Panoramic camera System for Fish Recognition

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Abstract—Underwater drone are one among many other methods used in the marine industries when it comes to looking or keeping track of the marine species. This paper presents the design and implementation of a panoramic camera system for fish recognition. The system was implemented in Python and computer simulation results are promising and show acceptable system recognition accuracy.

Keywords— Unmanned Vehicle Systems, Open source computer vision, Autonomous underwater vehicle, Panoramic camera

1. Introduction

Drone innovation empowers the utilization of drone in a wide range of territories, for example, in taking pictures for valuing the magnificence of wildlife, popular catastrophic events through human arbitration stands inconceivable, otherwise in farming for splashing insecticides to annihilate poisonous creepy crawlies [1]- [2].

These underwater drones uses camera as an eye for the system. Most of these drone comprises of a 360 degree panoramic cameras as it covers maximum range of sight and the panoramic camera have gained popularity amongst the latest social media namely Facebook and YouTube. Innovations for future are in line by the introduction of the 360-degree panoramic camera underwater drone, which is amongst some recent research subject by researchers. Major use of these prescribed underwater drones includes investigating and observing the fish species in the location the drone is being driven into. It also helps researchers in monitoring the aging process of the dam walls and many more functions [3]-[5].

The basis of the research conducted were based on the automatic fish recognition on the variety of fish species in the lake or sea wherever the drone in applicable of use. Deep learning has been the major technique that is being used in object recognition and observing of the high-level recognition and classification of object.

Fish devise a wide-ranging scope of perceptual capacities enabling it to typically respond to altered environmental improvements, for example, graphical, audio, automatic, material, and electromagnetic signs. In our "energetic" universe of today, various misleadingly induced signs go over marine natural environments, where directions to see them and react to it is in commonly exceptional way. The best possible refinement among regular and intensified conduct is of most thrilling significance in natural examinations that endeavor to differentiate the common fundamentals and components distressing the fish numbers, dissemination, plus assorted variety.

The rest of the paper is organized as follows: Section 2 presents the literature review on the proposed system. In Section 3, the mathematical modeling of the proposed system. Section 4 shows the simulations results. Finally, in Section 5, conclusion and the future work, which could be carried out, has been discussed.

2. Background

The need to consider human-incited conduct unsettling influence as a significant factor in natural investigations [6] applies even to occupants of remote sea-going living spaces, for example, the remote ocean. In situ considers utilizing different kinds of Underwater Drones have fundamentally changed the origination that the occupants of the profound, overcast and for the most part unfriendly sea are less typically dynamic and henceforth less vulnerable to anthropogenic unsettling influence.

After beginning for the usage for investigation and revelation of yet obscure living species and creatures, Underwater Drones remained embraced to methodically examine the environment of remote ocean life forms, particularly the bigger and simpler noticeable wildlife in the vast marine. In similarity to registration examines led by jumpers in shallow waters, vertical or flat transects with underwater vehicles were used to fine the species of the fish by using the size and the structure of the fish [6], [8]. The quantitative conduct controls were easy after using utilizing the drones for classifying the fish that are unique in shapes and sizes. Some study shows that the existing underwater drone are not that friendly to the marines life's due to the shape, size and design of the underwater drone [9], [10].

Unsettling influence reactions in remote ocean fishes might be brought about by various elements like commotion delivered by engines and thrusters, the light utilized for brightening purposes, movement, electromagnetic fields, or smell crest getting from the vehicle. Itemized examinations with respect to the genuine source(s) of unsettling influence are commonly deficient. Here, depiction and classification of unsettling influence reactions are given and contrasts between vehicles, environments, and species are explained. This information recommends that unsettling influence reactions are complex methods of deep-sea angles.

Different methods of fish recognitions that had been successfully innovated by the researches in recent years. Some of their innovated technology can cater the use of video for fish recognition. Where the recorded video is used to differentiate the variety of fish in the region the video camera is focused. These technologies will move marine science into future when comparing it to manual identification, counting and differentiating the variety of fish in the locality. Changes in the spreading and relative price of fish species in various locations of the seas can demonstrate normal or anthropogenic changes in environmental conditions some of which can be made do with fitting activities. Fernandes, (2009) introduced the acoustic surveying and video-based monitoring was introduced by Harvey [15]. An acoustic survey uses scientific echo sounder to measure the echo that is returned from the transmitted sound from the echo sounder downwards to the water. In this research, it was found that these echoes from the echo sounder that are returned can be from other specious that are not fish. The echo traces that are obtained can be used to figure out the size, location whereas their specious are unknown [15]. Video based monitoring has widely deployed due to not being more expensive compared to other method of fish recognitions that had been introduced.

The ultimate aim of the project is to research and design the underwater drone for fish species recognition in the lakes and seas for the variety of the fish and type of these species that are present at the time the underwater drone is being used. Adding to the ultimate aim are successfully obtaining the result of differentiating the various type and counting the number of different types of species that are in the frame of the PICAM that is used for getting live feedback for the lakes and sea.

