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Hybrid Waterways Cleaner

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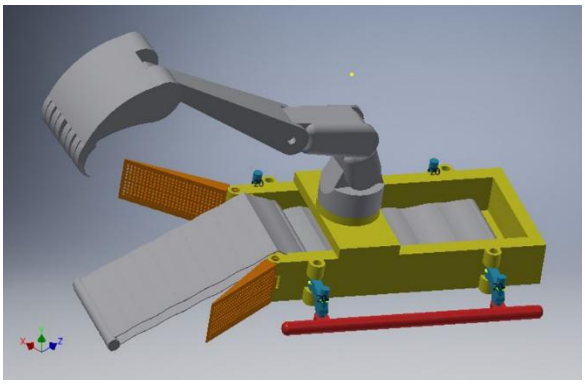
Abstract—Hybrid Waterways Cleaner, fundamentally a river cleaning machine, which incorporates the advantageous mechanisms of other different machines into one. This paper presents a detailed study on the study of these mechanisms, their relevant details and working parameters, and the methods adopted to combine these mechanisms into one machine. The key is identifying and categorizing the types of detritus found in different waterways, selecting some particular type of detritus that could be cleaned, and then selecting a set of mechanisms to achieve the cleaning. The dimensions are decided on a trial and error basis and a relevant simplified CAD model of the boat, arm, and bucket system, and Belt drivedesign is made. This project emphasis on design and fabrication of the river waste cleaning machine. The main fundamental mechanism consists of a conveyor belt with a vibration system, water releasing mechanism, gating mechanism, dumper mechanism, and hydraulic crushing system. This innovation is easy, less costly, and has a lot of room to grow more economical. This project "Hybrid Waterways Cleaner", designed with the hope that it is very much economical and helpful to river and Pond cleaning. Based on its design, cost, and availability of its parts, it is very cheap and useful for our Indian society.

Index Terms—Aluminium Alloy A5083, Aquatic weeds, Buoyancy, Centroid axis, Cleated conveyer belt, Coliform levels, Contaminated water, Detritus, Drag link, Garbage, Recycling, RF Module, Rudder, Sewage Treatment, Waterways.

1 Introduction

There many rivers flowing through India. A total of 13999 km of water flowing through these rivers. On an average 60 – 70% of this length is polluted.Water pollution is categorized into three main categories: clean, gray, and black water. Clean water is from a broken water supply line or leaking faucet.If not treated quickly, this water can turn into black water or gray water, depending on the length of time, temperature, and contact with surrounding contaminants.Greywater is all the wastewater generated in households or office buildings without fecal contamination. Blackwater is wastewater from toilets, which likely contains pathogens. Blackwater can contain feces, urine, water, and toilet paper from flush toilets. The Hybrid Waterways Cleaner is fundamentally a river cleaning machine, which is designed by keeping in focus, the removal of physical detritus in waterways. The design incorporates the advantageous mechanisms of other different machines into one. An aspect of the project also emphasizes on successfully and cost-effectively removing the detritus from these water bodies while maintaining the working of hybrid design.



2 Conceptional View

Image 1: Basic CAD Model of the Machine

The project of hybrid waterways cleaner presents the recent development and application of river cleaning machine in the field of cleaning of waterways. It is very much essential to throw light on basic concepts and technologies associated with conveyor belts, dumpers, and load lifters. The fundamental mechanism consists of a conveyor belt with a vibration system, water releasing mechanism, gating mechanism, dumper mechanism, and hydraulic crushing system.

2.1 Motor Selection

First, determine certain features of the design, such as drive mechanism, rough dimensions, Distance moved, and positioning period.Further, confirming the required specifications for the drive system and equipment (stop accuracy, position holding, speed range, operating voltage, resolution, durability, etc.). is done.

Then, the calculation of the values for load torque, load inertia, speed, etc. at the motor drive shaft of the mechan-

ism takes place. Select a motor type from AC Motors, Brushless DC Motors, or Stepping Motors based on the required specifications. Make a final determination of the motor after confirming that the specifications of the selected motor/gearhead satisfy all of the requirements (mechanical strength, acceleration time, acceleration torque, etc.

3 Conveyer Belt System

A conveyor belt is the carrying medium of a belt conveyor system (often shortened to belt conveyor). A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium—the conveyor belt—that rotates about them. One or both of the pulleys are powered, moving the belt and the material on the belt forward.

