International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 06 | June 2021 www.irjet.net p-ISSN: 2395-0072

WATERBIN - A Remote Controlled Water Surface Cleaning RoboT

M Amarnath[1], P Bhuvanashankar[2], V Krishna Ganesh[3], S B Bindu[4]

Abstract - Suspended Solids are solids in water bodies that can be trapped by a filter. They can include a wide variety of materials, such as silt, decaying plant, animal matter, plastic wastes, industrial wastes, and sewage. A high concentration of suspended solids can cause numerous issues for stream well-being and aquatic life. These suspended solids can block light from reaching submerged vegetation. As the amount of light passing through the water is reduced, photosynthesis slows down. Reduced rates of photosynthesis cause less dissolved oxygen to be released into the water by plants. Hence,there is a need of a solution to remove this trash from the water bodies. Water-bin Project is an attempt to clean water bodies with an ambitious mission: to achieve cleaner water-bodies that are free from suspended solids; to reduce human intervention and human labour; usage of renewable sources of energy by incorporating solar cells to operate our machine. Water-bin Project not only concentrates on technology but also believes that using Science, Technology and Community it is possible to build a sustainable environment.

Key Words: **remote-controlled robot, Water-bin, water surface cleaning robot, suspended solids.**

1.INTRODUCTION

Surface water covers around 70% of the earth, filling our seas, lakes, waterways, and remembering all blue pieces for the world guide. Surface water from freshwater sources other than the ocean represents in excess of 60% of the water conveyed to our homes.As per the Environmental Protection Agency of the U.S., nearly 50% of our rivers and streams and over one-third of our lakes are polluted and unfit for swimming, fishing, and drinking.

One of the significant reasons for water contamination is suspended solids. These outcomes in the various development of water-conceived diseases along these lines affecting human existence. People, yet the reduction in water lucidity brought about by suspended solids can influence the capacity of fish to see and catch food. Suspended residue can likewise stop up fish gills, diminish development rates, decline protection from infection, and forestall egg and larval turn of events. At the point when suspended solids settle to the lower part of a water body, they can cover the eggs of fish and aquatic insects, just as suffocate recently incubated bug hatchling.

According to the many surveys, the worst pollution, in decreasing order, were found in river Markanda (490 mg/l BOD), followed by river Kali (364), river Amlakhadi (353), Yamuna canal (247), river Yamuna at Delhi (70) and river Betwa (58).For context, a water sample with a 5-day BOD between 1 and 2 mg O/L indicates very clean water, 3 to 8 mg O/L indicates moderately clean water, 8 to 20 indicates borderline water, and greater than 20 mg O/L indicates ecologically unsafe, polluted water.

From the literature survey, the effects of these suspended solids (plastic debris) on the environment, and other living organisms is found to be devastating. One of these case studies shows that, globally only 9% of plastic wastes are recycled. Along the beaches of the Atlantic Ocean and the Caribbean Sea, it is found that these areas are dumped with macro plastic debris by the human population around the islands. Fishery materials constitute most of the plastic waste found.

As a solution to the above problem, there are a few machines and robots in practice with the following features:

1. Man controlled vehicle to clean the trash
2. Wired-remote control robot
3. Some are very large in size as they become very difficult to carry along

Thus, Water-bin would be a significant solution for the problems discussed above. The main purpose of this water bin is to collect trash floating in water bodies and guiding efforts to clean them. It is also meant to raise awareness and educate the public to prevent water body pollution. Hence, a well-installed water bin can be used to collect all the suspended solids in a given boundary of a stagnant water body

2. METHODLOGY

This project aims at collecting surface level trash to produce a cleaner water-body. At present, there exists a technology named SEABIN originated in Spain. The SEABIN also serves the same purpose. But there are a few constraints in the SEABIN.

- It sticks around a single spot and doesn't move.
- Requires a power source for working.

