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Project Title	Mixed Reality in medical Education based on Interactive Applications (MIREIA)

EXTERNAL EVALUATION – 1ST YEAR

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Responsible	TUDELFT, CCMIJU
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1. Summary

The project's planned roadmap is developing very well and it is aligned with market needs.

My personal overall assessment of the project's progress is very positive. Sometimes reports are a bit concise, but pragmatic; sometimes, some details are missing.

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2. Introduction

1.1. Summary of the project

Medical education is a long and demanding process, requiring the learning of extensive theoretical knowledge as well as a set of technical and non-technical skills. Traditionally, during the early stages of education, formative methods are often based on static learning content and are sometimes far removed from actual clinical practice. Currently, these methods are being replaced by new approaches based on the use of information and communication technologies (ICTs). New technologies, such as extended reality (which includes virtual (VR), augmented (AR) and mixed reality (MR)) and three-dimensional (3D) printing, are being applied in different aspects of the medical field, including education.

Despite the popularisation of these methods and technologies, several challenges remain to be addressed in order to extract the full didactic potential of virtual models: (1) there are no existing technologies for quick and automatic generation of 3D models, which means that models must be obtained from third parties with limited personalization; (2) there are no accepted standards to exploit these novel immersive technologies with methodological guidelines in medical training, and (3) scientific evidence to support the validity of personalized models as learning and training tools are scarce.

MIREIA (Mixed Reality in medical Education based on Interactive Applications) project is a unique Knowledge Alliance involving Higher Education institutions (HEIs) and companies that will combine the use of cutting-edge technology in immersive virtual technology and 3D printing with personalized learning content to promote the student-centred learning process of medical students and residents. This Alliance proposes the development of an innovative methodology and tools to provide interactive pedagogical content for customized training based on 3D models, such as anatomical models (with and without pathologies) built from real-patient cases (e.g., medical imaging studies) or virtual scenarios for basic training in minimally invasive surgery (MIS).

Contents will be accessible anytime and anywhere using portable devices, extended reality (XR) visualization technologies, or printed with 3D printing technology. This will allow students to train through immersive virtual environments or in physical simulators that use personalized 3D printed models. Mentors will also be able to create and share any clinical experience as learning content for students, such as medical imaging studies, 3D anatomical models based on preoperative studies, or video sequences of surgical procedures, following specific methodological guidelines. In addition, innovative tools will be implemented for the semi-automatic creation of customized 3D models for educational purposes.

This Alliance seeks to bridge the gap between classroom learning and laboratory training and actual clinical practice. All the guidelines and learning contents will be available through open access as part of the MIREIA repository, which will also act as a hub to share 3D models and learning content. To test the viability of the solution, validation will be carried out for three medical use cases: medical anatomy, laparoscopy and flexible endoscopy.

Project website: http://www.mireia-project.eu/

1.2. Quality Actions

Throughout the project, different mechanisms are being developed to ensure the quality of the work carried out. To this end, a Quality Plan is elaborated in the "WP2. Quality Actions". The main objectives of the quality plan are to document and evaluate the progress of the project, to evaluate (internally and externally) the results obtained with respect to the objectives of the project and to identify deviations or possible deficiencies in order to be able to apply corrective actions, if necessary, as soon as possible.

As part of the external evaluation, an external expert from the consortium is asked to carry out an external review of the project (1) from the point of view of the scope and (2) by evaluating the usefulness of the final technical solution implemented. The external evaluator will be contacted twice to evaluate the current scope of the project (at the beginning of the second and third years of the Project) to give feedback on the roadmap planned for the project and alignment of it with the needs of the market. Besides that, an additional evaluation of the content generation tools and learning contents developed throughout the project will be carried out with medical students and residents with the support of the European Association for Endoscopic Surgery (EAES). This will be incorporated into a report at the end of the project.

1.3. External evaluator

Dr. Alberto Arezzo is a General Surgeon and Digestive Endoscopists for operative procedures, mainly dedicated to clinical activity, with an academic role and deeply involved in several research projects sponsored by the European Commission and private companies. He is also Associate Professor at the Department of Surgical Science, University of Torino, Italy, and General Secretary of the European Association for Endoscopic Surgery (EAES).

3. External evaluation

Scope of the project

MIREIA (Mixed Reality in medical Education based on Interactive Applications) project is an Alliance that aims to provide interactive pedagogical content for customized training. This is achieved through the development of an innovative methodology and tools based on 3D models, such as anatomical models (with and without pathologies) built from real-patient cases (e.g., medical imaging studies) or virtual scenarios for basic training in minimally invasive surgery (MIS).

This is supposed to bridge the gap between classroom learning and laboratory training and actual clinical practice. All the guidelines and learning contents will be available through open access as part of the MIREIA repository. Three medical use cases are considered for validation: medical anatomy, laparoscopy and flexible endoscopy.

