PROJECT FINAL REPORT

Publishable summary

Grant Agreement number:	262160
Project acronym:	Digital Ocean
Project title:	Integrated multimedia mixed reality system, of real time virtual diving, by web teleoperated underwater data collecting robots, diffused online and through a network of submersible simulation devices.
Funding Scheme:	Capacities - RSME
Period covered:	from 1st of January 2011 to 31st of December 2012.
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EXECUTIVE SUMMARY

Introduction and rationale. 70% of our planet is covered by water and the very survival of more than 50% of humanity is conditioned by oceans. Nevertheless, only 0,4% of this population have ever seen, through actual diving, what exists under the sea, beneath water's hiding surfaces. 25 million people are considered practicing as they dive, in average, a week per year. They come essentially from Europe and from the US, are generally middle class males averaging 35 years old and are motivated by adventurous aspects of diving. The number remains practically stable. Women, children, handicapped and seniors are barely accounted for in diving. Diving remains a risky, expensive and complicated activity for the majority of people, especially in emerging markets. In such conditions, the contribution of the diving community to the discovery of undersea or to global awareness of challenges facing the oceans remains limited. There is a sense of urgency about offering to the public, ways to discover by themselves, how oceans – earth's fragile life support system, are being neglected, irreversibly polluted and impoverished.

Methodology. The discovery of ocean depths will eventually concern every one of us. Recent developments of new technologies and of geographic information systems are already changing dramatically the way people perceive the oceans, not anymore from theirs surfaces but through their depths, not in immersion but on-line. Only the new technologies are capable of challenging traditional scuba diving by creating a new form of diving, based on science and technology, not on bravery – virtual diving.

Digital technologies are applied to collect underwater data with smart robots, autonomous or remote controlled – to digitalize this data, to reconstitute the ocean depths scenery by mixing 3D animated imagery with real time 2D audiovisuals and to diffuse these productions on the web. A serious video game and an e-learning platform linked with marine life specialists will further enhance and enrich the multimedia content.

Results. As a result, anyone, anywhere and at any moment – at minimal costs and with no risks, will be able to "dive virtually" in the most remarkable sites around the world, independently of their depths, and get a quality of images, a variety of details and of scientific information, at least comparable to those collected by experienced divers, without any disturbances to the environment.

Associated with sophisticated multi-sensitive submersible display equipment, in swimming pools, beaches and sea, the process will further simulate the feelings of actual diving and attract diverse sectors of the market. Then, virtual diving may even surpass actual diving. This is the long term objective of the project Digital Ocean which is delivering the results that constitute the first building block of this process.

Potential users. 5000 marine protected areas, thousands of reserves and sanctuaries, diving sites, patrimonial wrecks and – much closer, millions of swimming pools and hundreds of kilometres of beaches, constitute the underwater space concerned by the project which will be structured as a dedicated network and a new playground for education, tourism, leisure and discovery, open to all "connected" people around the world. At a minimal access cost, "virtual divers" alone or in groups, will in days be able to discover and learn as much as a common diver during all his lifetime. Thanks to a collaborative editing platform integrated in the system, they will be associated to social networks and contribute to keep the knowledge of underwater sites constantly updated.

Dissemination and exploitation. Mixed and augmented reality combined with robotized underwater data collection in real time and the scrutinizing attention of internet users, open new opportunities and applications in the fields of fishery, marine science, marine technologies, weather forecasting and environmental industries. The approach of participative scientific research extends now to the underwater realm.

The team. Four European SMEs - VirtualDive (coordinator) (F), Mediatouch (I), Oceanscan (P), Ludocraft (FI), four leading European R&D organizations – Universities of Evry (F), Porto (P), Jyvaskyla (FI), the Engineering School EPITA (F) and the Antinea Foundation (CH) formed the multidisciplinary team that took the project from its background to an integrated and comprehensive foreground of an autonomous system of products being prepared for international demonstration and exploitation.

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1. CONTEXT, OBJECTIVES AND IMPACT

1.1. SUMMARY DESCRIPTION OF PROJECT OBJECTIVES AND RESULTS

The programme "Research for SMEs is tailored to offer to innovative European SMEs access to R&D through European laboratories. Projects must fit into the overall business and innovation needs of the SMEs which are given the opportunity to subcontract research to RTD performers in order to acquire the necessary technological knowledge, rendering clear exploitation potential and economic benefits for the SMEs involved. The relationship between the SMEs and the RTD providers is therefore a "customer-seller" relationship.

Considering these objectives of the programme, it seems opportune at this point in time, at the completion of the project, to get the viewpoints of the different parties involved in the consortium and evaluate if the project succeeded delivering the expected results and if the programme objectives were attained.

These nine partners from five different European countries worked together at their highest management level, to deliver a quite innovative foreground, combining technologies usually distant such as serious games, underwater robotics, virtual reality, e-learning and computer systems. The SMEs discovered the European Commission R&D programmes, accepted to invest time and resources – under a particularly unfavourable economic context, because they are convinced that the project is feasible – scientifically and technologically, is based on sound marketing assumptions and shall, sooner or later, fulfil growing aspirations of our societies in the search for a visionary challenge. There are still difficulties to be surmounted before reaching the markets, but at project successful completion, what was already accomplished gives to all partners the necessary confidence to pursue the venture. Their viewpoints are presented herewith.

Digital Ocean at a glance

1.2. SMEs VIEWPOINT ON S&T RESULTS

1.2.1 VIRTUALDIVE – n°1 Coordinator

Context. VirtualDive was involved, since its inception in 2005 in projects concerning aquatic applications of the new technologies for the public in general. The company developed, through a national programme financed by the French Agency for Research (ANR) during the years 2007-2009 the project Digital Ocean with the objective of creating the basic modules for the digital reconstitution of diving sites allowing people in swimming pools, using a special submersible device named Tryton, to have feelings comparable to those of scuba divers at actual sites. The project results and tests performed in different pools proved that the concept was feasible but required further R&D and a wider technical and technological approach to become operational and

exploitable. Decision was then taken to apply for European Commission funding and the programme RSMEs was selected as the most appropriate for the purpose. After two unsuccessful trials and changes in the consortium, in 2010 the project Digital Ocean was selected and it started the 1st of January 2011, VirtualDive assuring the coordination of a team of 9 partners from 5 different countries.

Description of project objectives. The work plan of the project consisted in eight work packages. Two WPs represented the company's objectives:
- WP3, aimed to develop, from the experience acquired with the Tryton, a new submersible device, named Dolphyn, autonomous and mobile, integrating a tablet from the market, conceived to be used in beaches and in pools and
- WP5 developing a new method of teleoperation in real time of a distant ROV via the internet associating real video images collected by the robot with 3D digital images of the site. This method may be called "virtual diving".

Both WPs accomplished the expected results, which were presented, tested and validated during progress meetings and different professional fairs and conferences.

The Dolphyn and its testing in diverse environments

Impact on VirtualDive. These two results are of course not ready for commercialisation and industrialisation but represent for VirtualDive new challenges that can be summarized as follows.
First challenge: Prioritizing the commercial effort. The decision was taken to give priority to the development of the Dolphyn and to condition the development of the method virtual diving to the commercial success of the Dolphyn.
Second challenge: Completing the development of the prototype produced by the project to comply with market requirements. The tests and presentations of the prototype of the Dolphyn to potential clients confirmed the need for further technological improvements to comply with market expectations. In particular, the Dolphyn needed to be miniaturized for easy transportation by all groups of users; its electronics required more reliability and improved water tightness. Further, the design had to be revised for better ergonomics.
Third challenge: Finding the required resources to reach the markets. After approaching few potential financial and industrial partners and specialists in international commercialisation, industrialisation and marketing of innovation, VirtualDive decided that the best alternative to find complementary resources to take the Dolphyn from prototype to the market was to present a new project for the call for proposals of the programme 2013, RSMEs – Demonstration. A team composed by the same four SMEs and the university of Evry of the present programme, with three new partners bringing a complementary underwater technology, international marketing expertise and industrialisation competences, under b VirtualDive's coordination, presented a demonstration project named "Ocean iWay" to the European Commission on November 2012. The results are expected by April 2013.

Exploitation plan and perspectives. The project Ocean iWay is one of the alternatives being considered to assure the exploitation of the two project results. In the mean time, VirtualDive proceeded with the plan to take the Dolphyn to the market and to combine this objective with the joint commercialisation effort with Mediatouch, to take the result of WP4 – the Digital Ocean portal and its integrated collaborative platform to the market, extending the cooperation beyond the consortium. The Dolphyn is being redesigned, miniaturized and its electronic reliability considerably improved. The production of the second prototype of this version is expected to be available in March 2013. The marketing to support its progressive introduction in the market will be deployed from April to the end of the year starting with the Geneva Inventor's Fair, in April. The first order of Dolphyn was received by VirtualDive from the Marine Reserve of Port-Cros in South of France. It shall constitute the show room for the Dolphyn. As the Dolphyn starts to be introduced in the French market during the current year, it is expected that financial partners will join the company, reinforce its structure and allow the growth of sales and revenues, which in turn will allow the company to start the process to take virtual diving, its flagship product, also to the market.

Five results from five RTD WPs

1.2.2 MEDIATOUCH – n°2

Context. MediaTouch, an Italian company, is a partner in the open source project Moodle and offers e-learning services related both to platforms and to course development. MediaTouch was born as a very specialized company producing multimedia products related to scuba diving (Multimedia Dive Guide CD-Roms and Videos) and has always been operating in edutainment activities.

Description of project objectives. MediaTouch joined Digital Ocean Project in order to open new business perspectives in the on-line educational and entertainment market related to the underwater world. As a matter of fact the company aimed to recover and reuse a wide asset of know-how and multimedia elements that it had previously developed for the off-line scuba diving sector and for marine biology enthusiasts. As specific objectives of the project MediaTouch aimed to create:

- an on-line collaborative editing platform in order to produce 3D underwater environment from users' information and data and also from its own previous knowledge and work
- an integrated e-learning environment to propose any kind of marine related courses, both for free and for charge
- some tools, integrated with the global platform, for the exploitation of its multimedia underwater resources, both available and to be produced.

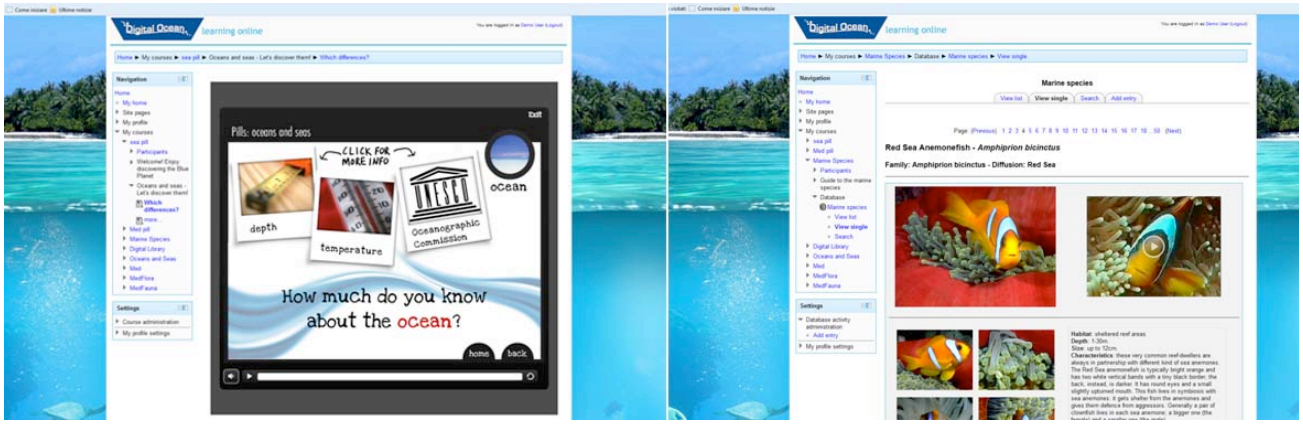
Impact on Mediatouch.These objectives were achieved by MediaTouch through Digital Ocean Project. In the difficult current market situation MediaTouch got new business perspectives to support and expand its current business.Besides the project allowed MediaTouch the exploitation of the previous knowledge obtained in more than five years of work and acquired before the foundation of the current company, with the old name "MediaTouch Sas".

Exploitation plan and perspectives. As described in table H of Section B2 MediaTouch intends to exploit the on-line site that was produced, according the two aspects:

- 3D collaborative editing platform
- Under water learning environment

These two elements will be commercially used both together, as a whole, and as single items. As a matter of fact it will be possible to have users enjoying seamless the two areas of the site while users joining only a single area. This will:

- allow to address a wider potential target of users, that is “generic” sea-lovers and people specifically interested into one item (creating 3D dive sites, learning about sea and all related aspects)
- generate “cross-selling” effects between the two elements.

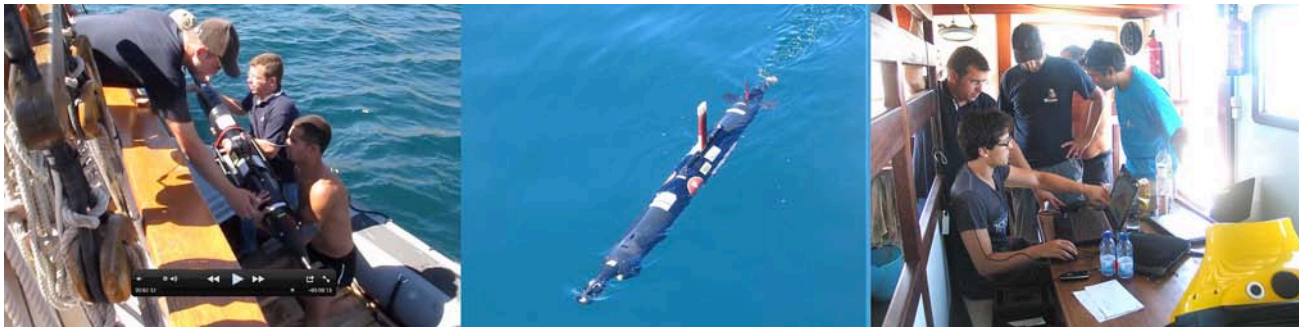


E-learning applied to the knowledge of the underwater world

1.2.3 OCEANSCAN - n°3

Context. The idea to develop an imaging acquisition module (DOAM) to be integrated as an add-on to the existent underwater vehicle (LAUV), caught the interest of the OceanScan-MST. This new module will allow the users of autonomous underwater vehicles, the ability to combine video and photos images with the traditional sonar images (feature already available in the LAUV).

Description of the project. The main objective was to develop an imaging acquisition module (DOAM) to be integrated as an add-on to the existent underwater vehicle (LAUV). The developed module should include hardware, software and the methods required to collect imaging data and recreate representations of ocean floor. This work was contracted to the FEUP RTD performer and resulted in a product of this project. The existent version of LAUV previously capable of acquiring bathymetric data allied with the new feature of capturing geo-referenced underwater images facilitates and resumes the consuming-time task to retrieve data from sea floor. This allowed the project partners to create the digital ocean scenarios and build their own virtual diving sites.



