Newsletter #6

iToBOS

Intelligent Total Body Scanner for Early Detection of Melanoma

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 965221.

2024

Content

Seeing is Believing: How AI might transform skin cancer education

The integration of digital technologies, e.g., smartphone apps, has been shown to represent an impactful advancement in training for melanoma diagnosis[1]. As artificial intelligence (AI) rapidly advances, its integration into dermatology, particularly through Cycle-Consistent Adversarial Networks[2] (Cycle-GANs), we present possible new horizons in patient education and skin cancer diagnosis. A GAN functions with two neural networks: a generator creating images and a discriminator evaluating them, producing increasingly realistic results. A Cycle-GAN links two GANs for bidirectional data transformation between domains. GANs have already found a significant application in dermatology, particularly for data augmentation in skin cancer classification models. The GANs have been enhancing the robustness and accuracy of these diagnostic models[3]. We propose the application of Cycle-GANs in the transformation of benign dermoscopic images into artificially created malignant counterparts. This technology allows dermatologists to visually demonstrate to patients the subtle differences between benign and malignant lesions using actual dermoscopic images from the patient's body. During skin screening procedures, dermatologists can present both the original benign image and the AI-generated malignant version. This side-by-side comparison aids in explaining why certain lesions do not require excision and what changes to look for in the future, potentially making patients more attentive. Conversely, for lesions appearing malignant, the AI could generate a benign counterpart to illustrate the necessity of excision.

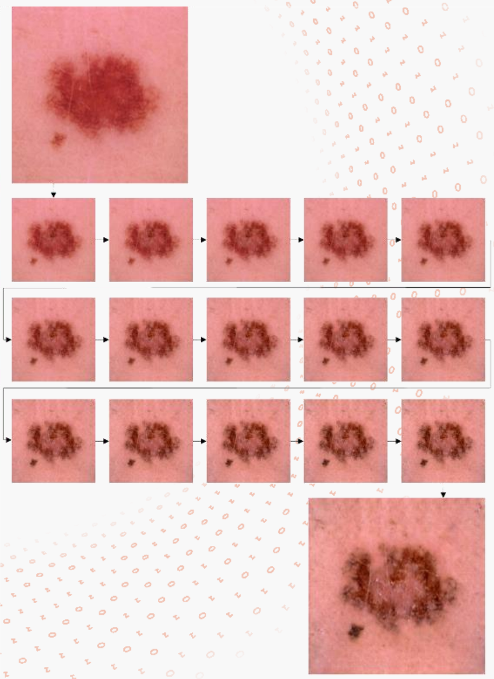

Figure 1: Top: Original benign skin lesion from ISIC dataset. Centre: Selected frames from the frame interpolation video generated with Runway (2024 Runway AI, Inc., New York, USA). Bottom: AI-generated image showing the lesion's potential malignant progression.

Figure 1 shows a dermoscopic image of a benign lesion from the ISIC dataset[4] and

[1] Nervil GG, Ternov NK, Vestergaard T, Sølvsten H, Chakera AH, Tolsgaard MG, Hölmich LR.
[2] J. -Y. Zhu, T. Park, P. Isola and A. A. Efros.
[3] Eduardo Pérez, Sebastián Ventura.
[4] Rotemberg, V., Kurtansky, N., Betz-Stablein, B., Caffery, L., Chousakos, E., Codella, N., Combalia, M., Dusza, S., Guitera, P., Gutman, D., Halpern, A., Helba, B., Kittler, H., Kose, K., Langer, S., Lioprys, K.,

an artificially created malignant counterpart as well as selected frames from a frame interpolation, showing the gradual transformation from the original benign image to the artificial malignancy image.

Utilizing frame interpolation, we create a seamless and gradual transition from the original benign dermoscopic image to the AI-generated malignant counterpart. This results in a brief video, illustrating the subtle progression of skin changes, potentially enhancing patient understanding of skin cancer indicators. Figure 2 displays the transformation for another example.

