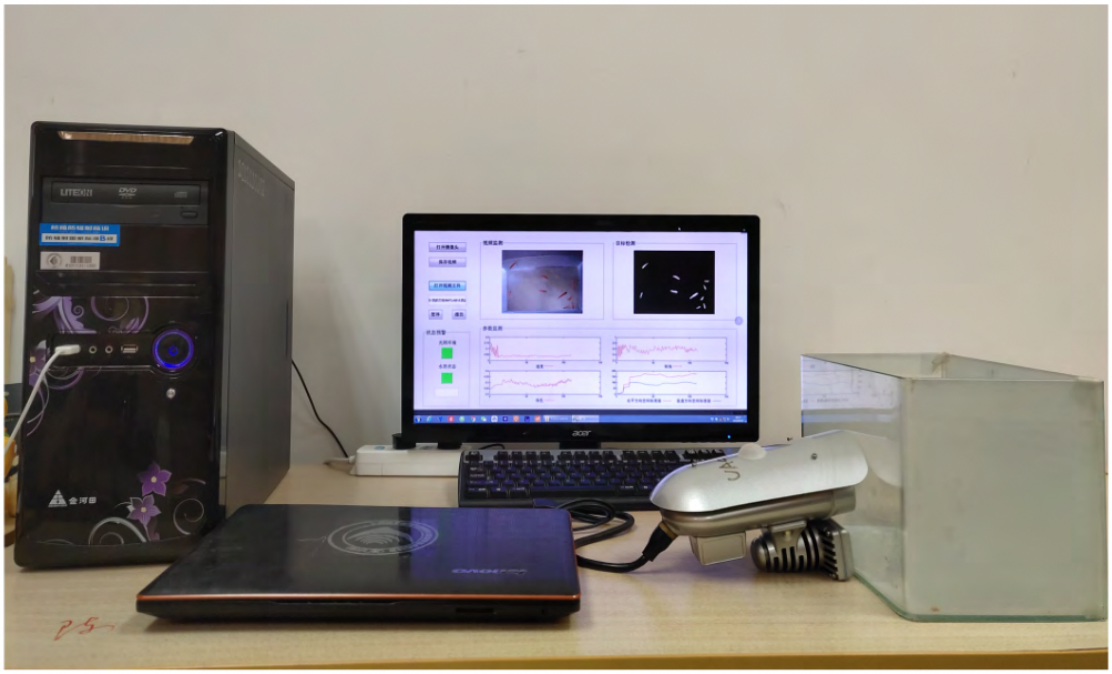
FIGURE 2. System structure diagram.

TESTBED, PLATFORM, TOOLS:

1. Sunshine.
2. Fish tank.(the back and bottom surfaces are made of frosted glass to reduce the impact of reflection.)
3. Sample fish.
4. LED Source.
5. Gopro.
6. Computer processor.
7. Monitor.



(a)



(b)

Pros:

1. Handles the illumination very well.
2. Controls white balance for better tracking of the fishes.

Cons:

1. Sacrificing of fishes.

Algorithm:

VIDEO SEQUENCE PROCESSING METHODS
A. LIGHT ADAPTIVE ADJUSTMENT MODULE

- The lighting environment may reduce the quality of the video sequence and affect the subsequent moving target detection.
- we select Image Quality Assessment (IQA) method to detect the quality of the captured video, and then determine whether the lighting condition of the current video frame is normal.
- we also perform image processing techniques such as white balance to decrease the impact of different application environments on system detection.

:- Number of images from the actual environment are collected, the standardise the effect of lighting on the image quality using some quality evaluation algorithms.

- And finally, we evaluate the performance of each objective quality evaluation algorithm by calculating the PLCC, SROCC and RMSE values of the average subjective score
- we finally select the GWH-GLBH objective evaluation algorithm to detect the quality of video frames for configuring the illumination.
- Then white balance is performed in the pre-processing module, to correct color shift, in order to better achieve moving target detection using the machine vision.

