Enhancing Bruise Detection in Diverse Populations Using Alternate Light Sources, Deep Learning, and Explainable AI

Mehrdad Ghyabi, Ph.D.[1], Amin Nayebi, Ph.D.[2], Kiyarash Aminfar, M.S.[1], David Lattanzi, Ph.D.[1], Katherine Scafide, Ph.D., RN[2], Janusz Wojtusiak, Ph.D.[2]
[1]College of Engineering and Computing, George Mason University, VA, USA
[2]Colledge of Public Health, George Mason University, VA, USA

Introduction

Accurate detection and documentation of injuries, such as bruises, are essential for timely interventions and forensic assessments, particularly in cases of violence, abuse, and mistreatment. Detecting bruises on individuals with darker skin tones presents a challenge, leading to underreporting or misinterpretation. This study enhances bruise detection across diverse skin tones using alternate light sources (ALS) [1] and deep learning, aiming to create a more equitable and reliable injury detection system for clinical and forensic needs.

Data

Our research builds on over six years of collaboration focused on using ALS imaging for injury detection. We conducted a randomized controlled trial with a diverse participant group, evaluating ALS effectiveness in improving bruise visibility. A dataset of 30,000 images of induced bruises under 11 lighting conditions was used.

Method

We used transfer learning to fine-tune the last layers of a pre-trained YOLOv5 model for bruise detection, adapting it to recognize bruise-specific features like color and texture. This approach allowed us to optimize computational resources and focus on bruise localization. To enhance interpretability, we applied SHAP [2] (SHapley Additive exPlanations) to visualize which image regions influenced the model's decisions, improving transparency in the detection process.

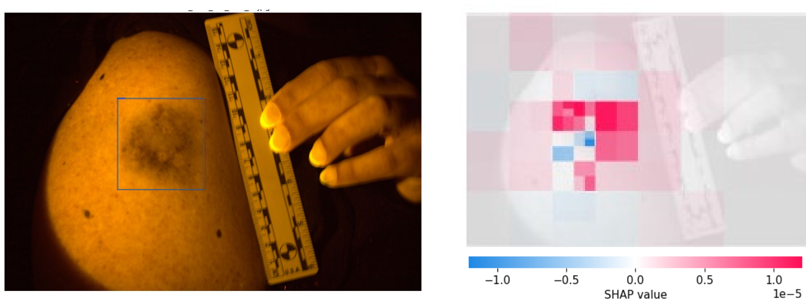

Figure 1- Bruise detection with a bounding box from our deep learning model (left) and corresponding SHAP heatmap showing influential regions for the model's decision (right).

Results: This approach significantly reduced training time and improved bruise localization efficiency. The model demonstrated good performance, with a mean average precision (mAP) score of 0.76, making it effective in detecting and localizing bruises in images.

Discussion: We are continuing to refine this study, focusing on how the model performs across different skin tones. Our goal is to understand both the accuracy of bruise detection and the model's reasoning across skin tone variations. To achieve this, we will use SHAP explanations to explore how the model's decision-making process differs based on skin tone, ensuring that bruise detection is both effective and fair for all populations.

References

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[2] Lundberg, S. M., & Lee, S. I. (2017). A unified approach to interpreting model predictions. Advances in neural information processing systems, 30.