Recognition systems that are automatic advanced along with two primary courses, either the investigation of grey scale data or the extraction of geometrical highlights, (for example, shape, profile or shading). It tends not out of the ordinary that the most dependable frameworks will consolidate the two methodologies and [16] depicts how the mix of shape and dim dimension data can accomplish preferred outcomes over each methodology utilized independently. We present the methodology next.

3. System Modeling

In this paper, we propose an optimized solution for an automatic fish recognition system.

Panoramic camera uses modern technique to photography for image generation; therefore we will be using two methods of image generation which is distortion of fisheye correction and image joint correction. To achieve this we will be needing software for image generation, software like RICOH Theta, Matlab Works and KODAK

SP360. The 360-degrees panoramic camera derives mapping from points (i, j) of the target point to (x, y) on the fish eye image [18]. Figure 1 shown below describes the high level algorithm adopted for processing images.

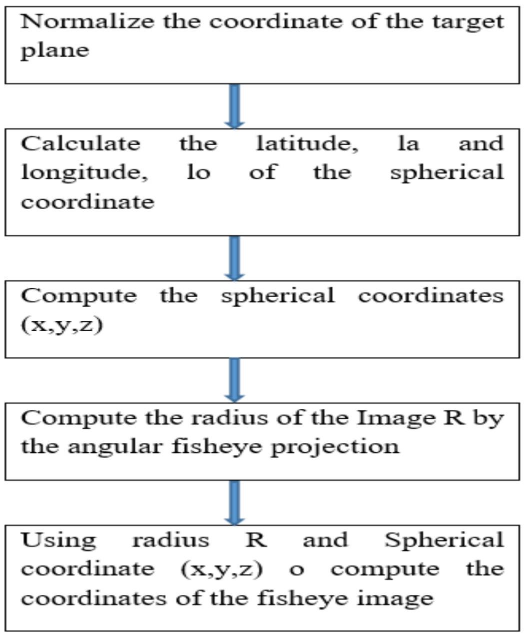

Fig. 1 Processing flow chart.

The image is normalized by converting the fish eye image into the normalized target image, as shown if figure 2.

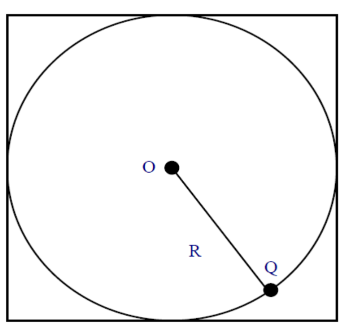

Fig. 2 Fisheye image in 2-dimension.

Underwater drones uses the Graphic Processing Unit (GPU) while achieving the live feedback from the fish eye panoramic camera the will be used. From the 2-dimensional images, the 360-degree panoramic method of image generation is used to map the point from the target to the camera. The two-dimension image is converted into 360-degree panoramic image.

The coordinates from the 2-dimensional image (i, j) is changed into the coordinate of (x, y) as shown in figure 3 below.

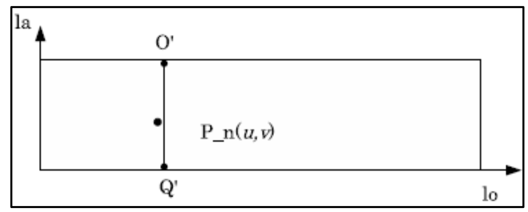

Fig. 3 Normalized target image.

From $P_{f(i,j)}$ to $P_{n(u,v)}$

$$u = \frac{2i}{width - 1} \qquad (1)$$

$$v = \frac{2j}{width - 1} \qquad (2)$$

Equations 1 and 2 are the mapping function formulas of the two planes. Its computed when the targeted image has been normalized.
Once the image is generated, we can find the angle for the 3D plane to see the approx. location of the object.

$$l_o = (1 - u) \times \frac{\pi}{2} \qquad (3)$$

$$l_a = (1 - v) \times \frac{\pi}{2} \qquad (4)$$

Equations 3 and 4 are used to calculate the latitude and longitude of the image. The latitude is in direction of the x-axis and the longitude in in y-axis direction as shown in figure 4.

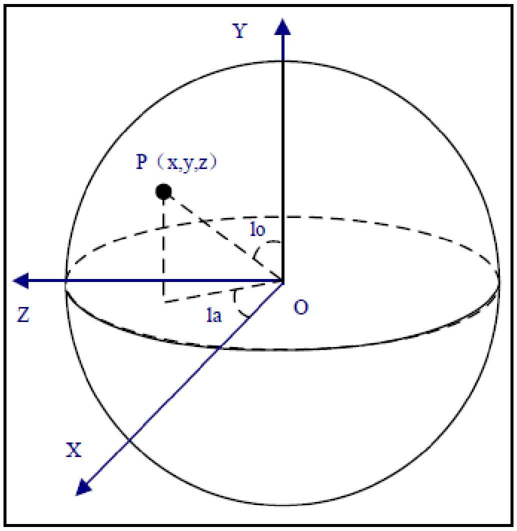

Fig. 4 Latitude and Longitude coordinates.

