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AUTOMATIC RIVER CLEANING MACHINE

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ABSTRACT

This research emphasis on design and fabrication of the river waste cleaning machine. The main aim of this work is to reduce the pollution of rivers which are dumped with hugh amount of sewages, factory wastes, etc. Govt of India has made huge investments in various river cleaning projects. Nowadays most of the manufacturing process is being automated so as to deliver the products at a faster rate. Automation plays a vital role in production.

In this research we've fabricated the remote operated river cleaning machine, the primary aim of the research is to cut back the the manpower, time consumption for cleaning the river. Here we've automated the functioning of river waste cleaning with the assistance of a motor and conveyor drive arrangement. Here an RF transmitter and receiver are provided to control the cleaning machine.

KEYWORDS: Debris; Automation; Chain drive arrangement; RF transmitter; Receiver.

1. INTRODUCTION

Nowadays, the environment problems arise in many towns in India these problems come along by developing activities like construction of homes, offices, and other business areas. The Environment problems occur because of several reasons they're the low budget allocation on environment management and public awareness in protecting the environment. The Environment issue which comes up from year to year and still can not be solved is about garbage and waste from various places dispose into rivers. That waste can clog water flow, induce the water become dirty, smelly, and sometimes over flow so then give effect floods. Traditional methods used for collection of floating waste are done manually by humans or by means of waste collecting boat, thrash skimmers etc. and deposited near the shore of rivers. The above mentioned methods are complex, needs lot of time and money.

The main problem associated with cleaning the chemical wastes is that it can cause respiratory diseases and it plays a challenging problem for the municipality workers. Currently, we can see automation process in all major fields but still using automation for cleaning sewages and debris's is a challenging task. The municipality workers have to get down into the sewage sludge to wash the wide sewage. It affects workers health badly and also causes skin diseases.

By taking the parameters of river surface cleaning systems and overcoming the disadvantages of the methods used earlier, the automated river cleaning machine has been designed which helps in cleaning river surface, cleaning effectively, efficiently and eco-friendly. This machine is consisting of conveyer mechanism which collect & remove the wastage, garbage & plastic wastages from water bodies. This also reduce the difficulties which we face when collection of debris occur. The river cleaning machine will take the floating wastes from the water surface and it will reduce water pollution and thus saves aquatic life.

Design challenges

Main design challenge was the load which act on the bottom frame. Both conveyor mechanism as yet as propelling motion of the machine affects the load of the machine apparatus which has effect on the floating of the machinery.to make sure maximum buoyancy of the apparatus, weight should be balanced on all sides.

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Second challenge was calculation of the friction acted by the water on the apparatus. If the water moves faster, there'll be more friction acting between the moving water and apparatus. So to cut back the friction the apparatus is formed as streamlined as possible. Also base frame is formed using PVC material to cut back friction. Force acted by the water is calculated using formula F=ALC/T where F is that the force, A=average area, C=coefficient for the underside of water bed, and T= time travelled. The coefficient is variable because it is for rocky bed and 0.9 for steams with muddy bed.

The third challenge is to reduce the manufacturing cost. The model should be compact and also the mechanism should be simple and reliable. Another challenge is little radial size of collecting plate so it collect the waste only upto 75 cm deep under the water.

Literature survey

[1] M. Mohamed Idhris, M. Elamparthi, C. Manoj Kumar Dr.N. Nithyavathy, Mr. K. Suganeswaran, Mr. S. Arun kumar, DESIGN AND FABRICATION OF REMOTE CONTROLLED SEWAGE CLEANING MACHINE [2017]
The paper gives the idea about the working and positioning of various components in the machine. In the proposed system, the machine is operated using a remote control to take waste. Therefore, the system avoids the harmful impacts from the sewage waste and gases. When the system is ON wiper motor that starts running. The two power window motors are connected to the wheel and it is operated with the help of the remote control set-up. The system collects the sewage wastes by using the arm and put it into waste bin fixed in the machine. The set-up runs in the sewage area with water so it collect the floating waste.. The waste which affects the drainage is also taken and removed. This system has less human intervention in cleaning process and in turn reduces wide spreading of diseases.

[2] Basant Rai Pollution and Conservation of ganga river In modern India [2017]
This study helps the successful analysis of pollution level in various rivers in India especially Ganga river and identification of various pollutants and debris present in river.

Considering the World Bank Sponsored Study regarding various pollution level in the rivers in India(State of Environment Report - U.P.) (In: Mallikarjun, 2003), pollution levels in the Ganga river is contributing about 10-12% of total disease burden in Uttar Pradesh. The level of coliform bacteria present in the water is very high and are in excess of 2 lakh MPN while considering against the national water quality standard of 5000 (Mallikarjun, 2003). The report estimated total health damage caused by water pollution in up to is around 6.4 million daily (Disability Adjusted Life Year).