B. MOVING TARGET DETECTION MODULE

- we choose the saliency target detection algorithm (Seg) based on the saliency metric and the Conditional Random Field (CRF) model proposed by Rahtu *et al*
- *2 steps:-*
- 1) SIGNIFICANT MEASUREMENT :-
  - to obtain a saliency image using the statistical framework and comparing the brightness, color as well as motion information in the local features.
  - Use a sliding window on the image to compare the distribution of certain features in the internal window with the distribution of the window edges in each window.
    - F(x) is a mapping of each pixel from original image to sliding image.
    - Z is a R.V representing each pixel.
    - Whole window W is divided into 2 parts:- Internal part (K) and Boundary part(B) which may be considered as part of the background.
    - So significant measurement of the point $x \in K$ is defined as the Bayesian conditional probability as shown in the following equation.
- $$S_0(x) = \frac{P(F(x)|H_0)P(H_0)}{P(F(x)|H_0)P(H_0) + P(F(x)|H_1)P(H_1)}.$$

H0 => Z belongs to K (needed internal part).
H1 => Z belongs to B
F(Z)=QF(x)
S0(x) => feature of x

If the feature of the pixel *x* is similar to the feature of the point in the inner window, the pixel *x* belongs to the significant target portion. In other words, *S*0(*x*) is close to 1.

- 2) SIGNIFICANT TARGET SEGMENTATION

Data Obtaining (QUANTIFICATION OF CHARACTERISTIC PARAMETERS): -

A. ACTIVITY PARAMETERS

:- Under normal circumstances, the fish is in a state of smooth swimming.
:- When the water environment is abnormal, the fish will produce stressful behavior, such as a sudden change in swimming velocity, sharp swing and so on.
:- we select the movement velocity and rotation angle to characterize the activity level of the fish group.

:- we use the optical flow method to extract the motion change vector of the foreground target from the two-dimensional video sequence.
:- The extracted characteristic vectors of fish behavior include the amplitude and direction information, which characterize the movement velocity and rotation angle of the fish group.

1. **Movement Velocity:**

$$V(x, y) = \sqrt{u^2(x, y) + v^2(x, y)}.$$

2. **Rotation Angle:**

$$angle(x, y) = \arctan \frac{u(x, y)}{v(x, y)}.$$

3.

B. POSITION PARAMETERS

:- Under normal conditions, the fish is randomly distributed in all directions in the water tank
:- position is evenly without drastic changes.
:- When the water environ- ment becomes abnormal, fish will appear stressful behaviors resulting in the change of position coordinates

- Each fish is represented as a Foreground Target Area.
- centroid coordinates are (Xc,Yc) of each fore-ground area.
- Group Centroid(Cx,Cy) is calculated as the centroid of the area traced by connecting centroid of each fish.

$$CX = \frac{\sum_{k=1}^{N} A_k X_k}{\sum_{k=1}^{N} A_k}, \quad CY = \frac{\sum_{k=1}^{N} A_k Y_k}{\sum_{k=1}^{N} A_k}.$$

- Spatial Standard deviation from the Group Centroid characterises the density.

$$SDX = \sqrt{\frac{\sum_{k=1}^{N} A_k (X_k - CX)^2}{\sum_{k=1}^{N} A_k}},$$

$$SDY = \sqrt{\frac{\sum_{k=1}^{N} A_k (Y_k - CY)^2}{\sum_{k=1}^{N} A_k}}.$$

C. BODY COLOR COMPONENT

:- Red zebra fish is selected due to bright red body color and high sensitivity.
:- Under normal physiological condition, body color remains bright red.
:- When the water environment is contaminated by heavy metals(*Hg*2+ , *Cu*2+ and *Zn*2+) or other toxic substances, the body color will gradually change with the decrease of physiological functions.
:- We use the Hue-Saturation-Intensity (HSI) model to characterize body color of fish.

$$S = 1 - \frac{3}{R + G + B}[\min(R, G, B)].$$

Analysis:-

A. FISH TOXICITY EXPERIMENT DESIGN

1) EXPERIMENT MATERIALS

:- When the water environment is contaminated by heavy metals(*Hg*2+ , *Cu*2+ and *Zn*2+), zebra fish is sensitive to it and the body color will gradually change.
:- Therefore, copper sulfate pentahydrate (*CuSO*2 · 5*H*2*O*) is selected as the toxic pollutant in our experiment.

2) EXPERIMENT PREPARATION

:- Before the formal experiment, the zebra fish are domesticated for more than two weeks in the formal experiment environment.(pH~7, temp~20 to 24, plenty of light), so that mortality would be less than 1%.
:- 24-hour semi-lethal concentration (24h−LC50) is used as the refer- ence concentration to evaluate the toxic effects
i.e at this concentration half the population will die within 24hours.
:- The 24-hour semi-lethal concentration (24h−LC50) of *Cu*2+ ions for zebra fish is 1.472 mg/L.

