Stage Master 2 :

Title: Tracking underwater stress features: camera-based gaze and breath monitoring

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Profile: Master 2 student in image processing, computer vision, applied computer science, or robotics, with good programming skills (c++/python/matlab) and a taste for experimentation.

Funding: Project PACA DPII / Notilo PLUS

Place of the internship: University of Toulon

Scuba diving is a very popular leisure activity on the Mediterranean coast and its maritime national parks. For a few years now, in order to enhance their offers, commercial structures have been offering souvenir shots during explorations or video feedback for training courses. These shots are generally taken by the guide or instructor who takes the groups. But if in an exploration with experienced divers, this task is easily managed, it can be more perilous in the context of beginners' baptisms or training courses. For a few years now, underwater drones have been marketed in order to deport these capture tasks from the guide to an autonomous robot.

Figure 1. Diver using ultra sound remote control to select the IBubble mode.

However, it worth analysing if the introduction of a robot in a group of divers is neutral from the point of view of safety and training. The project DPII (intuitive interaction between a UAV and a diver) funded by the PACA region and the company NotiloPlus, will explore for two years, the interactions of an IBubble robot with divers' lines. The aim is to evaluate the impacts of the presence of a UAV on the behavior of divers and their emotional states.

In order to follow the behavior of the divers in the presence of the IBubble robot, we want to explore the possibilities offered by embedded sensors: 360° cameras fixed on masks coupled with cardiofrequencemeters.

Underwater 360 cameras, such as Go Po fusion, are mounted on the mask. They allow to film simultaneously the diver's face and the scene he is looking at (see Figure 2). They can also capture the noise caused by the diver's breathing system.

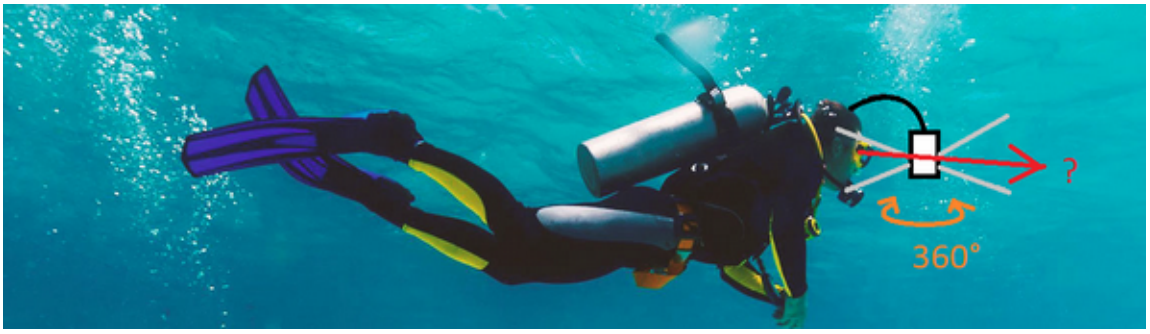

Figure 2: Positioning of the eye tracking system to film the diver's face and the environment. By following the orientation of the eyes, it is possible to record the areas of the environment observed using the other half of the 360° view.

Our objective is to identify markers of stress, panic and mental overload in the diver's face and eyes. These markers are numerous: gaze direction, gaze fixed on the devices, over consumption of air, pupillary dilatation, change in heart rate... Initially, it will be a question of exploiting video capture in order to develop a system for monitoring the direction of underwater gaze. The limits of the field of vision will be projected in the observed view in order to identify objects of interest and in particular to note the presence of the robot. The measurement of pupil dilatation will also be studied. The difficulty to achieve a robust monitoring of the underwater pupil lies in the variations of the optical conditions of the environment. They depend on the orientation of the head in relation to the light sources (sun, diver spotlights), the depth, the turbidity of the water (particles in suspension).

Figure 3. The direction of the diver's gaze indicates what he is observing and the portion of the face seen through the mask shows signs of his emotional state.

In a second step, we wish to use sound capture to: 1) synchronize (using a peak intensity for example) the images of the cameras carried by several divers of the same dive site and analyze the similarities between the objects observed in the same instant 2) study the breathing rhythm of the diver carrying the camera. This data can be synchronized with the heart rate given by a heart rate belt in order to classify the emotional states of the divers.

These tools will also be used for a first quantitative study of the disturbance caused by the presence of the robot by evaluating, for example, the time spent observing it and correlating the variations of the heart and respiratory rhythms during the observation moments.