Oceanscan’s team testing the DOAM with the LAUV in Sesimbra

Impact on Oceanscan. We received very positive feedback from the scientist and military community about this new module. This new prototype fully integrated in the LAUV (Light Autonomous Underwater Vehicle) will allow users to collect quality images from the ocean floor from a reasonable price. The potential of business is real interesting. We believe it's secure to say that

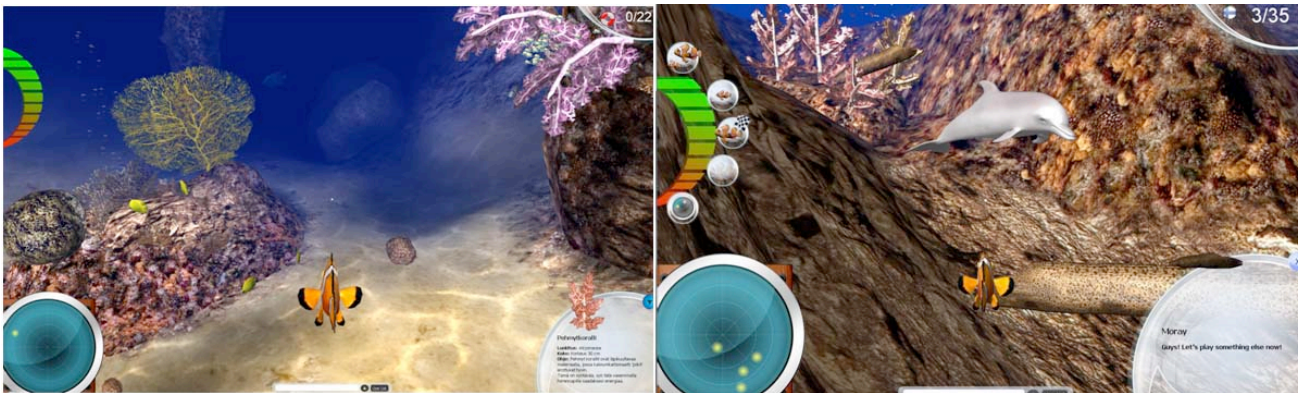
the LAUV will be the first commercial AUV vehicle from the man portable class with this capacity implemented. This definitively will have an important impact on the vehicle sales.
During the Digital Ocean project we understood that the tourism industry and education has big potential to become client of the LAUV services. The general public is becoming more interested in the ocean and a new business division can be a possible solution. This potential business model needs to be further studied and evaluated.

Exploitation plan and perspectives
The DOAM (Digital Ocean Acquisition Module) will be further developed and fully integrated in the LAUV. This module can be sold as a product (vehicle option) or as a service (video/data survey services). The module is already in the further development phase and we expect during this year (2013) place this new option in the LAUV catalogue.
Other option to be considered is the development of add-ons for the Dolphyn. The Dolphyn owners can choose to add several options, such as: single beam echo-sounder, water quality sensors, etc. This possibility will be further discussed with VirtualDive.

1.2.4 LUDOCRAFT – n°4

Context. Serious underwater game (SeaGate) is a game for diving fans, sea world tourists and "want to be" divers who wish to discover the rich, engaging and authentic underwater resorts around the world.

Description of the project. LudoCraft has been participating in the project as SME. The main objective was to develop a serious game demo for further business exploitation. The game idea is to explore and learn the ocean through surviving, performing tasks and collaboration. The game is a multiplayer game consisting of a number of diving sites, which each are modelled according to a real-life site. Each site is a virtual world capable of having 20-30 players at the same time. The game is quite casual and targeted for a wide audience of people interested in diving and the seas.



SeaGate game opens to teenagers a boundless space for exploration and discovery

Impact on Ludocraft. The potential of the immersive 3D diving game targeted at tourism business is huge. The size of the tourism industry in the six largest tourism countries in Europe (Spain, France, Italy, Germany, UK and Turkey) was 223.5 billion dollars in the year 2010 (Source: World Tourism Organization). The market of diving businesses has been constantly growing year after year. PADI, the leading training organization in scuba diving has certified over 20 million divers until the autumn 2011 (www.padi.com). The growth of the number of the divers certified by PADI was 66% between 1996 and 2010.
The number of potential tourists that are interested in sea world and diving is impressive. We are expecting to reach hundreds of customer organizations all over the Europe in a couple of years from the date the game is published. With this size of customer base the number of end-users might easily grow to millions. After Europe's market we will extend the business to the rest of the world, which can double or even triple, the revenue.
During Digital Ocean project, LudoCraft achieved the prototype version of the game. This version requires further evaluation in terms of market expectations and quality requirements. We plan to

survey the feasibility of this type of product in terms of pricing and value chain expenses. Furthermore, the SeaGate game needs international level branding operations in order to guarantee the global success.

Exploitation plan and perspectives. The final version of the game will be sold on the Internet and it will be distributed using digital distribution (DLC – Downloadable Content). We believe that applicable sales channels for the game are websites of famous diver's clubs and diving associations. Additionally, the tourism industry provides a wide range of sales channels for the game, e.g: travel agencies, spa hotels, aquariums and virtual tourism businesses. The game will be playable on their websites or as an onsite experience.
SeaGate will work both for entertaining and for training purposes. The potential customers for us will be diver's clubs, divers training organizations and tourism businesses in general. The game is an efficient way for attracting people to start diving hobby and to join in the diving communities. It can also be used as a kick-off tool for diving courses. At the same time different tourism businesses benefits from it as a marketing tool. The game provides an immersive undersea adventure for ordinary tourists and wannabe-divers.
Other kind of business model will be used with Dolphyn. A suitable model for Dolphyn could be one based on licenses. Customers for this version will be partly same with the DLC game but the focus will be in spa resorts and educational organizations.

1.2.5 ANTINEA FOUNDATION – n°5

The Changing Oceans Expedition, coordinated by the Antinea Foundation with "Fleur de passion" as the flagship, offered an unique platform, at appropriate times, for Digital Ocean participants to get closely involved with the development of this scientific mission to explore some of the most important and threatened marine regions, identified by the WWF's Global 200 project. The expedition is conducted with support from the international union for Conservation of Nature (IUCN) and under the patronage of UNESCO. Its two main objectives are:

Scientific Research: Contributing to a better scientific understanding of the marine environment and providing scientists access to their navigating platform. This was accomplished successfully during the campaign of tests realised by an integrated team of VirtualDive and Antinea Foundation in the Red Sea, which demonstrated the feasibility of digital recreation of 3D underwater sites by implementing a simple data collection and editing method that will eventually become robotised.

Two prominent events of the project: the Red Sea campaign and the Sesimbra meeting

Communication and Education: Raising public awareness and media attention on marine conservation issues. This objective is common to the expedition and to Digital Ocean project.
Following on from its earlier contributions to the Digital Ocean project, Antinea Foundation convened a progress meeting onboard the changing oceans expedition in Sesimbra, Portugal. This event also proved to be an excellent opportunity to test and communicate around some of the

innovative tools developed by the project. In addition Antinea organised meetings and events in Brittany (France) and Rabat (Morocco) to raise public awareness while testing some of the new communication tools provided by the digital ocean project including:- mixed reality, simulation and digital imagery, associated with underwater robotics, surface gliders and marine communications.

The Changing Oceans Expedition will continue throughout its route to explore opportunities for working with both the products and partners it has been involved with on Digital Ocean project.

1.3. RTD PROVIDERS VIEWPOINT ON S&T RESULTS

1.3.1 UNIVERSITY OF EVRY – n°6

A- Development of a submersible autonomous multimedia simulation console (WP3)

The Dolphyn. Result of WP3, the operational prototype of the Dolphyn constitutes one of the most innovative features of the project foreground. It is a portable, submersible, autonomous multimedia console, conceived to be used on beaches and pools.
This prototype integrates a PC computer tablet which is connected to different kinds of devices: user interface device, GPS, sensors and WIFI device. The device includes an evaluation support, which will be used to test the operating architecture. Two modules compose the prototype:
Waterproof case which contains the tablet-PC and a waterproof electronic case which monitors all connected devices: webcam, GPS, Wi-Fi interface, flow meter sensor, accelerometer, user interface devices, joysticks and measuring instruments such as a temperature sensor.

Research and testing developed by the University of Evry for WP3 and WP5

The launcher and multimedia contents. The Dolphyn launcher is the main Dolphyn application that allows controlling its functions (camera, internet, GPS, etc.) as well as to run dedicated contents. Users need to employ the right joystick to select the content and the right button to validate it.
Virtual reality content. Nautilus Quest has been developed by VirtualDive previously. This serious game aims to explore the underwater world of the Mediterranean in an entertaining and educational manner. The game can be installed on several Dolphyn allowing for multiplayer gaming. It offers three different missions simultaneously. The major issue with this game is the hardware compatibility. It was conceived for a classic desktop computer with huge memory. As the Dolphyn is using a tablet with less hardware capabilities, we only selected tablets that were able to operate with this game.

The ***"Tables"*** virtual reality tour represents a famous diving spot. In fact, it is a rocky area of less than one hectare and it is located a few hundred meters from the cliffs of Cap d'Agde. This site has a very diverse flora and fauna (white gorgonians, sponges and anemones jewelry). This configuration attracts divers of all levels, as well as underwater photographers that will appreciate the contrast between the black volcanic rock and the colors of life set. Since 2006, in order to protect this unique environment, seven ecological moorings are freely available to all boats.
The ***Seagate*** (WP6), game from Jyvaskyla University and Ludocraft, was conceived as a way to explore and learn the ocean through surviving, performing tasks and collaboration. The game

background is a real diving site modelled using real-world data. The site selected is Abu Galawa in the Red Sea, where Antinea Foundation and VirtualDive realised a first diving mission. The florae and faunae used in the game are indigenous of the site.

ROV training system. This system is used to have an on-hand experience of the teleoperation. In fact, users have access to all features of the program that are applied on a virtual representation of the ROV as well as the real diving spot itself. To train users on controlling the robot via the application, a virtual path is launched at the start of this mode. A learning course consists of several trajectories to be accomplished by the robot in order to validate the training.

Augmented reality content. uses using AR markers on buoys recognized by the camera's dolphin

(using algorithms of the Mixed Reality module done of WP5. Two scnearios have been set up. The goal the scenario 1 is to learn the navigation signals. The diver/swimmer must follow a path illustrated by AR different buoys. The goal of the scenario 2 is to find a treasure, while buoys are located on the sea or in a swimming pool. However, to find the treasure, the player must first find the treasure key. To help the user, a virtual “fairy” character can help him find the compass, which is a mandatory object to find the treasure.

Dual Diving. The Dolphyn can also be used to remotely teleoperate the ROV. In fact, we have integrated a control method that uses the left joystick as well as the flow meter. The flow meter (z axis) is used to send a *forward* command and the left joystick X-axis is used to send a *left/right* command. Finally, the left joystick Y-axis is used to send an *up/down* command.

Fitness. Fitness is a concept that concerns having a virtual coach on the Dolphyn, which can be used as a sports device. When we select fitness in the home screen, a new menu appears where there are some fitness classes’ available:

- Body building: in order to use the Dolphyn as dumbbells as the user is following the video on the Dolphyn.
- Bike: the Dolphyn can be put on an aqua bike while the user must follow the coach in the video;
- Swim: the user can follow a virtual dolphin in order to learn swimming

Hardware testing. Hardware tests have been performed on October 2011 at UCPA, Villeneuve la Garenne. Those tests were performed to detect potential waterproof problems in the waterproof case. The waterproof case contains the tablet-PC and the electronic parts of the DOLPHYN. After waterproof case tests in October 2011, we have decided to perform another test with the DOLPHYN body.
Tests have been performed on January 2011 at UCPA Aqua 92 diving pit at Villeneuve-la Garenne. Those tests were performed to detect potential waterproof problems with the body and test the Augmented Reality content in underwater conditions.

Content testing. New tests have been performed on March 2012 at Versailles swimming pool. Those tests were performed to allow young people as well as children to use the Dolphyn. The software used for the test was the underwater safari application.
During the meeting 3, Digital Ocean partners have tested the DOLPHYN in the swimming pool of the hotel. The software used for the test was the serious game developed by the University of Jyvaskyla and Ludocraft (WP6). We have also tested the aqua fitness application called Dolfit. This application is using Augmented Reality. Users must follow a virtual animal in the real swimming pool

In September 2012, during the meeting 4, another pool test was performed. We have tested the internet communication using video conference software. For sea testing, a new antenna has been integrated in order to test the internet access near the beach and test communication capabilities. We also have tested the GPS tracking capabilities of Dolphyn using Google Earth. The Dolphyn was also successfully tested at open sea, around the Antinea Foundaton yacht.

Results. In order to get a feedback from users, which have tested the DOLPHYN, we have created a questionnaire to collect statistical data. 176 have tested the DOLPHYN and 25 of them returned the questionnaire. 66% of them are women. Participants are aged from 30 to 50. The two main categories of users were the swimmers and those who do aqua fitness. The number of persons doing diving or snorkeling was quite big.
90% of participants have lost the time notion when they were using the DOLPHYN. 80% of participants said that don't have been disrupted during the experience.

100% of participants said that the actual prototype looks like good but it was too much heavy and actions were taken to take seriously this question and find the right solutions.

The majority of respondents felt that the DOLPHYN must be used for applications related to water aerobics (first choice). In the second choice, the discovery of underwater world is the. Note that the overall number of responses, applications related to relaxation comes first, followed closely by applications related to the discovery of underwater world and diving

B - New method of teleoperation via the internet of a distant ROV robot (WP5) Introduction

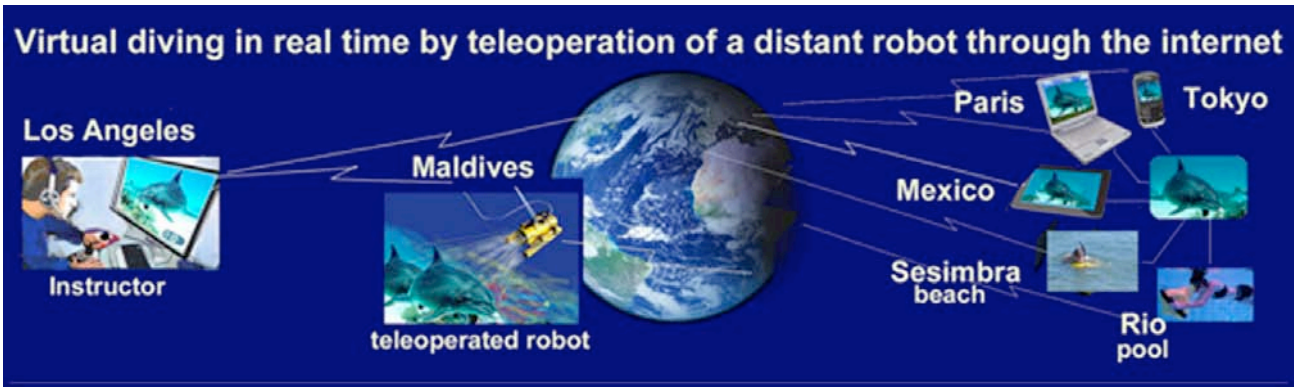
The overall objective of this WP is to develop methods of virtual diving thanks to the teleoperation of a remote operated vehicle *(ROV)* placed in a given diving site. The ROV is equipped with video cameras, artificial lights and other instruments (compass, depth) and its movements undersea can be guided as to follow a predetermined trajectory. Two types of Human-Robot-Interfaces (HRI) have been developed. The first is based on the WEB. Hence anyone from anywhere can control the ROV via a simple WEB browser. The second HRI is based on Mixed Reality (MR) techniques. It gives to the user a multisensory exploration of the underwater site and enhances the feeling of presence thanks to stereoscopic display, 3D interaction devices and haptic interface.