3) EXPERIMENT PROCEDURE

:- Ten zebra fish are used in each experiment and stop feeding 24 hours before and during the experiment.
:- The process is divided into two steps: normal conditions and abnormal conditions.
recorder for around 30mins at each mentioned time.

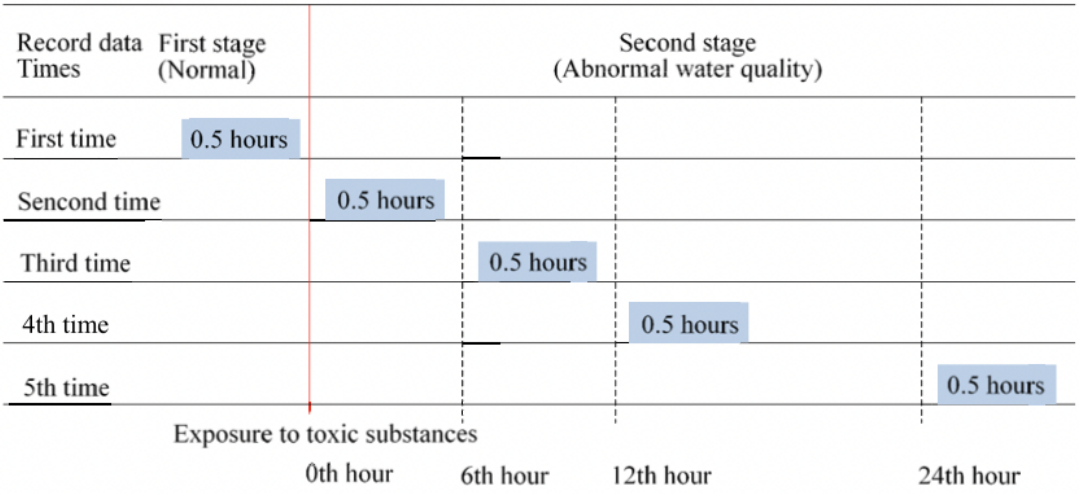


FIGURE 4. The flow chart of fish toxicity experiment.

B. ANALYSIS OF FOREGROUND EXTRACTION RESULTS

:- We select several widely used methods to evaluate the target detection algorithms: Precision-Recall curve (PR), Receiver Operating Characteristics curve (ROC), F-measure param- eter, Area Under ROC Curve (AUC index).
:- and directly calculate the Mean Absolute Error score (MAE) between the artificially estimated results (Groundtruth) and the target detection results.
:- In order to compare the performance of Seg used in this paper with other methods, four algorithms are used to extract foreground of the same video sequence (900 frames): visual background extractor (ViBe) algorithm, Saliency Filters (SF) based on saliency estimation algorithm, Structured Matrix Decomposition (SMD) and Seg algorithm.

