TECSIS PROJECT: SUBMARINE CAMPAIGN IN NAPOLI ARCHAEOLOGICAL AREA

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Abstract

The project TECSIS (Diagnostic technologies and intelligent systems for the south Italy archaeological sites) was dealing with the concept of remote museum that is an extension of the virtual museum concept. The remote museum allows the use of the cultural goods also in hostile environmental (marine sites, caves) or in site where the human presence can damage the goods (site sensible to climate change or similar). The aim is the application of advanced new technologies in archaeological research, maintenance, supervision and valorisation of the historical and artistic patrimony to help archaeologists in surveys of important sites and inspection of submarine finds; moreover the remote visual touring , possibly integrated with multimedia interactive instruments, can develop a new kind of tourism. This poster is concerning with some measurements performed during the marine campaign leaded by ROV (Remotely Operated Vehicle) in the archaeological sites in the Napoli's area, as suggested from the local authorities proposed to the protection of the sites. In particular we performed bathimetric and morphological measurements by Side Scan Sonar, Multi Beam EchoSounder integrated with camera vision. The visited sites were the city of Baia (Napoli), the Agrippa Postumo's villa (Sorrento), some columns close to Procida and a modern ship sink close to Ischia. All the measurements were georeferenced by GPS and local pinger to mark the position of the ROV.

1. Introduction

TECSIS is a project financed by the Italian Ministry of Research (MIUR) to develop "Technologies and Intelligent Systems for the development of Archaeological Parks in Southern Italy" (http://robotica.casaccia.enea.it/tecsis/index.php). The project was dealing with the concept of remote museum that is an extension of the virtual museum concept. The remote museum allows the use of the cultural goods also in hostile environments (marine sites, caves) or in site where the human presence can damage the goods (site sensible to climate change or similar). The basic idea is to open to the cultural tourism the archaeological and artistic areas currently unavailable owing to the position of the historical sites and samples and often to the physical impossibility to move them to Museums. Moreover it opens the possibility for the expert people to work in situ from their laboratories.

Tecsis is one of the biggest national projects on robotics funded by the Ministry of Research in the last years and collects the contributions of three industries, two Universities and four public Institutes with ENEA (Italian National Agency for New Technologies, Energy and the Environment) as the main operator.

ENEA has a long tradition in the exploitation of high-tech diagnoses in the preservation of artistic masterpieces. Recently, cultural heritage thematic has been chosen as one of its reference projects. The relevant element of this choice is in the possibility to support the preservation of the goods and the opportunity to appreciate the cultural heritage itself through the exploitation of the technological know-how of the Agency.

ENEA has developed and is still working on many facilities, among these acoustical, optical and X-ray analysis instrumentation, Remote Operated Vehicles (ROV), Underwater Autonomous Vehicles (AUV), underwater communication systems and others. These facilities have been used in the projects focused on the archaeological research, maintenance, survey, protection of the historical heritage, both marine and terrestrial. It includes a number of research activities including the exploration and data acquisition of archaeological masterpieces and historical rests lying on the Mediterranean basement. The aim is to support archaeologists in surveys, inspection and digital reconstruction of submarine sites as well as in the valorisation of the historical and artistic goods by means of remote visual tours.

A multi disciplinary technological approach to cultural heritage currently represents the preferred solution to preserve the masterpieces from environmental and "aging" damages. A cautious exploitation of the tools that the modern technology is able to supply opens new possibilities to enjoy the masterpieces and also allows increasing the number of the visitors of artistic heritage sites and Museums. More specifically, the use of Robotics in cultural heritage could allow the introduction of an entirely new concept of "artistical journey", potentially able to cope with many of the before mentioned concepts.

A very advanced digitalised museum can offer to many more visitors the opportunity to access to masterpieces, to preserve the goods from the attacks bound to the presence of hundreds and thousands of human beings, to deepen certain analyses and studies in such a way that couldn't be allowed in a "real" visit. Advanced technology can lead to feelings similar to those that the most of people can enjoy during a "real" visit and the effort of the research in this field is to make the difference between walking among the masterpieces and perceiving their magnificence through electronics devices minimal.

Robotics approach, moreover, can allow the visitor (as well as the archaeologist) to recover some feelings of the "true" visit, avoiding at the same time the difficulties coming from hostile environments as deep waters, caves, and other "hard" places where archaeological goods are often hosted and cannot be removed. A significant part of cultural heritage is in fact located in

similar places. Therefore robotics can develop a new kind of virtual museum where the visitors are active actors of the scene for a cognitive experience. We called all of that a “Remote Museum”.