State of art. The teleoperation consists of remotely commanding and manipulating robot systems. This type of control permits to do complex tasks, some of them may be impossible for the human being. In fact, teleoperation permits also to do interventions in hostile environments as well as basic manipulations that are known and mastered by humans. The application domains of the teleoperation are numerous and are present in most of research fields (submarine, medical, spatial, etc.). The WP5 nevertheless proposes to develop an unique teleoperation via the internet of an underwater ROV robot associated wit mixed reality. As such, this RTD objectif represents the state-of-the-art.

Robot's teleoperation. Although the teleoperation is a relatively young technology, it already underwent a very great number of evolutions. During the first decades of its history, research related to the way of improving the performance and reliability in the achievement of tasks with the study of the control laws. Modern teleoperator control architectures combine cleverly a supervised and a full manual operating mode. Nowadays the tendency is more oriented to supervisory since the bilateral coupling and direct robot control through a master-slave classical control has revealed many drawbacks. Among them, the operator's performance is affected by an inadequate visual feedback of the control actions. The visual feedback in turn is corrupted by the bandwidth limitation of communication support connecting the operator's site and to the remote one. Thereafter, the need for improving safety of the operators made it possible to direct research towards the man-machine interactions. It has generated many works on the integration of virtual reality and the augmented reality in the teleoperation systems. These techniques also made it possible to circumvent the problem of delay inherent in the teleoperation.

Requirements: the ROV robot. A remotely operated vehicle *(ROV)* is a tethered underwater vehicle. They are common in deep-water industries such as offshore hydrocarbon extraction. ROVs are unoccupied and operated by a person. They are linked (with an umbilical cable), a group of cables that carry electrical power, video and data signals back and forth between the operator and the vehicle. Most ROVs are equipped with at least a video camera and lights. Additional equipment is commonly added; include sonar, magnetometers, a still camera, etc.

With the help of our partners University of Porto and Oceanscan, a study about mini-ROVs available on the market has been realized. We have identified three companies and six products. The Observer by Subsea-Tech is the only one, which has a RJ45 link. The RJ45 link will permit to easily link the ROV to Internet. It is equipped with embedded batteries. Video images and commands can be received or sent using a LAN network. This ROV was selected and acquired for the project, giving the University of Evry the required technical resources and autonomy to develop the WP5's RTD assignment.



A new usage is being shaped – virtual diving in real time

Video viewing. Live streaming permits to bring media and broadcasting live over the Internet. The process involves a camera for the media, an encoder to digitize the content, and a content delivery network to distribute and deliver the content. The media can then be viewed by end-users in live.

Specifications. Two types of Human-Robot-Interfaces (HRI) will be developed. The first is based on the WEB hence anyone from anywhere can control the ROV via a simple WEB browser. The second HRI is based on Mixed Reality (MR) techniques and gives to the user a multisensory exploration of the underwater site and enhances the feeling of presence thanks to stereoscopic display, 3D interaction devices and haptic interface.
The *semi-immersive* solution uses a projector piloted by the *VR computer, which* is executing the semi-immersive virtual diving application. The user can interact with the application using virtual reality devices. Those devices are piloted by the *VR devices computer*. The two computers are linked together thought the network. The semi-immersive application will capture the distant video from the distant ROV and put 3D elements to get an augmented view. The user can interact using a VR device on the ROV in order to command the ROV. He can also interact with geo-localized data (videos, images). For Web teleoperation, a simple computer can be used to control the ROV with a mouse and a keyboard.
The two diving demonstrators permit to:

- Control a distant **ROV** under water;
- Permit a natural and intuitive interaction to command the robot must using VR devices (VR diving) or the mouse and keyboard (web diving);
- Combine real image provided by the **ROV** camera and 2D/3D data;

To do that, the semi-immersive application will use data content provided by VirtualDive.

Technical integration. The WP5 is built around three applications:

Client side application which represent the virtual diving simulator, the ***robot server application*** and the ***video streaming service*** which permit to control the distant ROV and grab video images. The user interacts with the application (Web or VR) in order to visualize the distant video camera. He can also move or rotate the distant ROV to modify his point of view through the internet network.

The client side application will capture the distant video from the distant ROV and put 3D elements to get an augmented view. The robot application get sensors' data and send commands to

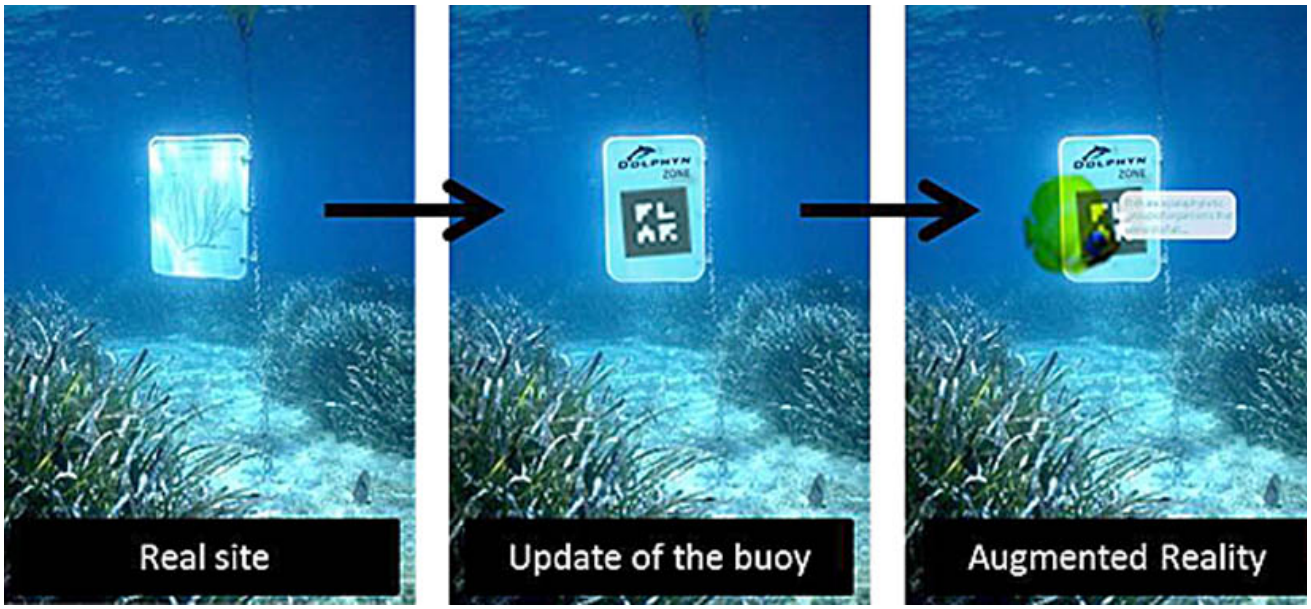
the ROV using the Modbus protocol and a video streaming application in order to diffuse video from ROV (Internet broadcast). Live streaming permits to bring media and broadcast over the Internet. The process involves ROV's camera, an encoder to digitize the content and a content delivery network to distribute and deliver the content.
Web. The proposed solution is based on master-slave control methodology. The master site is a web application. The *Web Application* is written in HTML5 and JavaScript hosted on an Apache Web Server (port 80) provided by EPITA.

Semi-immersive. The proposed solution is based on master-slave control methodology. The master site is a human scale semi-immersive platform composed of a large screen and a projector that provides active stereoscopy. The VR computer that is executing the semi-immersive virtual diving application pilots this projector. We use stereoscopic glasses and their corresponding transmitter. The control system is ensured by a handheld flystick that includes a set of markers for real time tracking, using two infrared cameras.
The procedure we propose is organized as follows when the user sends a command to the robot; it is tested according to the application's constraints. If the test is successful, the command is applied to the ROV. Otherwise, a localization module of the ROV is launched. From this localization, a correction of the control is realized and a new command is sent to the ROV. At the same time, an assistance module using VR methods is used to communicate sensor's data as well as guides for 3D interaction. Each of these modules is detailed in further sections. We offer two types of assistance in teleoperation:

- First, by the location of the ROV: this will overlay both virtual and real worlds and maintain coherence between the real behaviour of the ROV and the virtual ROV..
- Second, by assistance to 3D interaction: we use an assistance model developed in our laboratory in order to help the user perform his task with precision and security for the robot.

The multimodality is also used in the 3D interaction assistance. Indeed, assembling the different issues due to human, environment and teleoperation factors, we observed some technical constraints (Loss of ROV manoeuvrability, transmission delay/stop, etc.) affecting the application's usage (navigation precision, safety of the robot and spatial awareness for diver).
Therefore, we applied an assistance model that includes a set of guides (virtual fixtures) in order to enforce the application's constraints. To give an example of a virtual fixture, the operator must choose a diving path that he/she must then follow. In this case, to be as accurate as possible, we show a 3D curve representing this path as well as an arrow directed towards the trajectory.
The user can choose among several diving paths. When the user selects a path, a 3D curve is created in the virtual diving site. The 3D curve is created from a file on the ROV's server (remote). This file contains all the waypoints of the robot ((x,y,z) 3D coordinates) where 2D markers are placed. If one changes the file, the 3D curve changes consequently

Mixed Reality Module integration. The goal of the Mixed Reality Module is to calculate a transformation for each detected marker. These matrixes represent the marker's positions from the *ROV* camera.
ARToolkit is a system of markers used for Augmented Reality applications. It includes several two-dimensional models of markers. These markers consist of a black square border surrounding a model that compares to other models pre-registered in a database for matching. Initially, *ARToolkit* transforms the current image in a black and white image (binarization). Then, *ARToolkit* will search for the marker in the image in its binary format. Once markers are detected, it compares them with predefined templates for identification. Then, it calculates a transformation matrix to extract the coordinates of the camera in the 3D scene's referential (associated with marker). Once the camera position is calculated, the virtual object can then be readjusted to the desired location in the image. This process is repeated for each image provided by the camera (online).



Mixed reality contents for the Dolphyn

Four software modules have been integrated:

- *Search for markers:* this module is dedicated to detect the marker in the video frame. To do that, the video frame is converted to a binary image. The marker can be identified;
- *Tracking:* this module is dedicated to calculate the extrinsic parameters (position and orientation of marker relatively to the camera) of the camera using its intrinsic parameters. Camera intrinsic parameters were calculated offline using Zhang method;
- *Identify markers:* This module allows extracting features from images in order to detect the symbol. The module is contacting a local database to match the detected marker to its unique identifier (id #);
- *Position and orientation of virtual objects:* this module allows aligning the virtual object with the marker in the video frame using the extrinsic parameters calculated by the tracking module. The result is the position and orientation of the object in real time.

The location of the *ROV*'s camera position and orientation in real time is determined using markers in the real world to calculate the camera position and orientation. In this case, instead of trying to directly recognize the objects in the real world, it is sufficient to recognize those different markers. In addition, real markers' positions are well known in the real word. Once the markers are detected, a transformation matrix M is calculated for each detected marker, representing the marker's positions according to the ROV (ROV's camera).
The *Mixed Reality Module* allows adding multimedia content in a marker. At the end of the localization process a media corresponding to the identified marker is recovered from the database. The media can be a video, textual instructions or 3D content. Then, it will be rendered in the video frame seen by the user.
These markers are also used by the ROV's camera while exploring the diving path. We also may use them as waypoints on the diving path. Hence, users have to pass by each marker during the teleoperation session. This assures the user the way to take and, at the same time, allow us to locate the ROV.

Testing. Many tests were accomplished with the WWW and semi-interfaces of ROV teleoperation. Are included different tests of the interfaces, in outdoor and indoor environments, in order to consider the adjustments and improvements in software. First tests have been performed on October 2011 at UCPA Aqua 92 diving pit at Villeneuve-la-Garenne. Those tests were performed to

detect potential waterproof problems in the ROV and also to test the WWW demonstrator. A waterproof problem was then detected.
On March 2012, another test was done. The ROV was at UCPA Aqua 92 diving pit at Villeneuve-la-Garenne. The ROV was controlled in EVRY using the Virtual Reality platform with the use of the semi-immersive interface.
On November 2012, an outdoor test was performed. The ROV was on a lake connect to the Robot Computer Interface (RCI). This RCI was connected to a 3G System which gives an Internet access to the RCI (3G system is connected to cellular antenna). The ROV was controlled by the WWW demonstrator. The computer used for the test was connected to a cellular antenna using also a 3G system.

Results. Preliminary feedbacks from users, to gather their opinion in the WWW demonstrator have been realized. The majority of respondents felt that the WWW-Demonstrator must be used for applications related to underwater world; the second choice is for the discovery of underwater diving. All people said that the application is better for urban divers who want to view live images from oceans.
We have made some measurements for testing the delay of the video images from ROV. In pool (indoor) we have tested it using a local network through Wi-Fi. The video delay is 2 seconds in average. This delay is acceptable and we can control the ROV quite easily. However, in outdoor conditions the delay reaches 5 seconds. The video feedback comes 5 seconds after, so it's very difficult to control the ROV. We have made some measurements for testing the delay of the control transmission to ROV. In pool (indoor) we have tested it using a local network through WIFI. The delay is about 15 ms average. This delay is very low so the control of the ROV is very easy. In outdoor conditions the delay reaches to 85 ms.

As a conclusion, we can say that the results of WP4 and WP5 have fulfilled the expectations of partners and stakeholders involved. The Dolphyn is closer to the market as it results from previous developments and tests done within the framework of a national R&D programme. The teleoperation of the ROV via the internet, that started with the European project, can be considered now as technically and technologically feasible. The model produced requires nevertheless further developments before reaching the market, in particular concerning the commands of the underwater robot at deep sea and the improvements that such robots may need to be easily geopositionned underwater.

1.3.2 UNIVERSITY OF PORTO – n°7

Data collection module for an underwater autonomous vehicle (WP2)

Work-package 2 regards the development of an imaging acquisition module (DOAM) to be integrated as an add-on to the existent underwater vehicle (LAUV). This module includes equipment, software and methods necessary to collect imaging data and recreate representations of oceans bottom. The existent version of LAUV previously capable of acquiring bathymetric data allied with the new feature of capturing geo-referenced underwater images facilitates and resumes the consuming-time task to retrieve data from sea bottom.

State-of-the-art. The work started by gathering enough information to realize the state of the art. The first approach targeted research of commercially available systems to small AUV/ROV but soon converged to search of products and technologies thought to be pertinent to the development of the DOAM. Still, the research efforts focused on commercially systems proved to be useful since contributed with design and feasibility guidelines.
The preparation of the state of the art revealed the absence of a stand-alone commercial solution capable of fulfilling the necessary requirements to satisfy the objectives foreseen in the project proposal.