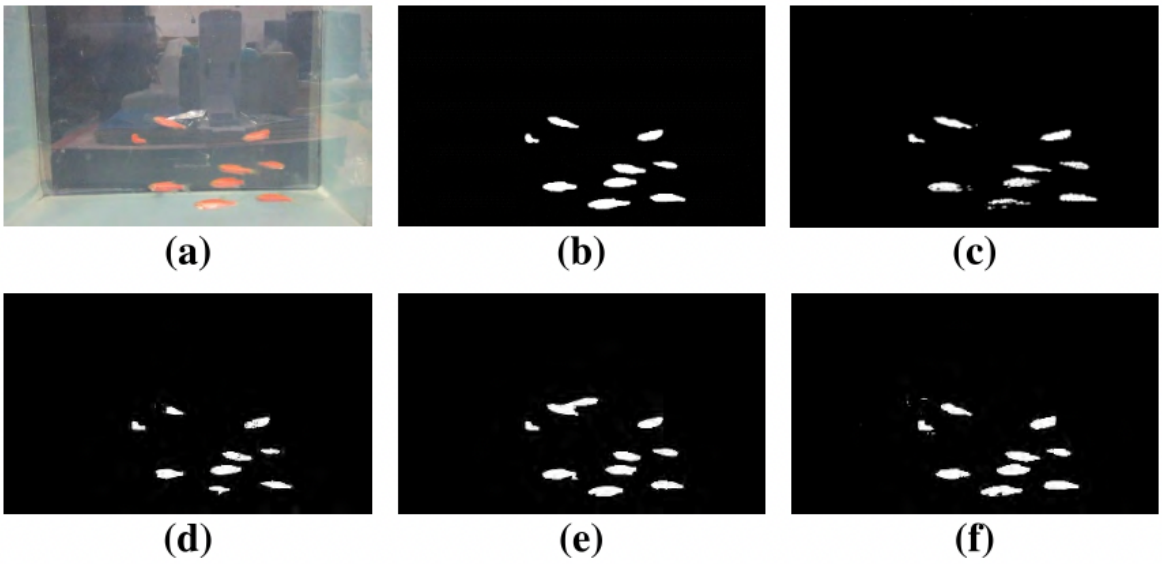


FIGURE 5. The comparison of moving target detection results. (a) The original image. (b) Groundtruth. (c) ViBe. (d) SF. (e) SMD. (f) Seg.

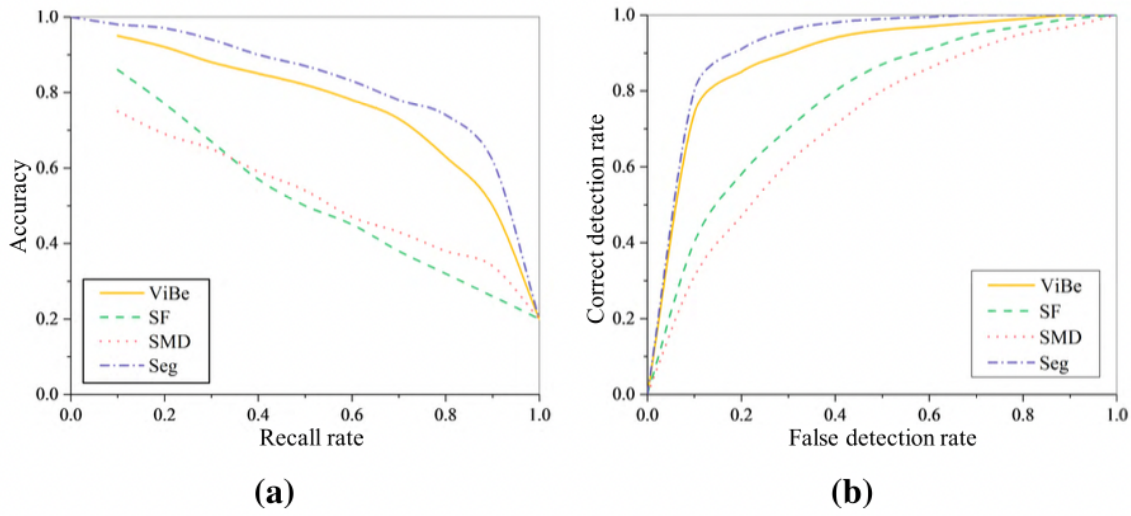


FIGURE 6. The algorithm evaluation results. (a) PR (Accuracy rate - recall rate). (b) ROC (Correct - false detection rate).

In order to describe the performance of detection algo- rithms more intuitively, each algorithm is evaluated by three indicators: F-measure, AUC (closer to 1, the better) and MAE(closer to 0, the better).

TABLE 1. The performance evaluation of algorithm simulation results.

Algorithm	F-measure	AUC	MAE	Time(second/frame)
ViBe	0.84023	0.82236	0.00875	0.0038
SF	0.82182	0.81889	0.00848	1.1482
SMD	0.84546	0.93438	0.00624	5.0974
Seg	0.93532	0.95815	0.00335	0.6117

C. ANALYSIS OF CHARACTERISTIC PARAMETER RESULTS

1) RESULTS OF ACTIVITY PARAMETERS

A) Velocity

:- It can be seen that under normal conditions, the velocity of the fish group is mainly concentrated between 0 and 5 unit vectors and in a state of steady low-speed motion.

:- When toxic substances such as heavy metals are added in the water to cause abnormal water environment, the fish will produce stressful behavior and the velocity is mostly distributed between 5 and 20.

