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1. Summary

This deliverable is part of Work package 6 (WP6): *Creation of learning content*, which is focused on providing contents for the project using the guidelines and tools defined within the new paradigm of model-based creation. Apart from the 3D anatomical models and the virtual reality (VR) environments, VR tasks and 3D-printed models for minimally invasive surgical training, additional learning material for medical and surgical training will also be provided as part of the MIREA learning platform.

This audiovisual material with different types of learning content will be focused on three main aspects: (1) human anatomy, (2) laparoscopy and (3) flexible endoscopy. These learning contents will include, among others, medical illustrations, videos of surgical procedures and preoperative imaging studies. These contents will be stored in the system's repository.

Table of contents

| | |
|-------------------------------------|----|
| 1. Summary | 3 |
| 1. Introduction | 5 |
| 2. Human anatomy | 5 |
| 2.1. Imaging studies | 5 |
| 2.2. Medical illustrations | 6 |
| 2.3. Video Animations and 3D models | 8 |
| 3. Laparoscopy | 9 |
| Robotic surgery | 10 |
| 4. Flexible endoscopy | 10 |
| 4.1. Imaging studies | 10 |
| 4.2. Surgical videos | 11 |
| 5. References | 11 |

1. Introduction

In order to use already-available scientific resources, the additional contents of the project for medical education and minimally invasive surgical training will be mainly based on partners' own contents and open access databases.

In the following sections, there is a list of additional resources that can be accessed for free, including medical imaging databases, video tutorials and animations, 3D models of human anatomy, etc.

2. Human anatomy

The following are various data sources regarding preoperative imaging studies, with and without pathology, as well as medical illustrations focused on education in human anatomy that can be added to the MIREIA platform.

2.1. Imaging studies

There are several open-access databases of imaging studies that could be used as sources of additional content for medical training in human anatomy both with and without pathologies. Three of them are listed below.

Cancer Imaging Archive (TCIA)

<https://www.cancerimagingarchive.net/>

The Cancer Imaging Archive (TCIA) is a service which de-identifies and hosts a large publicly available archive of medical images of cancer for public download. TCIA is funded by the Cancer Imaging Program (CIP), a part of the United States National Cancer Institute (NCI), and is managed by the Frederick National Laboratory for Cancer Research (FNLCR).

The imaging data are organized as “collections” defined by a common disease (e.g., lung cancer), image modality or type (MRI, CT, digital histopathology, etc.) or research focus. DICOM is the primary file format used by TCIA for radiology imaging. An emphasis is made to provide supporting data related to the images such as patient outcomes, treatment details, genomics and expert analyses.

Open Access Biomedical Image Search Engine (Open-I)

<https://openi.nlm.nih.gov/?it=xg>

Open-i service of the National Library of Medicine enables search and retrieval of abstracts and images (including charts, graphs, clinical images, etc.) from the open-source literature, and biomedical image collections. Searching may be done using text queries as well as query images. Open-i provides access to over 3.7 million images from about 1.2 million PubMed Central®

articles; 7,470 chest x-rays with 3,955 radiology reports; 67,517 images from NLM History of Medicine collection; and 2,064 orthopedic illustrations

The National Library of Medicine – MedPix

<https://medpix.nlm.nih.gov/home>

MedPix® is a free open-access online database of medical images, teaching cases, and clinical topics, integrating images and textual metadata including over 12,000 patient case scenarios, 9,000 topics, and nearly 59,000 images. Our primary target audience includes physicians and nurses, allied health professionals, medical students, nursing students and others interested in medical knowledge.

The content material is organized by disease location (organ system); pathology category; patient profiles; and, by image classification and image captions. The collection is searchable by patient symptoms and signs, diagnosis, organ system, image modality and image description, keywords, contributing authors, and many other search options.

2.2. Medical illustrations

CCMIJU and its Medical Illustration Unit

The CCMIJU, in collaboration with its Medical Illustration Unit, will provide various medical illustrations of the human anatomy that will be uploaded to the MIREIA platform (Fig. 1 and Fig. 2 are some examples). They will mainly be focused on the following specialities:

- Urology
- Gynaecology
- General surgery

However, possible illustrations for training in human anatomy for other disciplines (e.g., thorax) can also be included.