So, the main objective of this project is to overcome the above mentioned limitations, by incorporating remote controlled circuits for movement with a wider range of connectivity thereby reducing human intervention to obtain cleaner water bodies. At present, the robot runs with the help of batteries whereas the project can be further improvised by using renewable sources like solar energy to get the necessary electricity for its operation

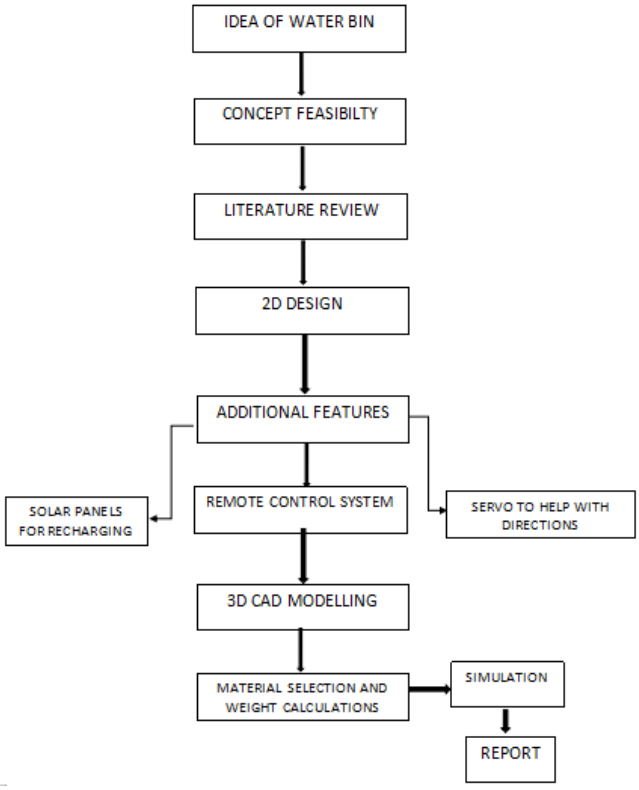

Fig -1: Methodology flow chart

3. MATERIALS

The various factors that is considered during material selection are:

- Design requirements
- Availability of material
- Cost of material
- Material properties like strength, corrosion resistance, toughness,
- Recyclability

The project required four different materials for different components out of which two materials are selected. One for the waste collecting compartment and another for the rod beneath.

Material for Waste collecting compartment:

This compartment is partially suspended in water, so the material requirements were corrosion resistant, chemically inert, easy to process by various methods, less dense than water, impact resistant, strength and cost efficient.

High Density Polyethylene Plastic (HDPE) is used in this robot.

Why HDPE?

- Zero Corrosion.

HDPE is not affected by salt, oxygen and water.

- High Impact resistance.

HPDE is resistance to bumps and scratches, which means it is both tough and flexible – plus it won't be punctured by rocks and other sharp objects.

- Low Carbon Footprint and Recyclable:

HDPE has a carbon footprint that is five times lower than that of aluminium. HDPE can also be completely re-melted and recycled into a new blend.

- Flexible
- Translucent/waxy
- Easy to process by most methods:
- HDPE can be easily processed by injection molding, extrusion, blow molding and rotomolding.
- Low Cost: HDPE costs around Rs.87.25 per kg.
- Good chemical resistance.

Density: The density of HDPE is less than that of water around 0.940 kg/m^3.

Material for the Rods:

These rods are completely suspended in water. These rods will carry the weight of the waste collecting compartment, motor and solar panels. The material requirements for the rods are it should be corrosion resistant, light weight in nature optimal strength to weight ratio, minimal density possible and cost efficient.

Material used for the rods is **Aluminium 5052**.

The alloy composition of 5052 is:

Magnesium: 2.2% - 2.8% by weight

Chromium: 0.15% - 0.35% maximum

Copper: 0.1% maximum, Iron: 0.4% maximum,

Manganese: 0.1% maximum, Silicon: 0.25% maximum

Zinc: 0.1% maximum, Aluminium: Remaining

Why Aluminium 5052?

- Aluminium is light weight in nature.
- Corrosion Resistant:

5052 Aluminium does not contain any copper, so it does not readily corrode in saltwater environment attacks and weakens copper metal composites.

- It has excellent strength to weight ratio.
- It is easy to fabricate.

Its density is 2.680 kg/m3.

It costs around Rs.275 per kg.

Rubber Tubes:

Material chosen: Rubber soft

Density of the material: 9.3e-04 g/m3

The tubes are filled with Helium gas, which in turn helps the robot to float on the water.

