The Multimodal and Multidimensional Content and Media CNR project

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Abstract—**This poster describes the aim and the main research activities carried out within the project *Multimodal and Multidimensional Content and Media* of the ICT Department of the National Research Council in Italy. The project, which involves 10 research Institutes of CNR and about 141 man year effort, is aimed at making advances in all the various phases of the digital content life cycle: from the acquisition and creation to the presentation and interaction with the final user and/or software applications in the view of the effective creation of a society of knowledge where the content is active, easily accessible and rich of information. Considering the stronger digital convergence, the fundamental assumption of the project is that such a leveraging step from "passive" to "active" content can only be achieved if all the knowledge available at each processing step can be captured and exploited.**

Index Terms— **digital content, context dependent parameter extraction, data fusion, content interpretation and understanding.**

I. PROJECT RATIONALE

The digital representation of the mono- and multidimensional signals (voice, music, video, images, charts, 3D scenes, animations, etc.), enables the uniform elaboration and transfer of several kinds of information. This together with the vision of ambient intelligence, which emphasizes the user's role in the future developments of a knowledge-based society, make the acquisition and handling of multidimensional media and their crucial role in the interaction with the user a key issue for the ICT research.

Currently, 2D images and videos are the most widespread multidimensional contents in our applications and in the web, but other typologies, such as 3D digital shapes, animations and data from physical sensors, are expected to be prevailing in the next future communication. The information related to the multidimensional media is exponentially growing and generates an increasing demand for efficient techniques for information coding and compression, that can reduce its generated, delivered and stored volume (data-deluge and info-smog are nowadays often mentioned). The use of the multidimensional content in the most diverse applications is broadly widening: think of industrial design and production, environment, entertainment, cultural heritage, etc. In particular, 3D and 4D digital shapes are poised to become the fourth wave of digital multimedia communication, where the first three waves were sound in the '70s, images in the '80s, and video in the '90s. Moreover, the integration between real and digital world is greatly developing, increasing the multi-sensorial perception of digital objects and phenomena, and making the digital reconstruction of physical object more and more realistic.

It is then recognized that crucial objectives to solve the inherent issues of the above scenario are:

- the implementation of advanced tools for the multidimensional data processing in those fields, where the acquisition systems are evolving towards multidimensionality, e.g. remote sensing;
- the production of content and context based systems, for the acquisition, the analysis and the thorough representation of the multidimensional media knowledge;
- the implementation of technologies and platforms for the diffusion, the remote handling and the real-time users' fruition of the results.

The project *Multimodal and Multidimensional Content and Media* is addressing all of them.

II. PROJECT AIMS

The main purpose of project *Multimodal and Multidimensional Content and Media* of the department of Information and Communication Technologies of CNR is the coordination and integration of all the activities carried out by the CNR institutes on the creation, representation, processing and context-dependent interpretation and restitution of multidimensional media content.

This project is aimed at the achievement of a radical improvement in the representation and fruition of multidimensional media aiming at the realization of "intelligent" contents that should enable a contextual representation and presentation being readily comprehensible both for the field experts and for analysis and evaluation tools. At the same time, it wants to provide a more realistic multi-sensorial interaction, e.g. through virtual reality and haptic interaction; such interaction should guarantee (easy) access to any user, thus following the ambient intelligence and eInclusion approaches.

In this project multidimensionality is considered as either intrinsic to the datum type (e.g. 2D images and 3D shapes), or due to the multiplicity of the types of signals and data concurring in the description of the same phenomenon, e.g. in

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the remote sensed data, the multidimensionality can be given by factors as space, scale, frequency and time.

Similarly, multimodality is meant as the utilization both of one or more sources for the data acquisition and creation, and of different tools and methods for the user interaction, that go beyond the traditional mouse and keyboard, thus providing a high degree of realism and immersivity in virtual environments.

For achieving this goal, the adopted approach is the definition/integration of the different activities of multidimensional media acquisition, analysis, and synthesis, in an efficient and effective way, at different levels of abstraction and meaning, both in the production and in the interpretation process.

This will make it possible to strengthen and create innovative technologies that:

- improve the expertise in multidimensional media acquisition, modelling, processing and reconstruction;
- contemplate new content forms: visual, immersive, intuitive, human readable and machine readable;
- allow new levels of multimedia and multimodal interpretation, communication and interaction (both with human and computer actors), as well as the remote handling and the system interoperability;
- improve the capabilities of representing and handling the context-related knowledge associated to the content;
- enable new multimedia representations both of real and virtual phenomena at different levels of knowledge and detail.

III. RESEARCH ACTIVITIES

Therefore, specific objectives are considered related to the various phases involved in digital content creation, processing and rendering. They have been grouped in the four macro areas and executed in 10 groups of activities.

A. Signal and Image Acquisition and Processing

The goal of the related activities is the development of advanced systems in contexts where acquisition is moving towards multidimensionality, such as remote sensing, multitemporal, multifrequency, multisite, multiplatform electromagnetic diagnostics.

In such contexts, advancements are proposed in the development of sensors, models and techniques for signal processing and data fusion, in addition to methods for enhancing data quality and transmission.

B. Vision and understanding

the goal of the related activities is the implementation of models, methods and algorithms for the representation, analysis, classification, interpretation and reconstruction of signals and images in two or more dimensions, starting from acquisitions obtained through different sensorial methods and, possibly, repeated at regular intervals, for the realization of efficient software systems for different application fields, as well as for the implementation of innovative dedicated architectures.

C. Interaction and visualization:

The related activities deal with graphics rendering, realistic visualization, virtual and augmented reality, user interaction and dedicated hardware. The main aim is the definition of techniques and tools that, through rendering, interaction and immersivity, enhance the phenomena comprehension as well as the process knowledge and/or facilitate the decision-making process. The researches and the implemented tools lead to the realization of borderline applications such as visualization of large-sized objects and scenes; handling of deformable objects or tissues; highest realism and immersivity degree; robust and friendly human-machine interaction mechanisms.

D. Modeling

The aim of the related activities is the integrated definition of object modeling tools adopting the shape paradigm, which represents and unifies all its aspects (geometry, structure, appearance, semantics, history, etc.). An important objective is the implementation of models and methods for the analysis of the shapes, and their structuring in components (elements) so as to make their adaptation to the different application contexts possible.

E. Representation and sharing of the multidimensional media knowledge

The aim of the related activities is the implementation of systems for the annotation, representation and management of the semantics of multidimensional media that can be adapted to the context requirements, including user capabilities. The activity also includes the formalization of the content elaboration processing tools and workflows.

IV. APPLICATION TRIALS AND EXTERNAL COLLABORATIONS

The various techniques and methods developed are also tested in specific application fields to check their validity and applicability in real contexts. Among them it is worth to mention edutainment (e.g. cultural data, 3D animation, virtual performances, video and sound annotation), medical diagnostics, surveillance, environment planning and monitoring. This is performed in collaboration with the experts of the fields possibly in the scope of other funded projects (e.g. IDEUnivers, AIM@SHAPE, MUSCLE, CROSSMOD, HEARTFAID, CRIMSON, IP-RACINE) or research agreements.