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UNDERWATER OBJECT IDENTIFICATION USING ULTRASOUND

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ABSTRACT:

Many research topics interest the researchers in underwater acoustic studies. Underwater object identification is one of the topics which has great scope for exploration. Ultrasonic techniques have the advantage over the hindrance created by visibility underwater. Ultrasonic sensor other than camera give the depth information which can be further used for object identification, by making an image from the depth information. The 2D to 3D conversion techniques have visual information but not depth information. This paper proposes a method for object identification using ultrasound techniques. An ultrasonic sensor is used which gives the depth information. This depth information is plotted to give a depth map. The pre-processing of the depth map is done to remove unwanted spikes. Then a process of stereo rendering is applied to form a query images for view from both the eyes. These stereo images are then combined to give us a 3D anaglyph image visualized through anaglyph glasses. In the anaglyph image the objects can be detected using thresholding technique. These objects are then recognized based on the eccentricity of the shape detected. This gives us an idea of the shape of the object.

KEYWORDS: Ultrasound, Depth information, 2D to 3D conversion, Anaglyph, Object identification.

INTRODUCTION:

71% of earth's surface, approximately is covered with water, of which most are oceans which divided into several bodies of water like seas, rivers and lakes. Not much portion of this world has been explored and understood. This limitation persists because of inherent structure less environment and the nature of propagating medium underwater. Sonar technology has more usability than optic cameras and other techniques for the above hindrances.

Ultrasound is a technology that uses sound waves in various applications like measurement, imaging, detection, cleaning and also medical applications. Ultrasonic waves are cyclic sound pressure wave with frequency higher than upper limit of human hearing range. . If an ultrasonic pulse encounters an object in the path of pulse, a part of the pulse or the entire pulse is reflected back to transmitter which are considered as echo and are detected by the receiver. [i] The advantage of using ultrasound is that there is less diffraction for shorter wavelengths. Due to this the smaller objects can be detected as the beam spreads less for shorter wavelengths.

Humans have stereoscopic vision. Three dimension is another topic gaining an abundance of consequentiality in diverse fields like gaming, sculpture, scientific arts etc. Due to the constraints of availability and visualization on the 3D contents, 2D to 3D conversion is considered as an alternative way to fulfil the 3D requirements. To create 3D sense using 2D images is called 3D modelling. 3D modelling is possible only when an illusion of the 3rd parameter depth is created. The methods used for 2D to 3D conversion are based on the process of capturing image or images with the camera which provides us visual information and the

depth information is calculated. To form a 3D image from a single image, two images for the view of the two eyes are created by the process of stereo rendering. This process works on the principle that the same image when viewed by the two eyes, one at a time, has a slight difference between them.

Anaglyph combines the two images for each eye view to give the 3D visualization of the image. It blends the two images filtered from the red and cyan color filters. These images gives the sense of depth using the anaglyph glasses. The object can be identified by segmenting the image using thresholding. Shape of the object is identified by finding the eccentricity, perimeter and area of the segmented portion of the image.

The goal of this paper is to identify underwater objects using ultrasound techniques. The next section gives the literature review. Section three provides the methodology of the work. Section four is conclusion.

LITERATURE REVIEW:

Sensors like ultrasonic transducers are employed with a mechanical part to measure the depth of water. Angles through which the mechanical part can take the measurement of the water depth are measured. This provides an efficient and effective way using ultrasound sounds to measure water depth and object. This provides a better understanding of the characteristics of measurement of depth and object and also of ultrasonic signals. This paper gives a fair idea about ultrasonic measurement and identification. [i]

An algorithm to produce anaglyph images with a single 2D image and depth map. 2D image is converted into left and right images to have a stereoscopic view. The blending of the two images to create a 3D image. This technique is tested in different light conditions with the use of glasses. [ii] This technique uses a device called Microsoft Kinect sensor which gives visual as well as depth information simultaneously. This sensor cannot be used underwater and is also not very economical.

A new class of methods developed based on different methods of learning from examples.One method is learning a point mapping from local image attributes to scene depth. [vi]Other is globally estimating the entire depth field of a query directly from a repository of image+depth pairs using nearest neighbor-based regression. [vi] Anaglyph images are produced by both methods. This algorithm is based on images captured from device which have camera as well as depth sensors in them. These algorithms use the neural and learning depth from examples. The sensors which are combination of camera and depth are very costly are not useful in all areas like underwater survey etc.

