Patent Draft

ABSTRACT

The invention aims to provide an autonomously operating surface water robot capable of solving the issue of floating debris, microplastic and oil spills in polluted water bodies. We utilise deep learning and digital image processing to detect floating debris. The debris is then collected using a conveyor belt mechanism and stored in a net attached to the back of the robot. The oil and microplastic present in the water is first sucked in using a hydraulic pump. The oil is separated using a filtration system consisting of a sieve, fine sand, pebbles and a semi-permeable cloth. The separated oil is stored in a floatable storage balloon. The microplastic is separated using a sieve and is stored in a chamber. The movement of the robot is controlled with the help of two forward motors and one lateral motor.

FIELD OF INVENTION

The current invention is a method of collecting waste/debris that floats on the surface of a water body along with the separation of microplastics and cleaning oil-water mixture. The mentioned tasks are performed by an autonomous robot. The main scope of the invention is in the field of robotics and clean technology- specifically, the cleaning of polluted water bodies.

BACKGROUND OF THE INVENTION

Water pollution is a growing concern with plastic waste and oil spills taking a heavy toll on marine life. Water surface cleaning robots are being used to clean debris which are found floating in their vicinity. Examples of water surface cleaning robots are C.N Pat. No. 103935476A, 206691339U.

For instance C.N Pat. No. 103935476A describes a robot with a control setup and a central processing unit. The control setup comprises a video acquisition device, a homing device and an actuating device. The control setup is connected with the central processing unit using a communication module on the hull of the robot. A rubbish harvester is also present inside

the hull. The rubbish harvester comprises a refuse collection framework present at the bottom of the hull and a collection mouth positioned in the working direction of the hull. Communication is carried out wirelessly between the robot and the central processing unit at the base station(ground).

The video acquisition device first identifies the garbage and guides the actuating device towards target rubbish. The garbage is then collected with the help of the rubbish harvester. The rubbish harvester utilises a cleaning nozzle, water pump and water outlet. The collection mouth of the rubbish harvester is controlled with the help of servo driving which closes and opens the folding door.
The homing device comprises GPS satellite alignment sensor, electronic compass and an inertia measuring module which are all electrically connected with a central processing unit.

Another patent, CN206691339U focuses on cleaning marine oil spills using a robot. This robot utilises a master board, solar panel, flexible pipe pallet, oil-absorbing pipeline, gyroscope, pumps, sensor and an oil storage tank. The robot is operated on solar power and the solar panels are located at the left and right sides of the master board.

BRIEF SUMMARY OF THE INVENTION

The current invention provides a method to clean the water bodies by collecting the debris floating on the water surface, cleaning oil spills and removing microplastics from water. This invention is one of a kind as it solves multiple issues affecting marine life. It incorporates various mechanisms to deal with the above mentioned issues.

The robots use computer vision and deep learning algorithms to detect the debris, for which a camera module and TF-LUNA Distance Sensor is attached on the roof of the main body. The TF-LUNA Sensor is utilized to prevent collision with the environment and ensure proper navigation to the

collection point of the floating debris. The main body consists of an inclined backward moving conveyor, which will guide the trash to the waste-collecting net attached to the rear of the body. A compressor is provided in the middle of the conveyor, which will compress the trash. This reduces the volume of the trash and increases the trash storage capacity. DC and servo motors are present at the rear of the body, which will work as per the navigation algorithm to guide the robot in forward and lateral directions to reach the collection point. The robot is equipped with separate motors for forward and lateral movement which increases its maneuverability. This enables our robot to navigate around sharp corners and rough waters.

The collision of the robot with the underwater terrain is prevented by implementing a collision-prevention system, using a SONAR, attached to the bottom of the robot. This system prevents our robot from running into underwater rocks. Also, a sieve is attached to the bottom surface to ensure drainage of water from the compressed trash. This makes our robot lighter and more agile.

The current invention is equipped with a filter system whose purpose is to separate the microplastics and further clean the oil-water mixture. Oil-water mixture is pumped to the filter using the pump-funnel mechanism present at the bottom of the robot. The filter consists of various layers of gravel, sand along with a semi-permeable fabric to allow the flow of water back into the water body. The separated oil will be transferred into a floating balloon container via a one-way valve. Also keeping green energy in mind, a solar panel is also incorporated with the invention. The solar panel is mounted on the roof of the robot. The sole purpose of the solar panel is to recharge the batteries and provide an extended power supply to the robot.