[3] Osiany Nurlansa, Dewi Anisa Istiqomah, and Mahendra Astu Sanggha Pawitra AGATOR (Automatic Garbage Collector) as Automatic Garbage Collector Robot Model [2017]
The research paper provides a detailed view about the automation process. The research is done to design and make AGATOR(Automatic Garbage Collector), which is a rotor robot model to make it as a automatic garbage collector to counter accumulation of waste in the river which has no flow efficiently. The method of implementation is construction and design . This method includes the identification of needs, analysis of the components required specifically, software engineering, hardware , developing, and testing.

[4] Rajendra Patil, Rahul Itnare, Sagar Ahirrao, Amol Jadhav, Ajay Dhumal,1,2,3,4B.E. Scholar BVCOE&RI Nashik (Pune University), Assistant Professor BVCOE&RI Nashik,"Study Of River Harvesting & Trash Cleaning Machine."[2019]
The journal provides the idea about the designing of collecting plate and shaft. Design consists of application of scientific principle, technical information, and imagination for development of new mechanism to perform specific function with maximum economy and efficiency.

Harvesting starts when plants grows and reaches the top surface of water. In the harvester system cutting head is lowered deep into the water and the harvester moves forward, cutting and collecting plants infront of it.

Harvesters varies in the size and capability. Most of the underground plants are located about five feet beneath the water and in a swath between five and ten feet wide. Large machines with larger cutting heads and holding capacities is more efficient, but it is less manoeuvrable. The same area may need to be harvested again in a few weeks depend on the time of year, weather, and depth of cut.

2. COMPONENTS AND DESCRIPTION

Components

Floating frame

For making floating frame, we used 6 inch, 4kg/cm PVC pipe, 6 inch couplings(2nos.),Elbow joints(2nos.),T joints(2nos.),and end caps(2nos.) are used to join PVC parts and together they constitute about 200 cm length of the prototype model and 95 cm of width. The purpose of this pipe is to float on water, carrying the whole load of conveyor belt system and propeller motion weight and compressed air is placed in pipe forming a differential pressure head that helps the machine to float on river water.

Base frame

The base frame is made of 1 X 1 inch GI square tubes and is clamped on the floating frame on 4 sides. The clamp is made using 1 X 0.25 inch MS flat. 3/8 X 1.5 inch nut and bolt is used to fasten the clamp(16nos.). The length of base frame is 180cm length and 85 cm width. The primary step is the assemble of base frame of the project with the help of hand cutting machine and electric welding machine to overcome the model and its operation. All the equipments are placed above the Base frame.

Fig 1: Base frame Assembly

Conveyor belt

For making conveyor belt the shaft is made of 2.5 inch, 10 kg/cm PVC pipe(2nos.). The belt used in making conveyor belt is made of treadmill sheet which is to be fixed in an inclined structure made of GI square tube and the collecting plate is made cut in half piece of PVC pipe . The chain drive and collecting plate are rotating frequently with the help of motor. The waste collecting plate is attached between the two chain drives for collecting the garbages waste materials from river.

Power transmitting shaft

The power transmitting shaft is modelled using M16 threaded rod and the 2.5 inch PVC pipe is closed using 2.5 inch coupling, reducer bush. We placed 6302 bearing inside the reducer bush and the M16 threaded rod is placed inside this bearing. The Shaft is used to transmit the torque from motor to chain drive. There are two shafts which are assembled in the machine. First shaft is fixed is at the front chain drive of machine and second shaft is fixed at the back chain drive using inclined selection.

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Collecting tray

The collecting tray is made grill metal sheets. The collected wastages are disposed in the collecting tray with the help of conveyor belt mechanism. Collecting tank is to be placed behind conveyor belt.

Wiper motor

12V DC Motor used in lorry wipers is to be placed above the inclined section to provide torque to rotate the conveyor belt. M16 shaft is connected to the motor shaft to transmit power.

