Autonomous Water Trash Collecting Robot

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Abstract- *The Great Pacific Garbage Patch is a collection of marine debris in the NorthPacific Ocean. Marine debris is litter that ends up in the ocean, seas, and other largebodies of water. It is also known as Pacific Trash Vortex. It is estimated that by 2050, there could be as much plastic as there are fish in the ocean. They circulate in largecurrents that thread through the oceans called Gyres. Plastics in general are highDensity Polyethylene which naturally resists natural decay of any form. The entire lifecycle of plastic is poisonous, it manufacturing depends on harmful chemicals and when released into the environment, it sold up even more toxins and transports them oceanwide. Plastic chokes the ability of the ocean to absorb CO2 from the atmosphere, Exacerbating climate change. The idea that it could be 50% plastic and 50% marine lifeis absolutely unacceptable and horrifying. Autonomous Trash Accumulation solutionsin preliminary stages to avoid pollutants entering the main stream water bodies resultingin oceanic tragedies.*

Keywords- Marine debris, Trash collector robot, PixHawk controller, Missionplanner software

I. INTRODUCTION

In this project we present a cursory view of the current plastic water wastecatastrophe, associated robot research, and other efforts currently underway to address the issue. The goal of the project is to spur interest, perhaps even indignation within the robotics community, to further study how we can meet the great challenges posed by this situation. We believe that robotics has tremendous potential to offer realistic solutions to the catastrophe of plastic waste in our waters. The autonomous water trash collecting robot have characteristics like collision detection, move over vertical and inclined surfaces, saves time, they occupy less space; they can easily reach nook corners to collect the trash. But there are some negative sides too, they have limited working area, electrical components to be protected from water, they need efficient algorithm to detect the amount of trash collected. A boat would need: A hull, an electric drive train, self-driving capabilities, internet controllability. The goal was not to turn it into a fully-fledged measuring boat, but to get all the systems up and running and install an autopilot. The hull is the biggest part of the boat. An off the shelf RC boat was unfortunately not in the cards for us, as those boats have a very limited payload capacity. A boat without motors or sails has the driving characteristics of a piece of driftwood. Therefore we needed to add a propulsion system to the empty hull. Propulsion is cool, but a boat also needs to turn. There are multiple ways to achieve that. The two most common solutions are Rudders and differential thrust. The boats motors claim to be able to handle 2s to 6s which translates to a voltage range of 6V all the way to 25.2V. Here is a quick rundown of the three battery iterations that the boat went through: 1. LiPo Battery Pack, 2. Car Battery 3.LiFePo4 Battery Pack. The brain is connected to the batteries ground while the ESCs and Servos are separated by a shunt resistor. This allows the current to be measured through the little orange connection as it causes a small voltage drop over the shunt resistor. The rest of the wiring is just red to red and black to black. The flight controller runs the ArduPilot Rover Firmware. It does a variety of things. It controls the motor controllers. The receiver is connected to a remote control. The video signal of the camera is passed to the FC that adds an on screen display (OSD) to the video stream. This little transmitter is an input/output device that connects the flight controller to the ground station. GPS module and a compass module is what enable the boat to know its position, speed and orientation. The inside looks much more convoluted. There are basically numerous steps to get an ArduPilot Rover up and running after everything is wired up correctly. ArduPilot gives an advanced playground of hundreds of parameters that can be used to build pretty much any self-driving vehicle anyone can think of. RGB LED's are very cool and show what's going on inside the controller. Green is good, red is bad and there is also a lot of colour codes.

Need of the study

The marine debris pollution problem has been widely recognized on all levels of jurisdiction, international, federal, state, and local. Though the problem has been recognized and work has been conducted, marine debris still persists today. Marine debris has primarily just been “cleaned up” in the past and more recently specific sources of the debris have been identified. Clean-ups have illustrated that the debris comes primarily from the land and not the ocean. Though ocean-based forms of debris (e.g. large nets and monofilament fishing line) are fairly low in occurrence in most areas, they should not be ignored. Ocean-based debris potentially poses some of the severest threats of entanglement for wildlife and can cause major habitat degradation. A national scientific study, the NMDMP, is being conducted by CMC to determine trends and changes in marine debris. It is clear that as populations continue to grow along coastlines and fishing and tourism remain important to coastal communities, the marine debris issue will merit attention. Future research should focus on finding the most prevalent and destructive sources, treating the problem at the sources through examining solid waste practices and changing people's behaviours. Since enforcement of regulations is often difficult, ways of changing people's behaviour through other means (e.g. education, incentives) should be investigated.

