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Auto Trash Collection in Water Bodies Using a Smart Device

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***Abstract*—** The major issues in water bodies is contamination which results in the reduction of dissolved oxygen level. This leads to various environmental hazards and also affects the aquatic animals. Cleaning water bodies of these waste materials requires manpower and long hours. Instead of wasting manpower at once we can build an autonomous device which can decrease the human effort and interference by periodic cleaning of the water body. This device which is built using the Raspberry Pi is to help people by frequent maintenance of the water bodies with minimalist human interference. An object detection algorithm is used for the detection of trash on water bodies. Computer Vision Technology is used for image processing, object detection and object tracking. The device navigates towards the detected trash with the control signals generated by custom made algorithm. After the device navigates towards the trash, the trash is collected inside the mesh structure built into the structure of the device.

***Keywords*—** *Raspberry Pi, Object Detection, Computer Vision.*

I. INTRODUCTION

Due to the negligence of the humans and the increase in population, the scenario of cleanliness with respect to waste management is decreasing day by day. The washing up of the trash on the banks and shores of the water bodies creates unhygienic condition for the surroundings. The pollution of water bodies is one of the major problems. Most of the major rivers water quality has been severely affected. Several water resources like lakes, ponds, rivers and oceans are facing severe threats from floating wastes. The waste which comes are majorly man-made waste, which causes risks to public health, water transport system and environment. The floating wastes like trash bags, water bottles and other polythene products does not dissolve easily in water. These floating wastes will cut off the oxygen exchange between atmosphere and water, resulting in decrease of dissolved oxygen level in water, which harms the aquatic ecosystem. These floating wastes carry the harmful bacteria like pathogens from one place to another place, resulting in pathogenic colonies which lead to disease like diarrhea, cholera and many more. During the past few years, debris monitoring has been majorly conducted by the process of manual spotting using patrol boats. This solution is only scalable for small-scale monitoring and it is labor intensive. The organisation of the paper is as follows, Section I contains the introduction, Section II contains the related work, Section III contains the architecture, Section IV contains the methodology, Section V contains the results and discussion, and finally Section VI contains the conclusion and future scope of the work carried out .

II. RELATED WORK

Recent studies have demonstrated the feasibility of such type of device. The first example was “Garbage Detection and Collection of Garbage Using Computer” [1]. Here the detection is trash is done by edge detection algorithm and they used vacuum function to collect the trash but these are only meant to be used on land. The second one is “Aquatic Debris Detection Using Embedded Camera Sensors” [2]. Here they used background subtraction to detect debris on water bodies and they used the camera for capturing the debris which is uploaded to the server. But here they didn't use any mechanism to collect the debris. The next one is "Aquatic Debris Monitoring & Detection using Raspberry Pi based AQUABOT” [3]. Even here they used background subtraction to detect debris. No new method is used and didn’t deploy any collection or disposal method. Next is “Economic Floating Waste Detection for Surface Cleaning Robots" in which laser sensors are used for detection [4]. The drawback is the range of laser scan which is 5m and it only detects the debris. In "A Vision-based Robotic Grasping System Using Deep Learning for Garbage Sorting”, here a robotic grasping system was developed which is used to segregate the garbage. Here they used the “Region Proposal Generation (RPN)” and the “VGG-16” model for object

recognition and pose estimation. The drawback is it is a time-consuming process. It works only on terrains.

In this project, a Smart and Autonomous device is proposed which detects the trash using object detection algorithm and collects the detected trash. Here we used Haar cascade algorithm for object detection and developed an efficient algorithm for navigation and collection trash.

III. ARCHITECTURE

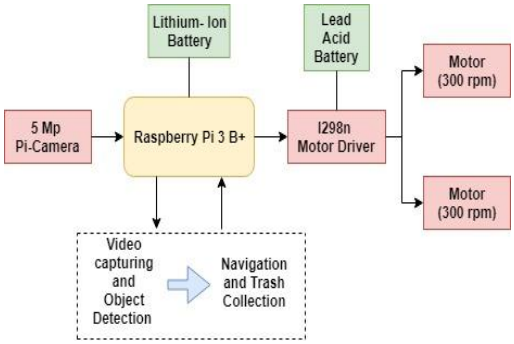

Figure 1. High-level design of the device

The device is built around the Raspberry Pi 3 B+ which is powered by Lithium-Ion Battery. The 5MP Pi-Camera is used for capturing the image. The motors controlled by Raspberry Pi through L293n motor drivers. The lead acid battery is used as a power source for motors.

IV. METHODOLOGY

A. Video capturing and object detection

"Haar Cascade Algorithm" is used to detect the object. This module consists of two sub units: Dataset creation and object detection.

