Newsletter #3

iToBoS

Intelligent Total Body Scanner for Early Detection of Melanoma

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2022

Contents

Why the global semiconductors crisis affects us

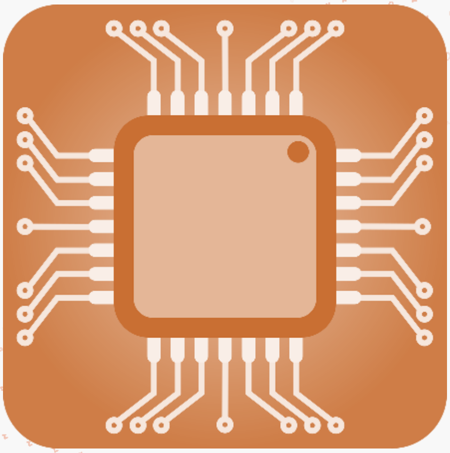
In the last two years, the scarcity of semiconductors has become a global problem. The shortage of microchips is a consequence of the restrictions imposed by the pandemic situation and the closure of some factories and companies. This situation has affected many sectors, demonstrating the importance of these components nowadays.

The semiconductors are electronic components that have the property of conducting electricity, it allows current to pass or not to pass, depending on what a given circuit requires at every moment. Its function is to collect information, process it, store it, and then transmit it. Semiconductors are the essential building blocks of digital and digitised products, from smartphones to cars, through critical applications and infrastructures for healthcare, energy, mobility, communications, and industrial automation.

Microchips can be found in integrated circuits, optical sensors, lasers and electrical transmission modulators. Their versatility is what has given them the relevance they have today. For this reason, their scarcity has made many industries to experience issues, compromising production, which in turn can make their products more expensive or can make them run out of stock.

The production of semiconductors is concentrated in Asia, specifically in countries as South Korea, China and Taiwan and this concentration has been a problem since the beginning of the Covid-19. The cutting supply lines caused bottlenecks and microchips were not arriving in the required amounts to the industries to finish their products. In addition to these disastrous consequences, the supply crisis causes delays in the execution of European projects, as is the case of our iToBoS project, since delivery times are delayed much longer than initially planned and costs have increased.

Faced with this situation, governments around the world are trying to find solutions. Companies are already working on new, more efficient and less polluting materials that ensure both an environmentally friendly approach and digitisation. Materials such as graphene help technologies such as 5G realise their full potential. Such developments may be the key to securing the connectivity of the future.



The EC recently proposed the European Chips Act to confront semiconductor shortages and strengthen Europe's technological leadership. The proposed European Chips Act will boost the Europe’s technological sovereignty, competitiveness, ensure the resilience of supply chains and reduce external dependencies.

The optical challenge of the total body scanner

Total body scanner development

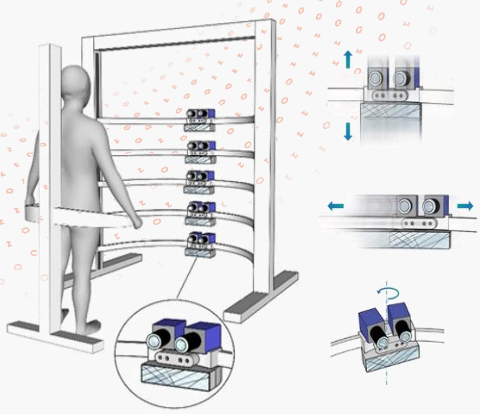
The engineering tasks of the iToBoS project can be divided into two main groups. On the one hand, the design and construction of the total body scanner, that is the hardware. On the other hand, the design and implementation of the data processing and artificial intelligence software that will analyse all the information (skin images and clinical data) and generate a comprehensive output for the clinicians. In this article, we will focus on the hardware side of the project (mostly WP3 -Specifications & WP5 – Development) and, in particular, on the special optical system needed to acquire high-resolution images of the skin of the patients.

The complexity of acquiring a full-body high-resolution avatar

The currently available systems allow doctors to take low-resolution full-body pictures of their patients and tag the positions of the skin lesions in a 3D avatar. To analyse a specific lesion, they take a local high-resolution image with a hand-held dermatoscope which can be linked to its position. The goal of the full-body scanner is to take hundreds or thousands of high-resolution pictures covering the whole body of the patient and create an avatar in which doctors can zoom in to see the details.

