UNIVERSITÀ DEGLI STUDI FIRENZE

Can engineering improve your health?

Innovative applications of image processing and 3D printing to medical training and decision making

PhD program in Industrial Engineering

re-vip reverse engineering, virtual and rapid prototyping

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Abstract

The entanglement between engineers and medical doctors significantly increased in recent years. The advent of new imaging and 3D-printing techniques revolutionized the approach to medicine.

Within the TIP research group, collaborating with the Meyer's Children's Hospital and Careggi's Hospital of Florence, the Department of Industrial Engineering develop new methods and tools, tailored to support challenging medical issues using the most advanced technologies from different engineering areas.

Realistic patient-specific simulators are increasingly been asked by clinicians to customize the simulation experience and properly form the medical staff on sensitive procedures. Reverse Engineering (RE) and additive manufacturing (AM) allow meeting those needs.

To reduce human bias in the diagnostic image reading, Artificial Intelligence (AI) tools can be used to support the tumors' characterization and staging.

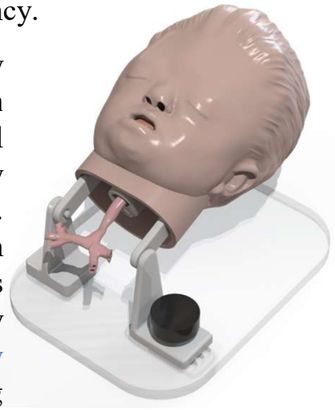
Similarly, to fulfill the need for objective data to evaluate the burn scar treatment's efficacy, RE and digital image processes can be combined.

TIP TEAM INNOVAZIONE PROCESSO E PRODOTTO

T3Ddy pediatric 3D technology

Personalized Physical Simulators

Physical simulation is becoming a standard clinical practice in training the medical staff on new procedures and in surgical planning. Commercially available devices lack patient-specificity and anatomical fidelity, compromising the session efficiency.



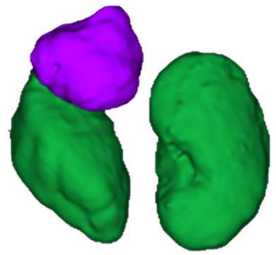
The ability to successfully perform **endotracheal intubation** is a fundamental skill for medical and surgical staff, especially when facing difficult airways. Being a high-risk procedure, an advanced level of proficiency is crucial to avoid patient morbidity and mortality. A **high-fidelity mannequin** was designed starting from the CT scans of a pediatric patient who was considered particularly significant as a clinical case and realized using AM techniques. case and realized using AM techniques.

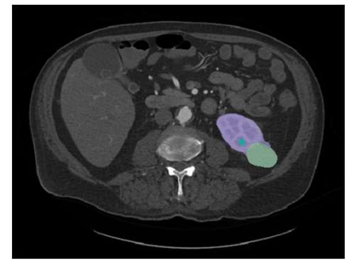
Teaching, planning and rehearsal of non-invasive cardiac surgery can greatly benefit from **patient-specific physical models**. Starting from standard diagnostic imaging, **3D-printed simulacra** of cardiac anatomy have been realized; the final aim of this research is to create a **modular simulator** usable to reproduce all the cardiac catheter interventions in a safe and realistic environment.

Computer Assisted Diagnosis

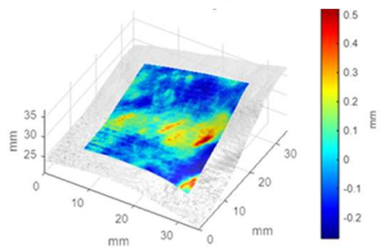
The use of **image analysis tools** to assist clinicians in the diagnosis phase is an innovative approach to medical care.

AI techniques have improved the analysis of patient-internal anatomy using **diagnostic imaging modalities** (e.g., CT, MRI). For renal tumors of small size, in which the differentiation between malignant and benign lesions is challenging for physicians, AI algorithms have been trained to **recognize and diagnose the tumor type**.





Moreover, the combination of **digital images and 3D scans** enabled better support for the physician in the assessment of the patient's health status. In the case of **burn skin scars**, **objective procedures** based on image processing and 3D reconstruction have been developed to evaluate their characteristics (e.g., **elasticity**, **roughness**).



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2. Magherini, R., et al. (2022). Machine Learning for Renal Pathologies: An Updated Survey. Sensors, 22(13), 4989. doi: 10.3390/s22134989

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