Water sealed Compartment:

Material Used: Fiber glass

Cost: 45 rupees/sq. ft.

Material: MS joint sealent (295 rupees per pieced)

It is used to seal all the edges.

After sealing, liquid rubber coating is given for water proofing the outer surface so that short circuit is avoided.

4. DESIGN AND CALCULATION

Some calculations are carried out to design and build a perfect model with all the standards and factors considered. One main objective of Water-bin is to check if it can float on the water surface without any failure. Thus theoretically buoyancy calculation performed with the details (such as mass, COM) from the CAD model.

4.1. BUOYANCY CALCULATION

Buoyancy force (Upward force)

Dimension of balloon:

Length of the balloon = 83cm

Breadth of the balloon = 15cm

Height of the balloon = 17cm

Immersed height = 0.5 * Height

= 0.5 * 17cm

= 8.5cm

Volume of balloon immersed into water, V = L*B*Im.h(Immersed height)

= 83*15*8.5cm3

= 10582.5cm3

Density of water, ρ = 1gm/cm3

Force of gravity, g = 981cm/s2

Now, buoyancy force, Fb = V*ρ*g (Upthrust)

= 10582.5cm3*1gm/cm3*981cm/s2

This value is for one balloon, then for two balloons;

Fb = 2*10582.5*981 = 20762865gcm/s2

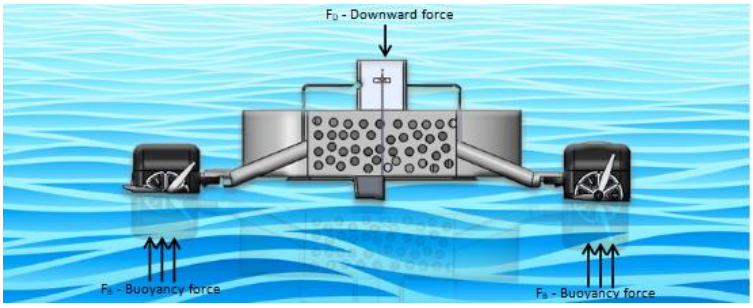

Fig -2: Force distribution - Buoyancy

(Downward force) Force exerted by the total body into the water

Force due to gravity, Fd = Total mass * gravitational force

Total mass of the robot is calculated to be 7.7kgs from the software.

Fd = 7.7*1000*981 gcm/s2

Fd = 7553700 gcm/s2

Fd < Fb, which helps to understand that the unloaded robot can float in water rather than sinking.

Now, to calculate the weight it can withstand without sinking:

Fb - Fd = 20762865 gcm/s2 - 7553700 gcm/s2

$$= \frac{13209165}{100*1000} \text{ kg m/s2}$$

= 132.09N

$$\text{Extra weight it can withstand} = \frac{Fb - Fd}{g}$$

$$= \frac{132}{9.81} \text{ kg}$$

= 13.465kg

So, it can be arrived to a conclusion that the robot can withstand approximately 13kg extra without sinking into water.

4.2. Alternate way to check if the object floats over water

There is another way to check if any object floats over water or not.

Substitute the material of the component as water and get the total weight, total weight of the component with the material that have been chosen is already calculated. If the weight of the component with the material is less than the weight of the component with water as the material, then the object will float.

Mass of the robot with water as the material = 7.75kg

Mass of the robot with water as the material = 7.37kg

Mass of the robot with water as the material < Mass of the robot with water as the material. Therefore, the robot will float.