To acquire all the necessary images, the full-body scanner will use several cameras covering different regions of the body. This is important to keep the comfort of the patient, a key factor in the design of any medical device. In our case, comfort translates into reducing the acquisition time as much as possible. In addition, each camera will need to move following the shape of the patient's body and acquire images perpendicular to the skin. Only by doing this, all the images will have comparable quality and it will be possible to construct a super-resolved full-body avatar.

Due to safety reasons, however, any moving element needs to be placed at a certain distance from the patient (several tens of centimetres). At such distance, the focal spot becomes very small, and features slightly closer or further from the camera are out-of-focus. Because our bodies have irregular shapes, the cameras of the full-body scanner will take several pictures focused on different distances -a stack of images- and combine them into a single image where all the regions are in focus. Acquiring a stack of images at every position multiplies the number of pictures to be taken. To keep the scan time low, the optical system needs to be able to focus very fast and precisely.



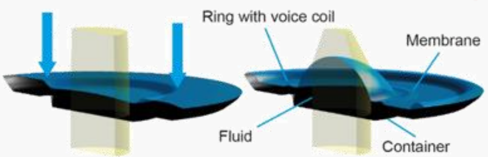
First sketches of the full-body scanner showing the various moving cameras needed to image different regions of the patient's body.

A tuneable liquid lens system for optimal image quality

Traditional optics are based on solid glass or plastic lenses which are moved back and forth to change the focus. Due to the massive nature of glass lenses, such focusing systems are bulky and slow. For this reason, the alternative given by Optotune's liquid tuneable lenses is going to be used.

These lenses are based on the same principle as the eye: a flexible membrane closing a chamber full of liquid, which can be pressed to change the shape of the membrane and modify the focal power of the system. A change in membrane radius of a few micrometres can have the same optical effect as moving an entire glass lens several centimetres. Focus tuneable liquid lenses thus allow optical systems to be designed more compact and without complex mechanics. In addition, the optical power can be tuned precisely in only a few milliseconds and repeatably through billions of cycles.

All these properties make them the perfect match for the fast high-resolution image stack acquisition desired from the full-body scanner.



The working principle of Optotune's focus tuneable liquid lenses is based on the eye, where elastic materials are bent to adapt the shape of the lens.

Optotune's task in the iToBoS

The main contribution of Optotune in the iToBoS project is concentrated in Task 5.2 and consists of two big challenges: developing an optical module including a liquid tuneable lens and implementing the already proven compensation technology for gravity-induced coma.

The liquid tuneable lenses can be designed with different optical apertures and different focal power ranges to fit different applications. To be more versatile, they can also be combined with off-the-shelf imaging optics to bring the tuning capability to large and low working distances, or to telecentric lenses with constant magnification. Depending on the application, the liquid lens can be placed before or after the off-the-shelf optics. However, to optimize the image quality, the best approach is to design the liquid lens directly in the middle of the optical module. Achieving high resolution at a long distance as it is needed in the full-body scanner requires such a custom design and it is the first task for Optotune.

The second challenge is related to the biggest limitation of the liquid tuneable lenses: the coma aberration produced by gravity (or any other acceleration). In the presence of an external acceleration, the forces exerted by the liquid on different regions of the membrane are different generating a coma aberration. As a result, Optotune's original lenses can only be used for high-resolution applications with their optical axis in a vertical orientation so that gravity affects all the regions of the lens equally. The latest of Optotune's inventions consists in adding a second optical liquid reservoir separated from the first reservoir by a secondary membrane.

Important advances have been made and we expect to show the results soon.

The presence of iToBoS on social networks

iToBoS project is constantly active, not only in the development of the total body scanner and the Artificial Intelligence (AI) system, but also attending conferences, presenting the project in specialized congresses, conferences, or publishing scientific articles, among others. Different information and approaches to interest many types of audiences.