A method for underwater object recognition for the images captured by underwater imaging devices like Multibeam Echo Sounder and Side Scan Sonar to provide a fast, flexible system. This system has different software packages and applied on created real-time data. Results show that the system can recognize pipelines, rocks, and shipwrecks. This system uses imaging devices. These are not easily available for use on small case. Mostly are used in areas with large scale recognition for example in parts of ocean or seas etc. ,also are not much economical. [vii]

The real-time sonar data flow collected by multi-beam sonar is expressed as an image and pre-processed by the system. An improved Otsu method has been carried out to detect the object with the contour detection algorithm. The algorithm separates the foreground object from background successfully. This algorithm also uses sonar technology instrument. This is also not readily available and not economical. [ix]

After reviewing these algorithms, an algorithm is finalized which will carry out the object of our work. This algorithm is explained below in the next section of methodology.

METHODOLOGY:

The block diagram shown below shows the algorithm proposed. Fig.1, the block diagram describes the procedure of the algorithm. Firstly, the depth data is taken using an ultrasonic sensor. The data is then plotted to produce a depth map. This depth map is then pre-processed to smooth any sudden spikes or ripples. Stereo rendering is performed on this data to produce the query image for one of the eyes. Anaglyph image generation is used to combine the two images and produce a single image which gives a 3D effect. To detect the objects thresholding is applied to segment portions of the image using height as the parameter. Feature extraction gives shape and geometry and object recognition will recognize the object.

COLLECTION OF DEPTH INFORMATION:

Ultrasonic sensor HC-sr04 is used to collect the depth information with the microcontroller PIC16F877A. Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules ultrasonic transmitters, receiver and control circuit.The transmitter transmits anultrasonic pulse which when encounters an object returns the pulse received by the receiver.

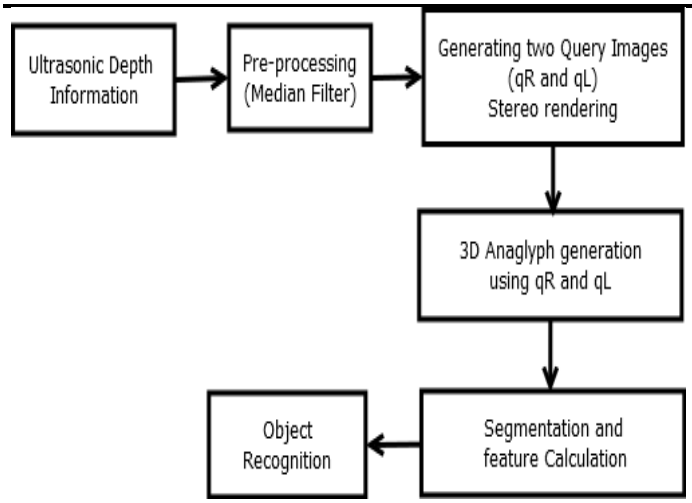

Fig.1 Block Diagram

The delay is then measured and the distance or depth is calculated. The setup to collect the information is shown in Fig.2 below. The setup has a serial to USB converter. This converter is connected to the system and the values from the sensor can be directly collected in the MATLAB software for further processing. This depth data collected is then plotted as a surface plot to produce a depth map.