Sophisticated rendering technologies, joined with the opportunities inside the concept of Remote Museum could allow the augmentation of perceptive and cognitive feelings in a large number of visiting persons and the quality itself of interactive perceptions.

The project explicitly does not preview the realization of a pilot park, but the realization of demonstrative experiences. Some not commercial demonstrations are realised with campaigns in collaboration with the local authorities. This cooperation leaded to recognise some central keys of the project:

- Diagnostic function,
- Recovering and maintenance of the goods,
- Mobility function,
- Remote ability to use the good function.

Points of force of the project are the integration of possessed innovative technologies from various partners into an “”homogenous corpus”; the introduction of the concept of “remote museum”; the development of totally new technologies, such as the submarine LIBS (Laser induced breakdown spectroscopy) and the model of the plume (plasma spandrel) the underwater laser cleaning, and some techniques of control adopted for the first time on submarine’s robot.

The results obtained by the project were many: 4 patents, 3 copy writes of software, more than 100 publications, 6 measurements campaign, to name a few..

Some of the principal improvements are:

- The quantitative analyses of underwater technique LIBS;
- The application of sophisticated control techniques for the laser treatment of surfaces exposed to the action of polluting agents;
- The development of low cost technologies for surveying the coastal submarine;
- The development of “in situ” measurements technologies where the only applicable option was (and not always usable), with very high costs was laboratory analysis;
- The improvement of the 3D reconstruction systems, using special technologies increasing the precision by active stabilization.

Four terrestrial and two marine campaigns were performed. The marine were on the historical site of the Egadi battle (among Romans and Carthago ships) and within the Naples bay.

The poster presents some of the measurements performed during the marine campaign leaded by ROV (Remotely Operated Vehicle) in the archaeological sites in the Naples’s area, as suggested from the local authorities delegated to the protection of the sites. In particular we performed bathymetric and morphological measurements by Side Scan Sonar, Multi Beam Echo Sounder integrated with camera vision. The visited sites were the city of Baia (Naples), the Agrippa Postumo’s villa (Sorrento), some columns close to Procida and a modern ship sink close to Ischia. All the measurements were georeferenced by GPS and local pinger to mark the position of the ROV.

2. Experimental

Archaeological sites

The choose of the archaeological sites has been leaded together with the local government of Napoli. The chosen sites are the following:

- Marbles wreck,
- Misero wreck,
- Pila di Bacoli,
- Villa di Agrippa Postumo’s villa (suppose),
- Baia sunken city,
- The Miseno wreck belonging to 1943 but it has been used to test technology,
- Marbles wreck.

The wreck is composed of the a sank ship into Procida’s channel with its load. Four marbles columns (about 1.6 m x 0.8 m and 2.5 m x 1 m) and three block squared. The ship belong to the 19th century but the load is oldest. depth is about 12 m.

Miseno wreck

The wreck is a modern ship (1943). Depth is about 70 m.

Pila di Bacoli site

It is a column (square section), part of a roman port in the city of Baia. The depth is between 6-20 m.

Agrippa Postumo’s villa

Agrippa Postumo was a nephew of Augusto; he was relegated to Pianosa for political reasons. Later he was killed to prevent him from participating in the struggle for succession, probably on the orders of Tiberio. Previously, by the will of Livia Drusilla Claudia (his stepmother), was confined at the present town of Sorrento. The villa in question was probably his residence. It is partially submerged but visible and accessible.

Baia submerged city

The ancient city of Baia (Baianus Lacus) was a holiday resort for the aristocracy and for the Roman emperors, favoured by the presence of thermal waters; it was subject to bradisism phenomena as the entire area of Campi Flegrei. Part of luxury buildings is today, therefore, below sea level in the Bay's Pozzuoli. These are the remains of buildings of old imperial remains of some of the richest villas that still have whole floor mosaics. Also visible are a piece of a street, taverns and remains of a thermal building.

3. Technical resources

The ROV “Falcon”

The ROV “Falcon “ (SeaEye) is one one of the most versatile and light currently on the market.