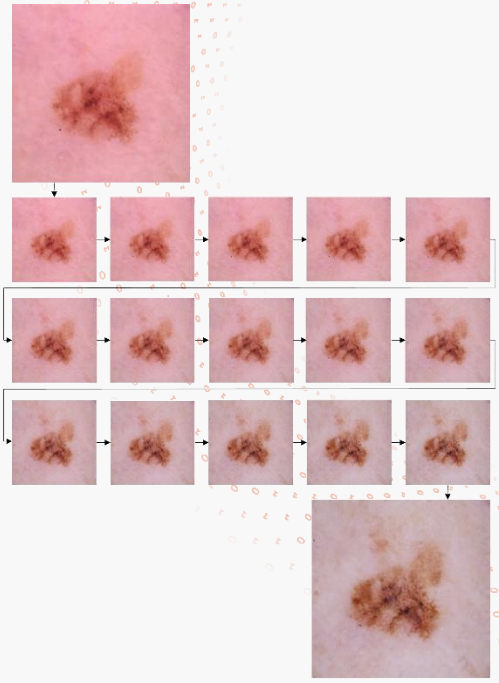

Figure 2: Transformation of a second sample benign image into its AI-generated pseudo-malignant counterpart with frame interpolation.

The frames demonstrate the transformation from the dermoscopic image of a benign skin lesion to an artificially generated pseudo-malignant counterpart.

This visual tool goes beyond the traditional ABCDE rule for skin cancer diagnosis, offering a more intuitive and understandable approach. By seeing the potential progression from benign to malignant, patients gain a clearer understanding of their diagnosis, fostering confidence in self-examinations and early detection. Melanoma patient education on skin self-examination improves their self-efficacy. With this, the level of perceived physician support increases[5].

Generative AI in dermatology is not just a technological advancement; it could be a step towards empowering patients with a deeper understanding of their skin health. By bridging the gap between complex skin cancer diagnostics and patient comprehension, technology could enhance proactive skin care and early cancer detection. The broader application of this technology could improve patient education across various diseases, that require visual diagnosis. Deploying AI in patient care and education necessitates careful consideration of ethical issues, including patient privacy, data security, and the need for transparent AI decision-making processes[6].

Malvehy, J., Musthaq, S., Nanda, J., Reiter, O., Shih, G., Stratigos, A., Tschandl, P., Weber, J. & Soyer, P.

[5] Z. Czajkowska, N.C. Hall, M. Sewitch, B. Wang, A. Körner.
[6] Alowais, S.A., Alghamdi, S.S., Alsuhebany, N. et al.

Use of Neural Radiance Fields in the Medical Domain

Understanding the geometry of an existing scene and being able to use this knowledge to produce (and refine) data, is an important task in any research field, particularly in the medical domain where the study and understanding of 3D structures of interest play a crucial role in abnormality detection.

For this task, the state-of-the-art methodology is based on neural radiance fields, or in short NeRF models, which are rapidly adopted by the computer vision community and aim to:

- To produce a three-dimensional representation of a scene, an object or a structure of interest based on a reduced set of images taken from different vantage points;
- Understand the geometric properties of a scene, providing depth, normal field and occlusion estimation;
- Generate "new" images of an object or structure of interest from novel views, thereby contributing to the task of data augmentation.

Applying such techniques in the medical field can be beneficial for producing further insights into the structure of a scene. Moreover, being able to generate new data contributes to the further applicability of data-driven machine learning and deep learning techniques in fields where data scarcity is observed[7].

Among other applications related to the medical domain, NeRF based methods have been proposed for the 3D reconstruction of the human body in different poses as can be seen in the figure below. These methods can be employed for building a 3D avatar of the patient, which is one of the tasks performed in the context of iToBoS.

