Newsletter #4

iToBOS

Intelligent Total Body Scanner for Early Detection of Melanoma

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2023

iToBOS

Content

Artificial Intelligence for skin image analysis using Total Body Photography

Artificial Intelligence and Machine Learning for health purposes

In the last decade the application of Artificial Intelligence (AI) algorithms in dermatology to classify skin lesions, particularly melanoma, has advanced rapidly. Large international computer skin image analysis challenges have successfully drawn attention to the potential for AI to aid the detection of skin cancers.

A landmark study, reported by Esteva et al[1] in 2017, compared the accuracy of their algorithm against 16 expert dermatologists. The algorithm outperformed the average dermatologist score for detecting both melanomas and keratinocyte carcinomas. Since then, there have been several other reports of algorithms that have outperformed dermatologists in reader studies.

While reported algorithm accuracy and performance are promising, they do not represent a real-world clinical setting, where examination and diagnosis involve context beyond the pixels of a single lesion image. Furthermore, the image datasets generally used for Machine Learning (ML) can lack generalisability to the day-to-day skin lesions examined by dermatologists, as image archives often capture skin lesions that were deemed 'interesting enough' to warrant a picture. In a clinical setting, a dermatologist would consider several factors relating to the patient's clinical and family history, photodamage of the skin, naevi characteristics of the whole patient, age, and potentially genetic information when available.

Total Body Photography

The growing use of Total Body Photography (TBP) systems represents both challenges and opportunities to standardise both the image acquisition and labelling of clinical metadata for ML. The opportunity to train algorithms to not just consider the image pixels of a single lesion, but also phenotype information of the whole patient, along with medical records and genetic information will produce the next generation of AI algorithms for dermatology.

The need of clinical trials and challenges organization

With funding from the European Union 2020 Horizons programme, the iToBoS consortium are developing an Intelligent Total Body Scanner with integrated Computer Aided Diagnostic (CAD) tools. To achieve this objective, a multi-site clinical trial for data acquisition is taking place in both Barcelona, Spain, and Brisbane, Australia. This clinical trial will collect TBP image data, patient health information, and genetic risk scores to create an image training dataset with

[1] Esteva A, Kuprel B, Novoa RA, Ko J, Swetter SM, Blau HM, Thrun S. Dermatologist-level classification of skin cancer with deep neural networks. Nature. 2017 Feb 2;542(7639):115-118. doi: 10.1038/nature21056. Epub 2017 Jan 25. Erratum in: Nature. 2017 Jun 28;546(7660):686. PMID: 28117445; PMCID: PMC8382232.

labelled metadata, to develop algorithms that consider the whole patient to better reflect a dermatologist's diagnosis.

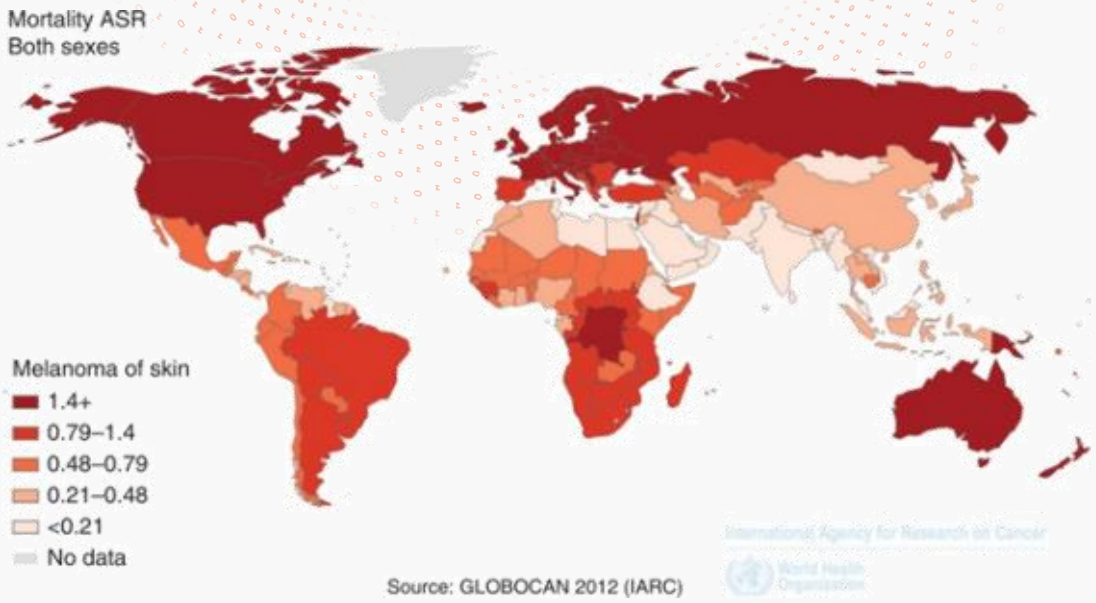
In recent years, it has been a common research practice to organize international competitions or challenges in which the algorithms of different researchers can be benchmarked on publicly released datasets. Over the period of the iToBoS project, the wider consortium will organise two competitive challenges where world-leading groups can participate in solving new problems on (i) lesion detection and boundary segmentation in regional body images, and (ii) on lesion classification. These challenges will facilitate advancements in the development of AI and CAD tools and contribute to the knowledge dissemination in the field.