Requirements and development challenges. Having realized the up to the date technology available in the market a first draft of features feasible to be implemented could be defined. The set of possible features was then refined to what turned out to be DOAM's requirements. This process was performed having bearing the mechanical and electrical constraints imposed by the vehicle's

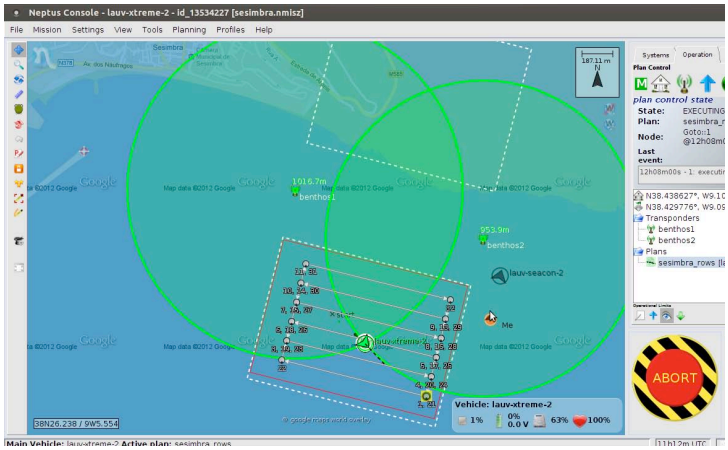
specifications and hydrodynamic behaviour. Size, power, autonomy and the possibility of integration in ROV were the key design constraints. The requirements defined for the final solution of DOAM can be summarized as:

***Autonomy*:** The autonomy and storage capacity should be enough to allow the coverage of a 100x100m area.
***Geo-referencing*:** The module should take Geo-referenced pictures of clear water environments.
Interfacing: The CPU should be able to trigger the light strobe and camera synchronously.
The CPU should be able to retrieve data from the camera, tag it with the geographic position and store it in the storage unit.
Mechanical: The module should preserve LAUV's hydrodynamics and should have hydrostatic equilibrium.
The module should be no longer than 60cm per 15cm diameter and operate at depths up to 50m.
Video: The camera should be able to capture HD 720p colour images at 4fps.
The camera should be able to capture colour video HD 720p at 20fps.
The System Breakdown Structure helped in decomposing the system into smaller sub-systems and providing guidance for work that could be parallelized by an efficient development scheduling.

Prototype development. After the acquisition of components thought to fulfil the DOAM requirements some preliminary tests were performed to each component regarding its suitability to the module as a whole. The tests concerning picture illumination performed with off-the-shelf commercial underwater LEDs unveiled deficit of lumen concerning proper imaging acquisition. Since there was no commercial solution capable of fulfilling the illumination requirements, an important decision of developing a custom-made illumination system was taken. Using more powerful LEDs with a designed surrounding reflector and suitable LED housing turned out to be a better and cheaper solution when comparing with off-the-shelf products.
At the same time, theoretical studies regarding the underwater imaging unveiled possible problems regarding light scattering, absence of red colour and image distortion (*Physics of Diving*[1]), (*Underwater Illumination*[2]). While both absence of red colour and image distortion could be corrected using a red filter and post-processing algorithms, the light scattering issue can only be solved by increasing the distance between the camera and the illumination system. Therefore, the original projected module was split in two parts by separating the image acquisition hardware from the illumination set by a distance of 1 meter. The camera module was projected to be installed in a dry sub-section of the vehicle while the LEDs were projected to be in a wet sub-section of the vehicle taking advantage of the good thermal dissipation characteristics of water (figures 1 and 2). Necessary LED fastening and orientation adjustments were thought so the illumination sub-system could be targeting the centre of the area to be captured by the digital camera.
Both sub-section structures were implemented in polyacetal (POM) and the imaging chassis, used to support the electronics and the camera, was implemented in stainless steel. The camera sub-section included electronics modules, like CPU (including the RAM and HDD) and the interface electronics (LED and camera controls). The CPU included on the camera sub-section is responsible for controlling the camera aboard, triggering the illumination system and tagging the taken pictures with the vehicle's position provided by vehicle's main CPU.

Tests and validation. After running both the bench tests and the swimming pool trials the vehicle was submitted to open water trials that took place at Sesimbra (figure 3) in July integrated in the REP12[3] (Rapid Environmental Picture 2012) under the protocol between the Portuguese Navy and the University of Porto. The vehicle (figure 4) performed surveys 100mx100m with success and, even though the site is not considered the best for scuba dive, the survey proved to be profitable since the LAUV (with DOAM) managed to take some interesting photos

[1] http://library.thinkquest.org/28170/35.html
[2] http://www.deepsea.com/pdf/articles/UnderwaterIllumination.pdf
[3] http://www.marinha.pt/PT/noticiaseagenda/noticias/Pages/Exerc%C3%ADciorapidenvironmentalpicturerep12.aspx



Console of mission at Sesimbra

Octopus trap at 18 meters depth

The test started with the adjustment of the vehicle's trimming for salt water to tune its hydrodynamic behaviour. Once run the sanity checks, basic mission plans to determine the topography of the sea were performed to attest the feasibility of the rows manoeuvre at 2 meters high from the bottom of the sea. These basic safety manoeuvres are always performed to avoid vehicle collisions with either sloped sea bottom or rocks. After having the path well defined and known free of obstacles several surveys were run having the vehicle completed all of them with success. The vehicle was able to fulfil the same path several times granting the opportunity to shoot identified objects a significant amount of times at different camera exposure configurations. Several surveys were performed at 3 and 2 meters depth, which is considered the minimum distance to the sea bottom from which the vehicle can avoid an obstacle in safe mode. The sanded seabed of the site attenuated the absence of clear coral waters allowing the objects to be easily found and perceived. All necessary tests were scheduled in order to have enough time to perform occasional upgrades or changes to the system if necessary.

Integration in the project. Both bathymetrical and imaging data liable of being acquired by the final version LAUV meet the needs of Work-package 4 and 6 by providing geo-referenced underwater images and the sea bottom shape. The bottom shape is defined using the bottom distance provided at a constant depth by an echo-sounder installed in the LAUV whereas the images taken by the camera installed on the DOAM are tagged using the vehicle's position and orientation. The final data can therefore be used to recreate maps of the surveyed area or underwater sites for the serious game

Innovative features. Comparing with other AUV commercial solutions specifically designed to capture images, the developed module is compact and therefore man portable requiring low logistics. The module design and development were refined to be energy efficient and the manufacturing costs are quite promising in what concerns competitiveness.

Dissemination. The prototype final demonstration took place aboard Antinea foundation boat nearby Sesimbra by later September. The project partners considered it as a good dissemination scenario considering synergies from Antinea foundation, Porto University and Virtual Dive. The reason for the choice of Sesimbra as the demonstration site concerned the experience acquired by FEUP in operating at the very same scenario and the presence of Antinea's Vessel at Lisbon by the date of the demonstration.
Many academic and industry announcement actions were performed both in Portugal and in Europe as an attempt to disseminate the advantages and features of the integrated system so the next commercialization step can be taken.

Future developments. The imaging technology is in continuous evolution and, therefore, the possibility of upgrading DOAM with higher quality cameras is high and increases as time passes.

The amount of data stored aboard is limited by the capacity of the solid state drive, which also tends to increase in the nearest future.
Surveys at darker diving site can be achieved by increasing the number of LEDs in order to have better illumination.
Installing more sophisticated sonar such as multi-beam sonar can increase the bathymetrical resolution.

1.3.3 UNIVERSITY OF JYVASKYLA – n° 8

Development of an underwater serious game in a real diving site scenario (WP6)

Its interface. Seagate is the model of an innovative serious underwater game, entirely subaquatic, which action develops in different real diving sites, conceived to link these sites and to give a global view of the environmental challenges facing sea depths. The scenario of this game will be extended to any one of these sites and, as the network of digital sites increase to include sites in different seas and oceans, these games will allow system users to get familiar with the undersea environment, its fauna and its flora and discover the biodiversity of different ecosystems through entertainment and play. The serious underwater game is based on the experience acquired with the model of Nautilus Quest, one of the few entirely underwater games with its action developed in a real diving site, exclusively dedicated to get the players acquainted with the subsea environment, orientation and ecological challenges. The objective of the game demonstrator is to conceive the scenario of a serious game that will be adapted for the different diving sites in different sea locations, changing the fauna and the flora accordingly, without changes in the educational messages and playing characters. For instance, among the subjects to be treated by such games are the protection of species in danger of extinction, the fight against the unregulated fisheries or the discovery of trans-oceanic migration of whales and turtles. Associated with the expedition around the world of the Antinea Foundation and with other expeditions, this serious underwater game is to be conceived as open and endless game adaptable to the changing undersea backgrounds.

Integration in the whole project. A special version of the SeaGate was designed for the Dolphyn device (WP3). This version of the game was developed to run in tablet PC that is used in the Dolphyn. The special version includes only the first level of the game and much smaller size textures in the 3D models compared to textures used in other versions. Usability of data collected by the LAUV (WP2) to create a site model for the game was investigated. University of Porto provided data gathered by the LAUV. At first a height map was created from bathymetric data with special algorithm. Terrain generation software was used to create polygonal model of the height map. The polygonal model of the seabed was converted to format suitable for 3D-modeling software in which the texturing and the conversion to the game engine format was performed. In order to make the site model creation from the LAUV automatic requires a separate project. There is a page in the Digital Ocean portal (WP4) that contains pictures and videos of the game, links to game installation package and list of available game servers.

S&T development challenges. RealXtend - Open Source Platform for 3D-internet was selected for implementation of the game. RealXtend provides client-server solution for 3D virtual-world multiplayer games. The serious diving game was developed to run on the desktop/laptop PC with Internet connection.
Documentation for realXtend is a little bit narrow and spread that can be common for open source systems. Also the QA process behind releases is not under some quality management system. During the development taking the latest versions of code base of the realXtend caused sometimes problems; things that had worked in the game earlier did not work anymore. When there was a “good” working version it was used in the development while waiting next stable release. However, it was necessary to upgrade platform code base when there were major enhancements done.

At the time when the first tests with tablet PC were carried out start up time of the game was painful long. During the development period loading time of the game assets was drastically improved that

effect straight to the start up time. Other challenge was how to manage connection to game server when the Dolphyn is in the water. The first observation was that antenna of the Dolphyn was too short to keep up connection to server. Tests with longer antenna made playing possible with external game server. Alternatively, game server and client can run on the same computer.

Results accomplished. The three basic requirements for the game were filled:
1. It shall use data collected from real diving sites to create 3D imagery representing underwater sceneries.
2. It shall perform as an operating link among diving sites allowing users to correlate and compare them through gaming. Players will be motivated to go from one to another site and, by exploring these sites, acquire a global vision of the subsea network being progressively built.
3. The game scenario may be positioned in-between the real dive and the virtual dive experiences, between real world and fiction. It will facilitate and develop the interface between potential users. The game mission is to increase public awareness on the situation of the oceans through knowledge and entertainment. By using “edutainment” and game inspired simulation, supported by scientific assumptions, the objective is to provide engaging and convincing scenarios based upon participatory design methodologies.

Concrete results of the project were five deliverables of the work package six:
D6.1: The user requirements plan defining the game development guidelines
D6.2: Game technical specifications and preliminary game storyboard
D6.3: Samples of game 3D scenes and features conceived for use on the web
D6.4: Model of the game completed for first demo
D6.5: Evaluation report from targeted user’s groups and review

Innovative features. For a diver or a non-diver person exploration of the underwater environment itself is an interesting journey. Making underwater environment as realistic as possible with exaggerated features in the game will motivate audience enter the sites with enthusiasm and attracted. These tasks are connected to ocean environment and harmful obstacles for the environment. Some of the tasks are totally educationally focused. Exploration of the reef provides interactively information about the species.
In the SeaGate – Serious Underwater Game a player will collect points by completing various tasks that non-player fishes will guide player to do. Target of the next task is always on the player’s radar. By completing tasks the player will advance in the game. There are five different fish characters in the game and eventually the player will get to play with all of them. The player can explore the reef in free form manner and will get information about the species by interacting with them.

Tests and validation. Testing of the SeaGate was divided to installation testing, functionality testing, gameplay testing and performance testing. Installation testing comprehends setting up the game server and client on Windows (Windows 7 preferred). Functions of the game characters and features of the graphical user interfaces were tested during the functionality testing. Gameplay testing evaluated task scenarios, co-operative gameplays and storyline progression. Acceptance testing determined does the produced game meet the predefined goals (requirements). For example acceptance testing gave answers for questions: Does the created underwater environment attract the players and raise their interest to explore it in detail? Does the player get knowledge of the current status of the seas during the gameplay? Different project stakeholders did acceptance testing. Performance testing of the game was done with different number of players and more or less capable PCs. In addition to performance tests were executed on Acer Iconia W500 Tablet-PC which is be used in the Dolphin device (WP3).

Demonstration of results of WP3 and WP6 during the progress meeting in Jyvaskyla

In the end of development period game testers from different user groups were invited. The first testing period was performed during 16th August 2012 - 28th September 2012. During the first testing period three different user groups tested SeaGate: elementary school pupils (17 persons), diving club members (4 persons) and university students and personnel (12 persons); total of 33 persons. At start SeaGate version 1.1 was used for testing and in the end SeaGate version 1.2.5. The major differences between versions are: improved level 1, game controls, ultra-light scene for low performances graphics adapters and a lot of bugs fixed in version 1.2.5. After playing the game each tester answered to query that contained about ten questions; a couple of personal questions and few game related questions.

During the first testing period the game was not polished and there were still some bugs in it. Game controls, lack of game objects and indication of game progression were mostly criticized. Game testing done with eleven year school kids was most interesting. It was remarkable how quickly they learned the game controls and played through the first level. It was also notable during school testing that seeing each other in the game activated immediate communication between players.
The second testing period was performed during 14th November 2012 – 31st November 2012. Following groups tested SeaGate 1.3.0: University students from the game design course (14) and testers from the previous groups (4). Obviously, now the group of testers were more educated as far as the game design and research is concerned. SeaGate version 1.3.0 was used for testing. Only the first level with high quality graphics was played during the testing because the improvements made in the game focused in the first level tasks, graphics and game controls.
According to the feedback, after the second period of testing the improvements done in the game answered to needs of the audience. Some comments: “clear controls and task assignments which made playing easygoing. Authentic looking appearance, especially fishes looked lively. Environment was clear and the user interface supported playing. Creation of the underwater world with texturing and effects was very successful.”
Overall it seems that the game characters, which are truly living creatures, fascinate players greatly. Through the game, players get close to species and they are able to investigate them freely in three-dimensional underwater world. To do this in real life might be impossible to some people. For divers it is important that the species look realistic as possible and the playing area is a true diving site where they have visited before or they will in the future.

State of the art. realXtend speeds up the development of the global standardized 3D internet of virtual worlds by making the best technology available to everyone, and entirely free of charge. The true value of the interconnected 3D worlds is in the applications, not the platform. Do not pay for the technology, invest in content.

Development of the game was divided to graphics content development, game programming, shader programming and sound world creation. Game programming included platform scripting and game platform development. SeaGate was developed with RealXtend -virtual world development platform. Technically, the game programming was done by using JavaScript language with QtScript extensions and game platform development by using C++ language. The 3D -modelling included

diving site, fauna and flora modelling. Modelling of the dynamic objects included rigging and animation of the models. The open source cross platform suite Blender was used for the modelling.

Three different configurations of the SeaGate were developed. The level of graphics varies between the versions. The most detailed version includes large textures on 3D game objects and shader programs. The shader programs which are executed in computer's graphics adapter produce special effects, which create underwater realism for the game world.

Future potential developments. Creation of the game was done by using already introduced realXtend. Nowadays it is reasonable that a commercial game supports variety of devices and operating systems. Currently realXtend runs on Linux and Windows. Strength of realXtend is well working multiplayer game support. Unity, a game development ecosystem has become more and more popular among the game developers. Unity's idea: "develop once deploy everywhere" is great. It would be still beneficial to convert the SeaGate to Unity. As a project it does not mean that everything needs to be re-done. Game assets such as game scripts, 3D-models, and textures can be used without too much bother in Unity.
The proof concept for the creation of the site model from the LAUV data was achieved. In the future project the process could be automated and an online database for the 3D site models could be developed.