We can calculate the spherical coordinate of the image by using the following trigonometric equations.

The Z-axis of the generated image can be computed:

$$x = \sin(l_o) \times \cos(l_a) \quad (5)$$
$$y = \cos(l_o) \quad (6)$$
$$z = \sin(l_a) \times \sin(l_o) \quad (7)$$

The Final image generate can be computed by evaluating the above equations as shown below. Substituting the latitude and longitude equations, we compute the final coordinates of the image (figure 5).

$$x = \sin\left(\frac{(1-u)\times\pi}{2}\right) \times \cos\left(\frac{(1-v)\times\pi}{2}\right) \quad (8)$$

$$y = \cos\left(\frac{(1-u)\times\pi}{2}\right) \quad (9)$$

$$z = \sin\left(\frac{(1-v)\times\pi}{2}\right) \times \sin\left(\frac{(1-u)\times\pi}{2}\right) \quad (10)$$

$\pi = 180°$

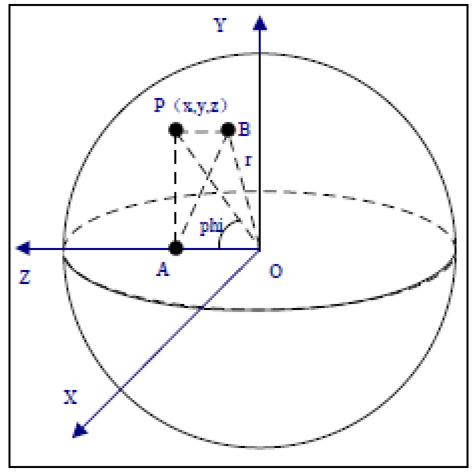

Fig. 5 Final image coordinates.

The distance of the image with respect to the width is expressed below.

$$Distance = \frac{width}{\pi} \quad (11)$$

From the figure, we can compute the distance of the 2D image form the camera

$$r = \sqrt{(x^2 + y^2)} \quad (12)$$

As shown in the figure, the angle between the (x, y, z) and the spherical center.

$$phi = \operatorname{acos}(z) \quad (13)$$

Obtaining the angular projection R, we use:

$$R = Distance \times phi \quad (14)$$

From the equations mention, we compute the coordinate of the fisheye camera image,

$$x_{src} = R \times \frac{x}{r} \quad (15)$$
$$y_{src} = R \times \frac{y}{r} \quad (16)$$

4. System Implementation

The proposed panoramic camera recognition system is implemented on a raspberry-pi processor and Python programming language is used for interfacing with a camera.

The automatic fish identification and recognition system recognize fish using photographic images processing and pattern recognition. Fish identification is done by detecting shape and detecting features such as color and texture of the fish.

Images of fish were extracted from video which was taken by the underwater drone. More than 200 images of fish were used to train the system. There are a large number of false positive results obtained due to factors like crowded scene, changes in water transparency, camera errors, and not enough light present underwater.

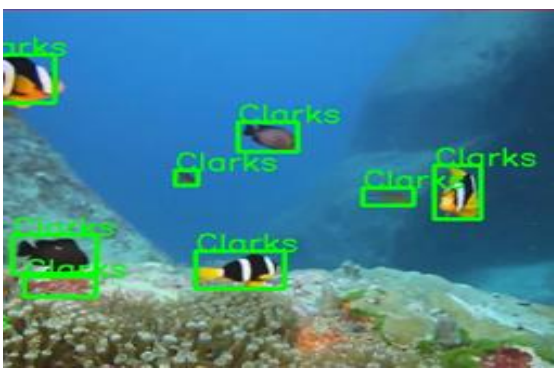

Fig. 6 Fish recognition system in operation.

Figure 6, shows the detection and identification operations of the Clark's anemone fish. The identification and recognition system was trained using over 200 images per input dataset. Image capturing and system testing were done using an underwater drone camera in open sea. There were some false positive results obtained since training fewer images has affected the recognition and accuracy of the system which was estimated about 58%.

Conclusion

This paper discusses the design, implementation of an identification and fish recognition system using a panoramic camera.

The proposed system was designed and implemented on a raspberry-pi board using Python programming language.

Obtained results show that the proposed system is promising and effective in identifying and recognizing fish in a sea environment. The system accuracy is acceptable but it depends on many other factors including the size of the image dataset used to train the system. We plan to further extend this work by adding intelligence and using deep learning techniques to optimize system performance.

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