Objective of the study

1. To makes water bodies pollution free. To provide cleanliest water bodies for next generation.
2. To save the life of aquatic animal and reduces human efforts required to clean the waterbodies.

Problem Identification

Marine debris, also called marine trash, is any human-made solid material that is disposed of or abandoned on beaches, in waterways that lead to the ocean, or in the ocean itself, regardless of whether disposal occurred directly, indirectly,intentionally or unintentionally.

II. REVIEW OF RELATED LITERATURE

Author: Rui L. Pedroso de Lima, Floris C. Boogaard and Rutger E. de Graaf- van Dinther, 2020, MPDI

With climate change and urban development, water systems are changing faster than ever. Currently, the ecological status of water systems is still judged based on single point measurements, without taking into account the spatial and temporal variability of water quality and ecology. There is a need for better and more dynamic monitoring methods and technologies. Aquatic drones are becoming accessible and intuitive tools that may have an important role in water management. This paper describes the outcomes, field experiences and feedback gathered from the use of underwater drones equipped with sensors and video cameras in various pilot applications in The Netherlands, in collaboration with local water managers. It was observed that, in many situations, the use of underwater drones allows one to obtain information that would be costly and even impossible to obtain with other methods and provides a unique combination of three-dimensional data and underwater footage/images. From data collected with drones, it was possible to map different areas with contrasting vegetation, to establish connections between fauna/flora species and local water quality conditions, or to observe variations of water quality parameters with water depth. This study identifies opportunities for the application of this technology, discusses their limitations and obstacles, and proposes recommendation guidelines for new technical designs. n this work, multiple mini/observation/exploration class ROVs were used for data collection campaigns. Their specifications vary between the different models, resulting in different advantages, as well as limitations. The propulsion and diving configurations range from using a single propeller, a rudder for steering and a ballast tank for diving (e.g., Neptune drone), to a vectored thrusters configuration that allows motion in multiple directions (e.g., BlueROV2). The drones are either tethered, with a real-time video feed, or controlled wirelessly via radio signals: operational depth restricted to a maximum of 5 m water depth. Some of the tested models allow features such as the ability to set a fixed depth and/or a fixed direction that is automatically maintained through the self- adjustment of the speed of the thrusters, based on the real-time processing of the on board pressure sensor and compass. The characteristics of the underwater drones are further compared. The drones were deployed from bridges, boats, or from the margins of the water bodies. The tether cable could be used to sustain the vehicle weight when the water was not within direct reach. These state of the art sensors and sondes are allowed to monitor water quality parameters such as pressure/depth, temperature, conductivity, nitrate, ammonium, dissolved oxygen and turbidity, chlorophyll-a and phycocyanin. A pressure/barometric sensor were placed onshore to allow posterior compensation for the atmospheric pressure in water depth computations. Although most sensors allow a sample rate of 1 s, data was collected every 10 s, due to a frequency limitation of the dissolved oxygen sensor. The sensors, in particular the ion-selective electrodes (ISE—nitrate and ammonium) require frequent calibration to provide accurate measurements. The underwater drones were able to dive and collect data at multiple water depths on the water column, generating three-dimensional datasets. These were used to obtain depthprofiles and maps at specified water depths. Sensors have a response time of a fewseconds, which means that the drone had to descend in small steps, in order to allow the sensors to stay for some time at each desired depth. Underwater drones were used to scan aquatic ecology, in particular to assess the presence of fish, aquatic plants or other aquatic organisms, and to identify and compare characteristics of underwater environments in different zones. The drones were guided to different regions of water bodies and collected images at multiple water depths. The underwater images were collected simultaneously with data collected by sensors. When surveying aquatic fauna, care was taken to minimize noise and disturbances underwater while operating the underwater drone. Lighting conditions were adjusted at each location to ensure optimal underwater image quality. The fact that the drones are limited to existing sensors and therefore can only measure a limited number of parameters is presently still a limitation of the application of this tool, due to policy guidelines. These guidelines often require that specific conventional/standardized methodologies are used and indicate a wide list of parameters that have to be monitored, including microbiological or toxicology parameters that can only be quantified by analysing water samples in laboratories. Moreover, in the field tests, the ROVs were used to collect data in a single moment in time, but end-users reiterated the added value for the data sets if the same measurements are repeated in different days/seasons, as this would provide much more comprehensive information about what is happening in the water system. Other aspects that generated concerns and discussions include: (i) the suitability of the aquatic drones to be used in areas with dense vegetation that would cause the clogging of propellers; (ii) the potential entanglement of the tether with underwater objects and obstacles; (iii) the effect on water quality and ecology of the movement, noise and turbulence caused by the propellers; (iv) lack of temporal data series, accuracy in determining/counting aquatic species; (v) knowledge of the position of the drone underwater; (vi) limitation of range and battery life; (vii) legal feasibility (e.g., suitability for complying with water framework directive monitoring requirements); (viii) limitations when navigating high turbidity and poor visibility conditions; (ix) problems caused by the interaction with other boats in waterways; (x) technology shortcoming regarding swarming and underwater communications; (xi) resources needed for data processing and analysis.

