TARGET DETECTION METHODS IN THE RAUVI PROJECT

Stephan Wirth, Gabriel Oliver
Systems, Robotics and Vision Group
Universitat de les Illes Balears, Cra. Valldemossa km 7.5 07122 Palma (SPAIN)
http://srv.uib.es

Abstract - Recent advances in underwater technology and robotics open the possibility for intervention field operations to be carried out with AUVs. Possible applications include wreck rescue, marine science, offshore maintenance and any task needing manipulation skills. In this context, RAUVI is a three years research project funded by the Spanish Government whose objective is to develop and validate a generic methodology for autonomously performing multipurpose intervention missions in underwater environments. RAUVI was split in three subprojects leaded by the Universitat Jaume I de Castelló (UJI), Universitat de Girona (UdG) and Universitat de les Illes Balears (UIB), respectively. This manuscript describes part of the activity developed by the UIB subproject, responsible for the vision-based methods providing information to the whole system. Specifically, the target recognition methods developed to carry out the project second-year demonstration are exposed. Due to the specific characteristics of the experiments designed, the methods developed take advantage of the colour information to detect the object to be manipulated. The frame of the project is introduced, the specific vision methods are described and some results are presented.

Keywords - Intervention AUV, Colour-based object recognition.

1. INTRODUCTION

Autonomous Underwater Vehicles (AUV) is a State-of-the-Art technology for survey tasks. Besides, operations requiring manipulation skills, very common in the offshore industry, the marine science or in rescue missions, are traditionally carried out by divers, manned submersibles or Remotely Operated Vehicles (ROV). Attempts to develop AUVs with intervention capabilities (I-AUV) started in the mid 90's and resulted on pioneering prototypes, mainly conceived as research test beds, like ODIN from the University of Hawaii or VORTEX/PA10 conceived in the context of the UNION European. More recently, ALIVE has been designed for panel intervention in the oil industry and SAUVIM is oriented to seabed object recovery. RAUVI (Reconfigurable AUV for Intervention) is a research project started in 2009 and granted by the Spanish Government. The main goal of RAUVI is to develop and validate a generic methodology, and its necessary technologies, to autonomously perform multipurpose underwater light intervention missions. To that end a generic methodology has been proposed in which the missions are split in two phases: first, the survey, where the vehicle explores the region of interest gathering visual and acoustic data of the region of intervention, synchronized with robot navigation; second, the intervention, where the robot goes back to a specific area of the surveyed region, identifies the target and performs the intervention task. Among these phases, the vehicle surfaces and downloads all the collected data, which are interpreted by a human operator helped by a specialized interface to determine the localization of the target and plan the manoeuvring details of the second phase.

RAUVI has been structured in three main areas, the vehicle, its control and navigation; the arm and its operation and the optical and acoustic perception services, which are under the responsibility of the UJI, the UdG and the UIB, respectively. The second year experiments, held at the Underwater Robotics Research Center (CIRS) in Girona, in March 2011, consisted in a Flight Data Recorder (FDR) recovery mission. A detailed description of RAUVI and a report of the whole experiment is out of the reach of this paper and can be found in [1] and [2]. Thus, here the attention is focused on the object recognition methods specifically developed to carry out the demonstration above-mentioned.

2. TARGET DETECTION

Generally speaking, visual object detection is split into two phases: A training phase in which a model of the object of interest is built from labelled images, and a detection phase where the trained model is applied to new images to determine the presence and location of the object of interest. Due to unpredictable underwater conditions, the appearance of the target of intervention cannot be known beforehand. Therefore, only the data gathered during the survey phase can be used to describe the target. The input data for the developed algorithm consists of one image, or a set of images, where the target is visible. On this image, the operator can determine the object of interest outlining it with a polygon, as shown in Figure 1.

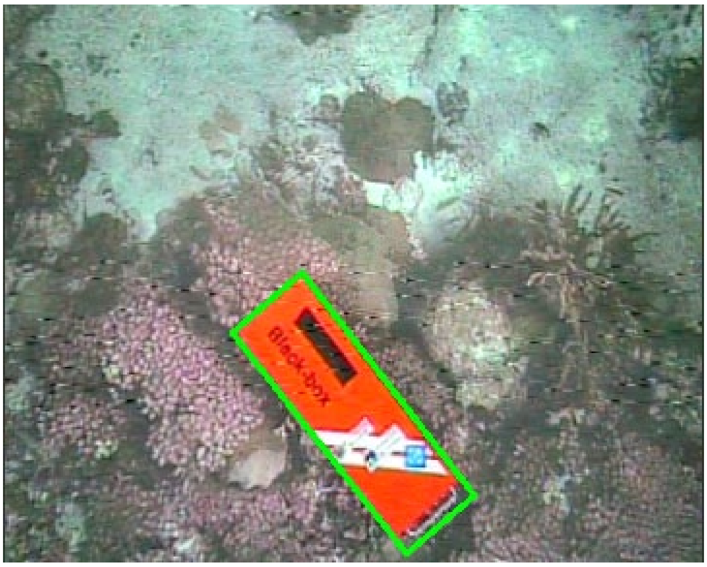

Fig. 1. Image taken by the AUV during the survey phase, labelled to train the system.