3.1 Belt Types and Belt Material Selection

When deciding on which conveyor system best suits your needs, a key consideration is the material is being transported. Some important characteristics to consider are size, flowability, abrasiveness, corrosiveness, moisture content, and the temperature at which it must be kept. Conveying is the moving of materials from one or more pickup points to one or more drop points. The desired window of time for this movement should be considered. The basic types of conveyor belts are:

1. Roller Bed Conveyor Belts
2. Flat Belt Conveyors
3. Modular Belt Conveyors
4. Cleated Belt Conveyors
5. Curved Belt Conveyors
6. Incline/Decline Belt Conveyors
7. Sanitary and Washdown Conveyors
8. Specialty Conveyor Belts

The project we are working on is having a necessity to move the material out of waterways in an inclined position and hence needs a perforated belt or porous material for the belt. Along with that, there is a specific need for the belt to be cleated. Hence we use the cleated conveyer belt system at an inclined position. The only major difference is that we have made a significantly small model portray our ideas and hence the belt system can be considered a simple pulley system.

4 Electronic Controls

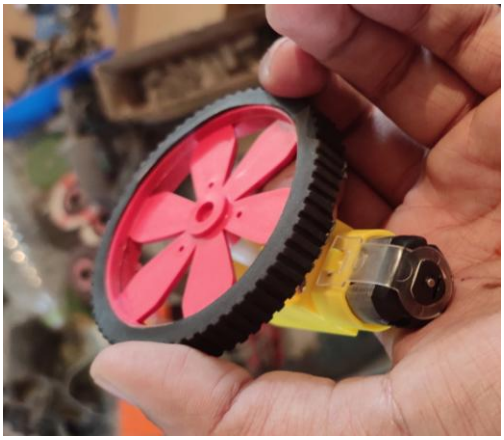
Control of a multi-functional machine, like a hybrid waterways cleaner,can be achieved through various methods. Some include complete automation, some use manual control. But in both cases, control and operation from a distance are desired. In such a case, RF control is a very effective method. (Radio Frequency remote control) A handheld, a wireless device used to operate audio, video, and other electronic equipment using radio frequency (RF) transmission.

4.1 RF Control

Unlike the common infrared (IR) remotes, RF remotes do not have to be aimed at the equipment. RF Receivers (Base Stations) are required. RF remote control (radio frequency remote control) a wireless device used to operate other electronic equipment using radio frequency transmission. Incorporation of this technology is essential to make the “Hybrid Waterways Cleaner” machine more usable and practical. To make this more efficient, further study on different modules is required such as the transmitter module, the receiver module, the transceiver module, and the System on Chip (SOC) module.

4.2 Transmitter Modules

An RF transmitter module is a small PCB subassembly capable of transmitting a radio wave and modulating that wave to carry data. Transmitter modules are usually implemented alongside a microcontroller,



which will provide data to the module, which can be transmitted. RF transmitters are usually subject to regulatory requirements, which dictate the maximum

allowable transmitter power output, harmonics, and band edge requirements.

4.3 Receiver Modules

An RF receiver module receives the modulated RF signal and demodulates it. There are two types of RF receiver modules: superheterodyne receivers and superregenerative receivers. Superregenerative modules are usually low cost and low power designs using a series of amplifiers to extract modulated data from a carrier wave. Superregenerative modules are generally imprecise as their frequency of operation varies considerably with temperature and power supply voltage.Superheterodyne receivers have a performance advantage over superregenerative; they offer increased accuracy and stability over a large voltage and temperature range. This stability comes from a fixed crystal design which in the past tended to mean a comparatively more expensive product. However, advances in receiver chip design now mean that currently there is little price difference between superheterodyne and superregenerative receiver modules.

5 Maneuvering Using Waterwheel

A waterwheel is used in two ways: creating energy from moving water, or to give motion to the machine, as is the case with a paddle-wheel boat. The boat mill has the outside appearance of the latter, but it works just like a water mill. There were two main types of boat mills, out of which, one type was composed of two hulls with a water wheel in between, while the other type consisted of one hull with two waterwheels on both sides (or, sometimes, one waterwheel on one side as well).

