A NEW APPROACH TO AN ANCIENT SUBJECT :

CAHRISMA PROJECT

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Abstract

In the conservation and restoration of historical monuments, usually concepts related only with visual sense are taken into consideration. However, preserving cultural heritage should include, preserving of the acoustical heritage as well. Therefore, a project proposal, aiming to upgrade the architectural heritage concept, has been prepared by the close co-operation of seven entities from six countries. The participants of the project are YTU (Turkey), DTU (Denmark), UNIFE (Italy), EPFL (Switzerland), UNIGE (Switzerland), INRETS (France), UOM (Malta). This paper aims to present the CAHRISMA, "Conservation of the Acoustical Heritage by the Revival and Identification of the Sinan's Mosques Acoustics", research project carried on within the Fifth Framework Programme of the European Commission.

The goal of this project is the identification, revival and conservation of Hybrid Architectural Heritage (visual + acoustical heritages) in a real-time virtual environment. Sinan's Mosques and Byzantine Churches, which are worship spaces well known for their good acoustical qualities, are chosen as the building types to be utilised for the realisation of that goal. Acoustical identification of the selected work will be done using all the possibilities of related fields; objective evaluations by measurements and computing, and subjective evaluations by psycho-acoustic surveys are aimed. Visual simulations will also be done including virtual humans. Then acoustical and visual systems will be combined in order to create a realistic virtual environment. These realistic environments, will then be used for evaluations, virtual restorations and virtual conservation.

INTRODUCTION

Human perception has five senses and people's impressions about the environments which he/she takes place depend on the combined data originating from all of the senses. Visual perception has always been regarded as the most important one, however auditorial perception pursuits it in the second range and reaches to important ratios within the total perception, especially where the activities are related with speech and/or music.

In some spaces such as concert-opera halls and religious buildings, acoustical perception is as much as and sometimes more important than visual perception. Mosques and churches are of those rare buildings that affect human perception almost equally both from acoustical and visual point of views. In other words, as the fundamental aims of religious buildings are to make the attendees feel themselves close to God and to direct their thoughts and feelings towards worshipping, acoustical perception is highly significant within these spaces.

Conservation and restoration of the architectural heritage were restricted with material means until now. However, it is obvious that, preserving architectural heritage should include preserving of the acoustical heritage, especially for the spaces having acoustical importance. The acoustics of ancient places of worship, like mosques and churches, that is the peculiarities of the listening attributes experienced by the listeners inside these marvellous places, is a fundamental aspect for the full understanding of the historical and social development of vast communities.

In this context, a research project named "Conservation of the Acoustical Heritage by the Revival and Identification of the Sinan's Mosques' Acoustics – CAHRISMA" has been designed and submitted to the EC Fifth Framework INCO MED programme. The participants of the project are Yıldız Technical University (Turkey), Technical University of Denmark (Denmark), Universita degli Studi di Ferrara (Italy), Ecole Polytechnique Fédérale de Lausanne (Switzerland), University of Geneva (Switzerland), Institut National de Recherche sur les Transports et leur Sécurité (France) and University of Malta (Malta).

Main objective of the CAHRISMA project which took start at the beginning of the February 2000, is to innovate the concept of "Hybrid Architectural Heritage". Hybrid Architectural Heritage is a new way of identification that covers acoustical characteristics besides visual peculiarities. It states that, for the spaces, having acoustical importance, "architectural heritage concept" should be upgraded covering acoustical and visual properties. The effects of this improvement will reflect to actual implementation of conservation and restoration.