Haar Cascade: Here the "Haar" feature is utilized for object detection. In Haar-like feature the adjoining rectangular regions at a selected area in a particular detection window is taken into consideration, in each region the pixel intensities are summed up and the difference is calculated between the sums obtained. This difference is used to categorize the section of the image. During detection phase, window of the desired target size is moved over the provided input image, and the "Haar-like" feature is calculated for every segment of the image. This difference is later compared with a learned threshold that distinguishes non needed objects from the objects. The calculation speed of the 'Haar' feature is greater than the other features.

Data set Creation: The step involved in dataset creation are:

Step 1: Collection of the positive and negative training images.

Step 2: Marking positive images.

Step 3: Creating a .vec (vector) file based on positive marked images.

Step 4: Training the classifier and creating an XML file.

Object Detection: The pi camera is used for capturing video which is then converted into images/ frames. These images are converted into a grayscale image and sent Haar Cascade model which returns the top left corner, height, and width of the rectangle which surrounds the object if it is detected and these values are sent to navigation module.

B. Navigation and Trash collection

In this module, the centroid of the rectangle is calculated i.e. the bounding box of which surround the object as well as the centroid of the image using moments function in OpenCV. The distance between them is calculated. Using which device is turned either left or right accordingly so that the object will be at the center of the image. Then the device is moved forward to collect the trash.

Specifically, GPIO (General Purpose Input Output) pins 17,21,22,23 of Raspberry Pi are used to control motors through the motor driver.

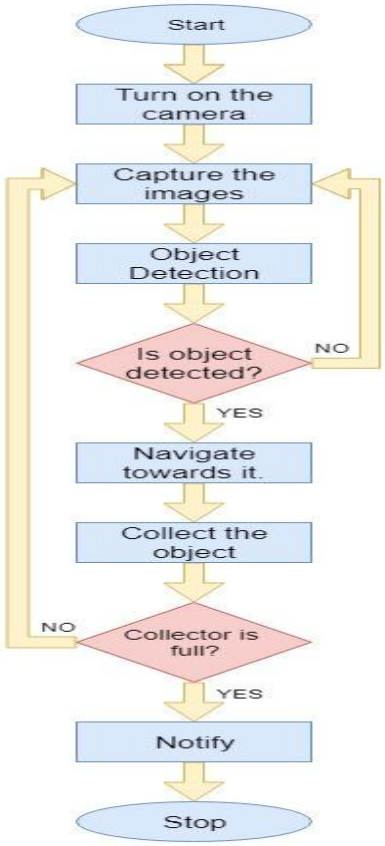

Figure 2. Working flowchart of the device

V. RESULTS AND DISCUSSION

Figure 3. Device Structure

In this project, a sample dataset was created with plastic bottle as an object to be detected, then the device is trained by feeding around 100 positive images and 200 negative images and then tested to detect the bottle. If bottle is detected then the device should navigate towards it and bottle should be collected in mesh of the device. The device is tested for several cases some of them are:

Case 1: The bottle is at the straight angle to camera (i.e. at the center of image). To collect the bottle the device should move forward i.e. both motors should turn on and the device should move forward until the bottle is collected in the mesh. The result was as expected.

Case 2: The bottle is present at the acute angle to camera left (i.e. left side of the image). To collect the bottle the device should first turn left and then move forward i.e. the right motor should turn on so the device will turn left until the bottle is at the straight angle to camera and then, both the motors should turn on so that the device will move forward until the bottle is collected. The result was as expected.

Case 3: The bottle is present at the acute angle to camera right (i.e. right side of the image). To collect the bottle the device should first turn right and then move forward i.e. the left motor should turn on so the device will turn right until the bottle is at the straight angle to camera and then, both the motors should turn on so that the device will move forward until the bottle is collected. The result was as expected.

VI. CONCLUSION AND FUTURE SCOPE

Day by day, water pollution is increasing which is leading to many problems. There is a need for a device which provides easy maintenance so there won't be a huge accumulation of trash which will lead to costly measures for the cleaning of the lake. This device is built around Raspberry Pi which will be using Computer Vision technology. For the object detection, Haar Cascade algorithm is used on the images which are obtained from a live feed using Pi camera. Then, if any trash is detected in the image obtained, the coordinates are calculated.

Based upon the coordinates, respective motor control instructions are sent to the motor driver which will result in the propulsion of the device towards the trash detected. This trash is collected in a mesh structure of the device. This process is repeated until the system is shut down. Based upon manual inspection if the collector is full, the device will be called back and the collected trash is discarded and the device is re-deployed into the water body and the above process is carried.

This way the proposed system provides an easy, cost-effective and efficient solution for the cleansing of the surface pollution on the water bodies.

As the current system is built around Raspberry Pi, the computational power is comparatively less to other systems. With the help of add-on, the computational power can be increased for sage of more efficient and faster object detection algorithm in the proposed system. If the design of the device is changed, it can be used on different terrains.

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