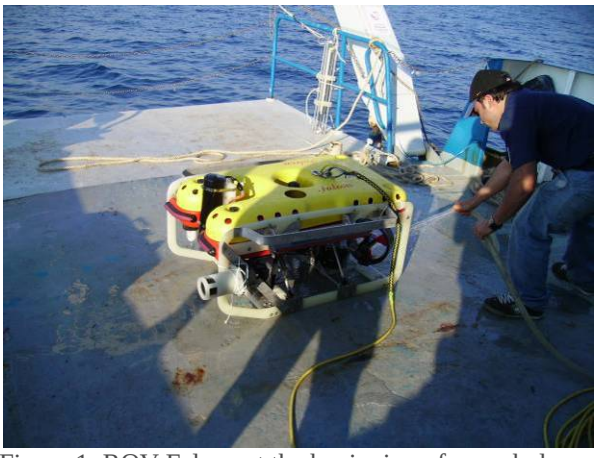

Figure 1: ROV Falcon at the beginning of a work day.

Its main features are:

- 300 meters depth.
- 300 meters of umbilical cord.
- 4 engines horizontal and a vertical coupled magnetically and without brush current control loop with 50 KG strength.
- Distributed intelligence control system.
- Full diagnostic system.
- High resolution color camera.
- Front lighting system 150 Watt.
- Auto adjust the depth and direction

Side scan sonar

The ROV “Falcon “ (SeaEye) is one one of the most versatile and light currently on the market.

Figure 2: Side scan sonar.

The Side Scan Sonar (SSS) Tritec seaking is designed to be installed on ROV and AUV. In picture you can see the two transducers and the head. It must be connected to the surface unit proocess, usually Seanet SCU or a PC card with dedicated (ARCnet protocol). In addition to external data can be superimposed as those from a differential GPS. The operational depth is 4,000 meters.

Sonar

The ROV is equipped with a panoramic sonar large radius (about 100 meters), shown in Figure together with its control unit. The sonar was installed on the ROV with its white protective hat, but was also used horizontally (to brush the bottom of the sea) to help the operator to search for artefacts.

Figure 3: Sonar mounted on the ROV and its control unit.

Processing unit

The surface control unit Seanet SCU is a multi purpose unit operating system with Microsoft Windows XP

preinstalled on a solid state disk. It allows you to control various instruments of Tritec and store the data collected. The communication system at high speed (156kBits/sec) protocol on RS232.

Figure 4: Side scan sonar: control unit.

Other instruments

Table 1: Other instruments used.

Instruments	Description
DGPS Fugro SkyFix	Differential GPS
HPR400	Acoustic ROV position system
Girocompass SGB Meridian	Gyroscopic compass
Multibeam EM3000	Sonar multibeam
TSS DM S2-05	Motion sensor to compensate multibeam
PC Nav	Navigation Software
SW nav Qinsy	Hydro graphic Software
Probe Valeport	Salt Measurement Probe and sound speed

4. Results

Starting the job

Here we shall present a few of the pictures and graphics that we have generated in a week of measurements.

Figure 5: Ship laboratory.

The work on the measured data is still in progress concerning mosaic three dimensional reconstructions, augmented reality by fusion of the information extracted by Side scan sonar and optical image. All the instruments were calibrated in situ.

Figure 6: ROV Falcon during immersion into the sea.

Archaeological sites

Here we show some photos and pictures of the archaeological sites visited. The material is still object of investigation to extract the information contained in the data. No photos or picture of the Baia submerged city is showed here because a cleaning job on the rough data must be performed. The intention is only to show the technical used.

Marbles wreck

Figure 7: Marbles wreck: columns.

Figure 8: Marbles wreck: columns.

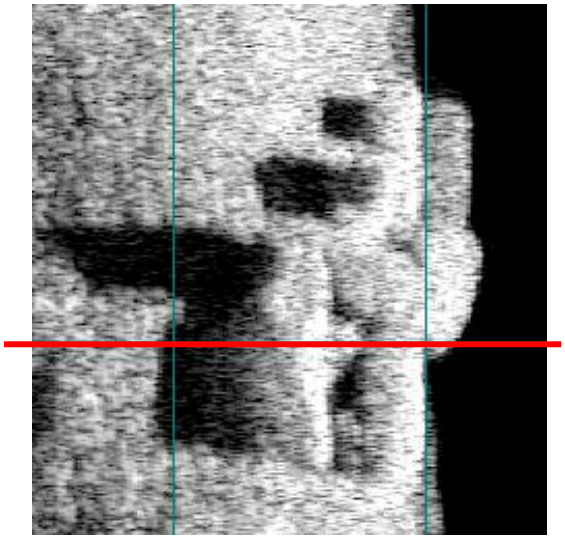

Figure 9: Marbles wreck: Side Scan Sonar picture.