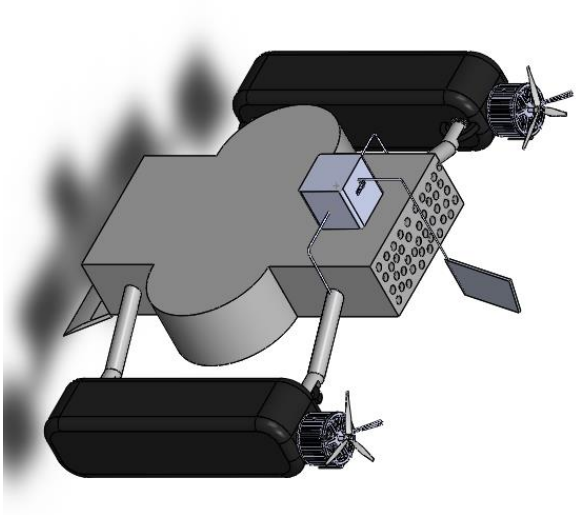

Fig -3: Final assembly

5. REMOTE CONTROLLER

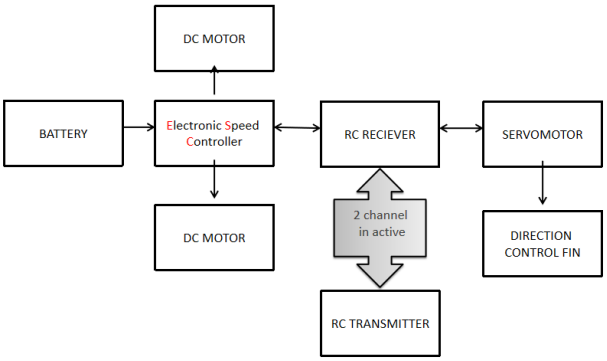

Fig -4: Block diagram of RC

Specification of RC:

Fly Sky FS-CT6B 6ch 2.4GHz Transmitter & Receiver

Table 1: RC Specification

Brand	Flysky
Model	CT6B
Bandwidth	500 kHz
Dimensions	46 x 26.2 x 15cms
No. Of Channels	6
Range of Transmitter	0.8W with 1km range
Operating Voltage	12V DC
Sensitivity	1024

6. RESULTS AND DISCUSSION

The simulations were performed at 198N, that is 20kg load on ANSYS 19.2 and it gave an overview of how much the main component deformed and the volume deformation information as well.

While performing the analysis fine mesh is created and the extended rods (Al rod) are fixed and a load of 198N is applied at the inner centre point of the body and 10m/s^2 acceleration is applied to the body.