GOALS AND OBJECTIVES OF THE CAHRISMA PROJECT

The basic objective of the CAHRISMA project is to innovate and implement the concept of "Hybrid Architectural Heritage", in the field of conservation and restoration. Sinan's Mosques and Byzantine Chruches have been selected as the buildings to be worked on at this study. (Architect Sinan "1492?-1588?" has a place on the history of architecture as a style – creating artist and he was highly influenced by Byzantine architecture) The reason of this choice is that, although they are well-known of their acoustical qualities besides others, few work has been done to identify and conserve their acoustical peculiarities. The study will cover the identification and revival as well as the restoration and conservation of the acoustical heritage (at the virtual environment) of the monuments such as Süleymaniye Mosque and Hagia Sophia Church. At this project, not only the architectural work will be reconstructed virtually, but the life inside will also be

recreated. In order to simulate the realistic effects, virtual humans will be simulated and reproduced. Specific scientific and technological goals of CAHRISMA project are summarised as follows;

- Identification of the recent and initial acoustical peculiarities of the Sinan's mosques and Byzantine churches, by acoustical measurements and computer aided modelling tools.

- Evaluation of psycho-acoustical and subjective characteristics of these worship spaces.

- Integration of acoustical and visual virtual environments into an interactive 3D real-time system.

- Creation of an integrated real-time system for CD-ROM of 3D architectural models with realistic virtual humans.

- Comparison of the mosques and churches acoustics and review of the acoustical influence of Byzantine churches on Sinan's mosques.

- Determination of the optimum acoustical conditions for mosques by the comparison of subjective parameters obtained from psycho-acoustical surveys with the objective parameters obtained from measurements and calculations.

- Conservation and restoration of the selected monuments architectural heritage (acoustical and visual) in a virtual environment.

By the achievement of the objectives and goals of this wide frame research, conceptual and practical innovations and improvements in the fields of acoustics, lighting, simulation technologies, architecture, conservation - restoration and tourism will be created. Besides the conservation of the architectural heritage and the development in the related scientific fields, this project will contribute to the increase of interest for historical monuments and enhance touristical curiosity, attracting attentions to a different feature.

PROJECT METHODOLOGY

Increased interdisciplinary and trans-disciplinary features should be used at the identification and conservation of the "Hybrid Architectural Heritage". The objective described above is reachable by the co-ordination of architecture, acoustics, psycho-acoustics and computer sciences. A methodology that will have apparent benefits both in identification and conservation fields, will be developed in order to transport the "Hybrid Architectural Heritage" into virtual environment. This methodology will cover the combination of visual and acoustical features of the architectural spaces in interactive 3D virtual environments. By the utilisation of the mentioned methodology, for the situations where architectural conservation and restoration are not available, virtual conservation

and restoration will have been provided. The methodology of the project consists of the following steps;

1. Acoustical identification and evaluation
    - Objective identification and evaluation (measurements, calculations)
    - Subjective identification and evaluation (psycho-acoustical surveys)
2. Creation of the Virtual Environment
    - Visual simulation (simulation of the spaces, simulation of the humans)
    - Acoustical simulation
    - Combined 3D real time simulation
3. Virtual revival and recovery

The flow chart of the methodology described briefly above, is shown at Figure 1. The project has been designed of ten work packages in order to reach the objectives and goals described above. Work packages of the project and their short explanations are given in Table 1. The participants of each work package are shown at Figure 1; first participants (written in bold) are the responsibles of work packages.