Skin cancer early detection with assistance of artificial intelligence

Skin cancer in the world

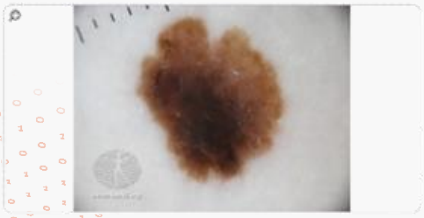
Skin cancer is the most common cancer in the world. According to media, more than 9.000 people are diagnosed with skin cancer every day in the US. 100.000 new cases of skin cancer diagnosed in France every year. In Australia, 2 in 3 people will get skin cancer in their lifetime. The annual treatment cost is estimated at $8,1B in the US and €236M in France.

Skin cancer rate increased 5-fold since 1970s and continues to increase in many places. In the meanwhile, there is an important lack of dermatologists, which leads to very long waiting time for patients and overwork for doctors.



Skin cancer at late stage often spreads to internal organs and becomes fatal. However, skin cancer at early stage can be cured with very high survive rate. Therefore, the key treatment is to detect skin cancer as soon as possible.

Cancer risk level:	**5/5**
Prediction:	High Grade Risk
Malignant melanoma:	0.97
Superficial melanoma:	0.85
Nodular melanoma:	0.43



Cancer risk level:	**4/5**
Prediction:	Risk
Malignant melanoma:	0.97
Melanoma in situ:	0.93
Superficial melanoma:	0.75

With the current lack of dermatologists all around the world, many people may have skin cancer without knowing it. The late skin cancer detection results in huge treatment cost, suffering for patients, and in many cases, the death that would be saved if being detected earlier.

Artificial Intelligence applications

Artificial Intelligence (AI) is an advanced technology that has been transforming the world and every walk of life. It has changed much the way people think and make decision. It enables people to integrate information and analyse data more efficiently, hence improve decision making. AI has various applications in finance, health care, national security, transportation, entertainment, and so on.

The application of AI in health care has been accelerated since 2020s. Medical chatbots, robotic surgeries, virtual nursing assistants are some of such amazing applications. In skin care, AI has been used for classifying skin diseases or scoring severity of inflammations such as acne, psoriasis and so on.

Skin cancer detection powered by AI

The use of AI for skin cancer detection has received a tremendous attention recently. The ISIC challenge, biggest international competition for melanoma detection, has attracted many thousand participants from both industry and academia all around the world since its first launching in 2016.

Torus AI (formerly Torus Actions), the second winner of the ISIC challenge 2019, is a French start-up that has been developing several AI solutions for skin care, and, in particular, for early skin cancer detection. Thanks to the success of its Skin Cancer AI, Torus AI has become one among 19 partners of iToBoS project, one of biggest European projects for fighting skin cancer.

The role of Torus AI in iToBoS project is developing AI solution for automatic mole detection, mole matching, UV damage scoring, and essentially, skin cancer detection. In the Task 8.5, Torus AI works on developing AI for mole classification and provide image-based cancer risk assessment.

Skin cancer AI for early melanoma detection

The current Skin Cancer AI developed by Torus AI can detect up to 12 types of melanomas (the deadliest skin cancer), 38 types of non-melanoma skin cancer, and over 70 types of other pre-cancer or benign skin lesions. This AI also provides a cancer risk index which range from 0 to 5 for very benign to very malignant or high-grade cancer.

The figure above shows some examples of melanoma detection using Skin Cancer AI. The clinical and dermoscopic images are taken from DermnetNZ, one of the most reliable websites for skin disease information. The two images are taken for a same lesion which is melanoma in situ, a kind of early-stage melanoma. The AI detected high cancer risk for both images, and in particular, detected melanoma in situ with high confidence using dermoscopic image.