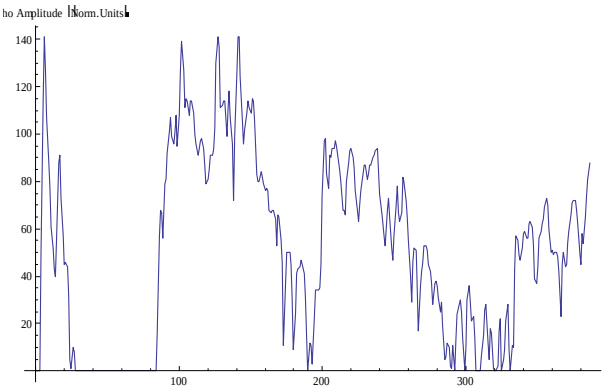

Figure 10: Corresponding envelope of the returned echo relative to the red line.

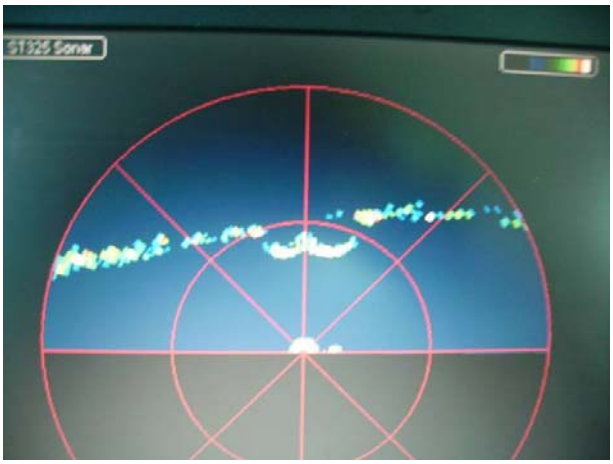

Figure 11: Marbles wreck: Sonar picture.

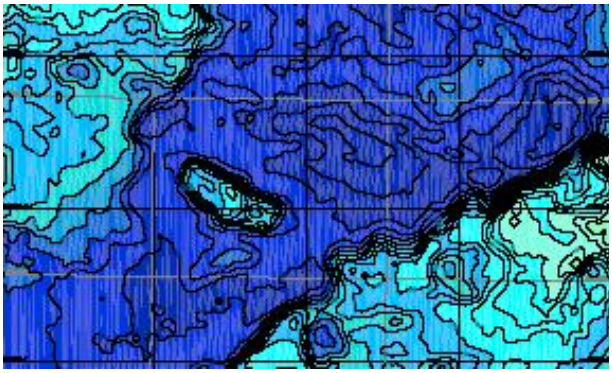

Figure 12: Marbles wreck: bathymetric profile.

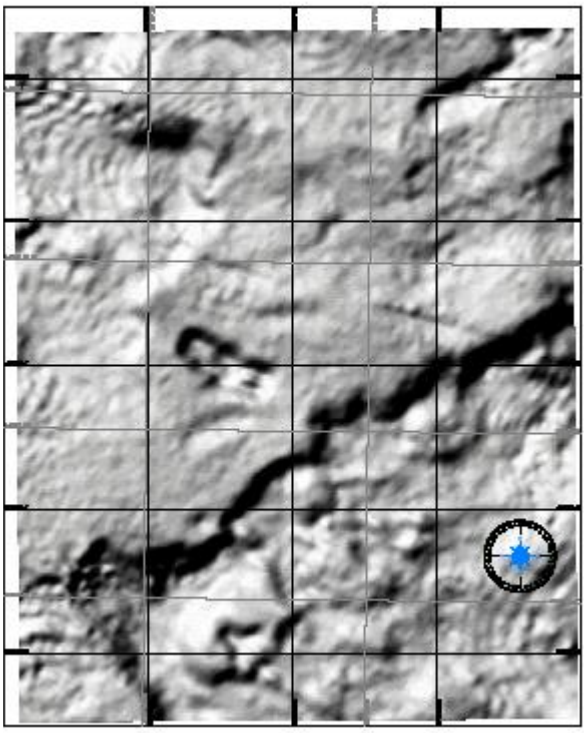

Figure 13: Marbles wreck: shaded relief picture.