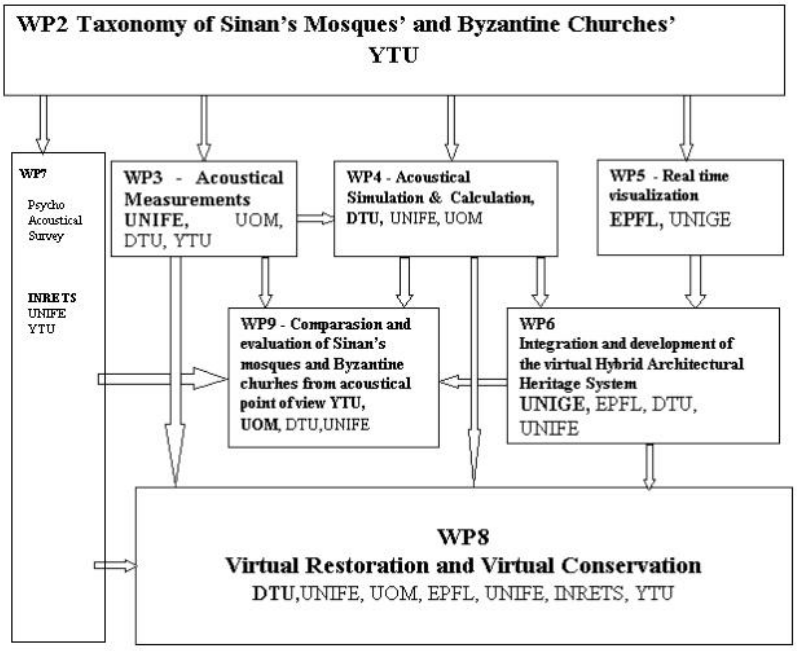

Figure 1 Flowchart for the Project

At first, Sinan's mosques peculiarities as architectural style, size and other properties which could affect acoustical behaviour of spaces, will be researched and evaluated. Then mosques to work on at this project will be selected. Selected mosques will be at adequate quantity and quality to illustrate general peculiarities of Sinan's architecture. Meanwhile, a similar work will be held on Byzantine churches that are known to have had affected Sinan's work, so their acoustics as well. Therefore, worship spaces that will be used in that project will be determined. Afterwards, all the reachable plans, projects, data on materials and technologies about the selected works will be gathered. Those will be the input data base, that all participants can utilise when necessary.

Table 1. Work packages and short explanations

WP no	WP Name	WP Short Explanation
WP1	Project Management	Project management; scientific, administrative and financial co-ordination between participants and/or Commission
WP2	Taxonomy of mosques & Churches	Taxonomy of Sinan's mosques & Byzantine churches Selection of worship spaces and research on acoustical activities
WP3	Acoustical Measurements	Measurements of room acoustical behavior of selected Sinan's mosques and Byzantine churches
WP4	Acoustical Simulations	Computer simulation of acoustical behavior of selected Sinan's mosques and Byzantine churches
WP5	Real-time Visualization	Virtual real time visualization of the architectural works with inhabitants
WP6	Integration & development of Hybrid Architectural Heritage System	Integration of visual and acoustical computer models into a synchronized real-time virtual environment for content production and architectural evaluations
WP7	Psycho-acoustical Surveys	Psycho-acoustical surveys for identification of subjective acoustical parameters of sound fields inside mosques and churches
WP8	Virtual Conservation. & Virtual Restoration	Development of Virtual Restoration & Virtual Conservation Systems for selected works Evaluation of acoustical parameters and determination of optimum acoustical conditions
WP9	Comparison & Evaluation of mosques and churches	Comparison of the selected mosques and churches acoustics in order to determine the influence of churches on mosques and Evaluation of mosques' and churches' acoustical qualities in order to improve the modern architectural design tools for halls with domes
WP10	Evaluation &Dissemination	Evaluation and Dissemination of the project

Measurement methodologies will be determined so as to permit and facilitate comparison between mosques and churches. After the determination of measurement methodologies taking into consideration mosques and churches peculiarities, room acoustical measurements will be realised by two different groups for comparative reasons. The measurements will be made basicly according to ISO 3382:1997 and different parameters will be derived from reverberation time measurements. In addition to RT measurements,

Speech Transmission Index will also be measured. Thus, current peculiarities of selected spaces for music and speech activities will have been evaluated. With a sufficient number of source and receiver positions the results will characterise the acoustical behaviour of the investigated rooms. The results of different groups will be compared and statistically evaluated.