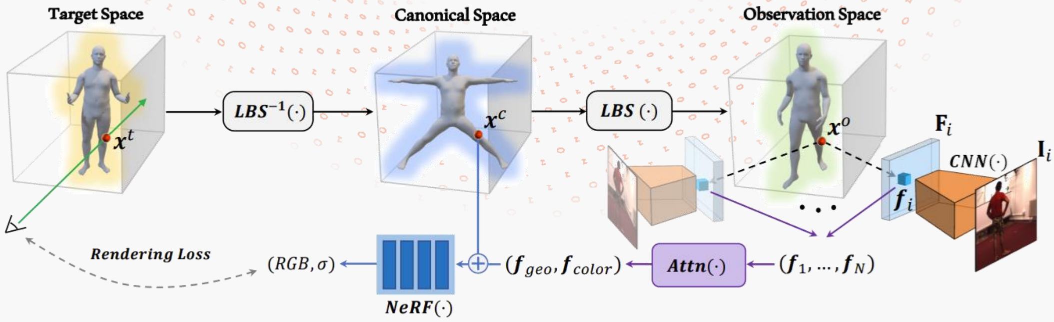

Figure 3: System Overview. To render the target image, we first cast rays and sample points in target space. Then, the sampled point xt is deformed to canonical space by inverse linear blend skinning algorithm and the deformed point xc is used as the input to NeRF. The point xc is further deformed to the observation space and projected onto the input images to retrieve the multiview features which are fused by self-attention blocks. The fused features are also used for density and radiance prediction.

[7] Gao, X., Yang, J., Kim, J., Peng, S., Liu, Z., & Tong, X. (2022)

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Some project events and activities

In the sixth semester of the project, which covers from October 2023 to March 2024, 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:

- Trieste, 4/10/2023. Barcolana 55.
- Madrid, 5-6/10/2023. iToBoS 6th GA and 5th PMB meetings.
- Berlin, 11-14/10/2023 European Academy of Dermatology and Venereology Congress 2023.
- Online, 26/10/2023. EC Workshop *Introduction and landscaping of data-driven projects in cancer*.
- Las Palmas de Gran Canaria, 27-28/10/2023. XVII Reunión Nacional Residentes de Dermatología y Venereología.
- Online, 6/11/2023. Fairness of AI in Medical Imaging Workshop.
- Lisbon, 6/11/2023. Challenging Malignant Melanoma Symposium.
- Madrid, 7/11/2023. AI and Cancer: Unleashing Opportunities, Overcoming Challenges.
- Barcelona, 7-9/11/2023. Smart City Expo World Congress.
- Taormina, 9-11/11/2023. ADI-ADMG Dermatology International Congress.
- Online, 15/11/2023. EC Workshop *In-depth discussion on three topics requiring coordination and support*.
- Punta Cana, 16-18/11/2023. Teracilad Congress 2023.
- Brussels, 23/11/2023. EADV course *Non-invasive technology*.
- Ede, 27/11/2023. 13th National Multidisciplinary WIN-O Melanoma Symposium.
- Online, 5/12/2023. EC Workshop *Reflection on future collaboration and support actions*.
- Montreux, 25-27/01/2024. 27th Annual Meeting European Dermatology Forum.
- Barcelona, 30/01-2/02/2024. Integrated System Europe 2024.
- Barcelona & online, 30/01-8/02/2024. ISE Open Innovation Challenge 2024.
- Berlin, 31/01-2/02/2024. MPNE consensus 2024 on data, AI and data-dependent business models workshop.
- Madrid, 16/02/2024. XII Reunión Anual del Grupo Español de e-Dermatología e imagen (GEDEI).
- Barcelona, 26-29/02/2024. Mobile World Congress 2024.
- Barcelona, 26-29/02/2024. MWC Open Innovation Challenge 2024.
- Barcelona, 26-29/02/2024. 4YFN Congress 2024.
- Girona, 06/03/2024. iToBoS 7th GA and 6th PMB meetings.