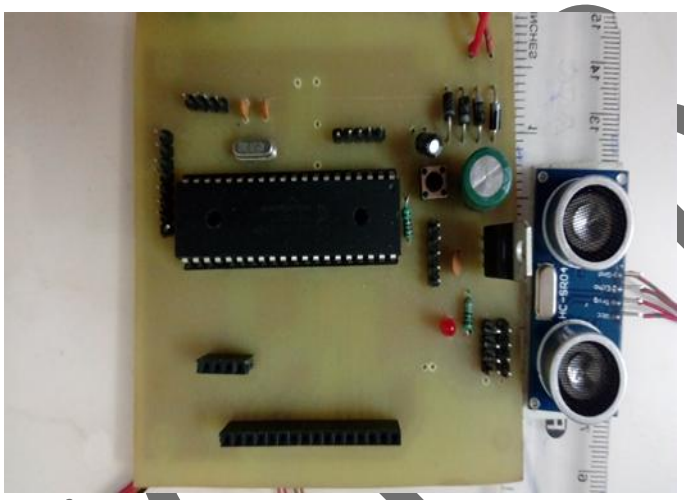

Fig. 2 Hardware for depth data collection

Some parameters of the HC-SR04 sensor are given

Working Voltage	DC 5 V
Working Current	15mA
Working Frequency	40Hz
Max Range	4m
Min Range	2cm

PREPROCESSING OF THE DEPTH INFORMATION:

After plotting the depth data into a surface plot, sometimes there are some sudden spikes or unwanted signals which are removed by smoothing the plot and the data using a median filter. The median filter takes the highest value obtained in the data and dives each value of the data by the highest value.

STEREO RENDERING:

Stereo rendering is a process based on the principle that 3D images are formed when either two images from different angles are available or a second image from a single image is formed to create a 3D image. The two images are considered for view of the two eyes. Creating a second image from a single image is the process of stereo rendering. These two images are called as query images. The formula to calculate the query image from a single image is given below.[vi]

$$Q_R[x + \delta[x, y], y] = Q_L[x, y] \quad (1)$$

$$\delta[x, y] = B\ f/d[\mathbf{x}] \quad (2)$$

B is baseline and f *is* focal length and $Q_R$is the query image for the right eye view and Q_L is the image for the left eye view.

ANAGLYPH GENERATION:

Anaglyph is a process which creates a 3D visualization by superimposing the two query. The 3D effect can be best viewed with the help of anaglyph glasses. The glasses have two color filters, red and cyan (blue and green) one for each eye. There are different types of methods of anaglyph. The method used is optimized anaglyph. The formula for the method is given below. Optimised anaglyph have partial color reproduction but no retinal rivalry.[]

$$\begin{bmatrix} r_a \\ g_a \\ b_a \end{bmatrix} = \begin{bmatrix} 0 & 0.7 & 0.3 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \times \begin{bmatrix} r_1 \\ g_1 \\ b_1 \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} r_2 \\ g_2 \\ b_2 \end{bmatrix} \quad (3)$$

Where, r_a, g_a, b_a are the RGB pixels of the anaglyph image, while r_1, g_1, b_1 are the left eye view and r_2, g_2, b_2 of the right eye view or vice a verse.

SEGMENTATION FEATURE CALCULATION:

After the anaglyph image is obtained segmentation is done on the image. Thresholding is used for segmentation. Thresholding is a type of segmentation where a particular value is considered as a threshold and then the image is segmented based on that threshold. For example if separation between object pixels and background pixel is to be done, a value considered as threshold will do it easily. [viii] Height is considered as the parameter for thresholding in proposed work. After segmentation, the objects are highlighted and segmented. Now, the features of the objects like eccentricity, area and perimeter are calculated to identify the objects.

OBJECT RECOGNITION:

Based on the features calculated the shape of objects can be identified. Whether it is round or rectangular or square etc. This information will be displayed on the command window of the MATLAB software.

This method is proposed to be tried in the field at CWPRS using a PLC based bed profile recorder. The bed profile recorder consists set up as shown in the Fig.3 below. It has a storage in the form of a memory card to collect the data later. The bed profile recorder covers a distance of 51cm of distance in 10 sec of time. The program will acquire data at the interval according to the specifications above. Output of the data after analysis will provide the submerged abject underwater. After validating the algorithm using bed profiler, the results of study will be submitted as a journal paper.

Fig.3 Bed profile recorder

CONCLUSION AND FUTURE SCOPE OF WORK:

The paper proposes a method for identifying underwater objects using ultrasound techniques. Methods for object identification consists of cameras which provide visual information. In this method the ultrasonic sensor is used which gives us the depth information. This method is useful where cameras cannot work. Camera setup can be very complicated and is not portable always. Also the cost of the setup is not economical. The setup and algorithm proposed is less complicated and economical also. This algorithm can be further used in different surveys for object identification and other purposes.

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