Room acoustics programs for computing simulation of the acoustical behaviour of selected works will be used to determine and evaluate worship spaces. Computer simulations will be compared with the measuring results in order to verify the simulation models. Then the computer simulations will be used to analyse the influence of a number of changes of surface materials, including estimated absorption properties of ancient materials. The comparisons will be made in two ways; objectively by the comparison of the calculated room acoustical parameters, and subjectively (where available) by listening to simulated sounds using the auralisation techniques.

Human's acoustical interpretation and understanding of halls are deeply affected from visual, social and psychological factors. That's why selected works will be visualised in real time and 3D, so as to create a synchronised real time realistic system. Besides the modelling of the ancient environments, simulation of people and their motion inside the mosque and synchronisation with sounds will constitute major parts of this work. Simulation of human crowds for populating virtual worlds will provide, a more realistic sense of virtual group presence.

Also, in the context of interaction, a multi-modal interface will be investigated in order to guide crowds including cyberglove, speech recognition and sound generator, and it will be managed between the different applications, as well as the virtual human animation. As main challenge of communication between multi-modal interfaces and virtual crowds, the issues such as analysing the various levels of sound perception which can occur depending on the people location and distance related to sound source, are of special interest. On the other hand, the number of occupants and the way they are dressed affect total absorption of the spaces and this effect is perceived by people. For the creation of the realistic and authentic environments, virtual humans should have to simulated and dressed properly. After making a study of the human bodies sizes representing a population, computer geometry algorithms that will allow create bodies of different sizes will be developed. A complete population will be created from a few different individuals, using a 3D morphing methodology. A methodology for automatic texturing of the body in order to give the impression, people are being dressed will also developed.

Visual and acoustical combination in 3D and real time system which is the main challenge of this study will be obtained by the trans-disciplinary work of four groups. In order to generate an inter-active CD-ROM, all the techniques and databases created in the research will be integrated. This CD-ROM will allow user to interact with the 3D architectural design and hear the sounds specific to this 3D architecture created through the acoustical computer models. Thus environments that person who use the final product feel that he/she is in the worship space; walk through crowds or sit at a place and hear

realistic sounds will be created. Those virtual environments will be utilised both in virtual restoration and virtual conservation.

Since the main domain of this work is highly related with human comfort and almost no statistical results exist on this area, a wide range of subjective evaluations will be held. Subjective evaluations, namely surveys (site and laboratory), will include two aspects; site surveys, for psycho-acoustical evaluation of the sound quality, the interviews will be made on two subgroups (the users and the visitors), laboratory surveys, for the evaluation of different aspects of acoustical quality, a different subgroup and several recorded sound samples will be utilised. A comparison of the two sets of survey results will then be used, both for the determination of the specific acoustical qualities of the environments and the development of predictive modelling tools.

By the interdisciplinary work of the groups worked on subjective and objective evaluations, optimum acoustical conditions for mosques and churches will be developed. Therefore knowledge that could be used on the design of worship spaces will be available. On the other hand, selected architectural spaces virtual restoration and virtual conservation will be held by the combination of ancient and initial audio-visual peculiarities.

For the designation of the Byzantine churches acoustical effects on Sinan's mosques, accumulated objective and subjective data will be compared and research on the proofs of mentioned effect will be done. For the utilisation of knowledge in the current applications, another interdisciplinary work will be held. By this work for the halls having concave surfaces, especially for halls with dome, establishment of data sets to be used on the acoustical design will be targeted.

Current state of the project

The project has begun recently, at 01 February 2000. First meeting was held at Yıldız Technical University in Istanbul, by the full participation of the partners. First sequence of measurements will be done at June 2000. As all teams need the data about the places to work on, YTU has begun to work on Sinan's Mosques' and Byzantine Churches'. Kadırga Sokullu Mehmet Pacha Mosque and SS of Bacchus Church (now used as a mosque called Little Hagia Sofia) have been selected as the monuments that will be studied initially and started the data collection of these buildings. At Figure 2., the plan and section of Kadırga Sokullu Mehmet Pacha Mosque can be seen. Project teams are going on the preparation about their parts.