1.3.4 EPITA – n° 9

Development of the project web portal integrating a 3D collaborative underwater site editing and marine e-learning platforms and the teleoperation (WP4)

Overview of the website. The Digital Ocean portal is a unique concept that will allow the diving community (diving clubs, biology and marine archeology associations) to post their data (audiovisual content), to geolocalize this information, in collaboration with their members, in order to edit in 2D/3D the underwater sites they dive to. The portal is linked to an e-Learning section that will allow users to obtain detailed information about the sea life, points of interest and online courses. A section dedicated to ROV distant teleoperation is also an innovative function.

Here is a detailed overview of the portal that offers diverse functionalities targeted towards the diving community and the general public interested in the oceans' discovery:

- The "Social diving" that allow the users browse, the divers browse, the diving clubs and diving sites and collaboratively editing diving sites though an interactive map.
- The "e-learning" that connects the users learns more about diving through interactive courses (made by MediaTouch)
- The "Forum" that let the user between each others,
- The "Teleoperation" that allow a user to remotely operate an underwater vehicle (WP made by University of Evry)
- The "Serious game" that takes place in real diving site and teach the user about the life of fishes and give him a global view of the environmental challenges facing sea depths (WP made by the University of Jyvaskyla)

Integration in the whole project. WP4 is the core part for dissemination of all work packages developed during the framework of the Digital Ocean project. As mentioned above, it integrates the results of the R&D work made by other partners. Data collected during the Red Sea mission by the Antinea Foundation will be now valorized and edited in the collaborative platform of the portal. This data was used by LudoCraft and JYU to create the SeaGate serious game that is downloadable in a dedicated section of the portal. Additional data (bathymetry, images, videos) acquired by the LAUV or the ROV (developed by the University of Porto) gathered in the future by OceanScan could also be used and posted on the collaborative platform. Concerning the ROV distant teleoperation by the internet developed by the University of Evry, a dedicated section has been implemented for future "distant diving" events organized by VirtualDive or by diving clubs members. Concerning WP3 (the Dolphyn), the portal will be used to promote the console and to communicate on events.

The Digital Ocean portal (future URL: www.digitalocean.org) offers a transversal and integrated tool of the services developed by the RTD performers that were conceived by the SMEs.

S&T development challenges. To provide the users with a seamless experience across the various sections of the website, a Single Sign-On solution has been implemented. This allows the user to connect only once to the Digital Ocean portal and still be able to access to his Moodle and his forum accounts (even if it's a phpBB3 forum that uses a totally different users database).
The challenge were the followings:
* Moodle: the e-learning website is hosted on another server so it has been necessary to use a mix of web services and standard web form authentication. The web services are used to replicate the Digital Ocean users on the Moodle server. Unfortunately there is not a login web service so it has been needed to programmatically call the Moodle login web form authentication (usually used by a human user).
* phpBB3: for the forum, reverse engineering and code digging was made because phpBB3 do not provide an API to let a developer create user or a forum.

The website is built around Symfony 2, a web application framework written in PHP that follows the model–view–controller (MVC) paradigm.
A framework aims to speed up the creation and maintenance of web applications and to replace repetitive coding tasks. Basically, it consists of:

- A toolbox - a set of prefabricated, rapidly integrable software components. This means that you will have to write less code, with less risk of error. This also means greater productivity and the ability to devote more time to do those tasks, which provide greater added value, such as managing guiding principles, side effects, etc.
- A methodology – an “assembly diagram” for applications. A structured approach may seem constraining at first. But in reality it allows developers to work both efficiently and effectively on the most complex aspects of a task, and the use of Best Practices guarantees the stability, maintainability and upgradeability of the applications you develop.

The interactive map is built using Google Maps, a web mapping service application and technology provided by Google.

The Google Maps API allows us to display the world map and add our own set of information using the “overlays”. “Overlays” are objects on the map that are tied to latitude/longitude coordinates, so they move when you drag or zoom the map. Overlays reflect objects that you "add" to the map to designate points, lines, areas, or collections of objects
Social diving
This part is a collaborative website for divers.
Users from diving clubs can collaboratively edit diving site maps with information regarding the fauna and flora, the bathymetric data, the highlights, etc.
The users have tools to interact with the various layers of data and can place media on a diving site.

Web portal architecture. Different elements compose the operating architecture of the project web portal and assure the functions this portal shall play in the diffusion and development of project results. Follows the short description of these components:
1. *Diving site directory* allows users to have access to collaborative editing of the map of a site, review information on a site, filter the list of sites using different criteria, select a site in an interactive Google Map,
2. Diving club directory: allows a quick browse all associated clubs, filter the list and find the club’s page with all related information,
3. Diving map editor: the most important tool provided to the user, allows to evaluate and modify the map of a diving site in many ways, getting information, browse, change data layers, add comments and images.... Two types of layers are provided: background layer, which defines the bathymetry and information layers, such as biocenosis, currents, diving paths, depths, media, biology...

4. *Dashboard:* Three tabs concern user's profile, club management, club's programmes.
It has 3 tabs for the following functionalities:
5. E-learning: using an existing Moodle platform, it provides courses and quizzes on diving world,
6. Forum: using phpBB3, allows users, with a single sign-on and a password, to communicate within Digital Ocean community and with dedicated forum accounts.
7. Homepage: providing direct access to most of website functions: a header, registration/sign-in, access to the other components, including games, connected network of Dolphyn,
8. Overview of the back office: This tool for the administrator offers him the possibility to manage the web site's operation and controls: users, partners, media, layers, creation, updating, news…

Results accomplished. The results accomplished achieved the objectives defined at the project start. The Portal, as a single web based system, has become the transversal link that connects the WP developed by the RTD performers and especially:

1- the e-learning module based on Moodle, a module for a marine imagery data base including photos, videos and 3D sites
2- the « distant diving »module that will allow the teleoperation via the web of underwater robots ROV equipped with High definition video cameras and the treatment through mixed reality of 2D video images in real time collected by such robots with 3D images of diving sites from the data base
3- Access and operation by internet users of the other project components: serious underwater game, Dolphyn, catalogue of 2D/3D sites, collaborative editing platform

The accomplished work allowed VirtualDive to start using the collaborative editing platform using their available data of the Marine Protected Area, La Gabinière in Port-Cros. On this first diving site, VirtualDive has started uploading audiovisual content (video, image) and local information (recommended diving path). On its side, MediaTouch has starting working on e-learning content that will be linked to edited diving sites.

Tests and validation. Tests were made at a technical level by our team of developers. Results were presented to our SMEs partner MediaTouch and by project coordinator VirtualDive. A debug Google document has been shared online, so both SMEs could test the platform and send back to our development team the list of encountered bugs and problems to be solved. Furthermore, both SMEs have carried out extensive functional tests focused on ergonomics and user interface. Revised documents were sent to Epita for improvements. VirtualDive has also integrated the feedbacks from potential end-users when the company has presented the demo version of the portal during the last exhibits and trade shows.

State of the art. There is no other comparable portal available online. Some websites propose Google Map API just to pin point the location of a diving site illustrated with a generic picture and text description. Eventually, it is also proposed to enter diving logs. The Digital Ocean portal allows to "zoom in" into the sites in order to post and geolocalize, by a collaborative work, the exact positioning of the media or observation taken by the divers. Those medias are also linked to a dedicated e-learning module that makes the service offered very complete. Furthermore, the possibility to use the gathered data uploaded into the collaborative platform into a 3D virtual visit of the edited site is unique. Only Google proposes 3D visualization solutions, Google Earth. This application, based on very large-scale bathymetrical information does not allow visualizing detailed underwater sites with their local sea life illustrated precisely with audiovisual or 3D content. The Catlin SeaView project based on Google Street View technology (360° images) does not allow real interactivity offered by real time 3D.

Concerning the "Distant Diving" concept of ROV web based teleoperation (integrated in the portal and developed by the University of Evry), is also a very innovative module. Up to know, teleoperation via the Internet has only been made for surface robots distant control.

Innovative features. The use of Google Maps API to allow divers to combine their own drawings, custom maps, diving path and media on top of a real map is the main innovative feature that has been developed. Also, an intensive use of Javascript was made in order to provide the user with a dynamic and responsive map edition. Seamless SSO across Moodle, phpBB3 and the Digital Ocean website are the other innovations.

Future potential developments. It would be very interesting to integrate a set of web services for additional outside information (weather, marine life ontology…) or linked with editorial content created by the community (Scoop It!, Twitter,…). We could also associate diving logs to the editing platform, which will allow divers to link their diving data (dive duration, depth, positioning of the photo taken) with a visual 2D representation of their itinerary made in the diving paths. It could also be interesting to automatize the process of editing a 3D site from data acquired in the 2D collaborative platform (XML exchange files). This process is actually made manually by the editor (VirtualDive).

Finally, it will be important to plan the development of an e-commerce tool in order to start making business. This online store should allow managing fees subscription, content and applications download, events reservation…).

Deviation from the initial objectives. There were no major deviations from the initial objectives. The only thing that is currently being finalized is the integration of the ROV teleoperation. The University of Evry has done this part and it is functional but it needs to be implemented in the dedicated section of the portal.

2. PROJECT WEB SITE

The project website is www.digitalocean.eu
The project portal resulting from WP4 is http://test.digitalocean.org
The final address when open to the public will be www.digitalocean.org

3. USE AND DISSEMINATION OF THE FOREGROUND

3.1. Reminder of the objectives of the initial plan

The initial dissemination plan dated October 2011 was prepared for the review meeting on January 2012. We are going to present the main features of this plan and update it with the experience acquired during the second reporting period and with the purpose of defining the guidelines for dissemination of the foreground achieved at project completion, in particular ***during the year 2013.***

The initial dissemination plan detailed the plan objectives, insisted on the importance of dissemination for the success of the project, more specifically for the improvement of SMEs involved, described the results expected from the project and the target groups related to these results.

The foreground that is concerned by this dissemination is constituted by five products: DOAM, Dolphyn, Digital Ocean portal, “virtual diving” method and SeaGate.

3.2 Plan of dissemination

The objectives of the dissemination plan is to assure that project results will be transferred to and absorbed by the SMEs, thus getting integrated in their current activities, opening them to applied research and multidisciplinary technologies, generating new business and revenues, allowing access to international markets on their medium and long-term development plan.

It is focused in reinforcing market position of SMEs participants; increase their visibility through web actions, publications, conferences…facilitating dissemination of the foreground with, nevertheless, an adequate protection of knowledge. For this dissemination to take place effectively, there is a need to mobilise necessary technical, human and financial resources and foster European partnerships with other SMEs and with RTD performers.

Dissemination is geared to raise awareness of general public, of potential users and of focus groups of professionals. Finally dissemination prepares subsequent exploitation of project results, including market research, potential user's group analysis and selling strategies, business planning, study of distribution and commercialisation channels and exploitation models.

3.3 Dissemination for project success

Dissemination is an essential part of the project. It is a long-term action that requires careful preparation and good knowledge of market conditions and market trends.
All project partners are committed to participate in the dissemination effort of Digital Ocean and of its components. The objective of this effort is to deliver project results to key target groups, improving the relevance and adequacy of these results by a continuous dialogue with different stakeholders concerned, enhancing project visibility and public awareness. The dissemination activities pave the way to commercialisation and exploitation of project results and will finally condition the success of the project.

Dissemination actions in professional fairs, public pools and international conferences

The present dissemination plan which is provided for in WP8, was improved and updated from month 6 through month 9 at the end of which the activities included in this work package started effectively, thus extending the implementation of the plan during 15 months, until the end of the project at month 24.

3.4 Dissemination objectives

SMEs partners and Research Laboratories worked together to reach the objectives of dissemination. During this period, following the closure of the project, results are still presented as prototypes or models and there is still room for improvement and changes to comply with potential clients and users requirements. VirtualDive is keeping open the ways for a close cooperation with the University of Evry from one side and with EPITA, from the other side, assuring that the effort of dissemination after the project completion will be pursued, in collaboration with these two RTD providers. Further, joint dissemination actions of two of more SMEs partners are being prepared, in the framework of new projects and new partnerships.

3.5 Results and target groups

As project delivered partial results and an integrated project result, it is important to consider different target groups for each one and specific dissemination approach for each target group. The five project results are treated individually:

Product n°1: DOAM – This product is a module developed by the University of Porto for Oceanscan that will allow their robot LAUV, already in operation and equipped for bathymetric data collection, to start collecting digital imagery of the sea depths, offering a new interesting functionality to their clients.
This product being an accessory for LAUVs in the market, in general, will be essentially disseminated and exploited by Oceanscan. Their potential end users are LAUV owners that are interested by the new applications that the DOAM allows. Oceanscan will of course integrate the DOAM in their own LAUV. This result becomes a module of their product.

Product n°2: Dolphyn – This product conceived by VirtualDive for beaches Is an extension and an improvement of the Tryton used in the pools. This product integrates a line of products that includes the Tryton for swimming pools, previously developed and associated contents. These devices will be distributed by existing networks – of equipment for pools and for beaches, equipment for tourism hotels, diving equipment, and/or introduced in the markets through commercial fairs (pools, aquatic leisure...). Its commercialization will require a strong marketing and sales team in-house, as the challenge is to introduce a totally new concept in very large and dispersed markets. So the dissemination actions related to this result will target the swimming pool, the costal tourism and the hotel sector.

The first prototype of the Dolphyn was tested in different pools and in a dive pit in the Paris region, during the progress meeting in Jyvaskyla and in the sea at Brittany (France) and Sesimbra (Portugal).
To prepare for the commercialisation and the industrialisation of the project foreground, the partners are studying presently different alternatives, the first being the coupling of two results searching to add value to the combined product or service. The integration of Seagate in the Dolphyn as an embarked content is one of the options that was tested in Sesimbra.
The LAUV equipped with the result of WP2 –DOAM, and the Dolphyn were both tested together at sea, also in Sesimbra. One of the purposes of the test was to consider the technical feasibility and the interest of using both devices, DOAM and Dolphyn, working interconnected to collect underwater data that can be checked and transmitted in real time.

Product n°3: Virtual diving by teleoperation of a distant ROV. This is the most innovative concept of the project and is also the one that required more RTD work and actual costs than those initially forecast. If the concept is simple to understand, it requires mastering numerous factors that are just becoming available in the markets and represent the state- of-the-art in underwater robotics

and in teleoperation of distant robots via the Internet. This result was tested in the diving pit in Paris and in a pond in the Evry region.

Product n° 4: Digital Ocean portal - The project web portal constitutes the access to these products. *Virtual diving* and *serious underwater game*, therefore both will be also commercialized on-line.
Following are the conclusions on this result, after the two tests performed:
-The feasibility of the teleoperation of a ROV underwater robot via the internet was confirmed and the result corresponds to the expectations.
- The small ROV acquired for the project, supplied by the French specialist Subsea Tech was able to perform the basic operations in a water environment without currents. The test at the open sea which was planned and was not realised, will be required for further R&D and improvement of the robot more precise control.
- It is also concluded that the type of ROVs to be used for such teleoperation may needed to be heavier or dispose of further command options to be operated safely in open sea.

Product n° 5: SeaGate – This game developed by the University of Jyvaskyla for Ludocraft may either be exploited through the channels already in place for other games produced by Ludocraft or/and be integrated in the previous package and be distributed through the web.