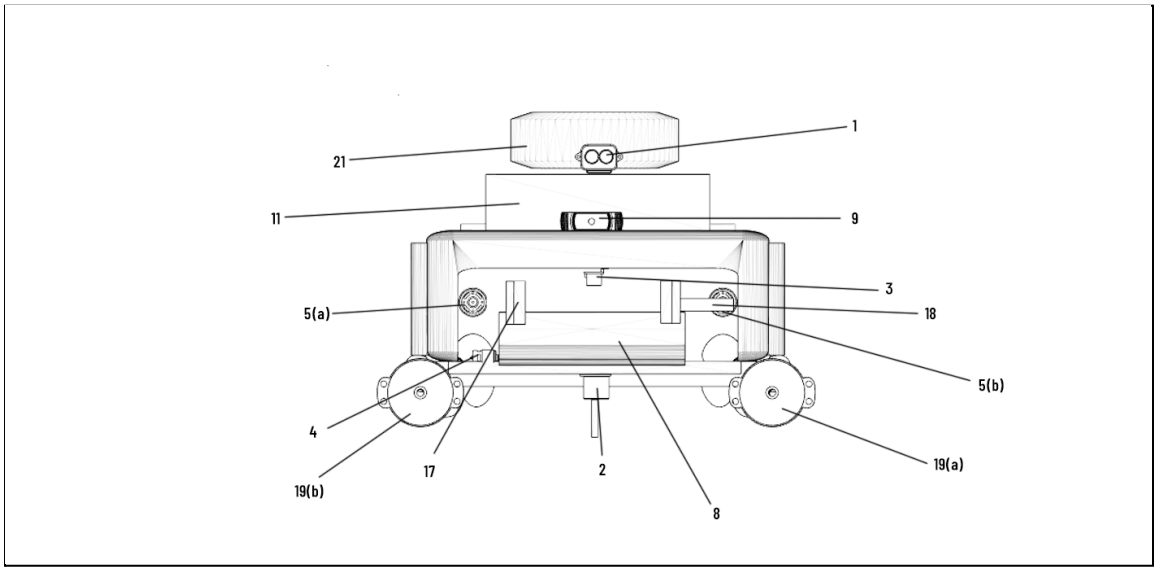


Fig-1

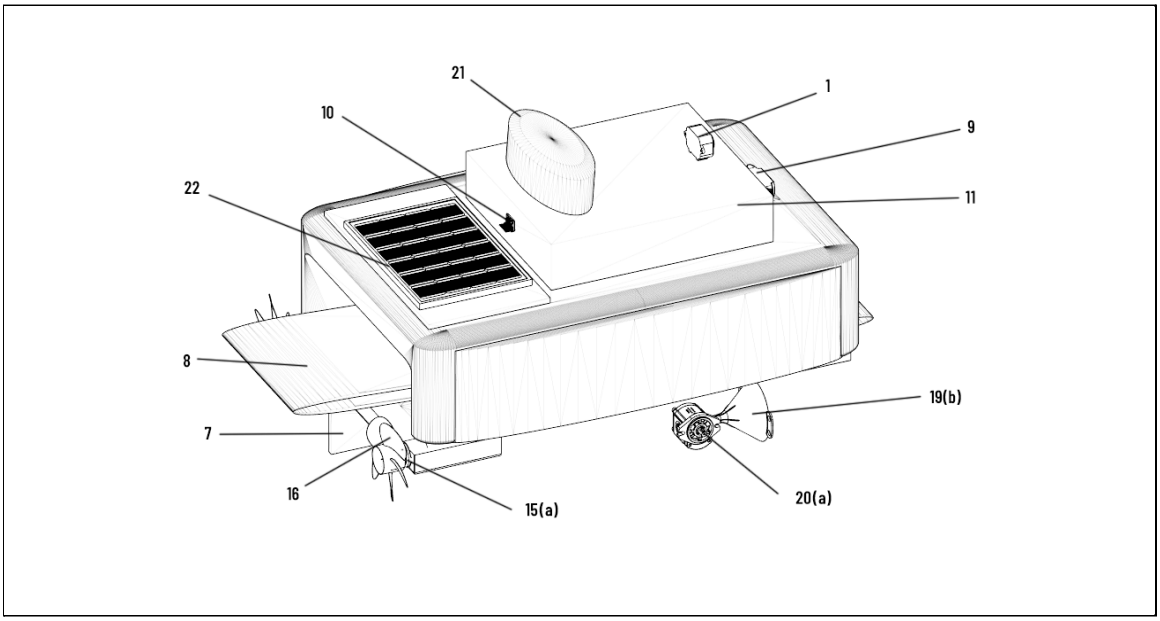
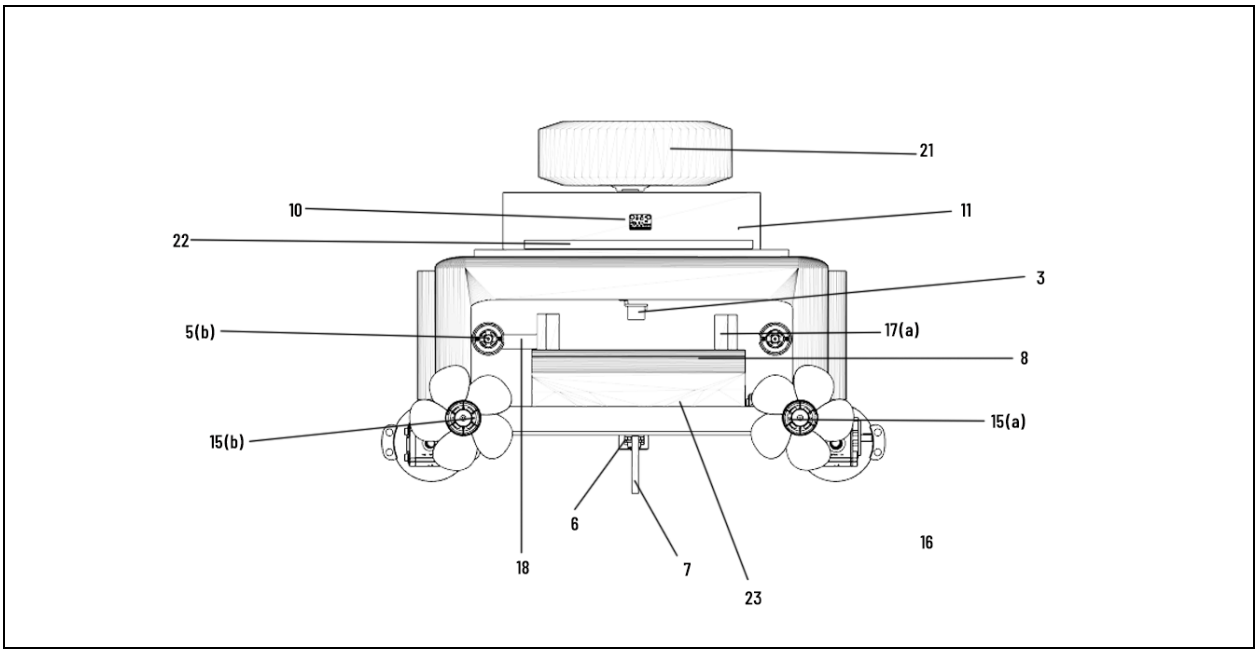


Fig-2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17(a)
8
15(b)
15(a)
6
16
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7
23