Miseno wreck

Figure 14: Miseno wreck.

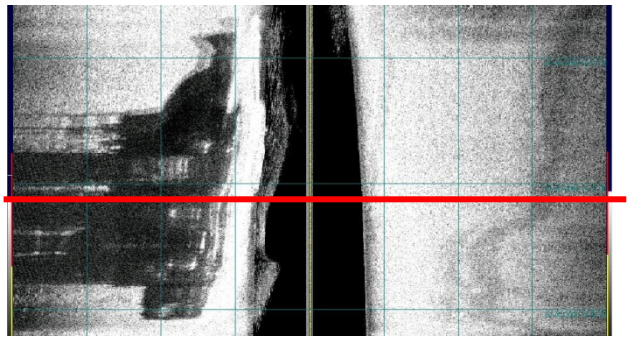

Fig. 15 – Miseno wreck: Side Scan Sonar picture.

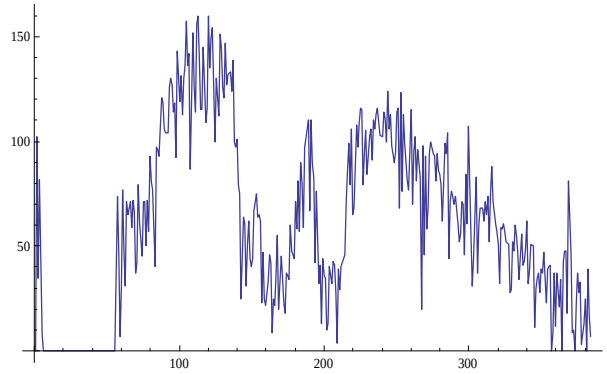

Figure 16: Corresponding envelope of the returned echo relative to the red line.

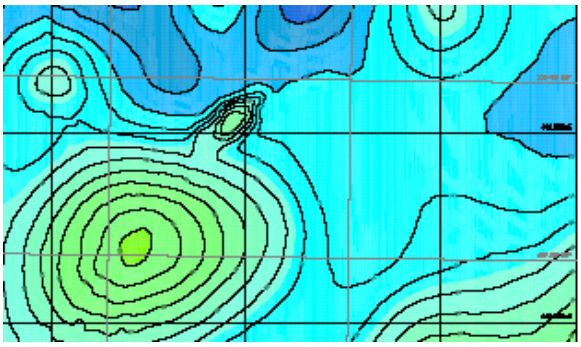

Figure 17: Miseno wreck: bathymetric profile.

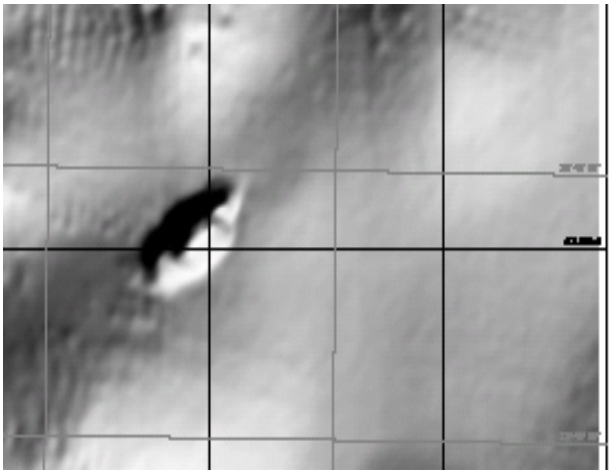

Figure 18: Miseno wreck: shaded relief picture

Pila di Bacoli site

Figure 19: Pila di Bacoli.

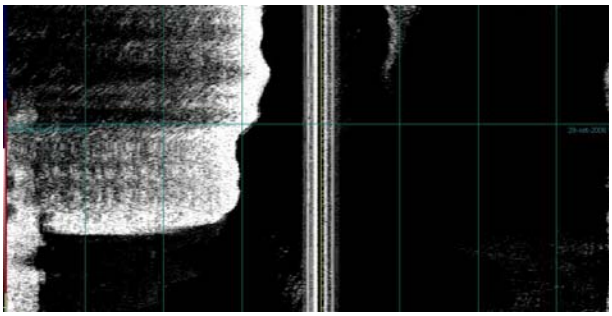

Figure 20: Pila di Bacoli: Side Scan Sonar picture.