3.6 Updating the dissemination plan beyond the Consortium

The project concluded on 31st of December 2012 but the foreground, with the exception of the last result of WP4, was already presented to the team during the tests at the project progress meeting in Sesimbra in September 2012. Since then the following options to add value are being explored:

3.7 Searching for new financing programmes to proceed with the development

VirtualDive conceived a project to take the foreground of Digital Ocean further towards the international markets, within the framework of the programme RSMEs-Demonstration. The project named ***"Ocean iWay"*** was submitted to the European Commission on November 11, 2012. The team includes the four SMEs partners of the present project and three new SMEs: Deltatec from Belgium, specialised in industrialisation of complex systems, Technomar from Germany which is an expert in marketing innovative products and systems and Evologics also from Germany that introduces state of the art underwater communications technologies that complete and integrate the foreground of Digital ocean. If the project is selected, the team will have the resources, the knowledge and the experience to take the Digital Ocean results to the market and assure their successful exploitation. This is of course the preferred choice.

VirtualDive is also searching for French national financing programmes. Leading a team of eight partners, VirtualDive submitted the project "Undersea.Log" to the French Research Agency (ANR) on February 11, 2013.

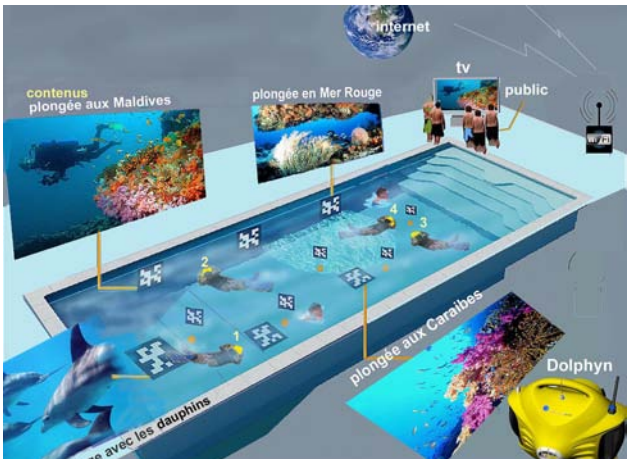
This project is conceived to create a catalogue of diving sites online, involving the public in general and the children in particular, to allow them to get more aware of the subsea environment and its rich biology.

3.8 Searching for financial, industrial and commercial partners

VirtualDive is participating on next April, in Geneva, at the International Exhibition of Inventions of Geneva, with the new prototype of the Dolphyn. This is one of the major events where inventors meet potential investors and representatives of the international manufacturing industry.

3.9 Developing new applications for the project results: project "Media iPool"

VirtualDive developed in cooperation with the University of Evry, a new concept that uses the results of Digital Ocean. It is named "IMedia Pool" and it aims to transform the public swimming pools by introducing the digital imagery, the augmented reality and the simulation, through tags positioned in the pools floor and walls. These pools may than become an interactive space for leisure, education and well-being. This project was selected for financing by the region Yvelines.



"iMedia-Pool"
Creating new applications for the foreground

Geneva Inventor's Fair
Increasing international visibility

3.10 Initiating pre-commercialisation of results after further development

Of course, none of the results of the project is immediately marketable. From the prototypes produced to the market there is still a way to go, improving the performances of the models and prototypes produced under the project and adapting it to the fast technological and market changes and to potential competition.
For these products to get the required visibility, different actions are being taken: networking with large international institutions, with oceanographic and marine scientific agencies, with museums and aquariums, with the diving community and with environmental organisations. Each one of the products will be treated as an independent profit centre with one responsible.

Virtual diving, by its complexity and the need to implement a local support system equipped with ROVs, is the product that will need for its dissemination and exploitation, larger human and financial resources. So the introduction of this method in the market will be planned for 2014, after the successful introduction of the Dolphyn.

4. CONCLUSIONS

Introductionary statement. SMEs are the key players in the European strategy for economic growth and employment. The RSMEs programme offers effectively a framework for SMEs to strengthen their "innovation capacity", contributing to the development of new technologies and new products by outsourcing the research to RTD performers. This statement applies to the four SMEs involved in the project Digital Ocean.
To start, there was a project – Digital Ocean, conceived by VirtualDive, a "young innovative company", and already developed in the French environment of the National Research Agency (ANR). The concept and the results obtained by end of 2009, gave to the project enough credibility to become European. It took nevertheless two unsuccessful trials before VirtualDive constituted the winning team, adjusted the proposal to the European standards and signed the Grant Agreement in October 2010.

The development. The project was developed during the years 2011 and 2012, as foreseen, with no scientific, technical or technological problems, under an excellent team spirit, with no internal frictions or divergent viewpoints and with a remarkable participation of the same players from the start to the end. These conditions assured the consistency of the group effort and facilitated reaching all project objectives within the work programme. The results constitute a foreground – that, as specified in the programme, is not yet ready to be taken to the market and require further developments and resources.

Lesson. One conclusion of this experience is that the simple outsourcing of the R&D by SMEs to RTD providers is not sufficient to succeed. The relationship requires a different approach than the usual "customer-seller" link. European SMEs and RTD providers in general are not used to work together, except in few cases, when SMEs are spin-offs of laboratories. The programme requires an active and close partnership between SMEs and laboratories to avoid waste of time, technical divergences during the project development and eventually the delivery of unmarketable results. It requires also a strong project management and an intense search for additional resources.

First choice. In normal market conditions this effort can be taken progressively by the concerned SMEs. They will self-finance the complementary costs either by bank loans, by owners funding or by national aide programmes.
This solution, today hazardous, is nevertheless still the ***first choice*** that may be adopted by project partners, such Oceanscan for the DOAM and by VirtualDive for the Dolphyn. Both are planning to integrate their project results in their ongoing activities. This choice may become more feasible if two SMEs join forces to develop together their results. This is what Mediatouch and VirtualDive

decided to do for the additional developments and commercialisation of the Digital Ocean web portal and for its editing platform.

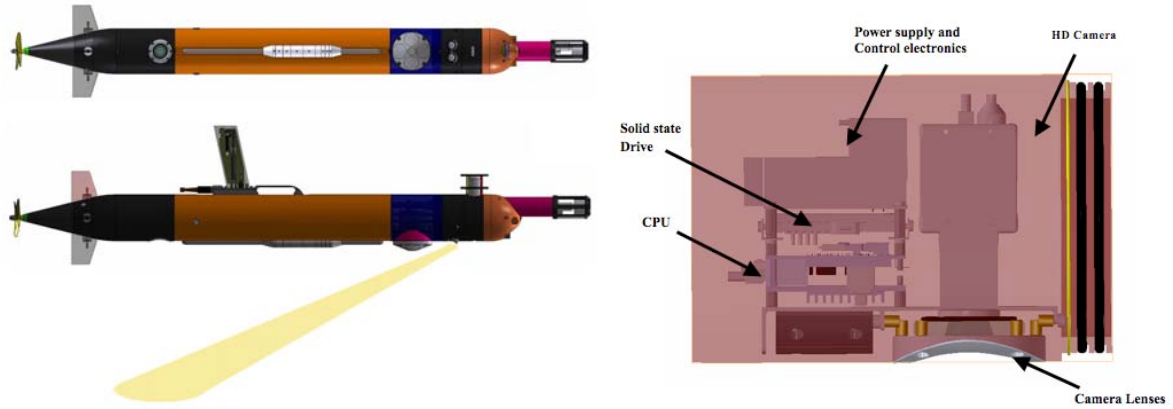
Second choice. The costs and time required to take the models and prototypes produced by the programme RSMEs to the markets, are estimated comparable to those required producing them, as a consequence of the present general economic downturn. So our ***second solution*** was to search for national and European funding. VirtualDive is pursuing both possibilities: French programme with the call for proposals ANR-Contint 2013, by submitting the project Undersea.Log on February 2013 – which shall generate contents for the Dolphyn and further develop the marine data collection by adding an "air-surface" robot; European programme RSMEs-Demonstration 2013, by submitting on November 2012 the project "Ocean iWay" with the same 4 SMEs and the University of Evry, project that will enrich the Digital Ocean foreground and assure its introduction in the international market and its industrialisation.

Third choice. The programme RSMEs offers a third alternative that we are also going to pursue actively. This alternative is based on the working links created between SMEs and RTD providers along the project duration, which opens opportunities for new projects targeted specifically by mobilising knowledge and experience developed during the European project. VirtualDive and the University of Evry will work together in a new project named "iMedia-Pool" introducing augmented reality in public swimming pools, in France.
The European project Digital Ocean opens therefore three new opportunities for further developments, consistent with the acquired foreground and on line with its objectives.

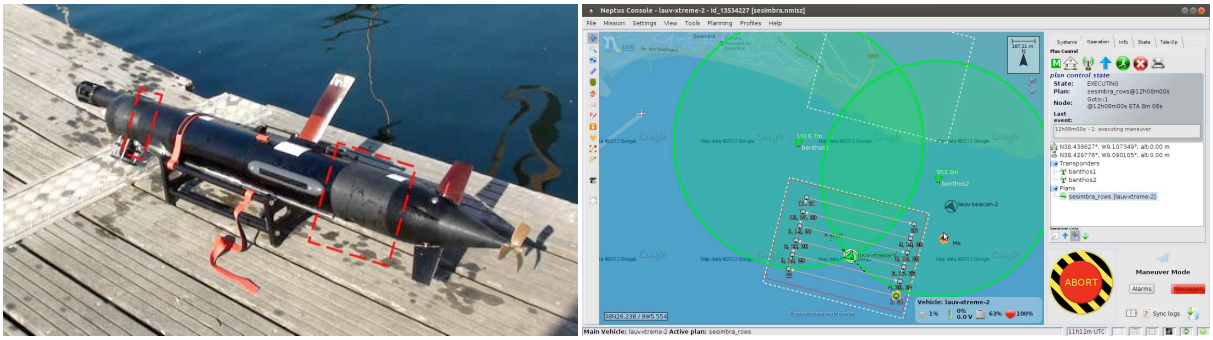
ANNEXES

DIGITAL OCEAN PROJECT AT A GLANCE

WP2: Digital Ocean imaging Acquisition Module for LAUV

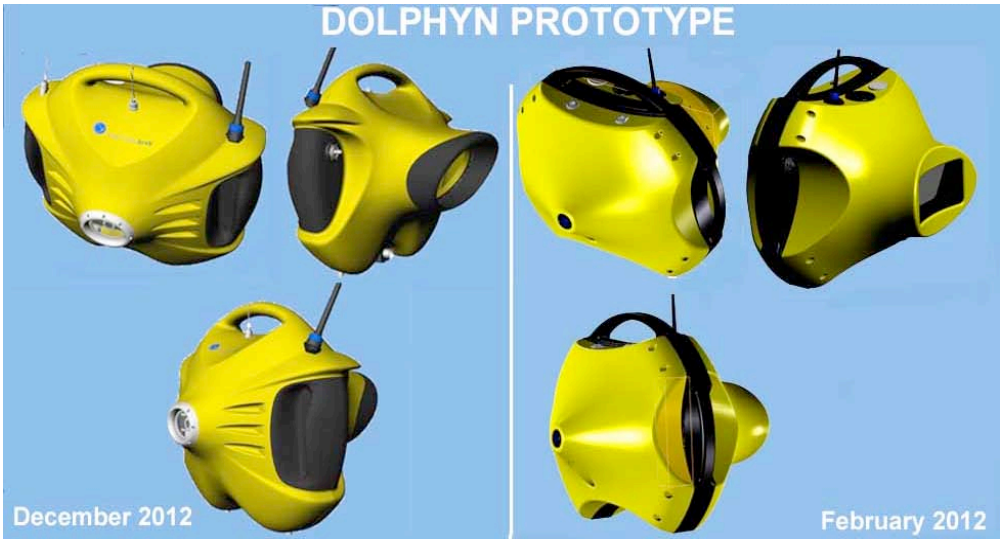


LAUV prototype with and the DOAM module in detail

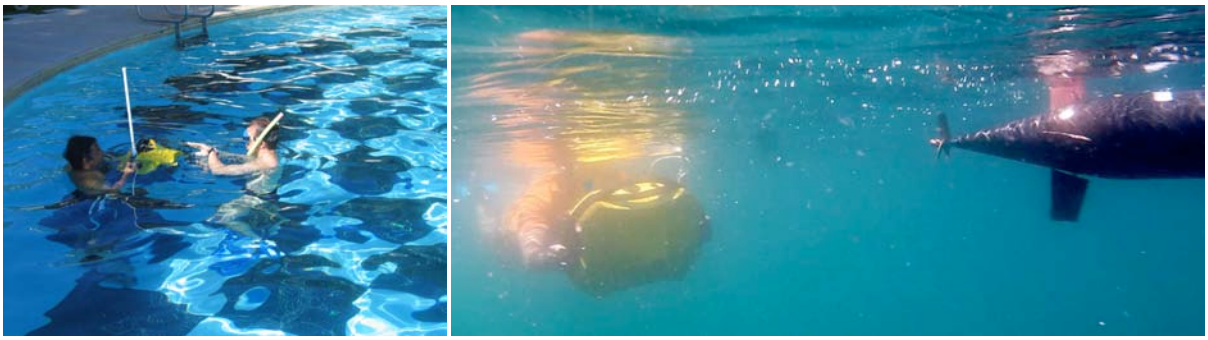


LAUV with its illumination and acquisition modules / LAUV programming console

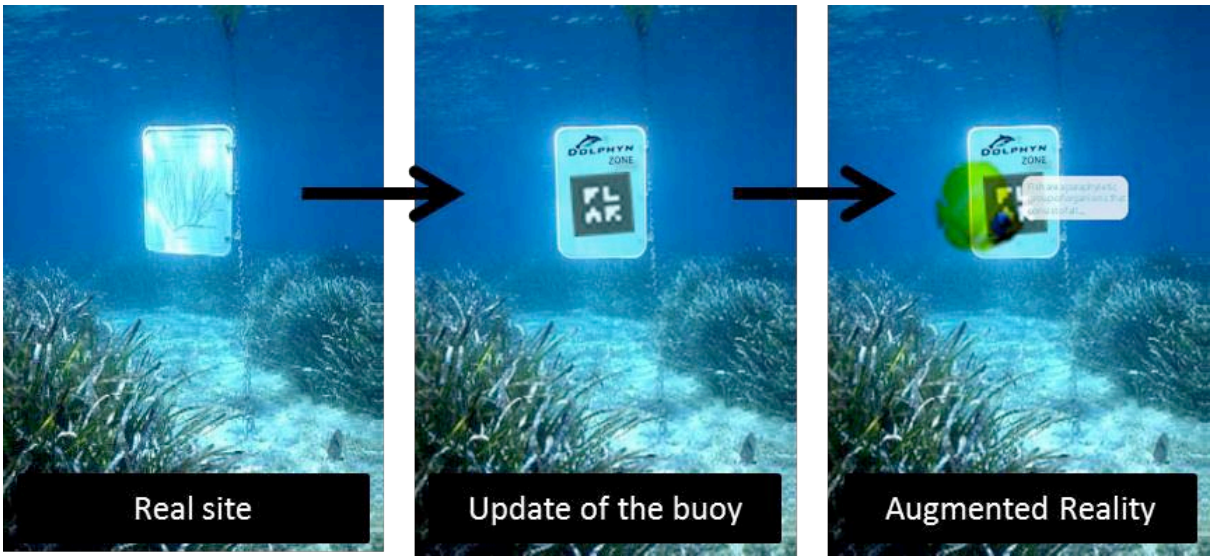
WP3: Dolphyn Aquatic Interactive Console



Two versions of the Dolphyn: final conceptual model and the initial prototype produced