Fig-3

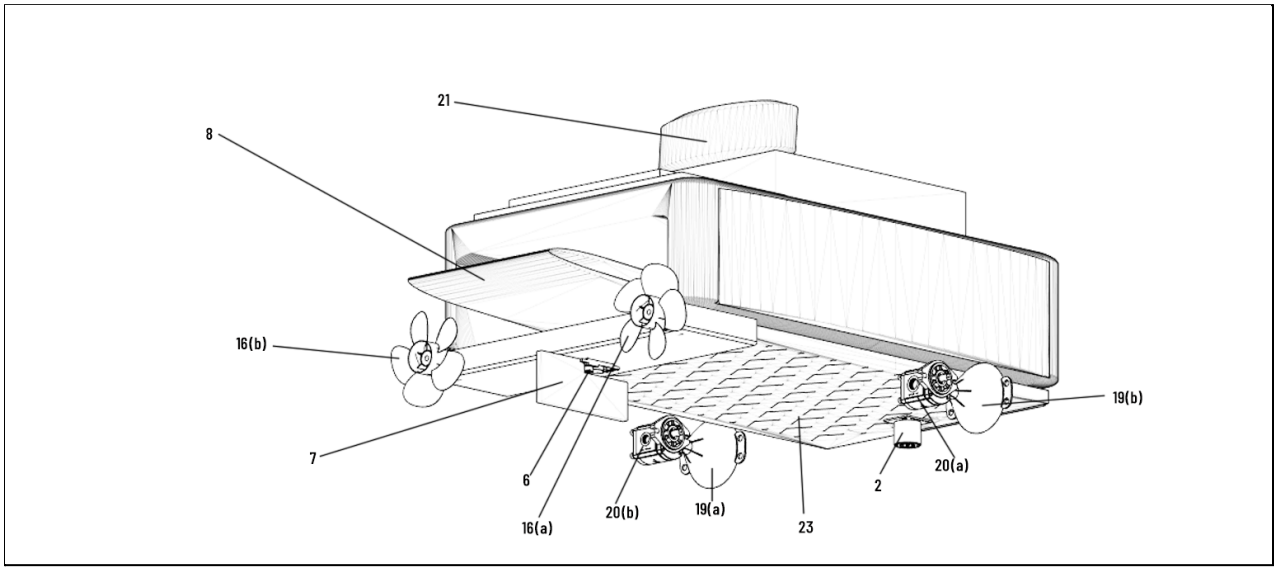
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Fig-4

