DEVELOPMENT OF IMAGE RECOGNITION ALGORITHM FOR UNDERWATER VEHICLE APPLICATIONS

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This project focuses on development of algorithm for image recognition of images from vision system for underwater vehicle applications. The main objective of this project is to develop algorithm from vision system sensor for Deep Submergence Vehicle (DSV) applications which have high performance automated detection and monitoring cracks on anchored ship at its port/dock as well as moving ship. It is also expected to recognize biological underwater object to support on deck auto monitoring system. The developed algorithm will be used to recognize relevant underwater object or living thing. This paper will discuss the experimental setup as well as the prior algorithm which will be used for this research. The approach that had been used to imitate the underwater world will be presented as well as related issues on underwater vision technology. This paper also discusses the expected result of this research and potential application of the developed algorithm.

Keywords: Vision system, multi sensor system, DSV, underwater technologies.

1. INTRODUCTION

This project is a continuation of a previous project on design and development of multi input sensor algorithm for Autonomous Underwater Vehicle (AUV) as shown in Figure 1. The main objective of this project is to develop algorithm from vision system sensor for AUV applications which have high performance automated detection and monitoring underwater object or living thing. The monitoring and detection will be based on multiple inputs received from an active vision sensors system and applied in the Deep Submergence Vehcile (DSV).

As we investigate in the previous project, the images from underwater are very blurry and difficult to recognize by the vision system, as shown in Figure 2. The experiment for this project will be done in three different conditions of water which are in the clear water, mix-up water with detergent as well with the sludge water as different environment might yield different result for determining the appropriate distance for producing different quality of underwater images [1]. New algorithm will be introduced based on dynamic size filter to enhance the image recognition capability of the vision system which could cater the challenges imposed by underwater environment. New set of vision sensor had been acquired to improve the resulting input.

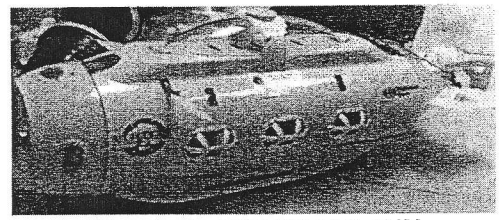

Figure 1: The FKE-UTeM-2 AUV

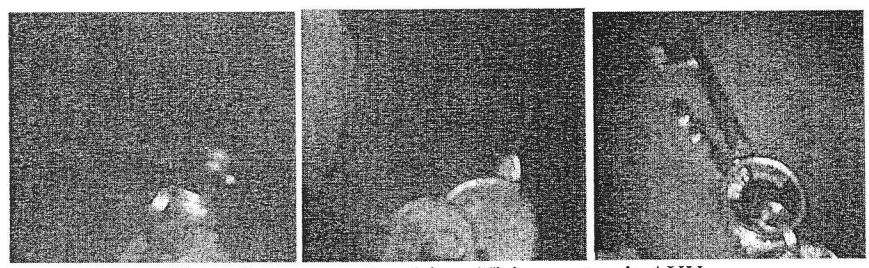

Figure 2: Image captured from Vision system in AUV

The major obstacle faced by underwater vision system is the extreme loss of colour and contrast when submerged to any significant depth whereby the image quality produced is low. Therefore, as to obtain clearer images, several investigations will be done in order to know the appropriate distance required between the images with the camera.

The application of this vision system can be widen so that the usage of the system is not only limited for exploring the underwater environment, but also can be used in education, research and rescue. However, in order to build this system, it might cost a lot as it design and ability is quite complex and expensive. Therefore, this project had been proposed as to design more simple design of vision system for DSV with a lower cost with better performance.

The method that will be proposed to improve the image processing technic could coup with the lacks of quality of the underwater image. The similar algorithm had been used before to work on environment with luminance of 20 lux. However the challenge of processing underwater image would prove more difficult as the properties of light underwater are different from above water.

Basically, the colour perception of an object is depends on physical and components such as spectral composition of light, spectral reflectance of the object, transmission of the light in the medium, and the visual system of the observer. Basically, the processes of underwater colour modification involve attenuation by distance, absorption from the object, diffusion reflection from the object and attenuation by distance.

This project expected to produce working algorithm which is capable to recognize image in underwater. The result is expected to have functional and optimum performance of vision sensor ranging system arrangement and integrated and interfaced between the DSV and both

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sensors system. The display panel on the Visual Basic's software would show the monitoring and detecting by using the algorithm.

