POLITECNICO DI MILANO

PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 39th cycle

Research Area n. 4 - Telecommunications

PNRR 118 PA Research Field: DEVELOPMENT OF AN INTEGRATED AND EFFICIENT SYSTEM FOR THE ANALYSIS, STORAGE, AND COREGISTRATION OF ORAL CAVITY SCANS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The research aims to develop an integrated system for the analysis and sharing of different intraoral scans, including microscopic stereoscopies, radiographs, tomographies, MRIs, and PET scans. Currently, various types of intraoral scanning are performed by different specialized centers that often store data in different formats, making it difficult for doctors to compare them in a single viewing environment. This results in long analysis times and high subjectivity in diagnoses linked to the doctor's experience. This proposed system will allow the visualization and analysis of scans using different techniques in a single environment, scaling and co-registering them with each other through landmark points (if present) or automated deep learning techniques for comparing point clouds/images. It will therefore be possible to view different sections of the scans and directly compare contributions from different types of acquisition. Direct measurements can also be taken on the data, and with progressive archiving, it will be possible to assess the evolution of a lesion and compare it with those of other patients and acquisitions made at other hospital centers. The data can be visualized in Augmented Reality and Mixed Reality modes, making the clinical case study procedure much more intuitive and

	efficient. With the system, it will be possible to encourage the use of new digital technologies based on Artificial Intelligence and Augmented Reality to redesign the programming of oral cavity surgeries, ensuring the effectiveness, rapidity, and efficiency of the public's action. The doctoral research proposed is focused on the interventions of the oral cavity due to the established collaboration with the dentistry department of the San Paolo Hospital, but it can easily be extended to other hospital diagnostic areas.
Methods and techniques that will be developed and used to carry out the research	The PhD candidate will develop a framework where data from various sources, such as DICOM (Digital Imaging and COmmunications in Medicine), PASCAL VOC, NIfTI (Neuroimaging Informatics Technology Initiative), HDF5 (Hierarchical Data Format), and FHIR (Fast Healthcare Interoperability Resources), can be imported in planar or volumetric form. The operator will have the opportunity to define common reference points between scans to align them or the system can autonomously use artificial intelligence techniques for automatic co-registration to align the scans. This will enable visualization of acquisitions from various scans, such as radiographs, tomographs, or magnetic resonances, in the same environment, or to compare scans taken at different times to determine the temporal evolution of the analyzed lesion (Hamid Reza Boveiri, Raouf Khayami, Reza Javidan, Alireza Mehdizadeh," Medical image registration using deep neural networks: A comprehensive review",Computers &Electrical Engineering, Volume 87, 2020, ISSN 0045-7906, ttps://doi.org/10.1016/j.compeleceng.2020.106767.) Using visualization techniques based on augmented reality (UNITY development environment), it will be possible to focus on different aspects and views of the lesion by studying the most significant parts. The system will be designed to easily archive and share co-registered scans in a single file, with an interface that allows annotated and analyzed data to flow towards an artificial intelligence platform for automatic diagnosis.

Educational objectives	The candidate will acquire an extensive knowledge of different acquisition and storage formats for biomedical scans and develop programming skills to allow their import into a single framework. Additionally, the candidate will develop knowledge in the field of Artificial Intelligence aimed at automatically co-registering point clouds, planar data, and volumetric data to achieve a homogeneous and coherent representation of different scans. Furthermore, the candidate will acquire programming techniques in the Unity environment aimed at representing heterogeneous data in augmented reality/mixed reality mode.
Job opportunities	Job opportunities range from biomedical companies developing diagnostic systems, public and private hospital research centers, and even university research centers operating in the biomedical field.
Composition of the research group	2 Full Professors 2 Associated Professors 12 Assistant Professors 7 PhD Students
Name of the research directors	Marco Marcon

Contacts
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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Ospedale San Paolo ASST Santi Paolo e Carlo di Milano
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	Departments of Endodontics, Texas A & M College of Dentistry, Dallas, Texas, USA.

By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Composition of the Telecommunications research group (ISPLab, Image and Sound Processing Lab) EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student. TEACHING ASSISTANTSHIP: availability of funding in recognition of supporting teaching activities by the PhD student There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations. COMPUTER AVAILABILITY: individual use. DESK AVAILABILITY: individual use.