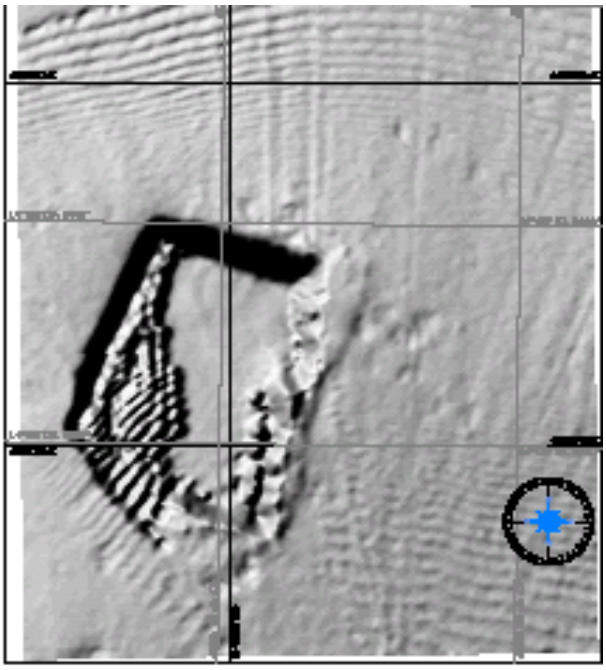

Figure 21: Pila di Bacoli: shaded relief picture.

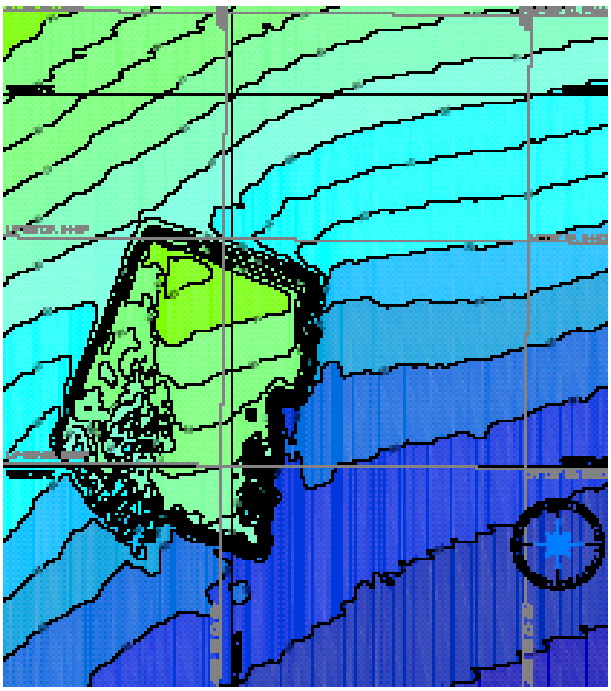

Figure 22: Pila di Bacoli: bathymetric profile.

Agrippa Postumo's villa

Figure 23: Agrippa Postumo's Villa: outside.

Figure 24: Agrippa Postumo's Villa: under side.

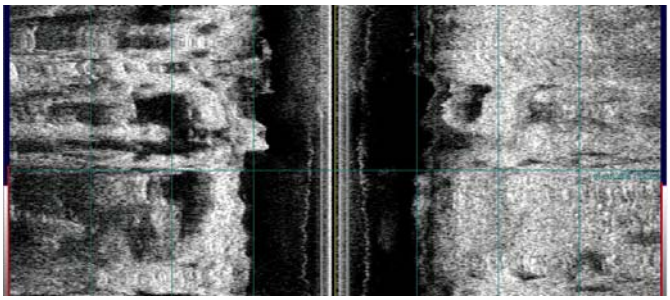

Figure 25: Agrippa Postumo's Villa: Side Scan Sonar picture.

6. Conclusions and plans for the future

In this paper we described the II marine campaign of the Tecsis project leaded in the Napoli's bay and some pictures are presented; our intention was to give a sharp look on the possible contribution of robot technologies for the study and conservation of the cultural heritage. A lot of data was collected and the material is still object

of investigation to build 3d mosaic pictures, synchronize video image with acoustic image and to improve the control technique of the robot to achieve the remote museum concept. This will be object of a more technical publication in a next future.

7. Acknowledgments

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