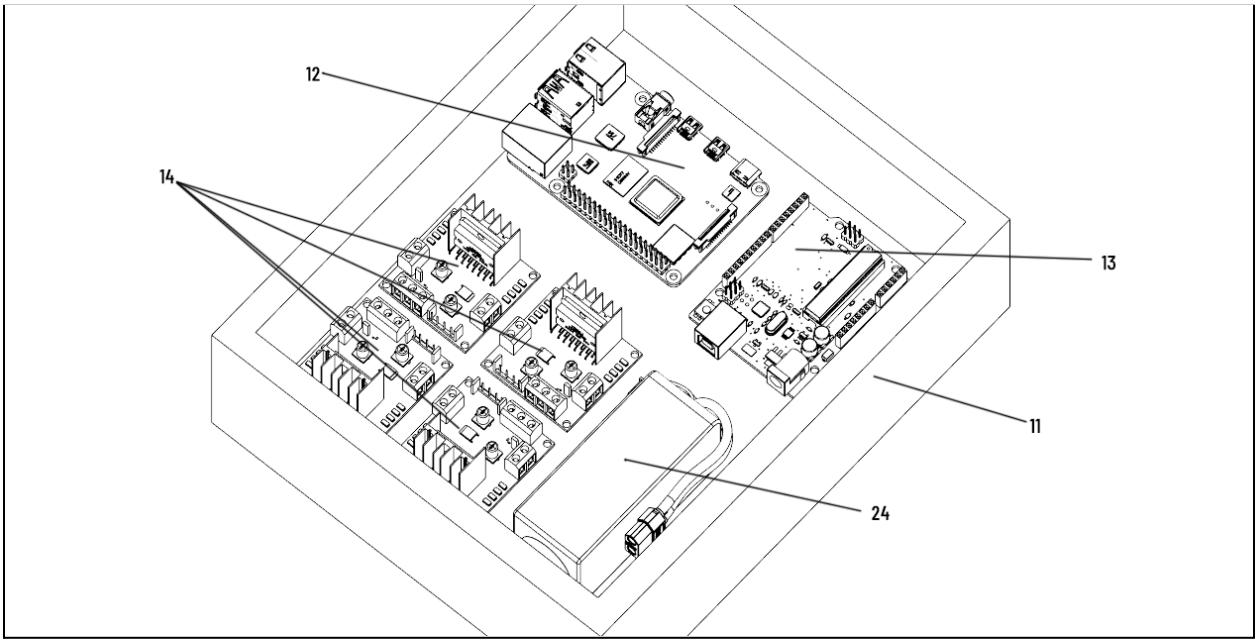

Fig-5

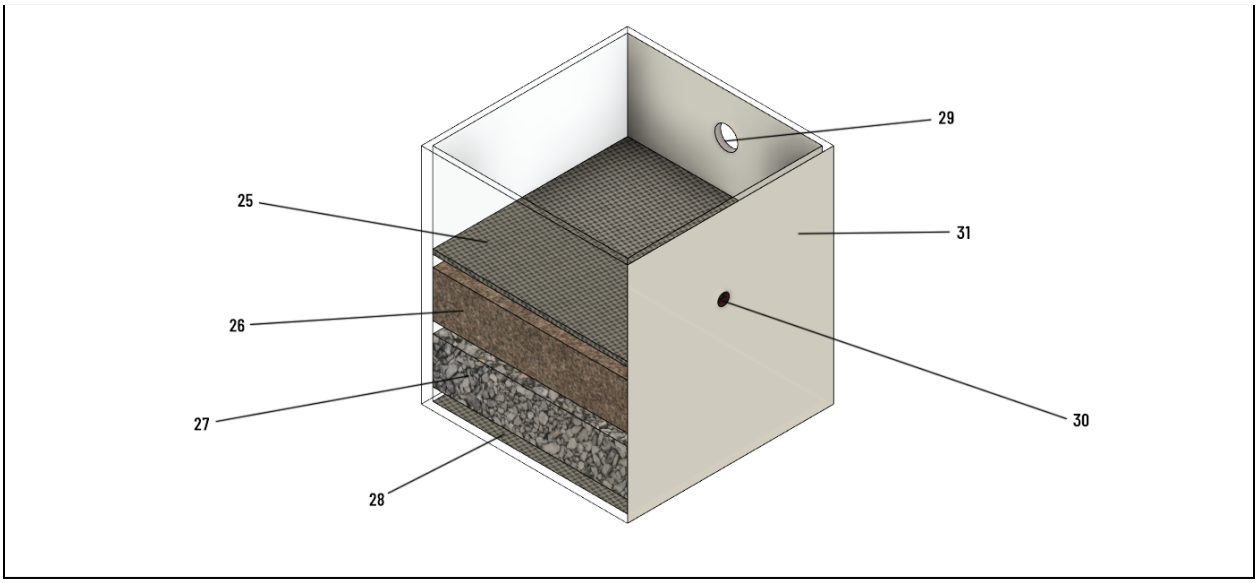

Fig-6

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF DRAWINGS

Fig-1 is the front view of the present invention showcasing the main structure of the robot with all the components annotated;

Fig-2 is the side view of the present invention depicting all the elements present on the top surface of the robot;

Fig-3 is the rear view perspective of the invention, majorly depicting the movement/**navigation** mechanism;

Fig-4 is a tilted view of the robot representing all the elements present on the bottom of the robot;

Fig-5 is the representation of the main circuit box, which consists of major electronic components.

DETAILED DESCRIPTION OF INVENTION

Figure 1 describes the front view of the robot. The camera module depicted by **[9]** is responsible for detecting the floating debris and trash on the water surface. Once detected, **[15a]** , **[15b]** motors and propeller **[16]** get activated and in turn make the robot move **(Figure 3)**. The rudder **[7]** attached to the servo motor **[6]** is responsible for the lateral movement of the robot**(Figure 3)**. The forward and lateral motors work in conjunction to guide the robot towards the target debris. On reaching the detected waste, the motor **[4]**, driving the conveyor belt **[8]**, is activated **(Figure 1, Figure 2)**. The conveyor belt is tilted at an angle and moves in a rearward direction to effectively collect trash. The trash collected by the conveyor belt is carried to the compressor system. The compressor system comprises an ultrasonic sensor **[3]**, two crushers **[17]** opposite each other and two motors **[5]** controlling these crushers through shafts **[18] (Figure 1, 3)**. The ultrasonic sensor **[3]** detects the approaching trash and halts the conveyor

belt with the trash aligned with the crushers **[17]**. The compressing mechanism is then initiated, and the trash is compressed, which reduces its volume and makes it easy to store. During the compression, the water stored in the trash will be removed via strainer **[23]**, making the robot lightweight and manoeuvrable. After completing the compressing procedure, the crusher will get restored to its original position, and the conveyor belt is again activated, further carrying the trash toward the net. The compressed trash is stored in a net located behind the robot.