:- It keeps on increasing further untill 6th hour.

:- When the fish is exposed to toxic substances for 24 hours, the movement velocity decreases significantly.

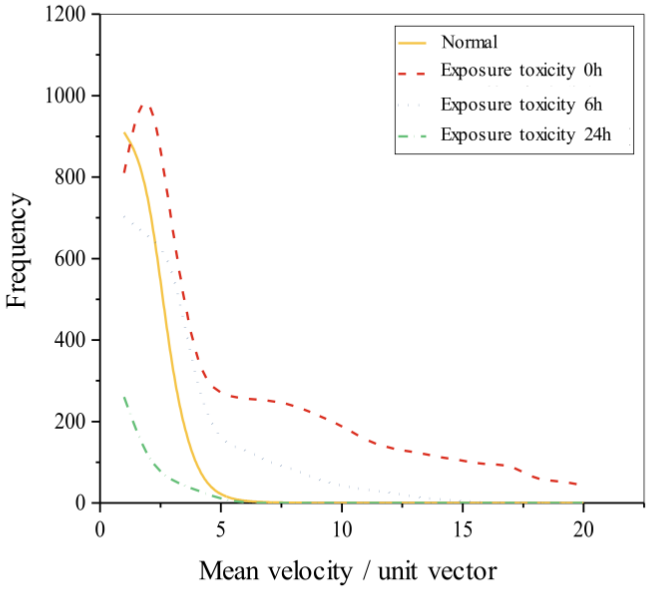


FIGURE 8. The histogram statistics of mean velocity.

B) Rotation Angle

:- Under normal circumstances, the rotation angle of fish is mainly concentrated in the interval of ±10◦ to ±90◦, and the movement is relatively stable.

:- On addition of toxic substances, rotation angle is mainly concentrated in the range of ±10◦ to ±90◦ and ±90◦ to ±180 and it is erratic.
:- When the fish lived for 6 hours with toxic substances, the frequency of the rotation angle is reduced.
:- When toxic substances are exposed for 24 hours, the angle is mainly distributed in the range of 0◦ to ±10◦, and the amplitude as well as frequency of the rotation are significantly reduced.

2) RESULTS OF POSITION PARAMETERS

:- There is not any significant change of the group coordinates under normal and abnormal water quality con- ditions. Therefore, group coordinates are not suitable as the index for determining water quality status.
:- Under normal water quality conditions, the fish is evenly distributed in the water tank. The horizontal spatial standard deviation is mostly concentrated between 100 and 175. And the vertical direction is mainly between 75 and 100.
:- When toxic sub- stances are added to the water, the fish escape randomly and the spatial standard deviations in the horizontal and vertical directions are stable in the range of 200 to 275 and 150 to 200 respectively.
:- When the fish is exposed to toxic substances for 6 hours and 24 hours, the physiology of individual with slower action is impaired and distributes more dispersedly. The horizontal spatial standard deviation is mainly between 150 and 200. However, the vertical spatial standard deviation is mainly from 100 to 150.

3) RESULTS OF BODY COLOR COMPONENT

:- The body color component is mainly distributed between 0.25 and 0.4 under normal water quality.
:- When the fish is exposed to toxic substances for 6 hours, the body color component decreases in the range of 0.15 to 0.3
:- When the fish is exposed to toxic substances for 24 hours, the body color becomes more gray mainly between 0.05 and 0.2.

D. STATISTICAL ANALYSIS

:- We use the Mann-Whitney U test

TABLE 2. The statistical characteristics of the sample under normal and abnormal conditions.

Parameter	Normal (Mean±SD)	Abnormal (Mean±SD)	Significant test (P value)
V	1.29±0.36	3.46±0.62	0.0000**
A	41.38±4.95	55.67±4.46	0.0000**
CX	8.64±2.43	7.34±2.97	0.0400**
CY	8.17±1.00	8.35±1.25	0.0910
SDX	136.29±34.56	100.28±39.84	0.0000**
SDY	85.55±23.85	58.18±17.76	0.0000**
S	0.27±0.01	0.25±0.02	0.0000**

Mean = sample mean value.
SD = sample standard deviation.
** indicates the results are significantly different.

WATER QUALITY CLASSIFICATION MODEL

A. CLASSIFICATION MODEL BASED ON LSTM NEURAL NETWORK

TABLE 3. The water quality classification results of LSTM and RNN.