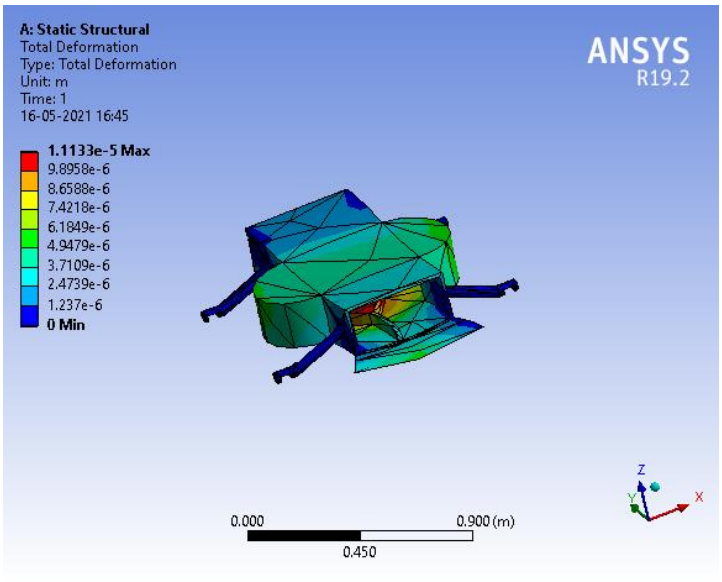

Fig -5: Total deformation

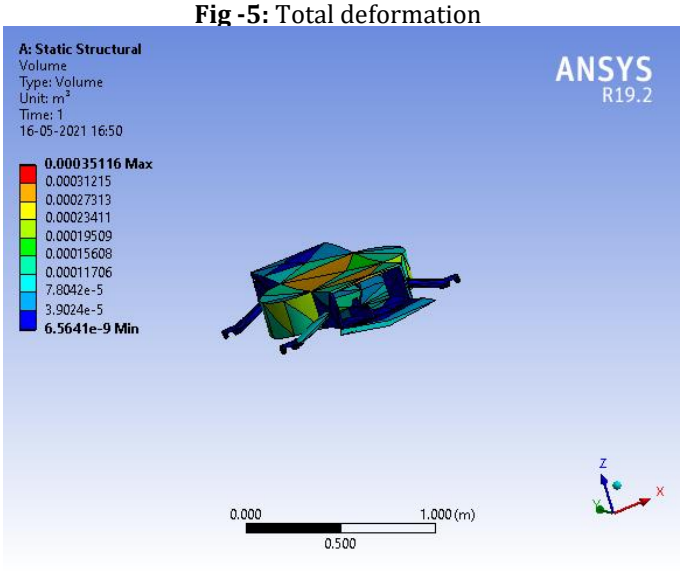

Fig -6: Volume deformation

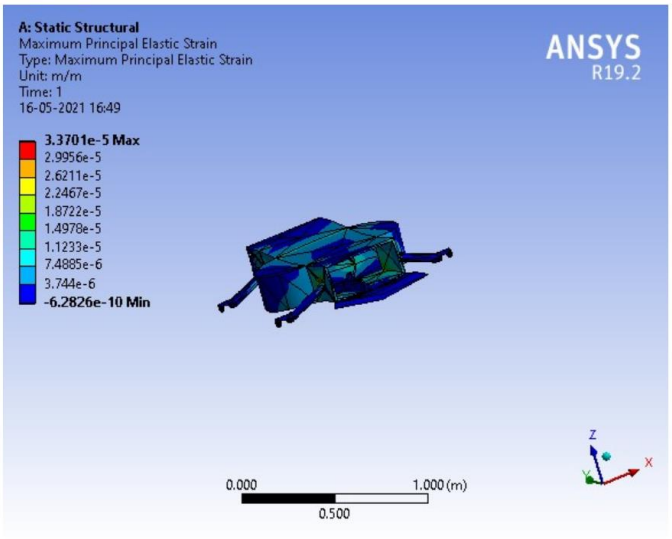

Fig -7: Stress analysis

There has been increasing waste disposal into water bodies which led to decline of aquatic population and contamination of drinking water bodies. As this problem is rising certain issues at a alarming rate some innovative ideas should be introduced to tackle the problem. This project is one of the innovative idea to reduce the water-pollution.

This robot is designed by taking consideration of social and environmental effects. The material is High Density Poly-ethene(HDPE) which is corrosive resistant so water contamination by the rust particles will not take place. The height of Main body of robot is designed in such a way that its at the surface level so it wont affect any aquatic life and only concentrate on cleaning the surface wastes. It is planned that this robot will be operating using solar power so that lithium battery are not required which reduces the post disposal of used batteries and increases efficiency as it don't need external sources other then solar energy.

Most importantly this design have a tight sealed compartments which will reduce the risks of short circuiting thereby increasing feasibility of our robot.

7. CONCLUSIONS

Understanding the problems discussed above, WATER-BIN is constructed in such a way that it clears out all the unnecessary plastic debris floating around in the water bodies, and prevents their pollution to some extent. A structural analysis is performed using Ansys on the model to confirm that the design is intact and doesn't fracture.

One of the important aspect that should be considered is, whether the robot will float or not. From the buoyancy calculation and the alternate method using water as material, it is clear that the robot can float on water. Then from the consecutive calculations, it can also be concluded that the robot can hold up to 13kgs without any failure.

It is clear from the Volumetric and total deformation analysis the deformation takes place only in the second compartment where all the waste is collected and stored. Also, it is inferred that the total deformation reaches only a few micrometers as a maximum value (at the centre) even when the highest load is applied.

The system would not experience any failure or break at any point. The maximum principal elastic strain values also seem to be under control. The project can be further improvised by using renewable sources like solar energy to get the necessary electricity for its operation

REFERENCES

[1] AQUATIC MULTI-ROBOT SYSTEM FOR LAKE CLEANING PRANAY AGRAWAL,BISHAKH BHATTACHARYA DOI: http://dx.doi.org/10.1142/9789814525534_0024

[2] A Water Surface Cleaning Robot E Rahmawati et al 2019 J. Phys.: Conf. Ser. 1417 012006

[3] Plastic pollution in islands of the Atlantic Ocean https://www.sciencedirect.com/science/article/abs/pii/S0269749117334310

[4] Plastic Waste is Exponentially Filling our Oceans, but where are the Robots? https://ieeexplore.ieee.org/document/8629805

[5] Design of a Marine Debris Removal System https://ieeexplore.ieee.org/document/7937696