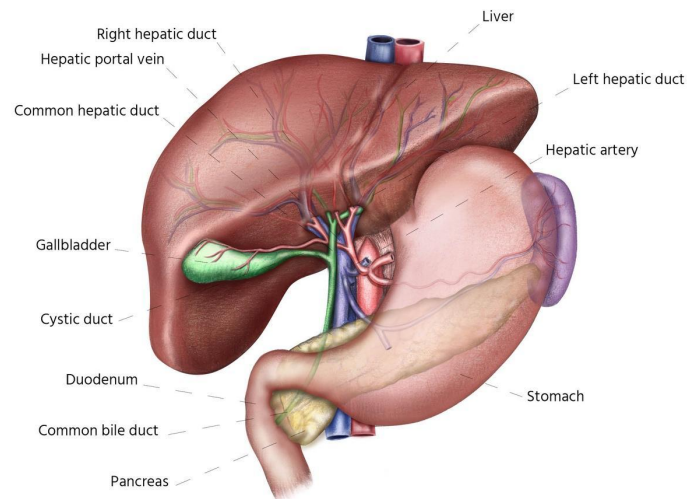


Figure 1. Example of medical illustration provided by CCMIJU: Anatomy of the liver.

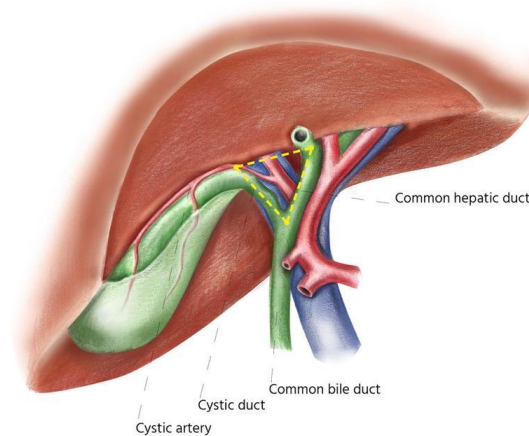


Figure 2. Example of medical illustration provided by CCMIJU: The Calot's triangle.

Smart Servier Medical Art

<https://smart.servier.com/>

A collection of over 3000 medical illustrations that are free to use. The images are organized by category: anatomy, cellular biology, medical specialties and general items, and further subdivided (for example by organs or specialties).

Ken Hub

<https://www.kenhub.com/>

Ken Hub is a platform for medical students and healthcare professionals to learn anatomy. You need to register in order to get free access to a high-resolution colour anatomy atlas, in-depth anatomy articles and sample videos and quizzes. With a subscription you also get access to video tutorials and interactive quizzes.

2.3. Video Animations and 3D models

Another example of learning materials that greatly enhance the efficiency of studying human anatomy are video animations and tutorials. They help to visualize the anatomical structures in 3D models and to understand the relation between different elements.

There are several YouTube channels with content that is free to access. Some examples are:

- **3D Diagram of the Human Body** (<https://www.youtube.com/watch?v=tgRjbPp5cVg>)
- **Abdominal Organs Tutorial (Plastic Model)** (<https://www.youtube.com/watch?v=rU7fkv0UTPg>)
- **Liver (3D animation) Anatomy** (<https://www.youtube.com/watch?v=RszdPqQCPbM>)
- **Human Anatomy Organ Real 3D Printing Technology** (<https://www.youtube.com/watch?v=Ya7ETDQdEQI>)

Related to 3D and Augmented Reality (AR) models, there are a few platforms that offer quite an extensive collection of resources, such as 3D models of human organs or human body. Furthermore, interactive apps offer a blended mode of education, by using mixed reality (MR) or augmented reality (AR). Some examples are:

Anatomical models for the University of Dundee, Centre for Anatomy and Human Identification

https://sketchfab.com/anatomy_dundee/collections/anatomy-resources-by-others

This is a collection of 186 3D anatomical models published by the University of Dundee. The Sketchfab platform comprises many more 3D and AR models that you can search by keyword. Content is free to view and there are several pricing plans for downloading the files.

Embodi3d - The Biomedical 3D Printing Community

<https://www.embodi3d.com/>

This is a platform that contains a collection of files intended for 3D printing, but includes volumetric medical scans (i.e., CT and MRI in NRRD format) for a variety of anatomic structures (bones, muscles, vessels). This is the largest and fastest growing library of 3D printable anatomic models generated from real medical scans on the Internet. Most of the material is free and

registered members can download, upload and sell models. They offer a free automated conversion service for turning your own medical scans to a 3D model.