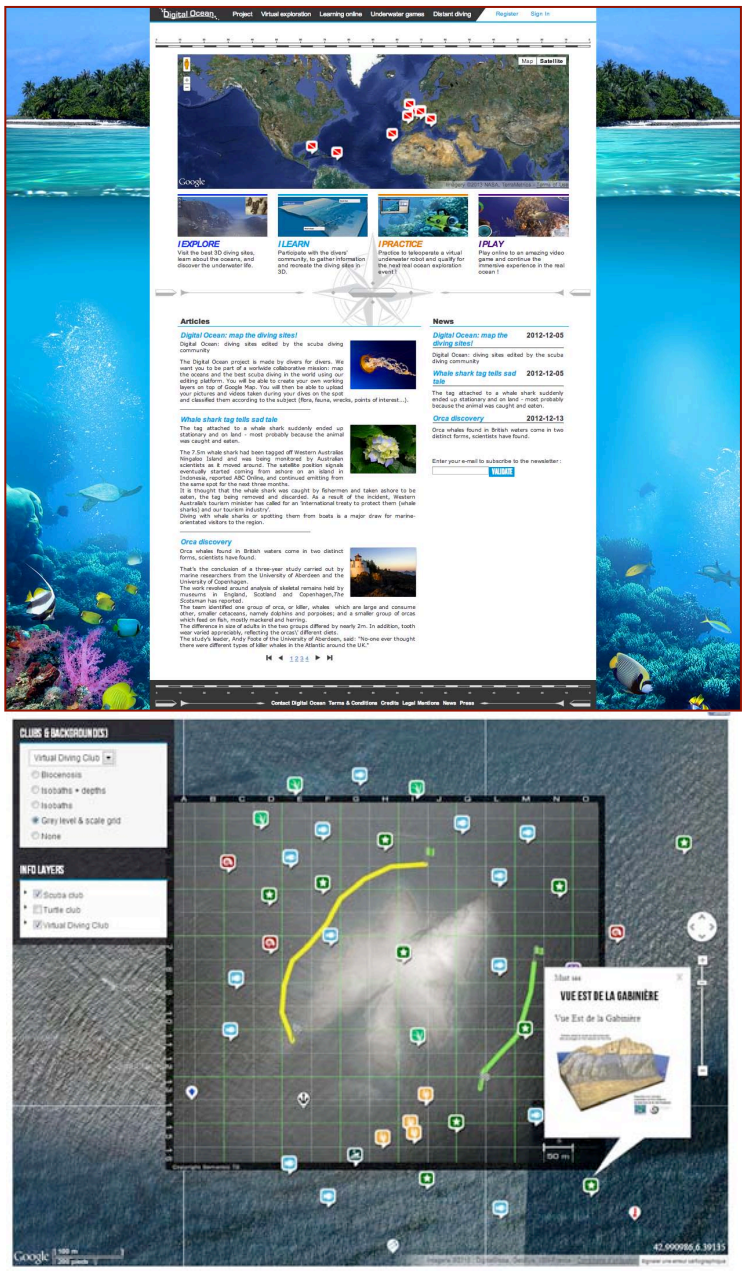


Tests in a swimming pool and at sea in Sesimbra

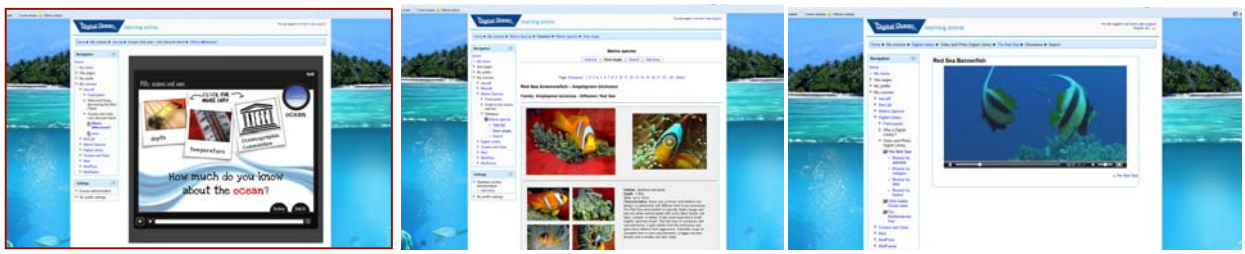


Augmented Reality application for the Dolphyn

WP4: Digital Ocean portal

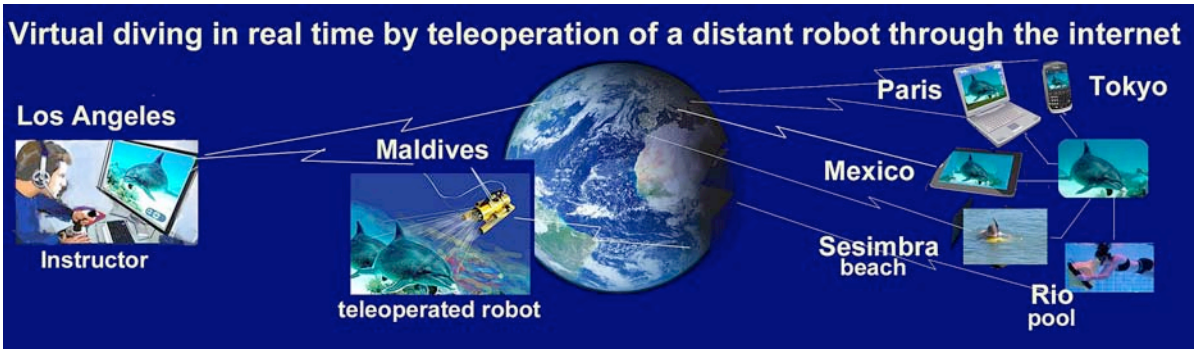


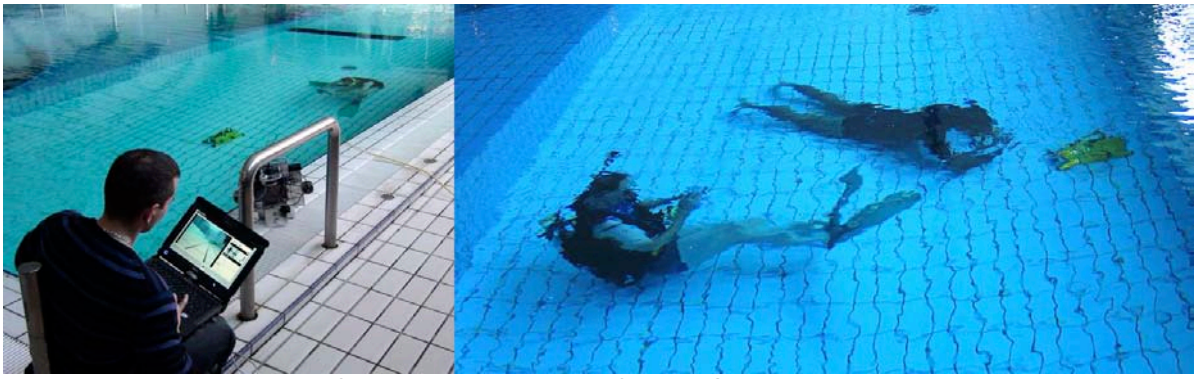
Digital Ocean Portal home page and collaborative platform interface



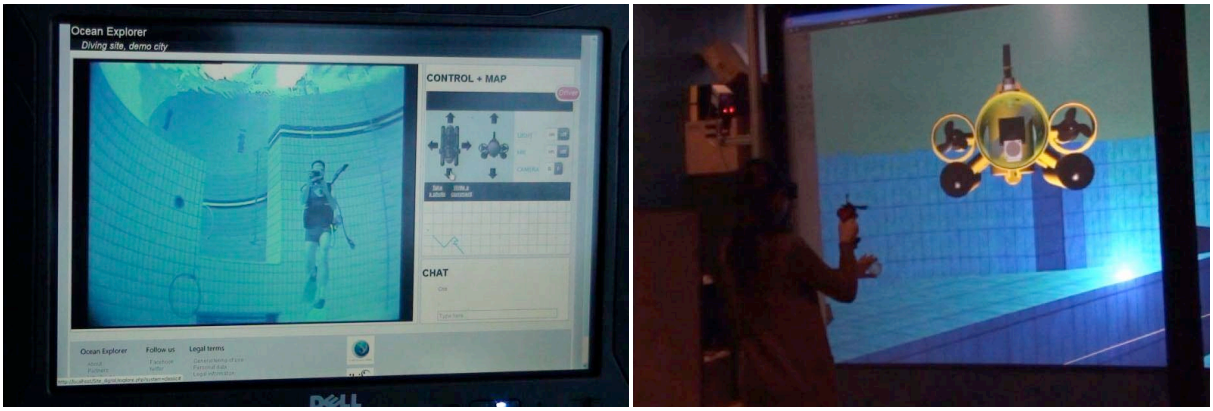
e-learning module: online course, marine specie database, video and photo digital library

WP5: Remote Operated Vehicle (ROV) teleoperation





Tests of the teleoperation of the ROV via the internet

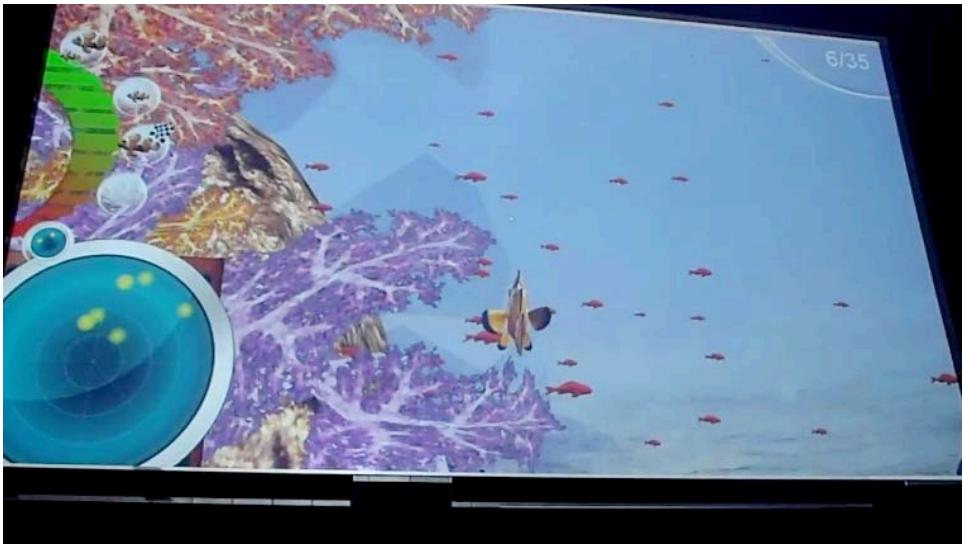


ROV teleoperation in a diving pit and Virtual Reality interface for ROV teleoperation

WP6: SeaGate serious game

Screenshot of SeaGate – “Serious Underwater Game”

Testing SeaGate installed in the Dolphyn



SeaGate displayed simultaneously on the SPA giant screens

PROJECT MEETINGS

Review meeting in Brussels

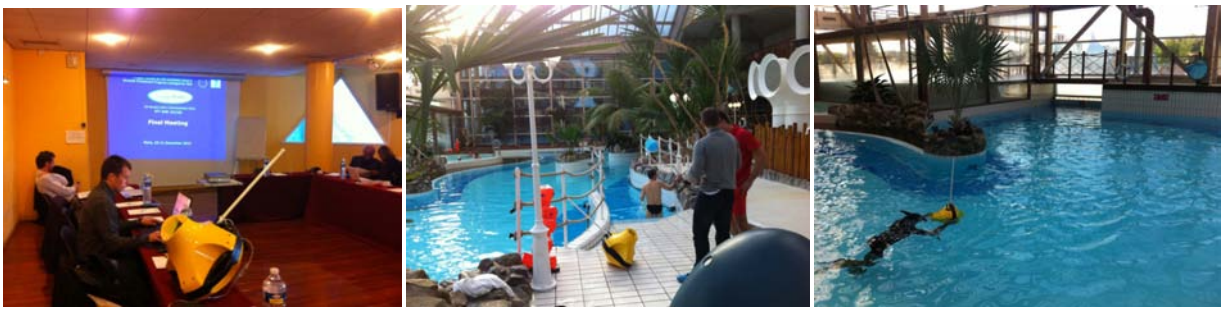
Project Meeting n°3 in Jyvaskyla (Finland)

SeaGate tested in the Dolphyn in Peurunka SPA Resort

Project Meeting n°4 in Sesimbra (Portugal)

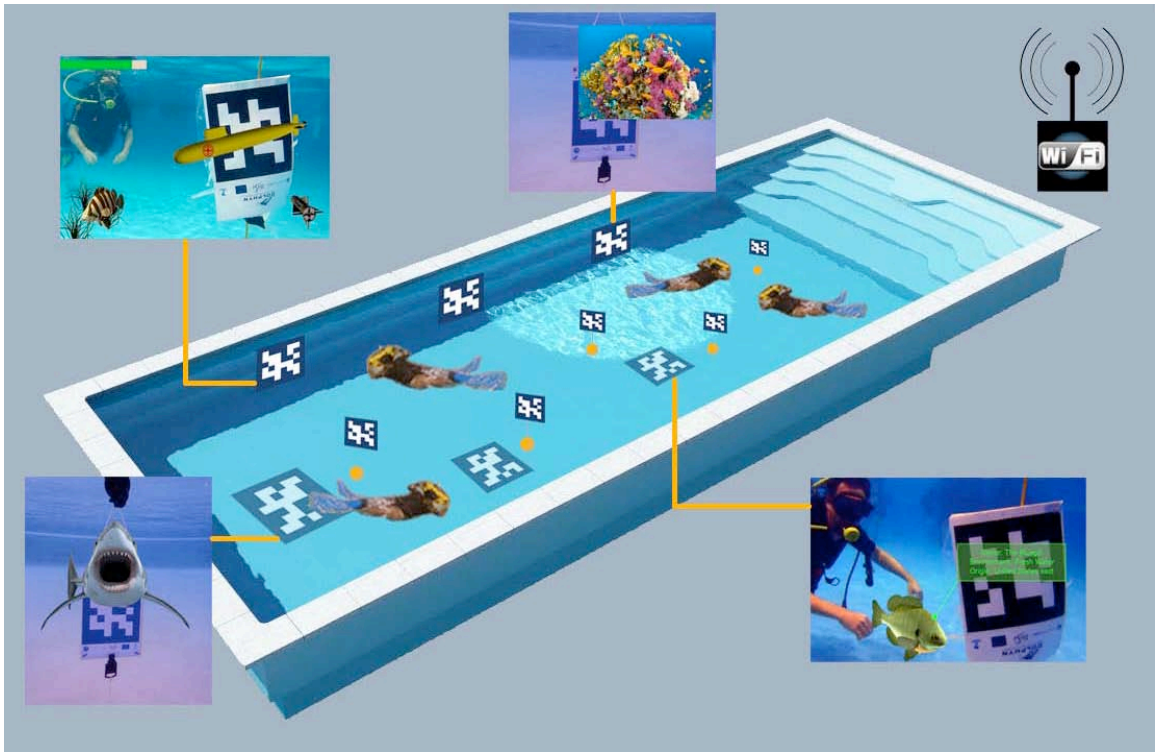
Dolphyn tested at sea with the LAUV

Project Meeting n°5 in Paris, Aquaboulevard Aquatic Center (France)