Classification mode		RNN			LSTM		
		Accuracy	Total accuracy	Time (second)	Accuracy	Total accuracy	Time (second)
Class II	Normal Initial pollution	92% 96%	94%	0.077	100% 100%	100%	0.056
Class III	Normal Initial pollution Final pollution	96% 92% 76%	88%	0.082	96% 100% 88%	93.33%	0.060
Class IV	Normal Initial pollution Middle pollution Final pollution	88% 96% 92% 68%	86%	0.792	92% 100% 100% 72%	91%	0.764

1) Class II can classify the normal and the initial stage of pollution. We mainly detect the sudden occurrence of water quality and distinguish whether the current water quality is in a normal state or an initial pollution state.
2) Class III can classify the normal, the initial and the final stage of pollution. It is possible to detect the occurrence of serious fish death at the final stage of pollution.
3) Class IV can classify normal, the initial, the medium and the final stage of pollution. Comparing the three modes, we join the identification of the medium-term pollution in the last one. And we can better monitor the water pollution.

CONCLUSION

We improve the existing monitoring system and combine computer image processing technologies with water quality monitoring to improve the applicability, accuracy and reliability of our system, specially solving the illumination, white balance problem, and including LSTM.

DIGITAL IMAGE PROCESSING TECHNIQUES FOR OBJECT DETECTION FROM COMPLEX BACKGROUND IMAGE

GOALS :

The goal of this project is to detect and allocate the object (here we consider using a mango) using few methods such as color processing and shape detection. The MATLAB program should automatically detect and count the total number of objects from mango trees.

ABSTRACT :

This paper discusses the method or techniques on how to detect the mango from a mango tree.

The techniques used are such as colour processing which are used as primary filtering to eliminate the unrelated colour or object in the image.

Besides that, shape detection has been used where it will use the edge detection, Circular Hough Transform (CHT). This technique will determine the candidates of mango and find the circular pattern with the given radius within an image by collecting the maximum voting.

The program should automatically detect the desired object and count the total number of it.

PROS :

- Detecting and location objects in digital images has become one of the most important applications for industrial use to ease users and save time.

CONS :

- Difficult in a scenario where the object is completely alike as the background.
- Targeted objects which are obscured due to presence of other objects is one of the main problems faced in the image processing field.
- Besides that, objects which overlap each other also made the process challenging where hidden objects will be detected and counted and the total number will be no accurate.
- Lighting intensity may also affect the original color of the object to be not accurate.
- Grayscale images will contain lots of noise because the grayscale filtering cannot eliminate the low intensity pixel which is declared as noise.

FUTURE IMPROVEMENTS :

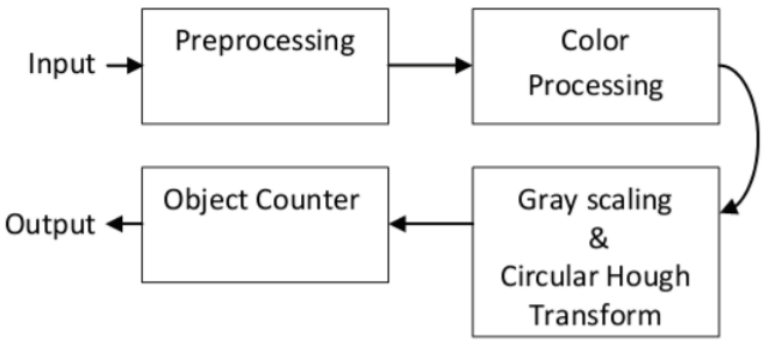
This technique has been developed years ago but improvement of it is still required in order to achieve the targeted objective more efficiently and accurately.

TESTBED, PLATFORM, TOOLS :

MATLAB : MATLAB software is one of the most powerful software used worldwide and it also consists of a lot of image processing libraries which can be used for object detection. For this project, the program code is written using this software and it shall be efficient to detect the mangos, eliminate the background image and automatically count the total number of objects.

PROPOSED SOLUTION :

The proposed solution includes the recognition of the objects in an image using the following algorithm. Given below is the flowchart :



ALGORITHM :

Colour Detection -

The images are sent into the preprocessing block and perform image resize where set to 320x240 pixels.