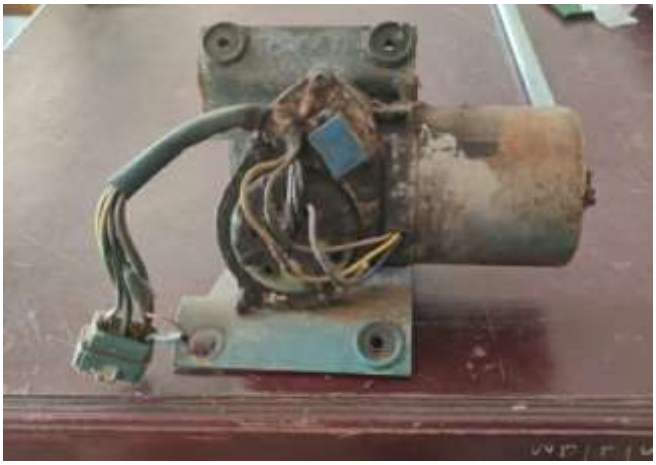

Fig 2 :12V lorry wiper Motor

Battery

Provides electrical power to run 12V DC Lorry Viper Motor,24V DC Propeller motor and for electronic parts(automation process)

DC motor

The selection of a DC Motor is based on the available voltage for application and the size of the motor shaft and casing(frame size).Since the size of the apparatus(2 m long and 85 cm width)is comparatively big, the propeller alone is not sufficiently enough to be powered by a battery. So 24V DC motor is to be placed in a framework to provide torque to rotate the propeller. Torque and speed also have an effect on motor frame size. High torque motors are much bigger in size than low-torque motors, which means that larger mounting hardware and larger housings are required. Though torque and speed are independent requirements in large number of applications, typically speaking when the torque increases the speed will decrease – if the voltage stays the same. Other specifications include;

Shaft speed: Shaft speed generally refer to the no-load speed, which is the maximum speed the motor can reach when no torque is applied. The shaft speed is represented in revolutions per minute (rpm). For numerical calculations, the unit of shaft speed is represented in rps(revolutions per seconds).The formula which describes the relationship between radians per second and revolutions per minute is

$\omega rad/s = \omega rpm \times (2\pi/60)$

For DC motor, the rotational speed is directly proportional to the provided voltage, or

$\omega = j \cdot V$

where j is the constant of proportionality, with units rad/(s-V).

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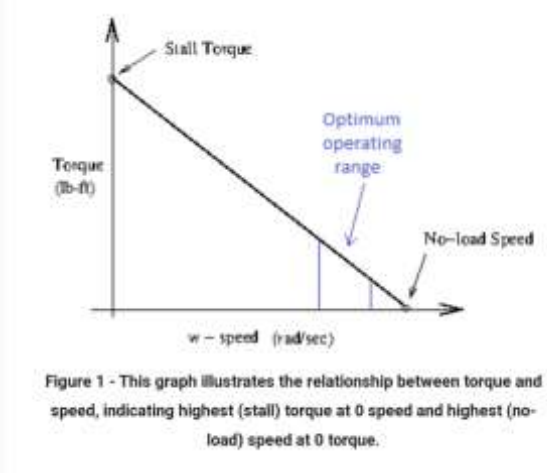


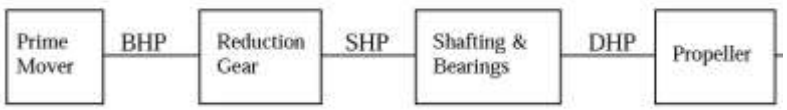
Figure 1 - This graph illustrates the relationship between torque and speed, indicating highest (stall) torque at 0 speed and highest (no-load) speed at 0 torque.

Fig 3 : Output Characteristics of DC Motor

A 24V DC motor is preferable than 12 V DC Motor as it requires lower current for same power and power control is more efficient due to its large size.

Fig 4 :DC motor

Propellor



It is made of stainless steel which is powered by 24 DC motor. Propeller is to placed just below the rear section frame. The purpose of the propulsion system is to convert electrical energy from the battery into useful thrust to propel the ship. There will be efficiency losses in the rotation of propeller in the form of mechanical losses, friction loss, thermodynamic loss(due to heat loss),losses in the gearbox, shafting and propellers themselves.

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Fig 5 :. Stainless steel based fishing boat propeller

Radio frequency transmitter

RF (Radio Frequency) transmitter is a circuit that has a ,wave guide, transducer modulator and an antenna used to transfer radio waves. Some circuits need not have a modulator when the range of receiver(consists same blocks as transmitter but performs a reverse operation) is nearby to transmitter. An RF transmitter receives serial data signals which transmits it wirelessly with radio frequency through the antenna connected at pin4. The transferred data is received by a radio frequency receiver operating at exact same frequency of the transmitter.

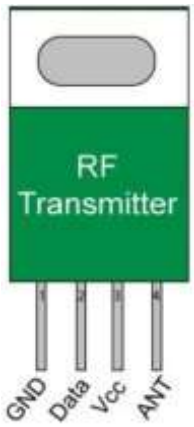

Fig 6 :Radio Frequency transmitter

3. WORKING

The automatic river cleaning machine system consists of 2 section –front section and rear section.