With the financial support of European Council, iToBoS project will bring the best value of AI to assist doctors in diagnosis and improve skin cancer detection in Europe and all around the world. This will help save lives, save time, save money, that benefits to all patients, doctors, and national health care systems.

Submission and approval of the first Periodic Reporting

The 1st Periodic Reporting corresponding to the period M1-M18 was submitted to the EC on November 24th, 2022 (M20) and it was officially approved on January 25th, 2023.

Along this reporting period, 27 deliverables and 9 draft deliverables have been submitted and 2 milestones have been achieved.

In total, 8 project meetings have been organized: 4 General Assembly meetings, 3 Project Management Board meetings and 1 Advisory Board meeting. Additionally, several WP meetings and other project meetings have been organized by the Project Coordinator.

The project Grant Agreement (GA) and Consortium Agreement (CA) have been prepared and signed.

The bi-annual technical and financial reports of the consortium (M1-M6, M7-M12 and M13-M18) have been coordinated, monitored and reviewed by the Project Coordinator.

On the first 18 months, the project has advanced in several fronts. First, the overall architecture behind the iToBoS concept has been defined, specifying the system requirements and ensuring interoperability between each of the main modules of the project. This definition included not only the algorithms used for image processing, 3D reconstruction, lesion detection and classification, data

integration and anonymization, but also the tools for applying machine learning to the gathered data and the full body scanner hardware to collect the skin images.

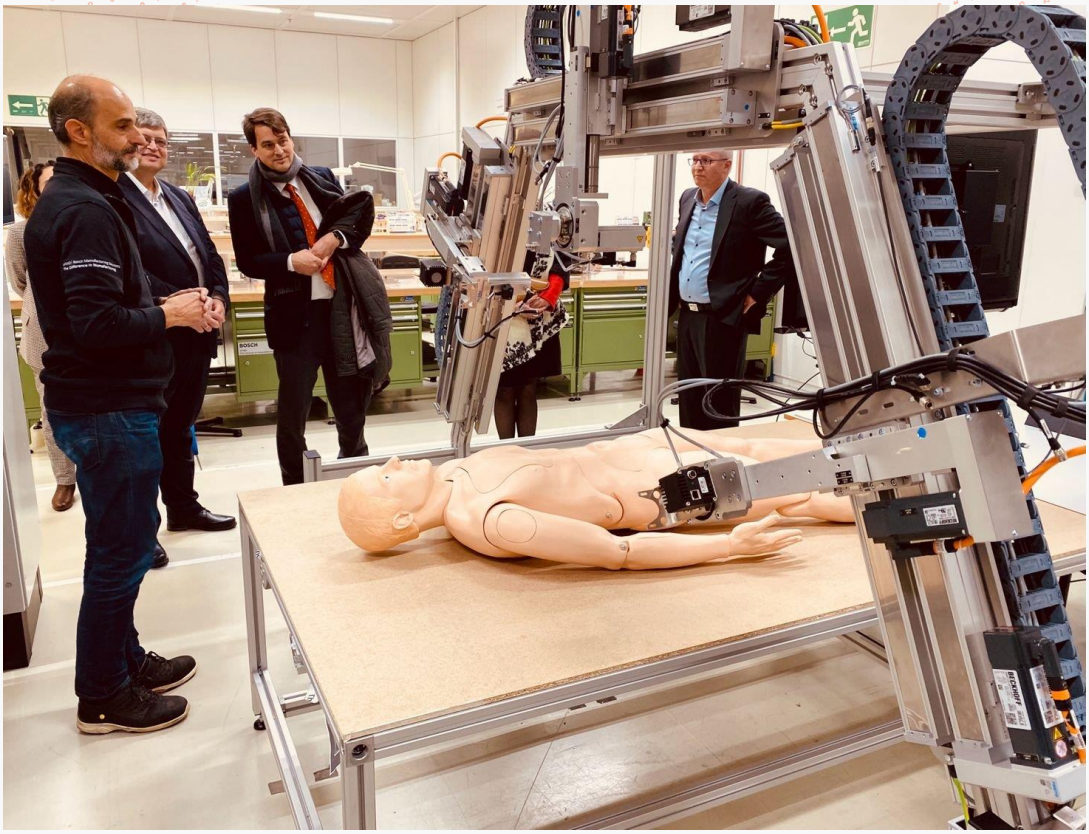
One of the main advances of this first period is the definition and validation of the high-resolution imaging module (HRIM), including the design of the liquid lenses for image acquisition. We have also advanced in the design and integration of this HRIM in the total body scanner. In this sense, a first prototype of the total body scanner was designed and the development of a prototype arch was completed (with some parts still pending to arrive by the end of the first reporting period, due to lack of components in the market). Given the materials shortage in the market, and the delays that this imposed in the design of the scanner prototype, a contingency plan has been implemented to keep advancing in the development of the AI cognitive assistant for early detection of melanoma. This contingency plan is based on the acquisition of skin images using the best total body scanner that could be found in the market (Vectra360 by Canfield). The team also started to develop the tools for image ingestion, as well as the anonymization and masking tools both for the images and the patient data. In this sense, we have defined the specific demographic and clinical data from the patients to be used by the AI, together with the lesion images. Secondly, a number of tasks such as lesion detection, lesion classification and development of eXplainable AI (XAI) have started by using public image datasets, allowing the advance in these domains. Moreover, both ethical risks as well as ethical opportunities, such as being able to detect melanoma earlier or personalizing the diagnostics, have been assessed during this first period. All the medical research ethics aspects have been addressed and the clinical protocols for the use of the VECTRA images and the patient's data have been submitted to the corresponding ethical committees. Finally, a patient engagement plan with touch points and educational needs has been developed, specifying how iToBoS will engage with the broader patient community. And regarding outreach, the consortium has defined and implemented the dissemination and communication strategy of iToBoS to set the guidelines, actions and tools to channel the efforts aimed at achieving a wide impact of the project among the target audience to extend the results and benefits of the project to the society in general.