Using this data, a colour and shape model of the target is computed. A histogram of the Hue and Saturation channels of the HSV colour space is used to describe the colours of the labelled target. Choosing the HSV colour space and leaving out the V-channel makes the model invariant to brightness changes. As the scene is assumed to be static, a histogram of the background colours can also be computed and used to filter the target colour histogram, highly reducing false detection. This process results in a histogram containing only those colours that are significant for the target in the current scene. This histogram forms the colour model of the target. Moreover, the shape of the biggest area having these colours is stored as the shape model of the target. Figure 2 shows the colour and shape models for the FDR shown in figure 1.

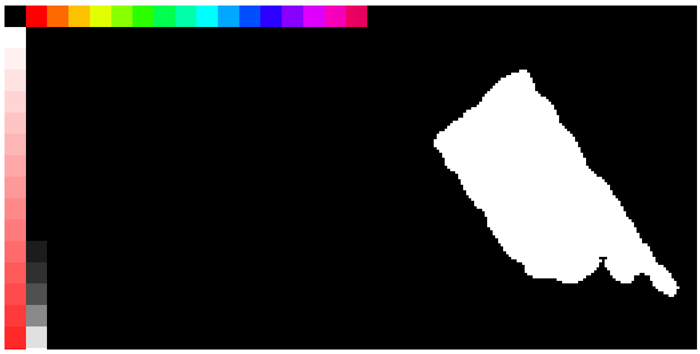

Fig. 1. The model of the target consists in a histogram of significant colours (left) and a shape (right).

For the detection of the target in the intervention phase, the histogram of significant colours of the target is back projected on the current camera image. This marks each pixel with its probability belonging to the target. After applying a threshold to this probability image we can extract the contours of the found shapes and compare them to the shape model we obtained in the training phase. The comparison is done in two steps. First the position and size of the candidate shape is normalized to fit the shape stored in our model. Then the candidate shape is rotated and the areas of intersection and union of the two shapes are computed. The ratio of intersection and union is used as measure for the quality of the match. The shape matching procedure returns the rotation with the highest score together with the position and scale parameters used for normalization. If all parameters lie in reasonable ranges and the shape matching score is greater than a given threshold the system reports the detection of the target, as shown in Figure 3. If the size of the object of interest is known and the camera is calibrated in relation to the robot arm, the information the presented algorithm provides suffices to perform an autonomous grabbing procedure.

3. CONCLUSION

A simple but efficient procedure for target detection is described that has been used to demonstrate the viability of a new Intervention AUV developed in the RAUVI project. Preliminary testing has been performed in a realistic but simplified scenario. In the near future, new experiments will be carried out in open sea conditions. Thus, more robust and reliable methods including texture and 3D information are under development.

REFERENCES

[1] P.J. Sanz et al., "Recent Progress in the RAUVI Project", Intal. Symp. ELMAR, Zadar (Croatia), September, 2010.

[2] M. Prats et al., "Reconfigurable AUV for Intervention Missions: A Case Study on Underwater Object Recovery". Submitted for publication, 2011.

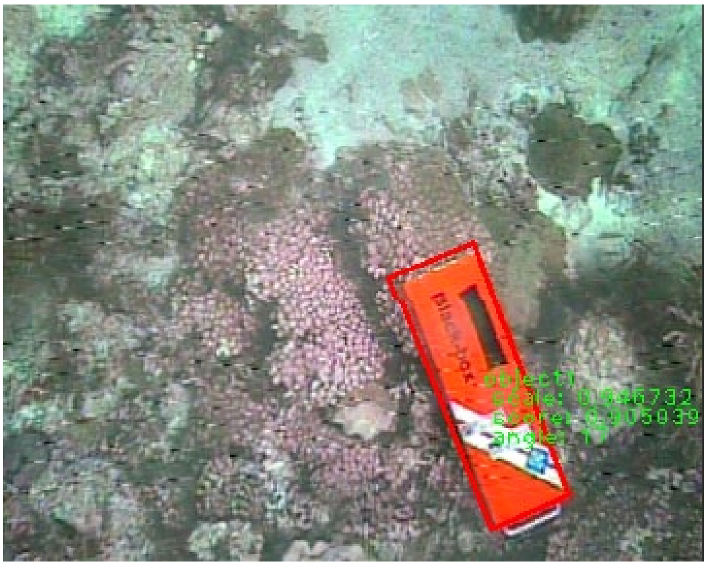

Fig. 3. Detection result. The target's position, orientation and scale are estimated.

Underwater life