After that, it will directly go to the RGB adjustment where it will readjust the lighter and darker parts of the object color and background.

Next, color processing takes place and the elimination of the unrelated color will take place. The elimination of the unrelated object here is done by comparing the current pixel RGB value with the default RGB value of mango. If detected color is not related then change the current pixel RGB value to 0 which is in black color.

After the colour processing, the only left for the image is a clear mango and the leaves which have the same color as mangoes.

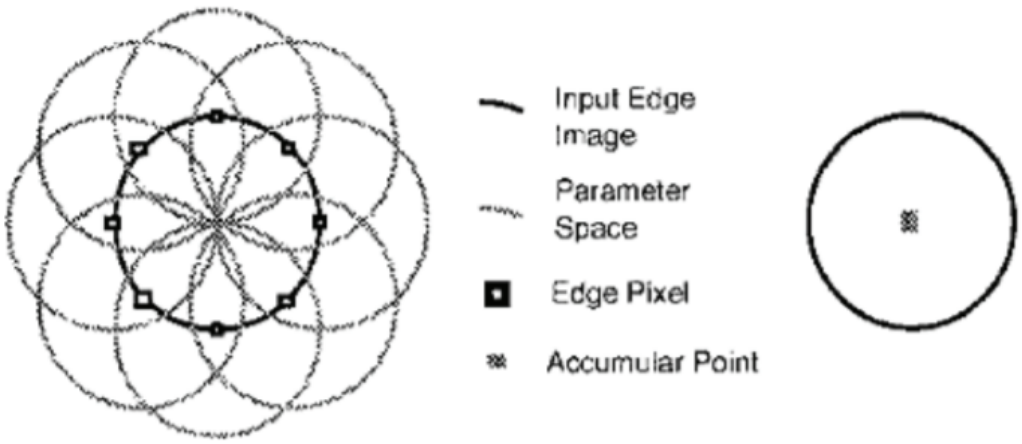
Here, the shape detection process is used to detect the shape instead of using color detection.

Before that, it must change to Gray scale perform medium filter to eliminate the small pixel and smoothing the image. In the medium filter, it will eliminate the pixel which is small and smoothen the images to make the object's edge more clear and clean. After that, it will be change to binary image and go through another object elimination that eliminate the binary objects which is lesser than 200 pixels in a group of objects.

Shape Detection -

After that the CHT (Circular Hough Transform) is applied on the selected image to find the circular patterns within an image. It is used to transform a set of feature points in the image into a set of accumulated votes in the parameter space. Accumulated votes are in the form of array and the highest number of array indicates the presence of the shape. A circular pattern can be described by -

$$(xp - xo)^2 + (yp - yo)^2 = r^2$$



USER INTERFACE :

User communicates with the model using MATLAB's interface.

RESULTS :

For the color processing, the readable images are very high percentages and it may achieve 100% of detection of targeted objects if combined with other features. The color detection will only detect the RGB color which is it will only detect the specified color that matches only and will eliminate others.

Although the color processing may stand the highest chances in mango detection, but it can only detect the targeted object with the static lighting condition.

Different lighting conditions may affect the colors of targeted object change not linearly. The color will have a lot of changes depending on the intensity of light, the reflected rate of the object and the background of the object may also generate the same RGB color as the object. Due to this project may need to detect the inconstant lighting condition and complex background, the method for object detection may be required to focus on shape detection by using CHT.

In this colour processing, it takes each pixel to compare to a common RGB colour of the green mango and perform the elimination. It takes a combination of RGB colour to perform accurate green mango detection which is such as table below where show the RGB value in decimal of maximum 255.

	Detected RGB Colour to be Eliminate		
	RED	GREEN	BLUE
Case 1:	<100		
Case 2:	>Green & >Blue		
Case 2.1:	<=100		<=100
Case 3:	<=100	<=100	<=100
Case 4:	>Green & >Blue		
Case 4.1:		<100	<100
Case 5:		>=100	>=100
Case 5.1:		<=170	<=150
Case 6:		> Blue	>Red
Case 7:	<200	<200	<200
Case 7.1:	>= Green	>= Blue	
Case 8:			>Red & > Green

Figure 3: Result of Mango 1 Detection after RGB Adjustment.

Figure 4: Result of Mango 1 Detection using RGB Filtering.

Figure 5: Result of Mango 2 Detection after RGB Adjustment.