III. BRAIN: ARDUPILOT

There are basically the following steps to get an ArduPilot Rover up and running after everything is wired up correctly:

1. Flash ArduPilot Firmware to FC.
2. Install Ground Station software like Mission Planner and connect the board.
3. Do a basic hardware setup
    - calibrate gyro and compass
    - calibrate remote control
    - Setup output channels
4. Do a more advanced setup by going through the parameter list.
    - Voltage and current sensor
    - Channel mapping
    - LEDs
5. Do a test drive and tune the parameters for throttle and steering.

ArduPilot gives you an advanced playground of hundreds of parameters that we can use to build pretty much any self-driving vehicle we can think of and if we are missing something we can engage with the community to build it as this great project is open source. Here is a little list of the advanced settings:

- Changed Channel mapping in RC MAP
    - Pitch 2->3
    - Throttle 3->2
- Activated I2C RGB LEDs
- Frame Type = Boat
- Setup Skid Steering
    - Channel 1 = Throttle Left
    - Channel 2 = Throttle Right
- Channel 8 = Flight Mode
- Channel 5 = Arming/Disarming
- Setup Current and Battery Monitor
    - BATT_MONITOR=4
    - then reboot. BATT_VOLT_PIN 12
    - BATT_CURR_PIN 11
    - BATT_VOLT_MULT 11.0

IV. MISSIONS

The boat is finally able to drive it, click on the map in my mission planner software to create a waypoint mission, upload it to the boat and it will drive the pre- configured route. Although the boat is not perfectly tuned and is also not yet well tested (this will hopefully be done by future project groups), it is able to follow simple routes and sends a constant stream of telemetry data to the ground station. On flipping the switch on remote control and the boat just starts moving on its own, without us touching the throttle stick and the route is highly repeatable. We can just store our waypoint map in a little file and the boat will drive the same route again and again and again. This makes it possible to sample certain points on surface of alake and generate heat maps over time. This can make trends that usually happentoo slow or on too big of a scale to notice visible.

V. PROPOSED IDEA

A pair of Pontoons is coupled with a lightweight aluminium frame that is skeletal. A cage or basket traps and accumulates all the trash that is on the robot’s path. Since all of the trash is floating, we do not need induction motors, just DC Thrusters with the right ratings. The volume of the cage to the density of plastic will give us the weight of a hypothetical tightly packed cage. In order to propel this load, Torque, RPM and voltage rating of thrusters is scrutinized for. Finally, grapheme batteries with subsequent capacities are also used to power the thrusters. Electronic Speed Controllers with the help of an Arduino Nano linked to a PixHawk controller will fulfil the basic functionality of the robot. A generic GPS module is used with the software, mission Planner to constantly locate and remotely control the robot.

VI. CALCULATION

Thrust of motor, Fv

$Fv = Fm \cos 0$ deg
$Fv = 7.024$ kg – f
Where,
Fv = Thrust of the motor
Fm = kg-f of the motor
For two motors, this will be 14.048 kg-f.

Floating calculation

Average density of hull > density of ocean
For the hulls to float, the average density of hull, ρAH < The average density of ocean, ρAO
$\rho AH < \rho AO$
$\rho AO = (2 \times 7.025) = 14$ kg/l
ρAH = mass of hull / volume of hull
$= (8 / 9.81) / (0.5 \times 0.26 \times 0.52)$
$= 13.693$ kg/l
Since $\rho AH < \rho AO$, the boat will float.

VII. RESULT

The autonomous water trash collecting robot was designed and fabricated.The connections were made using the specified electronic components. Itcollected floating trash subjects on a water body with the help of ArduPilot software.

VIII. CONCLUSION

This robot is upgradable; add-ons such as a LIDAR sensor can be interfaced for profound path planning. Live video casting using A VTX transmitter/receiver will allow the user to monitor the path of the robot for analysis purposes. The Lithium Polymer battery used can be linked with a Grapheme battery as reserve for burst current in case of overload or drifting.

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