5.1 Use of Waterwheel for Direction Control

The basic usage of the waterwheel is for two reasons. One, for power generation and other for flow and direction control in different waterways. Our project implements this technology of combination of two different motors on two separate waterwheels, with these waterwheels assembled at the rear side of the machine.When the direction control is desired, both the waterwheels can be rotated in opposite directions for maneuvering left or right, and also rotated in the same direction for forward or reverse motion of the machine. Theses emotions can be simplified by using the propulsion system and simply using the waterwheels to guide themachine along with the desired directions.

Image 2: Waterwheel attached to a motor

6 Assembling Procedure Of Machine

6.1 Considerations

The basic step is to assemble the base frame of the project by using a hand cutting machine and electric welding machine to withstand the model and its operation. The base frame is made of AA5083. A floater is assembled at the base frame with the help of the L- section through nut and bolt. It is made of a thin sheet by using a rolling and tapping operation.

6.2 Assembly

The purpose of this floater is to float on water, carrying the project weight as compressed air is placed in pipe creating a differential pressure head, causing the machine to float on water. L-clamp is welded in the base frame, which is used to hold the Floater with the help of nut and bolt.The shaft is used to transmitting the torque from the motor to conveyor Belt. The robotic arm is joined to the base Frame. IR module is connected to the motors joining the robotic arm. Conveyor belt motor is connected to the IR module.

7 Material Selection For Machine Framework

7.1 Aluminium

Many boat manufacturers because of its being lightweight, especially when compared to steel prefer aluminium. Aluminium boats are more stable and seaworthy and can travel faster due to reduced weight.

Image 3: Aluminium Alloy A5083 Square Section Tubes.

This means that you get better mileage for the same quantity of fuel from an aluminium boat. Easy workability and its properties like chemical and corrosion resistance, imperviousness to magnetism, and tendency for plastic deformation make aluminium a strong option for boat building.

On the downside, aluminium is expensive. Also, aluminium is a soft metal and hence more susceptible to abrasion. Coming to sustainability, aluminium is recyclable, so that is a point in its favour. Application of eco-friendly paint instead of lead-based paint can be a helpful addition to making an aluminium boat more sustainable.

7.2 Alloy 5083

It is s a non-heat-treatable 4½% magnesium, 0.15% chromium, 0.7% manganese alloy commonly available in flat rolled plate from a range of producing mills. Like all the

5000-series high magnesium alloys 5083 achieves a high strength by cold working, enabling a series of “H” tempers; 5083 is the highest strength of any of these alloys. Alloy 5083 is best known as a plate for ship building. The alloy is also produced as extruded seamless tube and other extrusions and as forgings; these are available on indent from Atlas.

8 Calculations

8.1 Load at no work (Pmin)

For working of no-load conditions, only the machine’s frame, accessories, and equipment weight considered.

Hence, load at no work (Pmin)= 39.248

8.2 Mass of the framework

Every member of framework is square section aluminium tube of the following dimensions:

1. Thickness t = 1.6 mm
2. Length of Framework L = 0.45 m
3. Breadth of Framework B= 0.28 m
4. Height of Framework H= 0.15 m
5. Cross Sectional Area (Ar) = $(019.05)^2$ - $(19.05-2x1.6)^2$
   = 111.68 mm2
6. Volume of Framework V = v1 + v2 + v3

= 4 (Ar) × (450 + 280 + 150)

= 39311.36 mm^3

7. Density of the material
   Aluminium AA5083 (ρ)= 2660 kg/m^3
8. Mass of Framework (m_f) = V × ρ = 0.955 kg
9. Approximate Mass of Framework
   (M_f) = 0.96 kg

Total mass is inclusive of 0.96 kg and masses of other equipment is given by:

1. Framework weight (Wf) = 1.26 × 9.81 = 12.36 N

The estimated masses of motor battery and other accessories are as follows:

1. Miscellaneous Mass (Mm) = 740 + 135 + 800
   = 1675 gm
   = 1.67 kg
2. Equipment weight (We) = 16.43 N
3. Pmin= We + Wf