The water, which contains liquid or minute impurities like microplastics and crude oil will be forced inside the filtration and collection chamber **[21]** of the robot by the suction pressure created by the pumps **[20]** placed behind the funnel. The water mixture collected through the pumps is forced via tubes to the filtration chamber **[21]**, through the inlet valve **[29]**. The filtration chamber is a plastic box, which has an inlet for the mixture and an outlet **[30]** to expel the pollutants into detachable, floating balloons, connected by means of one-way valves. The first layer of the filtration chamber is a layer of fine cotton fabric **[25]**, which allows passage of only fluids like water and oil, while capturing the micro-plastics and fibres over it. This layer is followed by a layer of sand **[26]** and gravel **[27]**, which only allow the passage of water through them, storing oil and other fine impurities like heavy metals, over it. All these layers are followed by a layer of fine cotton fabric **[28]**, through which all the water discharges to the bottom of the chamber and is directed out, by means of pumps, back into the water body. These can be referred to by **Figure 1** , **Figure 2**, **Figure 3** , **Figure 4** and **Figure 6**.

The path planning is based on the inputs of a camera module **[9]** and the TF-LUNA Distance Sensor **[1]**. The TF-LUNA Distance Sensor transmits an IR light ray and receives it after it gets bounced back by an obstacle. By this the sensor detects the distance between the sensor and the obstacle, hence, making distance an important parameter for obstacle avoidance and path planning. The other major input for path planning is obtained via a SONAR sensor **[2]**, which actively publishes the depth of the floor of the

water body, and helps the robot to avoid shallow waters. The positioning of these sensors can be referred to by image **Figure 1** , **Figure 2**, **Figure 3** and **Figure 4**. All these inputs, along with IMU **[10]** help in detailing out a map of the water body and the surroundings, which help the robot to perform Reactive Navigation. Based on the inputs received from the sensors, the Raspberry Pi 4 **[12]** controls the brushless DC motors **[15]** which helps the robot propel in forward and backward directions. For turning the robot, a rudder **[7]** is attached to a servo motor. The differential speeds of the left and right motors and the rudder, help in generating high torque, which help in navigating sharp turns. The motor-propeller and the rudders are placed at some depth beneath the main body of the robot, to provide enough room for the net. These are clearly shown in **Figure 2**, **Figure 3** and **Figure 4**.

Figure 5 refers to the components and the circuits controlling the robot. Circuit box **[11]** is a waterproof chamber that houses the Raspberry Pi 4 **[12]**, Arduino UNO **[13]**, motor drivers **[14]** and battery **[24]**. Raspberry Pi 4 **[12]**, is responsible for running the trash detection and the navigation algorithm. Arduino UNO **[13]**, controls the compressor mechanism and the conveyor belt. Battery **[24]** will be used to supply D.C power to the boards and the components. The solar panel **[22]** is utilized in order to recharge the battery which ensures the capability to operate for extended periods of time.

CLAIMS

1) Filtration and Garbage Collection
   The robot provides a novel method of cleaning floating debris and filtering oil simultaneously. Other patented surface robots aren't able to perform these tasks concurrently.

2) Microplastics

The invention is the first robot which tackles the issue of microplastics, which are disposed-off in water bodies during industrial activities. Separation of microplastics is a peculiar process because of its relatively small size(< 5mm). These wastes are separated from the collected water through a sieve present before the filter system.

3) Oil Filtration System
   The oil filtration system utilises layers of sand, stones and cotton and is a distinctive approach to solve the issue of oil spills.

4) Conveyor Belt System Inside the Robot
   The conveyor belt system which incorporates a compressor is a unique mechanism consisting of two parallel crushers and an ultrasonic sensor. It's role is to compress the incoming trash which improves the trash storage capacity of the robot.

5) Storage of Oil
   The robot stores the separated oil in a floating balloon which is connected to the outlet of the oil-water separation chamber by means of one-way valves.