With the aim that the society is informed about the latest developments, all the news regarding the project are duly updated on the stakeholder's network by means of blog posts.

iToBoS project is also present in different social networks in order to reach as many people as possible in almost real time, considering the widest spectrum, profiles, interests, technical skills, their interest with the melanoma, as well as the different perspectives present in the network.

The iToBoS accounts on social media are Twitter, Facebook, Instagram, LinkedIn and YouTube.

@itobos_eu   itobos.eu   itobos_eu

itobos project   itobos_eu

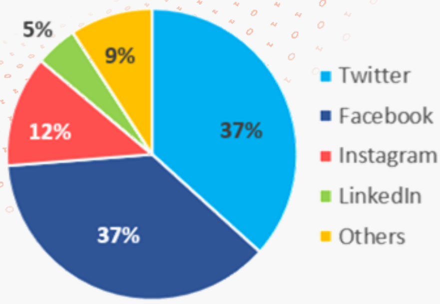
iToBoS accounts on the social media channels.

In addition, a newsletter is sent biannually to iToBoS community via e-mailing, and it is also available on the website.

The iToBoS social media platforms are the best channels to reach general audience, stakeholders and relevant groups, allowing to share information about news, achievements, content of interest and any relevant event in an easy and fast way. Likewise, it also allows the consolidation of groups of common interests in iToBoS topics, including research, healthcare, cancer, melanoma, optoelectronics, new techniques of diagnose, information technologies, the European framework and promoting networking and relationships between many teams at international level. Accessible to anyone who might be interested in iToBoS, the social networks also address innovators, policy makers, disseminators and other relevant target groups.

So far, more than 500 social media posts have been made through all the iToBoS social networks, presenting the news and achievements of the project and keeping the audience engaged.

The content that iToBoS publishes, focused on audiences of different profiles, has led the project to have more than 1,000 followers among all the social networks.



iToBoS on social media.

Stay tuned on the new updates that we will share, both on the website and on the social networks. Everything we plan, we do, or we achieve is there!

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Some project events

In the third semester of the project, that covers from M13 (April 2022) to M18 (October 2022), iToBoS has organized and participated in different events, pointing out the following:

3rd General Assembly meeting (extraordinary)

An extraordinary General Assembly (GA) meeting took place on 30th May 2022 throughout video conference system with the attendance of 28 participants belonging to the 19 project partner organizations.

In this meeting the project coordinator exposed the contingency plan to be applied in the project in coming months and the response of the Project Officer to the consortium.

Digital Communication workshop

iToBoS organized an internal workshop on digital communication on May 31st, 2022, via video conferencing system.

The event was led by RICOH within the framework of the WP12. This workshop aimed to develop the digital communication skills of iToBoS partners to promote and make fruitful use of the project's digital channels.

4th General Assembly meeting

The iToBoS 4th General Assembly meeting (GA) took place on 7/09/2022. The status, achievements, deliverables, milestones were analysed. UDG explained how to proceed to prepare their contributions to the Periodic Report that must be submitted by November 2022.

3rd Project Management Board meeting

The iToBoS 3rd Project Management Board (PMB) meeting took place on 7/09/2022. In this meeting, members discussed the next steps, updates, delays and problems to solve in the project. Sixteen face-to-face participants and five through videoconference system have attended, including Project Coordinator (PC), Project Manager (PM), Innovation and Exploitation Manager (IEM), Dissemination and Communication Manager (DCM), Data Manager (DM) and WP leaders.

Events participated

iToBoS representatives presented the project and shared experiences with a wide range of stakeholders, including relevant players from the information technologies, healthcare, research and innovation fields.

- Porto, 20-23/04/2022. 1st Spring Biophotonics Conference in Porto.
- Singapore, 6-8/05/2022. World Cancer Research Symposium 2022.
- Lisbon, 14/05/2022. Bootcamp22 Research Strategy.
- Bergamo, 24-25/05/2022. Liquid Biopsies Congress 2022 (European Association for Cancer Research).
- Nice, 27-30/05/2022. Medical Informatics Europe Congress 2022.
- San Francisco, 6-9/06/2022. RSA Conference 2022.
- Hannover, 12-14/06/2022. Humboldt meets Leibniz.
- Hannover, 15/06/2022. Phoenix D Laser Day.
- Spetses, 27-30/07/2022. VI 'Photonics Meets Biology'.
- Vienna, 23-26/08/2022. Cross Domain Conference for Machine Learning and Knowledge Extraction.
- Hannover, 28/08-02/09/2022 Europhoton.