2. METHODOLOGY OF RESEARCH

The algorithm will be tested by assigning the vision system to recognize coloured ball under water after being tested to detect the same object above water. This approach was designed to simplify the calibration of the system for the algorithm.

The project setup is divided into two parts, hardware and software development. Hardware development major phases include preliminary study of vision sensor and communication devices for underwater application. Vision system then designed and develops along with its virtual control panel before it will ready to be integrated with the DSV firmware arrangement to complete a task.

The software development major phases include preliminary study of image recognition for DSV, design and development of algorithm for real time simulation, data input, coordinate processing and storing image method which captured by DSV using Windows Software programming (Visual Basic Platform). It will also include designing a Graphical User interface (GUI) for its virtual control panel, data input, data storage and processing.

The whole system will then be tested through a series of test-run and debuging algorithms. The result of the test will be used to improve data input and output processing and making necessary finalization on the algorithm and the integrated system.

3. RECOGNITION OF COLOURED OBJECT

There are many ways to implement object classification algorithms. In the previous researchers they are based on colour histogram [4], [5], motion detection [6] and template matching [7], but using colour to classify the objects is more practical compare motion or template matching. The reason is there is no need for other information from other type of sensory pressure or sonar, or to train the template for matching process.

To determine the colours in the image sequence, hue saturation value has been compensated the weakness of saturation value [5]. This is because by using saturation value, the different colours with the same range of the saturation are difficult to determine. Depending on this situation, two components are needed to determine the colours.

For detecting certain colour, the saturated and hue value need to be used as every colour has a different hue and saturated value. After the image of the front side of the cupboard has taken, the area with saturation value within the particular colour saturation value will be selected by selecting the pixels from the input image whose saturation values, s fulfil the following condition:

$$\text{MinSaturation} \leq s \leq \text{MaxSaturation} \quad (1)$$

The value of the MinSaturation and MaxSaturation were selected so that all or most of the surface of every ball with a particular colour i.e. blue covered. All points of an image fulfilling the condition are returned as one region.

Afterwards, this region will pass another filtering process so that only the area with certain hue value corresponding to the particular colour within the region will be treated as possible surface of the balls. Small areas or large areas which are irrelevant to the balls in the region will be filtered out so that only the area with a reasonable size will be detected and treated as the balls with that particular colour.

Next, the detected coloured area transformed to rectangle shape depending on the smallest enclosing rectangle area followed by finding the centre point of the each rectangle. These points will be treated as the centre point of the balls in the next process.

4. SIZE FILTER

For this operation, threshold operator is used to select connected region built by connection region operator which have size within an interval that fulfilling it minimum and maximum size condition. All connected region in the image that fulfilling the condition are returned as possible object of interest. The possible value for the size must be choose properly so that it could filter out all or at least most of its possible noise.

The filter has two stages, namely as inner radius stage and box size stage. The inner radius stage will determines the largest inner circle radius of a selected region, i.e., the circle with the largest area of all circles that fit into the region. The series of value will be compared to threshold's size and eliminate those regions which are not within the range. The area for this selected region then will be transformed to box shape for next stage of size filter.

The box size stage will filter out the boxes resulted from the previous stage that are outside the previously calculated threshold value, a. The value will be set by calculating the average of the boxes' sizes. The average size value will be coupled with suitable range for each object which will be classified in a form shown in Equation 3.

$$\text{AverageSize} - \text{RangeValue} \leq a \leq \text{AverageSize} + \text{RangeValue} \quad (3)$$

5. PRELIMINARY RESULTS

This experiment done by image taken from the camera placed on top of working space. The image taken includes blue, orange and green balls image. After applying colour filter, blue colour filter for example, all area with same hue and saturation value detected, as shows in

Figure 3 to eliminate the irrelevant area, size filter had been applied and only area within the right size interval value treated as blue balls, as shows in Figure 4.