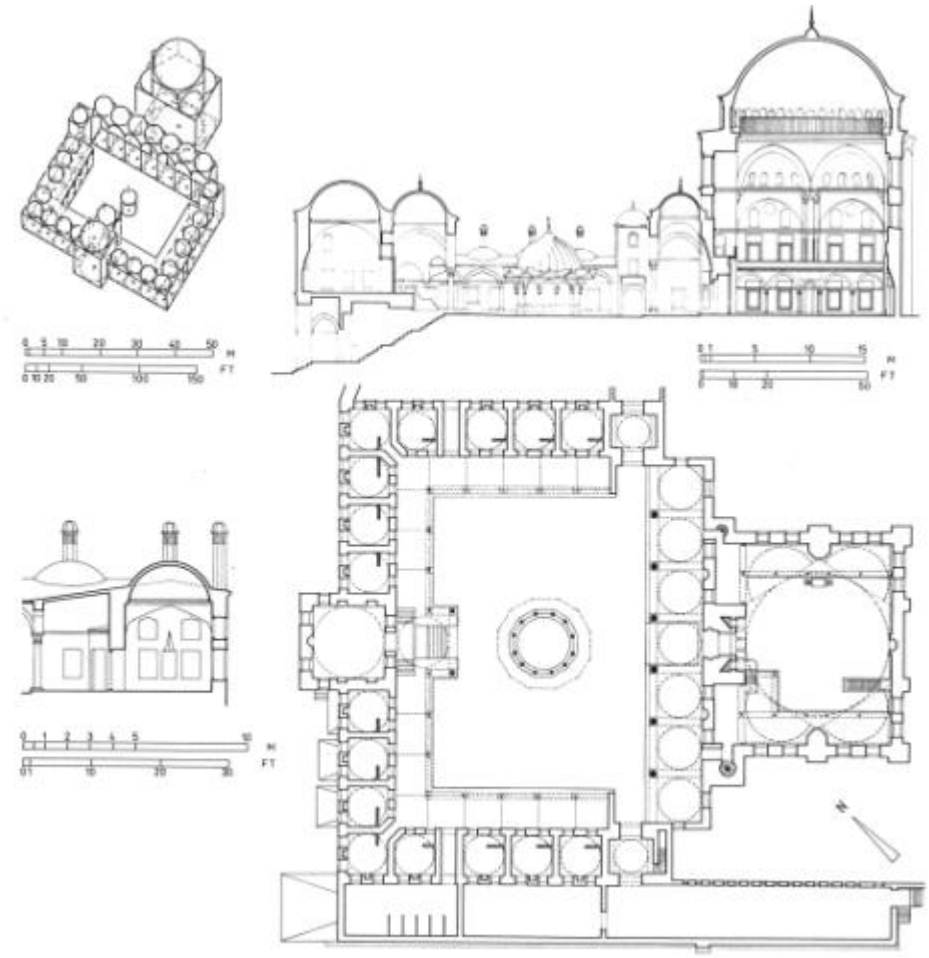

Figure 2 Isometric projection, longitudinal section and plan (Encyclopedia ofWorld Architecture)

CONCLUSION

Main objectives of this research are identification, revival and conservation of architectural heritage in a new way. Objective and subjective evaluations and audio-visual reconstruction of Sinan's Mosques and Byzantine Churches in real-time 3D virtual environments are the basic approaches to reach the goals of the project. Virtual restoration, virtual conservation, determination of different significant acoustical effects will be the main results. By means of this wide frame research, conceptual and practical innovations will be created in the fields of acoustics, architecture and simulation technologies.

By the application of the concept and techniques utilised in this project, humanity will protect and attend to an important and different part of his past. The Research Project CAHRISMA, will emphasise the role of Euro-Mediterranean Partnership within

the international scientific field, and will undertake an important support to the advertisement of marvellous work of arts.

ACKNOWLEDGEMENTS

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