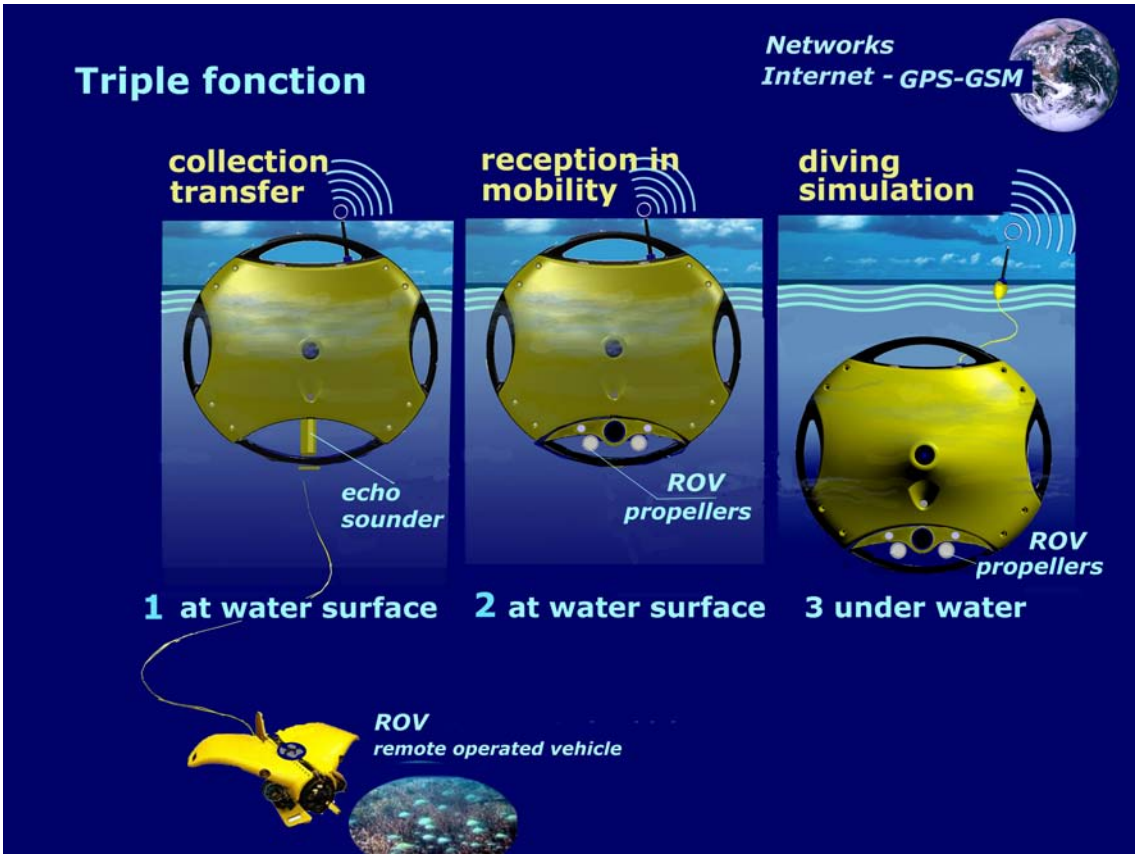


Dolphyn Wi-Fi connection tested in the pool

PROJECT FUTURE PERSPECTIVES



Interactive pool concept based on AR contents and Dolphyn

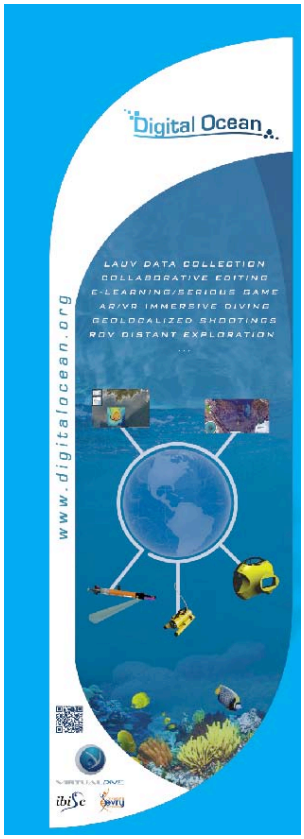


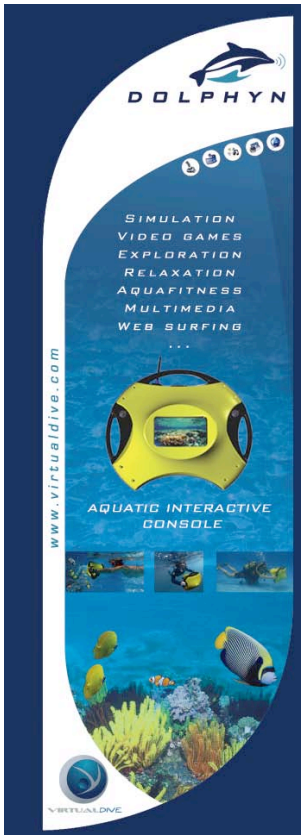
New functionalities planned for the Dolphy

COMMUNICATION TOOLS

Project logos

Proposed logos for ROV teleoperation and AR buoy for Dolphyn





Flags and kakemonos


DOLPHYN
INTERACTIVE AQUATIC CONSOLE
TABLET PC
PLUG
PLAY!
"OCEANS CONNECTED"
VIRTUALDIVE
IMMERSIVE NEW TECHNOLOGIES


Digital Ocean...ORG
OPENING: SUMMER 2013
DIVING SITES EDITED BY THE SCUBA COMMUNITY!
DIVE SITES COLLABORATIVE PLATEFORM
2D & 3D INTERACTIVE SITES CATALOG
ELEARNING PLATEFORM
SERIOUS ONLINE GAMES
DISTANT DIVING BY INTERNET WITH UW ROBOTS
VIRTUALDIVE
IMMERSIVE NEW TECHNOLOGIES

Post cards


VIRTUALDIVE
Les nouvelles technologies en immersion
Digital Ocean
Plateforme collaborative d'édition 2D/3D de sites sous-marins
Digital Ocean est un système informatique composé d'une plateforme collaborative basée sur un SIG (Système d'Information Géographique) dédié à l'environnement aquatique, d'un logiciel d'édition 3D, d'un module de eLearning et d'une application permettant la téléopération de ROV par internet.
La plateforme permet de mettre en ligne vos données audiovisuelles, scientifiques ou techniques et de les partager avec vos équipes. Vous pouvez éditer, géolocaliser et incrémenter collectivement vos informations dans votre espace de travail collaboratif.
Acquisition En ligne
Traitement Collaboratif
Valorisation Interactive
Diffusion Multi-supports
Les données géopositionnées peuvent être importées dans une cartographie 3D pour permettre une visite interactive enrichie de données multimédia. Ces représentations virtuelles, mises en ligne sur internet, deviennent des outils de médiation et de communication auprès des clients ou du grand public.
La section de eLearning permet de rattacher vos données à des cours en ligne (formation technique, accès à des bases de données documentaires et audiovisuelles).
Une application web est également prévue pour la téléopération d'un ROV distant (équipé de caméras) depuis une interface de commande web. Ce service peut vous permettre d'explorer, pour des besoins spécifiques, une zone sous-marine sans vous y déplacer (plongée duplex, inspections techniques et de surveillance).
Digital Ocean est une solution innovante pour cartographier en 2D ou 3D, des sites sous-marins pour des projets liés à la plongée, l'archéologie sous-marine, l'environnement subaquatique (Aires Marines Protégées) ou des projets à vocation industrielle (off-shore, portuaire, énergies marines).
Les domaines d'applications
Sites de plongée & AMP
Sites offshore
Port & Marinas
Sites archéologiques
VIRTUALDIVE : +33 (0)6 85 08 36 82 - adinis@virtualdive.com - www.virtualdive.com
VIRTUALDIVE
Les nouvelles technologies en immersion
DOLPHYN
Console informatisée d'exploration sous-marine
Le DOLPHYN est la première console aquatique mobile ayant les fonctionnalités d'un caméscope, d'un ordinateur et d'une console de jeux. Il intègre une tablette PC, une antenne Wi-Fi, un système GPS, une webcam HD, des joysticks et différents capteurs. Le DOLPHYN permet une double immersion, virtuelle et aquatique.
Le DOLPHYN permet, depuis la surface, en Palmes, Masque et Tuba (snorkeling), l'accès à une exploration du monde sous-marin, rehaussée d'informations virtuelles et multimédia se superposant aux images captées par la caméra frontale (Réalité Augmentée).
Les utilisateurs peuvent ainsi d'enrichir leur randonnée aquatique de contenus pré-installés ou accessibles en ligne, pour une exploration sous-marine en réseau.
Grâce à sa caméra HD, le DOLPHYN peut enregistrer des données audiovisuelles sous-marines. L'utilisation d'un sondeur (en option) permet des levés bathymétriques depuis la surface qui, couplées au GPS, offre la possibilité de connaître précisément l'emplacement de la photo ou vidéo.
Le DOLPHYN peut servir d'interface de commande pour la téléopération d'un mini-ROV équipé de caméra. Il est ainsi possible de déporter en profondeur le champ de vision de l'opérateur. Ce dernier, n'a pas besoin de plonger en bouteille pour explorer les fonds marins distants.
Les données collectées serviront à cartographier les sites sous-marins en 3D afin de créer des visites virtuelles accessibles en ligne, ou augmentées pour des consultations en mer via les consoles DOLPHYN.
Le DOLPHYN offre toutes les possibilités de l'informatique embarquée en milieu aquatique pour des usages de prises de données, de cartographie, d'exploration des fonds marins depuis la surface.
Les usages possibles
Randonnée loisirs ou exploration professionnelle pour les activités nautiques et aquatiques
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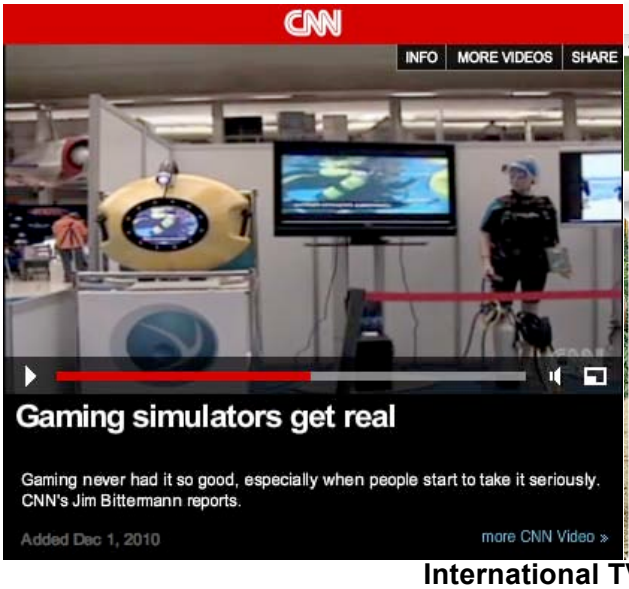
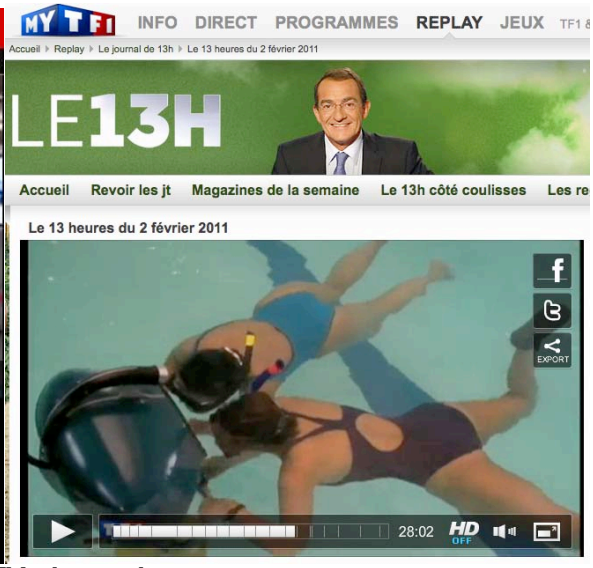
Flyers


innovation technologique
avec le Dolphyn,
pratiquez la plongée virtuelle en plage, en piscine
et autour de votre bateau

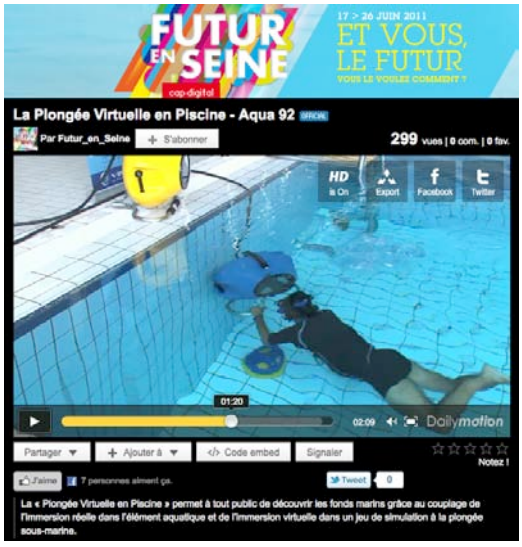
DIGITAL OCEAN IN THE PRESS





International TV channels

Cable TV channels



Web TV and French radio

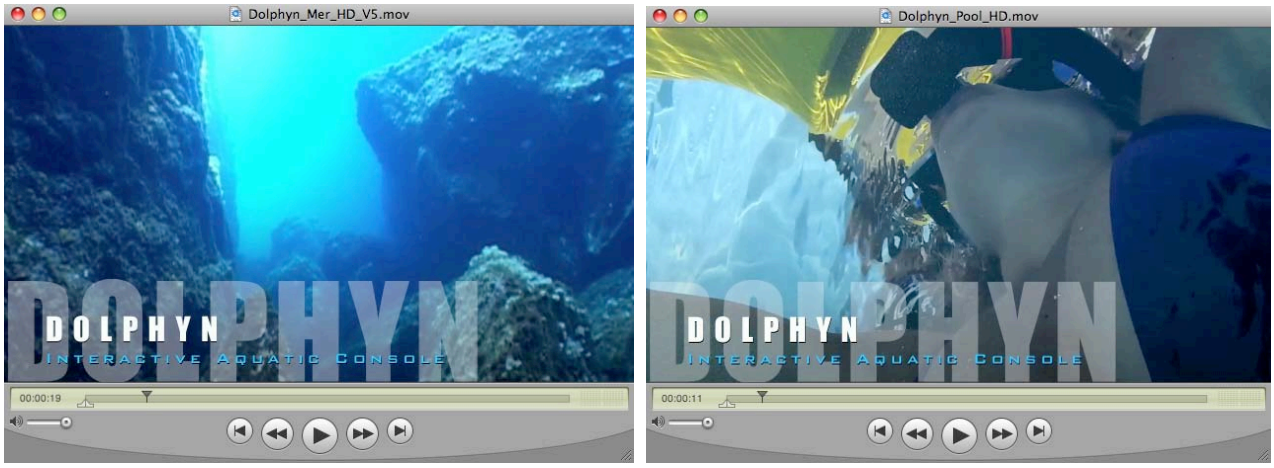
Finnish scuba diving magazine

French magazines

PROJECT VIDEOS

Overall presentation (end of the project)

Red Sea mission presentation (beginning of the project)



Dolphyn at sea and in pool vídeos

ROV teleoperation virtual and real tests

LAUV presentation video – SeaGital presentation vídeo

Videos available on the project web site: www.digitalocean.eu