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Abstract – The dredging is a process that intrinsically damages the aquatic environment. Suctioning part of the aquatic bottom surface suppose not only change the ecosystem but it endanger the life of the animal and plant species. Nowadays, there is doing a lot of efforts to improve the ecological aspect of the dredging process. In this work, we propose the introduction of machine vision techniques to obtain this improvement, using hyperspectral imaging. The performed tests show that is possible to reduce the environmental impact applying these techniques in two points of the dredging process.

Keywords – Dredging, computer vision, hyperspectral imaging, ecological dredger

I. DREDGING PROCESS

The dredging work refers to removing mud or residues from the aquatic bottom, extracting them and disposing at a different location. In order to perform this job, different types of dredger are available. One of the widely used [1] is the trailing suction hopper dredger (TSHD), which diggs up the bottom using pressurized water, extracts the material using a suction tubes and transports this suctioned material to other point. The dredging could have several targets, like the construction and the cleaning of the waterways or harbours.

II. ECOLOGICAL ASPECTS

Usually the dredging work is perceived as a non-ecological process which damages the aquatic life [2]. This is thought because the aquatic bottom material extraction is done in a very aggressive way. Frequently, the dredging zone contains contaminant materials which are digged up without a full control over the action.

Nowadays, environmental studies are the main way in order to minimize the ecological damages [3]. These provide a chemical characterization of the materials after a laboratory analysis, so that this data is not available at the very moment of the digging and suctioning tasks. Other ways to improve the process are focused, for example, on the efficient design of the suction drag head.

III. OUR CONTRIBUTION

Our work is centered on improve the ecological aspect of the dredging, applying new machine vision techniques. To this aim. we are working on hyperspectral imaging in the dredging process. The performed research is mainly focused on two parts of the whole process: the suction drag head and the hopper tank.

In the drag head, we propose the use of hyperspectral imaging in the 400 nm - 900 nm wavelength range which is the appropriate range to be used for underwater measurements as the absorption coefficient of the water gets its lower value at 400 nm.

From the captured images we performed a first basic processing selecting the three most discriminative bands from the whole spectra in order to be able to properly distinguish among the different materials.. In the laboratory tests performed with this basic approach, we could difference between three elements which were underwater: the test aquatic floor, a metal piece and some organic elements (underwater plant). There is a clear usage of this advance: It will be possible to determine if in the dredging zone exist some metallic element (like an anchor) which could damage the dredger or if it exist some special water plant species and be capable to avoid an ecological damage.

The second kind of research was focused in the dredged mud which is in the hopper. In this place, we have tested the possibility of including a hyperspectral camera sensitive i the near infrared range (NIR), exactly between the 900 nm and 2500 nm wavelength. This range provides great amount information about the chemical composition of the materials. Unhopefully, the absorption properties of the water prevents for the use of this range bands inside the water. Because of this, we propose the use of these bands outside the water. In this case, we achieved optimistic results. We can distinguish between different kind of muds by the means of their different concentrations of contaminant elements (zinc, cadmium, mercury and lead).

The tests we performed consist of finding the separability between four different mud samples. With this target, we created a model [4], in order to distinguish those four classes. For this purpose, a sample of each class of mud is obtained and processed spectrally and spatially. From this processing, a characteristic vector is extracted from each sample. This vector contains spectral information (which characterizes the chemical information of the sample), as well as spatial information. Spatially, the mud is composed with various elements like small stones, shells or sand. This fact means that each pixel of the mud hyperspectral image have a different chemical composition. Thanks to the spatial processing, we can generalize the information of a determinate mud, so its characteristic vector is going to identify the mud better than if it only had taken into account spectral information. The next step is the feeding of a specific Gaussian classifier with this characteristic vectors. Finally, this trained classifier was able to easily distinguish between the first four muds.

This advance has a clear application in an ecological dredger. During the dredging process, is possible to detect the kind of mud that is being suctioned and actuate consequently. For example, if the dredger is suctioning a kind of mud with a high concentration of contaminant elements, those elements could be dispersed along the whole marine environment. So, in this case, the objective will be to reduce the pressure of the suction in order to decrease the environmental contamination, and have an accurate control on the suctioning process.

IV. CONCLUSIONS

Hyperspectral imaging applied to the dredging works is an effective way to improve the ecological aspect of the process in a trailing suction hopper dredger. We have proposed the introduction of the hyperspectral cameras in two key points of the dredging chain. The performed laboratory tests show us that, in the suction drag head, we can detect the kind of the ecosystem that exist in the aquatic bottom and avoid damage it. These tests also show that using hyperspectral imaging in the hopper tank, we can detect if the suctioned mud is contaminant and actuate in consequence.

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