Front section

The apparatus collects waste using conveyor belt mechanism which is powered by a 12V DC motor and is rotated continuously by the motor. Fins made of PVC pipes cut in half is screwed to the conveyor belt so as to lift waste from the water. The conveyor belt is made of 3mm thick resin sheet which is rotated along 2 shafts-moving(at top where motor is coupled) and fixed(at bottom), made up of M16 stud bar and 2.5 inch PVC pipe whose ends are closed using 2.5 inch reducer bush and 6302 bearing. The incline section is made using 1 to 1 inch GI square tubes to fix this conveyor belt system. The waste lifted from the river surface is collected at the back of conveyor belt system called collecting tray. The collecting plate is coupled between 2 chain drives.

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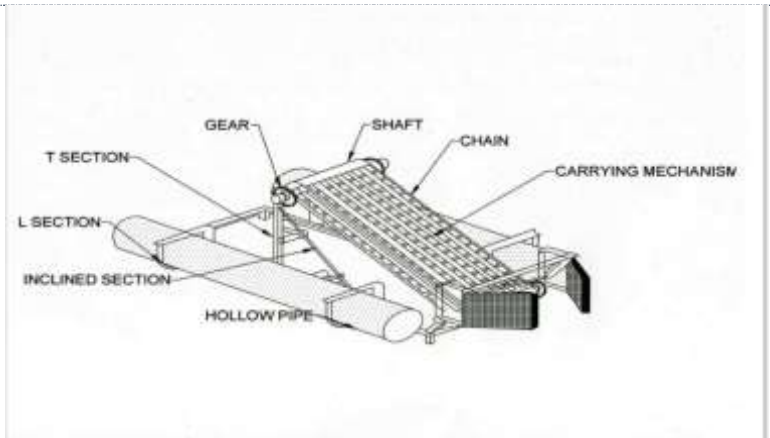

Fig 7: Front section of River Cleaning machine

Rear section

The forward motion of the apparatus is controlled by the rotation of propeller (used in small fishing boats) which is powered by the 24V DC motor. A framework is made at the rear section to support the weights of 24V DC motor (for rotating propeller),a 12V DC motor(for direction control) and a battery (which provides electric power to the motors) so as to ensure weight balance between front and rear section to prevent submergence of the system.

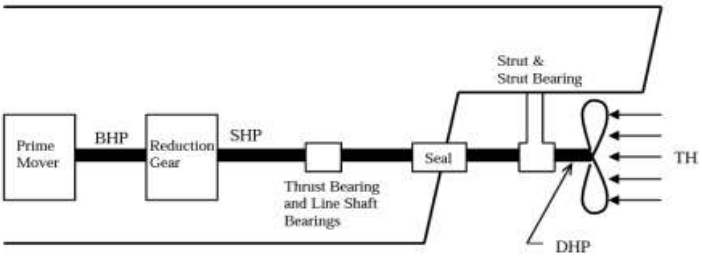

Fig 8 :Propelling Mechanism

Automation process

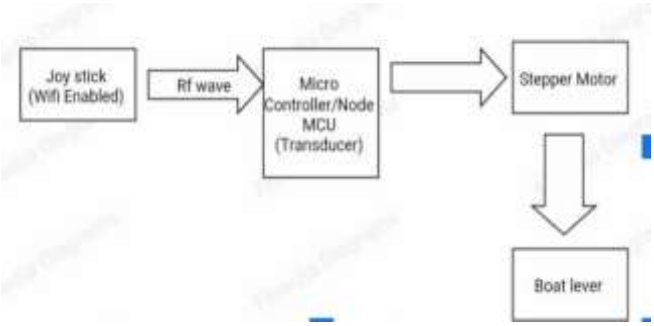

Fig 9 :Units of Automation process

Radio frequency signal is transmitted from joystick (wifi enabled) to the microcontroller. Microcontroller act as a transducer, as it converts the radio frequency signal to electrical signal. This electrical signal is transferred to stepper motor where electrical signal is converted to mechanical motion. Thus stepper motor turns according to motion of joystick controlled by a WiFi device. Stepper motor is connected to boat lever and boat lever turns.

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4. RESULTS AND DISCUSSIONS

Calculations

1. Base Frame

Length=200cm
Width=87cm
Square pipe 1 x 1 inch

2. DC Motor used for conveyor belt(12 V)

DC Motor used to rotate the conveyor belt is 12V lorry DC Viper Motor to handle more load through the conveyor belt,in the form of wastes.