= 16.43 + 12.36 = 29 N

4. Total weight with detritus
   Loaded completely (Pmax) = 87.65 N
5. Average load (P_{avg})= 58.325 N

TABLE 1
THE ESTIMATED MASS OF DIFFERENT PARTS

Sr. No.	Parts	Estimated mass of different Parts of the machine
1	Framework	0.96 + 0.1 + 0.2 = 1.67 kg (welded)
2	Styrofoam	0.05 kg (unloaded and uncut piece)
3	Wood	0.3 kg (uncarved or uncut wood)
4	Gate	0.2 kg (unassembled perforated)
5	Conveyor	0.4 kg (assembled conveyer x2)
6	Panels	0.3 kg (cut to desired dimensions)
7	Floaters	0.2 kg (unassembled, cut to dimension)
8	Total	4.38 kg (estimated masses total)
9	All motors	0.74 kg (approx. mass of all motors)
10	Battery	0.135 kg (estimate mass)
11	Miscellaneous	0.8 kg (arms, bucket and other parts)

8.3 Motor Selection

1. Type : DC Motor (Power)= V×I
   Where,
   Volt= 12V
   Current =7.6-Amp
2. Calculated value of Power = 12×7.6 = 91.2 watt

8.4 Boat Framework

*Some dimensions are predetermined that is based on Trial and Error method

1. Cross-section:
   Cross-section of the bar (A)= $19.052 - (19.05 - 3.2)2$
2. Stress on the section:
   I. Shear Stresses

(1)

$$\tau = S(A_2y_2 + A_3y_3 + A_4y_4)/(b \times I)$$

Where,

$$I = (b \cdot d^3)/12$$

$$\tau_1 = (5 \times 30.48 \times 8.725))/ (5715.44 \times 19.05)$$

$$\tau_1 = 0.0122\ \mathrm{N}/mm^2$$

$$\tau_2 = (5 \times 30.48 \times 8.725) / (5715.44 \times 19.05)$$

$$\tau_2 = 0.0122\ \mathrm{N}/mm^2$$

$$\tau_3 = 0.145\ \mathrm{N}/mm^2$$

$$\tau_4 = 0.0122\ \mathrm{N}/mm^2$$

(2)

$$\sigma_b = My/I$$

$$M = (WL^2)/8$$

$$\tau = 5 \times ((2 \times 12.86 \times 3.9625 + 30.8725))/ (5715.44 \times 1.6)$$

$$\tau = 0.20113\ N/mm^2$$

II. Bending Stresses:

(3)

$$\therefore\ \mathrm{M} = (5 \times 19.052)/\ 8 = 226.81\ \mathrm{N}\,mm$$

Hence,

$$\sigma_b = (226.81 \times 9.52)/(10.97 \times 10^3$$

$$\therefore \sigma_b = 0.19\ N/mm^2$$

According to beam calculations, the structural safety is under safe limits but it also depends on practical design when manufacturing is taking place there might still be some changes taking place, which would change the criteria of safety selection.

$$tan^{-1}(P/2\pi r)$$

8.5 Conveyer Belt

1. Diameter of shafts (Ds = 2r) = 15 mm
2. Shaft center's distance = 220 mm = 0.22 m
3. Length of belt (2πr + 2L) = 487.12 mm = 0.487 m
4. Length of shaft (w) = 240 mm = 0.24 m

8.6 Propulsion Blades

1. Pitch Ratio = 0.05
2. Pitch of the ship = 0.01 m
3. Diameter of propeller (D) = 0.18 m
4. Pitch angle (φ):
   (4)
   Hence, Pitch angle (φ) = 9.04306
5. Angle of blades (θ) = 90 – φ
   (θ) = 80.956
6. Length of blades (L_b) = 0.075 m

Sr. No.	Category	Dimensions
1	Framework Length	0.45 m
2	Framework Breadth	0.28 m
3	Framework Height	0.15 m
4	Conveyer shaft Centre Distance	0.22 m
5	Conveyer Inclination	35 degrees
6	Conveyer Shaft Diameter	0.015 m
7	Conveyer Belt length	0.487 m
8	Floater Radius	0.085 m
9	Floater Length	0.45 m

Image 4: Picture Depicting Final Dimensions of Machine

8.7 Final Dimensions

TABLE 2
FINAL DIMENSIONS ACCORDING TO CALCULATIONS

9 CONCLUSION

The fabrication of this project was based on literature and research on different journals and papers relevantly available and fabricated in accordance so it can provide flexibility in operation. This innovation is easy, less costly, and has a lot of room to grow more economical. This project "Hybrid Waterways Cleaner", designed with the hope that it is very much economical and helpful to river and Pond cleaning. Based on its design, cost, and availability of its parts, it is very cheap and useful for our Indian society.

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