Some project events and activities

In the fourth semester of the project, which covers from October 2022 to March 2023, iToBoS organized and participated in different events for communication, dissemination and outreach purposes.

iToBoS project representatives presented the project and shared experiences with a wide range of stakeholders, including relevant players from the fields of ICT, innovation, research, opto-electronics, healthcare, and business, highlighting the following events and activities:

- Barcelona, 13/10/2022. Skintalk on Cyberdermatology
- Online, 17/10/2022. Accomplishing AI Privacy and Compliance course with IBM Privacy Toolkits.
- Frankfurt, 18-20/10/2022. 15th Optatec Virtual.
- Hannover, 06/11/2022. Ansprechbar der Leibniz Universität Hannover.
- Madrid, 14/12/2022. Presentation of the iToBoS project to the German Ambassador at Bosch Spain premises.
- San Francisco, 28/01 - 02/02/2023. SPIE Photonics West.
- Online, 4/02/2023 "The different pathways of melanoma" lecture.
- Barcelona, 31/01 - 09/02/2023. IOTS World Congress and Brokerage Event.
- Barcelona, 03/02/2023. Integrated Systems Europe 2023.
- Barcelona, 01/03/2023. 4YFN Congress 2023.
- Barcelona, 27/02 - 10/03/2023. Open Innovation Challenge and Mobile World Congress 2023.



Work presented

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

Deliverable submitted	Month	Leader	Diss. level
D6.1-Software for image acquisition using liquid lenses and their enhancement	20	LUH	CO
D10.3-Midterm recruitment report for the prospective clinical study	24	UQ	CO
D12.2-Communication, dissemination, outreach and engagement plan (second release)	24	RICOH	PU

Publications

During the fourth semester of the project the following scientific works have been published in the iToBoS context.

- "*Focus stacking in non-contact dermoscopy*". 2022. Lennart Jütte, Zhiyao Yang, Gaurav Sharma & Bernhard Roth.
- "*What to Hide from Your Students: Attention-Guided Masked Image Modeling*". 2022. Ioannis Kakogeorgiou, Spyros Gidaris, Bill Psomas, Yannis Avrithis, Andrei Bursuc, Konstantinos Karantzalos & Nikos Komodakis.
- "*Impact of standardization in tissue processing: the performance of different fixatives*". 2022. Eleonora De Martino, Caterina Medeot, Lorenzo D'Amico, Giorgio Stanta & Serena Bonin.
- "*Mueller Matrix Microscopy for In Vivo Scar Tissue Diagnostics and Treatment Evaluation*". 2022. Lennart Jütte & Bernhard Roth.
- "*AI privacy toolkit*". 2023. Abigail Goldsteen, Ola Saadi, Ron Shmelkin, Shlomit Shachor, Natalia Razinkov.

In addition, different articles aimed at broader audiences have been developed and published on the project website, presenting the project from different perspectives, considering the different profiles of all 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**), **industries** (4 large 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.

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 as well as learn more about your needs.

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