Power required(no load)=Vx I=12 x 2.5=30W
Power required(load)=VxI=12x4=48w
Speed of the motor,N=55 rpm
Angular velocity=ω=2πN/60=(2π x 55)/60
=5.7595/s
Torque required for rotation=(P x 60)/(2π x N)
=(48 x 60)/(2π x 55)=8.33815Nm
Force required/load acting on the shaft that rotates the shaft=T/r(r=shaft diameter=16mm)
=(8.33815x1000)/16
=521.1343N/mm

Since it is a series motor,high starting torques at low speeds and, low torque at high speeds are possible. High starting, of torque enables, even a small series motor to start a heavy load.

Load characteristics of DC motor are defined by Speed-torque characteristics

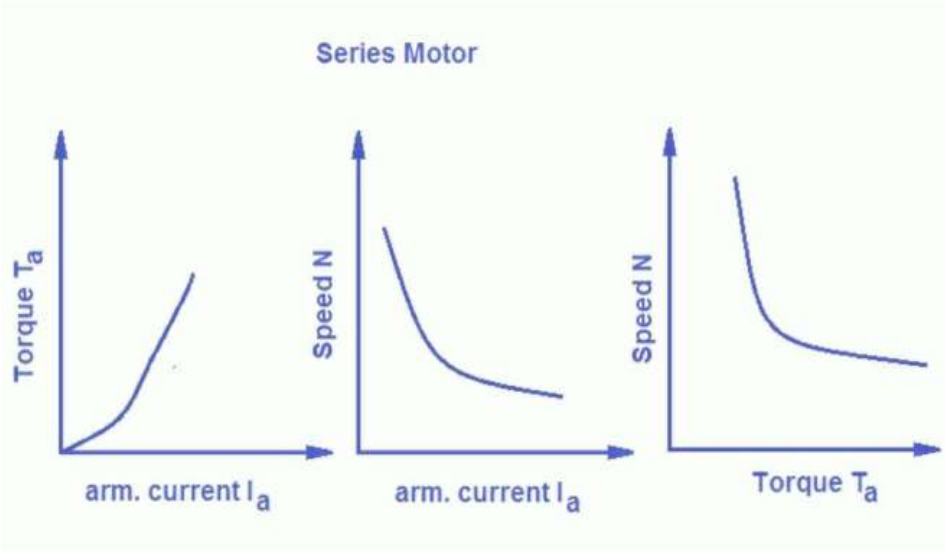

Fig 10 :Speed-torque characteristics

3 a. Design Power=Pd=Pr x Kl
=48 X 1.2=57.6 W =0.0576kW
Where Pr=rated power, Kl=Load factor= 1.2 for uniform load at 24 hr/day service.

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b. Design Torque=Td=Tr x Kl
=8.33815 x 1.2=10.00578Nm

4. Capacity of conveyor belt

M=ρ x K(0.9B-0.05)^2 x V
where ρ is density of material used in conveyor belt=925 kg/m^2
K=0.17, V-volume of waste collected(constant throughout the cleaning process)

5.Propeller Thrust

Propeller Thrust=mass flow rate x difference in velocity=ρ x A x V x (V1-V2)
=1000 x ((3.14 x 0.5)/4) x 10 x (10-2)
= 31400 N
*Speed of apparatus=10m/s(constant)
*density of water=1000kg/m^3
*Diameter= 0.5m
*Max. shaft rpm=300
4-bladed propeller
*Rotational torque =(P x 60)/(2 x 3.14 x 300)
=(24 x 5.5 x 60)/(2 x 3.14 x 300)=4.20382Nm
Propeller efficiency=P.E=(T x Vs)/(2 x 3.14 x N x Q)=(31400 x 10)/(2 x 3.14 x 300x 4.20382)
=39.603%

Advantages

1. It is a non-conventional river cleaning machine.
2. Its initial and maintenance cost is low
3. No requirement of skilled worker
4. Environmental friendly system
5. Easy to operate

Disadvantages

- The application depends on the velocity of flow of water. If the velocity of flow is high there is high friction acting across apparatus and water surface which leads to difficulty in forward motion.
- Underwater wastes cannot be collected
- Algae's which are deep rooted in water are difficult to remove.

5. CONCLUSION AND FUTURE SCOPE

This projected is fabricated on the basis of literature and research on different journal and paper relevantly available and fabricated in accordance so it can provide flexibility in operation. On the basis of its design and estimating cost and availability it is very cheap and very useful for the society. For future scope, the addition of solar panels may help with the, electrical power supply on automatic river cleaning machine.

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