Work presented

During the third semester of the project, the following deliverables have been produced and submitted:

Deliverable submitted	Month	Leader	Diss. level
D3.1-Operational requirements for the total body skin scanner.	14	BOSCH	CO
D5.3-Software tools for camera calibration and view planning.	16	COR	CO
D8.1-Software tool and form for multimodal data integration.	16	NTUA	CO
D4.1-Masking and anonymisation tools for datasets.	18	IBM	CO
D12.5-Dissemination, outreach and liaison activities report.	18	RICOH	PU

Publications

During the third semester of the project, the following scientific works have been published with the support of the iToBoS project.

- "*Quantus: An Explainable AI Toolkit for Responsible Evaluation of Neural Network Explanations*". 2022. Anna Hedström, Leander Weber, Dilyara Bareeva, Franz Motzkus, Wojciech Samek, Sebastian Lapuschkin, Marina M.-C. Höhne.
- "*Measurably Stronger Explanation Reliability via Model Canonization*". 2022. Franz Motzkus, Leander Weber, and Sebastian Lapuschkin.
- "*Beyond Explaining: Opportunities and Challenges of XAI-Based Model Improvement*". 2022. Leander Weber, Sebastian Lapuschkin, Alexander Binder, and Wojciech Samek.
- "*ECQ^x: Explainability - Driven Quantization for Low-Bit and Sparse DNNs*". 2022. Daniel Becking, Maximilian Dreyer, Wojciech Samek, Karsten Müller, and Sebastian Lapuschkin.
- "*Explainable AI Methods - A Brief Overview*". 2022. Andreas Holzinger, Anna Saranti, Christoph Molnar, Przemyslaw Biecek, and Wojciech Samek.
- "*CLEVR-XAI: A benchmark dataset for the ground truth evaluation of neural network explanations*". 2022. Leila Arras, Ahmed Osman, and Wojciech Samek.
- "*Applying Artificial Intelligence Privacy Technology in the Healthcare Domain*". 2022. Abigail Goldsteen, Ariel Farkash, Micha Moffie, Ron Shmelkin.
- "*Explain to Not Forget: Defending Against Catastrophic Forgetting with XAI*". 2022. Sami Ede, Serop Baghdadlian, Leander Weber, An Nguyen, Dario Zanca, Wojciech Samek, and Sebastian Lapuschkin.
- "*Explaining the Predictions of Unsupervised Learning Models*". 2022. Grégoire Montavon, Jacob Kauffmann, Wojciech Samek and Klaus-Robert Müller.
- "*Registration of polarimetric images for in vivo skin diagnostics*". 2022. Lennart Jütte, Gaurav Sharma, Harshkumar Patel and Bernhard Roth.
- "*Towards the Interpretability of Deep Learning Models for Multi-modal Neuroimaging: Finding Structural Changes of the Ageing Brain*". 2022. Simon M. Hofmann, Frauke Beyer, Sebastian Lapuschkin, Ole Goltermann, Markus Loeffler, Klaus-Robert Müller, Arno Villringer, Wojciech Samek, A. Veronica Witte.

In addition, different articles aimed at broader audiences have been developed and published on the project website, presenting the project from different scientific, medical, technological or innovation perspectives, considering the different profiles and background of the project partners.

iToBoS team

The consortium with 19 partners organizations is led by the University of Girona (Spain). This international consortium brings together **leading research/ academic institutions** (5 research centres), **industry** (4 companies and 6 SMEs) and **end-user entities** (3 hospitals and 1 patients' NPO).

The University of Queensland has received funding from the Australia's NHMRC under grant number APP2007014.

iToBoS

Let’s stay in contact!

iToBoS has deployed some **digital channels to keep in touch with you and bring you the latest news** about the project. They are also a way to receive your ideas and comments and learn more about your needs.

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Intelligent Total Body Scanner for Early Detection of Melanoma

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