Universitat de Girona
Escola Politècnica Superior

Final Degree Project

Grade: Biomedical Engineering

Title: Early detection of Melanoma using Artificial Intelligence

Document: Abstract

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Abstract

Skin cancer, particularly melanoma, is one of the most aggressive forms of cancer and has lately been raising the incidence rate globally. Despite the advancements in medical imaging and dermatological practices, early detection is still a big challenge that often leads to late diagnosis and poor patient outcomes. Melanoma, if identified in its early stages, is highly treatable; however, once it progresses, the survival rate drops drastically. This shows us how important and critically improved diagnostic methods that can help clinicians detect melanoma at its earliest stages are needed.

During the last few years, AI has gained a big role as a transformative technology in various fields, including, in this case, healthcare. AI's ability to analyze enormous amounts of data and identify patterns that may not be as apparent to the human eye has made it a very valuable tool in medical diagnostics. A tool that won't make clinicians disappear, but will create a powerful gap between those who use it and those who do not in their day-to-day work. Machine learning has shown a promising capacity for the task of analyzing medical images and may have the opportunity to bring clinicians potential solutions to these challenges in early cancer detection.

The aim of this project is to explore the applications of AI, especially deep learning and machine learning, in the detection of melanoma in crops. Crops are lesion images cropped from a total body map of the skin patient extracted by a 3D Total Body Scanner (TBP scanner). The project consists of the development of an AI model using advanced CNNs and transfer learning techniques to develop a model that can be used to assist dermatologists in identifying malignant skin lesions with a high accuracy.

The project is developed in Python using the PyTorch framework and uses EfficientNetB3 as the model backbone. Multiple datasets were used to train and test the models, including data from the iToBoS project and the ISIC 2024 challenge. Given the extreme imbalance of the datasets, where benign cases significantly outnumber malignant ones, oversampling and undersampling methods, as well as an extensive data augmentation techniques were

employed to try to mitigate this and improve the model's performance. Additionally, patient metadata, such as age, gender, and lesion location, was incorporated into some models to see its impact on predictive accuracy.

The best-performing model achieved an AUC of 0.91, an F1 score of 0.90, sensitivity of 0.84 with a predefined threshold of 0.9, and accuracy of 0.83, demonstrating a robust capability for classifying skin lesions even with low-resolution images as crops are. Models with metadata inclusion provided marginal performance improvements to the model but did slightly reduce sensitivity. Due to being in the medical and healthcare field, sensitivity is the go-to metric and most important thing to take into account. This leads to the conclusion that image-based models alone are more reliable for real-world applications. This is mostly because of two main problems. One of the problems is related to metadata acquisition procedures that lead to not very high quality metadata. And the second one is that up to day there seems to not exist any strong correlation between metadata and the lesion being malignant or benign that helps AI models in their performance and predictable capacities.

The project highlights the potential of AI as a powerful tool in not only in dermatology and in early skin-cancer detection but in all the healthcare ecosystems and disciplines.

The findings suggest that state-of-the-art projects like iToBoS, where AI models are combined with 3D TBP scanners, once implemented, will significantly improve the accuracy and speed of melanoma diagnosis, offering a high-quality and tailored service to the patient that will potentially lead to better patient outcomes. The project demonstrates the promising role of AI in the medical field, particularly for early diagnosis, while also acknowledging limitations related to data imbalance and the quality of artificially generated training data.

To conclude, the project leaves room for improvement and suggests multiple ways of improving the model. The most interesting being the ensemble of CNN models with other powerful machine learning methods like LightGBM (tree-based learning algorithms) that use

tabular data. This tabular data are calculous and coordinates/positions of the lesion that extracted by 3D TBP as well. So by combining these two techniques, all the available and possible data would be used. This ensemble would be a very diversified model that could probably outperform single CNN models like the one developed in this project.