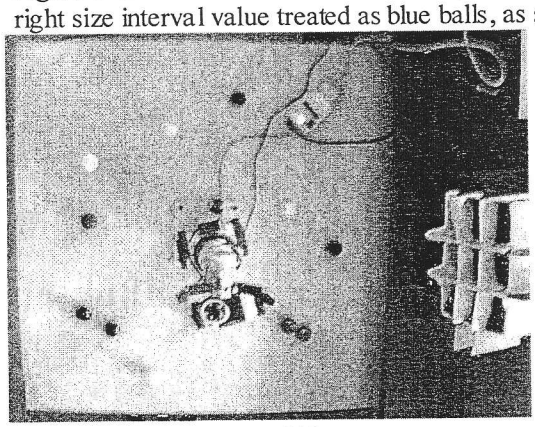

Figure 3: Detected blue area

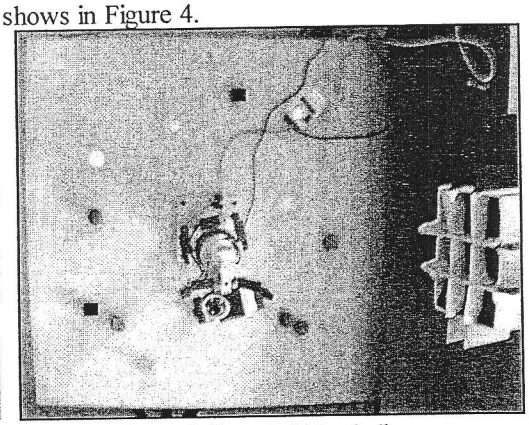

Figure 4: Detected blue ball

The algorithm had also tested with bad light condition which was 12 lux, after the value of the threshold had been adjusted specifically for the image light condition; the algorithms successfully detect all objects as shown in Figure 5. The results also show the differences in success rates for different colour. The algorithms work best for orange colour but seem most affected by the light condition when detecting blue colour.

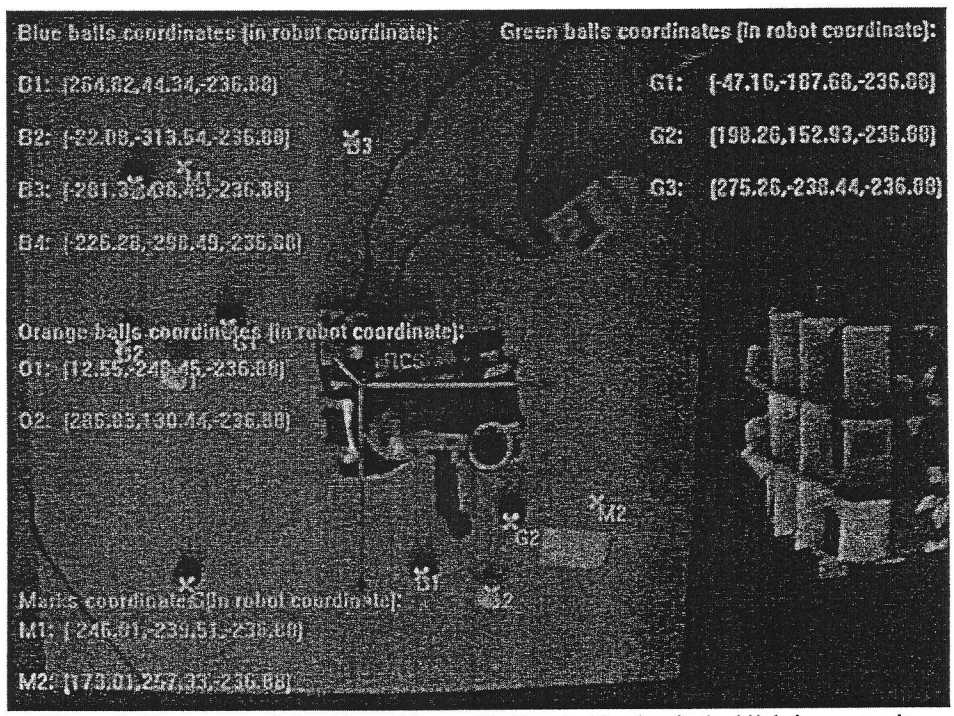

Figure 6: The output of algorithm with specific threshold value for bad lighting scenario

6. CONCLUSION

This project focuses and objectives had been discussed. The developed algorithm will be used to recognize relevant underwater object or living thing. This paper will discuss the experimental setup as well as the prior algorithm which will be used for this research. This paper also discusses the expected result of this research and its potential application.

The expected result of this project will be further proposed to the underwater application industry. The intension is to promote underwater technology based industrial application by making it more affordable. In addition, through this project, staff competency and expertise will be develop especially on the advance sensor and control algorithm as well as firmware and hardware practical implementation.

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