In order to achieve this, the contents will be accessible anytime and anywhere using portable devices, extended reality (XR) visualization technologies, or printed with 3D printing technology. This should allow students to train through immersive virtual environments or in physical simulators that use personalized 3D printed models. Mentors will also be able to create and share any clinical experience as learning content for students, such as medical imaging studies, 3D anatomical models based on preoperative studies, or video sequences of surgical procedures, following specific methodological guidelines. In addition, innovative tools will be implemented for the semi-automatic creation of customized 3D models for educational purposes.

The final and wide objectives of the Project would be:

1. The modernization of the European medical and surgical training system made available to mentors, students and residents alike a set of innovative pedagogical and training tools.
2. The creation of a European knowledge-sharing framework for the training and education of future medical professionals, thus promoting the efficient use of resources.
3. The additional value of the training services of HEIs and to expand their range of training solutions based on cutting-edge technology, as well as to reach a larger number of students.

This is a very ambitious, very demanded but also reasonably feasible project. Especially in times of pandemic, with restricted access to physical labs and clinical wards for training, digitalization should offer an alternative to physical education in person, even in a critical field such as medicine in general. This is perfectly in line with the novel concept of Healthcare 4.0. The introduction of physical simulators that use personalized 3D printed models based on real clinical case imaging makes this approach unprecedented at this level.

The project is illustrated with sufficient clarity and pertinence of the objectives, soundness of the concept, and credibility of the proposed methodology. The proposed work is beyond state of the art and demonstrates innovation potential. There is an appropriate consideration of interdisciplinary approaches and, where relevant, the use of stakeholder knowledge and gender dimension in research and innovation content. The KPIs are clearly defined.

Now, there is enough material to judge how the semi-automatic method for the creation of customized 3D models for educational purposes works. Clearly, this is based on the generation of specific dedicated software. Still, how the input of the “expert” will interact is not specified. It is a very good fact that a “human-in-the-loop” will be kept.

My only main concern here regards the knowledge of printing soft and elastic tissues with different stretching and inflatable characteristics. This may represent a challenge of paramount importance, extremely difficult and time-consuming to overcome.

Roadmap planned for the project

The work plan shows good quality and effectiveness, including the extent to which the resources assigned to work packages are in line with their objectives and deliverables. Partners of the consortium show complementarity. The consortium as a whole brings together the necessary expertise, provided that good expertise in soft 3D printing is available.

It is possible to read the appropriateness of the management structures and procedures, including risk and innovation management, in the deployment of resources.

There is the appropriateness of the allocation of tasks, ensuring that all participants have a valid role and adequate resources in the project to fulfil that role.

Alignment of the project with the needs of the market

The project is very much aligned with the needs of the market. The outputs of the project would contribute to each of the expected impacts mentioned in the work programme under the relevant topic. All substantial impacts that would enhance innovation capacity, create new market opportunities, strengthen competitiveness and growth of companies, address issues related to climate change or the environment, or bring other important benefits for society seem mentioned in the work programme. The involvement of an important European Scientific Association may represent a further strength

Is the progress reported in line with the objectives and work plan as specified in the project description? If there are significant deviations, please comment.

The approach and methodology are clearly described and justified in the application. The goals are ambitious, and the impact of the solution is clearly justified.

The advancements in the project are in line with the work plan as specified in the project description.

D 3.2, 3.3, 4.1, 5.2, 5.3, 5.4, 6.3, 7.1, 7.2, 9.1 are available and complete. The timeline is respected.

Recommendations concerning future work, if applicable

I would appreciate receiving in time the Annual report, including slides and videos presented at a Review meeting when it is held.

Concerns regard

1. a deeper study of 3D printing materials for higher reliability of the printed model

2. respecting ethical issues regarding the circulation of recorded material not sufficiently anonymised

Expert opinion on deliverables

Deliverable number	Deliverable name	Comments
D3.3.	Methodological guidelines for 3D printing with training purposes	This is very well done; no comments
D3.2.	Methodological guidelines to create learning content from 3D models	A bit concise, but very pragmatic, sometimes not sufficiently detailed.
D4.1.	Specifications	This is very well done; no comments
D9.1.	Exploitation plan	Not sure of the meaning of this Deliverable. If it was to be just state of the art at least the most popular physical trainer (LAPARO) is missing, while it is mentioned only the "cheap" version
D6.3.	Additional learning material	A bit concise, but very pragmatic, sometimes not sufficiently detailed.
D7.1.	Validation plan	A bit concise, but very pragmatic
D5.2.	Tool for semi-automatic generation of intracorporeal 3D models	This is very well done, no comments
D7.2.	Report for the technological validation	OK
D5.4.	System for creatin of virtual environments for MIS training	A bit concise, but very pragmatic
D5.3.	Pedagogical applications for extended reality devices	OK

Torino, March 19th 2022

Dr. Alberto Arezzo