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Work presented

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

Deliverable submitted	Month	Leader	Diss. level
D6.6-Software for automatic generation of imaging phenotypes	32	TA	CO
D7.4-Software and methods implementing XAI solutions for transparent mole detection and tracking	32	FHHI	CO
D7.5-Software and methods implementing XAI solutions for transparent imaging phenotype regression	32	FHHI	CO
D8.3-Methods for Genotyping Quantitative Risk assessment	32	NTUA	CO
D6.5-Software for inter and intra-exploration lesion tracking	34	TA	CO
D5.4-Body scan control software	35	BOSCH	CO
D5.5-Scanner and Imaging Modules Prototype Assembly	35	BOSCH	CO
D5.6-Interface for the Operator DUI graphical interface	35	BOSCH	CO
D13.2-H - Requirement No. 2	35	UQ	CO
D6.3-Methods for real-time 3D reconstruction and anonymous avatar creation	36	COR	CO
D9.3-Report on usability testing	36	CAN	PU

Publications

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

- *"Reveal to Revise: An Explainable AI Life Cycle for Iterative Bias Correction of Deep Models"*. 2023. Frederik Pahde, Maximilian Dreyer, Wojciech Samek & Sebastian Lapuschkin.
- *"Human-Centered Evaluation of XAI Methods"*. 2023. Karam Dawoud, Wojciech Samek, Peter Eisert, Sebastian Lapuschkin & Sebastian Bosse.
- *"XAI-based Comparison of Input Representations for Audio Event Classification"*. 2023. Annika Frommholz, Fabian Seipel, Sebastian Lapuschkin, Wojciech Samek & Johanna Vielhaben.
- *"Evaluating deep transfer learning for whole-brain cognitive decoding"*. 2023. Armin W. Thomas, Ulman Lindenberger, Wojciech Samek & Klaus-Robert Müller.
- *"Automatic Skin Cancer Detection Using Clinical Images: A Comprehensive Review"*. 2023. Sana Nazari & Rafael Garcia.
- *"AudioMNIST: Exploring Explainable Artificial Intelligence for audio analysis on a simple benchmark"*. 2023. Sören Becker, Johanna Vielhaben, Marcel Ackermann, Klaus-Robert Müller, Sebastian Lapuschkin & Wojciech Samek.
- *"Improved polarimetric analysis of human skin through stitching: advantages, limitations, and applications in dermatology"*. 2023. Lennart Jütte, Harshkumar Patel & Bernhard Roth.
- *"Dicing with data: the risks, benefits, tensions and tech of health data in the iToBoS project"*. 2024. Niamh Aspell, Abigail Goldsteen & Robin Renwick.
- *"Unraveling the Complex Nexus of Human Papillomavirus (HPV) in Extragenital Keratinocyte Skin Tumors: A Comprehensive Analysis of Bowen's Disease and In Situ Squamous-Cell Carcinoma"*. 2024. Claudio Conforti, Chiara Retrosi, Marina Agozzino, Caterina Dianzani, Ermanno Nardon, Anselmo Oliveri, Eros Azzalini, Stefania Guida, Giovanni Pellacani, Giovanni Di Lella, Franco Rongioletti, Iris Zalaudek & Serena Bonin.
- *"Monitoring of multiple fabrication parameters of electrospun polymer fibers using Mueller matrix analysis"*. 2024. Gaurav Sharma, Lennart Jütte, Jigar Gopani, Jules Brehme, Axel Günther, Ralf Sindelar, Franz Renz & Bernhard Roth.

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

iToBoS team

The consortium with 20 partner 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 7 SMEs) and **end-user entities** (3 hospitals and 1 patients' NPO).

Universitat de Girona
optotune shaping the future of optics
IBM
BOSCH
BARCO
Leibniz Universität Hannover
FUNDACIÓ CLÍNIC BARCELONA
RICOH imagine. change.
TRILATERAL RESEARCH
UNIVERSITÀ DEGLI STUDI DI TRIESTE
CORONIS COMPUTING Computer Vision and Machine Learning
TORUS AI INTELLIGENCE FOR LIFE
Fraunhofer HHI
isahit
THE UNIVERSITY OF QUEENSLAND AUSTRALIA CREATE CHANGE
SZTAKI
V7
MPNE
CANFIELD

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

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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.

iToBoS Intelligent Total Body Scanner for Early Detection of Melanoma

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