3D Organon

<https://www.3dorganon.com/for-educators/#augmented-reality>

3D Organon is a medical and healthcare education platform for teaching and learning anatomy across virtual reality, desktop, tablet and mobile devices. It offers numerous life-like anatomy models within immersive environments. Guest mode can be accessed for free, but for the full experience there are pricing plans.

3. Laparoscopy

The following are various data sources regarding laparoscopic surgery, including robotic surgery, that can be added to the MIREIA platform. These data sources include surgical videos and 3D models for 3D printing and AR technologies.

MEDtube

<https://medtube.net/>

MEDtube is a video-centric social eLearning platform for Healthcare Professionals exclusively. It is free to use by the healthcare professional community worldwide (registration is required to benefit from all the website's peer-reviewed educational content and tools). In 2021, the library reached 25,000+ medical materials and the community exceeded 300,000+ professional subscribers (global audience).

Journal of Visualized Surgery

<https://jovs.amegroups.com/>

The Journal of Visualized Surgery is an international peer-reviewed journal focused on Visualized Surgery. It aims to promote the development of Visualized Surgery around the world by providing a professional platform for the sharing of experience in Visualized Surgery between peers so that all patients may benefit. Hence, the focus will be on instructional and educational video clips, photos, schematics of Visualized Surgical procedures, rather than lengthy text.

3D Printing Technology for the laparoscopic surgeon

<https://www.youtube.com/watch?v=IqRFyEAtW7A&t=20s>

This is a video recording of the presentation of Dr Andrea Pietrabissa at the 2018 SAGES Meeting/ 16th World Congress of Endoscopic Surgery that addresses the use of 3D printed models in laparoscopic surgery training.

3D Printing and Augmented Reality for Laparoscopic Surgery Simulation

<https://www.youtube.com/watch?v=EsS9jWETrtA>

Presented by Maki Sugimoto at the Panel: Hot Topics in Japan as Compared with the United States (joint panel with JSES) during the SAGES 2016 Annual Meeting, this video offers a detailed approach of augmented reality devices used for simulating laparoscopic surgeries.

Robotic surgery

SARAS endoscopic vision challenge for surgeon action detection

<https://saras-esad.grand-challenge.org/download/>

This dataset contains digital recordings from the da Vinci Xi robotic system during different stages of a prostatectomy procedure performed by expert surgeons on real patients.

4. Flexible endoscopy

The flexible endoscopy is a modern medical procedure that is constantly evolving and adapting to the needs encountered in daily practice. The training pathway can greatly benefit from using some of the available online resources, such as the following.

4.1. Imaging studies

Endoscopic image documentation has become widely available and has gained a major role in endoscopic reporting, being strongly recommended by major endoscopic societies. Therefore, there are online databases that provide images of both normal and pathological findings of endoscopic examinations.

The HyperKvasir Dataset

<https://osf.io/mh9sj/>

HyperKvasir Dataset is the largest multi-class image and video dataset from the gastrointestinal tract. The data is collected during real gastro- and colonoscopy examinations at a Hospital in Norway and partly labeled by experienced gastrointestinal endoscopists.

NBI-InfFrames dataset

<https://nearlab.polimi.it/medical/dataset/>

The NBI-InfFrames dataset aims to provide the surgical data science community with a labeled dataset for the identification of informative endoscopic video frames. It is composed of 720 video frames, which are manually extracted and labeled.

4.2. Surgical videos

Video documentation of endoscopic procedures is not routinely performed, but the demand for it is on the rise, since in some situations, it can prove to be superior to image documentation by offering more information.

Colonoscopy and Flexible Sigmoidoscopy

<https://www.youtube.com/watch?v=uKw4ME66fAM>

This video provides a detailed description of the procedure of flexible colonoscopy and contains 3D animations.

Endoscopy Campus

<https://www.endoscopy-campus.com/en/lehrvideos/>

This website provides a collection of instructional videos of different endoscopic examinations. The platform also provides articles, images and hosts live educational events.

UCSF Radiology: What Virtual Colonoscopy CT Scans look like

<https://www.youtube.com/watch?v=ICtp9rPI96I>

UCSF Radiologist Dr Judy Yee describes what a low dose CT scan of a virtual colonoscopy looks like, from the 2D images to the fly-through of the colon.

It should also be mentioned that another manner of finding more specific data is to use the Google Data search engine:

<https://datasetsearch.research.google.com>

5. References

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