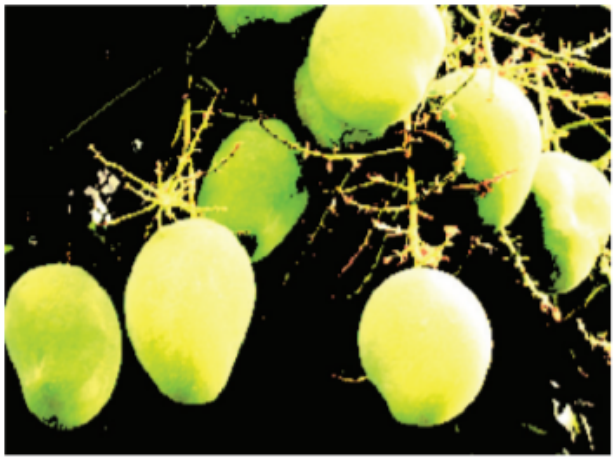


Figure 6: Result of Mango 2 Detection using RGB Filtering.

By referring to the sample mango picture Figure 3, we can clearly see the shape of the unit which almost looks like a sphere. By using the CHT, it can eliminate the object that is not considered as the circle such as leaves.

Figure 4 shows Result of Mango 1 after using RGB filtering. The natural colour of mangoes is lighter up and clearly can differentiate it. In CHT, it performs simple mathematical calculations such as circular formulas.

In here, it detects the location of “1” from the binary image and from there, it performs the calculation and determines the circular objects. To detect it, the radius of the object must be given in order to detect the required round objects size.

Example shows in Figure 5 which is a good sample of mango after RGB Adjustment since colour intensity of leaves are varied from colour intensity of mangoes.

While Figure 6 shows best result of RGB after filtering because it has the very clear intensity different between object and background image.

Figure 7: Good Result of Mango 1 Detection using CHT.

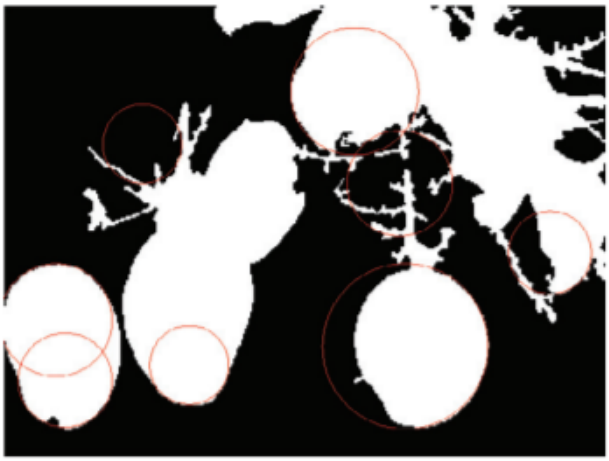


Figure 8: Result of Detected Mango 2.

While for Figure 7, it detects 60% of it. In this step, some unrelated objects are detected due to it having a similar circular area because the CHT detects the object based on the edge of each object.

In Figure 8, it also shows that one of the objects are detected twice due to the object having the longer shape.

In Figure 7, it clearly shows that there are a total 6 objects detected but only 3 of them are detected due to the perfection of circular are not clear. Figure 8, there is overlapping of circular detection where it detect extra 1 object from the total due to the object cannot fit in only 1 circle and also the object are not exactly circular.

Images	Total Objects	Circular Detected	Total Accurate Object Detected	Accurate Object Detected (%)
Image 1	5	6	3	60%
Image 2	9	8	5	55%

CONCLUSION :

In this project, it successfully detects the object from the background image using color processing used as the 1st filter to eliminate the background image, 2nd step by using grayscale filtering and lastly by binary filtering and Circular Hough Transform (CHT) for circular object detection.

The use of color processing is due to it’s one of the powerful techniques to detect the object as in real color processing it contains a lot of information as human eyes does.

While for the grayscale filtering, it filters the pixel and smooths the image to make the edge clearer.

Lastly, CHT takes place to detect the circular objects and display the total number of it.

In the processing of detection, back light conditions affect the image the most where the RGB color reflected will be different according to the light intensity and its effect on the color processing result as well. And the CHT may not exactly detect the circular object as sometimes it is connected with other objects together and gives an inaccurate result.

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