1. Introduction

This work is the result of the collaboration between DART (Laboratory of Documentation, Analysis, Survey of Architecture and Territory) and LARM (Laboratory of Robotics and Mechatronics) which, despite their apparent differences in terms of fields of research, for years have found time and motivations for opinion exchanges and cultural contacts, as well as research topics on which to begin genuine and fertile collaborations (Ceccarelli, et al., 2002) (Cigola, et al., 2005) (Cigola & Ceccarelli, 2006).

The project research group is made up as follows: for the DART Laboratory of Documentation, Analysis, Survey of Architecture and Territory: Michela Cigola, architect specialized in Restoration of Monuments, full professor director of DART; Assunta Pelliccio, architect, assistant professor; Sara Mattei, engineer, PHD student; for the LARM Laboratory of Robotics and Mechatronics: Marco Ceccarelli, engineer, full professor director of LARM, Giuseppe Carbone, engineer, assistant professor; Erica Ottaviano, engineer, assistant professor; Chiara Lanni, engineer, research assistant.

Our goal is to analyse the characteristics and problems that are related to the analysis and conservation of historical architecture, with an innovative approach with robotised systems. The design requisites and the distinctive aspects of the operations of a large range of robotised systems have now been fully defined and investigated. However, there are very few precedents for such specialized application, moreover, in connection to the subject of historical architecture that is apparently far away from general areas of robotics and mechatronics.

The case of study that is presented here, namely the pre-Cosmatesque floor of the abbatial basilica of Montecassino, is a good case to highlight the flexibility of robotics and possible interactions with architecture, particularly in the field of surveying. Thus, this research focuses specifically on the application of robotic systems in the study and survey of ancient floor surfaces, although the wider purpose is to study and refine robotized systems and automated procedures to develop activities and results in the analysis phase and for the safeguard and conservation of historical architectural sites at large.

Robots are used more and more frequently in difficult situations, such as inspections of internal sites of atomic stations, space travel and exploring inaccessible terrestrial sites, as volcanic craters. Thus, a new and different example could be the analysis and safeguard of historical architecture through the use of self-propelled robots performing highly complex tasks on various kind of surfaces under the supervision of a human operator.
Therefore, a proposal, is to develop a relationship between robotics and architecture, through a mechanical project that is especially studied and refined for analysis and architectural restoration. This is an extremely innovative application in the field of robotics, since it involves attempts to make a robot perform many architectural surveying actions through automated operations that can improve procedures and results, in terms of speed and accuracy.

2. Architectural survey

It is not easy to give a strict definition of architectural surveying, although now it is seemingly considered that it is not merely a simple instrument that is useful for other disciplines, but rather it is an autonomous operation with its own intrinsic value.

Fig. 1. Front side of the church of S.Crisogono, Rome. Survey by M. Cigola.

Surveying is now recognised as a complex discipline in its own right, the only one capable of penetrating the deepest and most hidden nature of an architectural organism, bringing to light the historical events of which it has been protagonist, original form and subsequent transformations over different eras, and providing us with full graphical imagery.
This type of monitoring, carried out in virtual 3D recreated by computer, is proving extremely useful, since it allows a reduction in time and costs in the planning phase, given that it is possible to thoroughly evaluate and test the model from the initial stage of design, operating within an environment that efficiently simulates the area in which the robot operates, allowing specific modifications and variations that would otherwise be cumbersome if carried out on a prototype.

7. Conclusion

The goal of this work is to test the possibility of designing robots and/or robotized system that are specifically dedicated to the field of cultural heritage and particularly to historical architecture. At the moment, our research is in the final stage of design of a robot, with activity that is carried out by the two LARM and RADET laboratories, with a continuous review of the needs that arise from the architectural application and from mechanical and mechatronic design.

Preliminary activity in Architecture Survey has been carried out at locale frame in Cassino with a construction of a very preliminary prototype and basic simulation experiences that were directed to the possibility to inspect and study the original cosmatesque Middle Ages pavement of Montecassino cathedral that is beneath the current pavement in a closed space with no air and no light. The mediaeval floor of Montecassino is an emblematic example of the interest and potentialities of using robotic systems in Architecture Survey, since it requires in-depth study to improve knowledge of the pavement that is not yet fully known.

It is also necessary to further study the related documentation and analysis techniques for the safeguard and conservation of stone surfaces and ancient basilica of Montecassino, which lies hidden as enigmatic architectonic good beneath the current basilica.

8. References


Della Marra, F. (1775) *Descrizione istorica del monasterio di Monte Cassino per uso e comodo dei forestieri*, Fratelli Raimondi, Napoli.


