

# DermaSense

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AI-Powered Skin Lesion Analysis & Bias Mitigation

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# Project Review



## Motivation

**The Gap:** Medical datasets are severely biased towards light skin, causing AI to fail on darker skin tones.

**The Goal:** Eliminate this bias using synthetic data to ensure equitable cancer detection.



## Evolution

**From Proposal:** Shifted from simple "data generation" to a rigorous **Validation Pipeline**.

**The Pivot:** We now prove utility by training two models (Biased vs. Diverse) in a head-to-head comparison.



## Novelty

**Innovation:** A safe **Hybrid Pipeline** (SDXL Texture + Poisson Blending) that avoids hallucinations.

**Contribution:** Created a high-fidelity "Digital Skin Bank" for Fitzpatrick Type VI.

# Previous Work & Literature Review

TITLE / YEAR	TASK	METHODS	DATA	RESULTS	RELATION TO PROJECT
<b>Dermatologist-level classification of skin cancer...</b> <i>Esteva et al. (2017)</i>	Binary Classification (Benign vs. Malignant)	Deep CNN (Inception v3), Transfer Learning	129,450 clinical images (Private dataset)	AUC comparable to 21 board-certified dermatologists.	Serves as the <b>Benchmark</b> for deep learning performance capabilities.
<b>Synthetic Data Augmentation using GANs...</b> <i>Rashid et al. (2020)</i>	Dataset Expansion via Synthesis	Generative Adversarial Networks (GANs)	ISIC Public Dataset	Increased accuracy and reduced overfitting.	Foundational <b>Method</b> : Validates using synthetic data to fill data gaps.
<b>Addressing Bias in Skin Cancer Classification...</b> <i>Daneshjou et al. (2022)</i>	Bias Evaluation & Reduction	Tone-focused data augmentation	Diverse sets (Western + Asian + African)	Diversity corrects error rates on darker skin.	Core <b>Innovation</b> : Inspires our focus on synthetic dark skin to ensure fairness.

# Dataset Creation & Analysis

## 1. The Dataset

**Goal:** Correct bias in ISIC 2016.

- **Generated:** Synthetic extension for **Fitzpatrick Type VI** (Dark Skin).
- **Composition:** Merged Original lesions with synthetic dark backgrounds.

## 2. Techniques

**Hybrid AI Pipeline:**

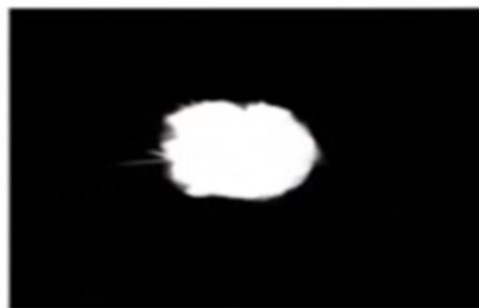
- **Generation:** SDXL 1.0 (Texture) + Medical Prompting.
- **Segmentation:** U<sup>2</sup>-Net (Rembg) for precise masks.
- **Blending:** Poisson editing for seamless integration.

## 3. EDA (Exploratory Data Analysis)

- **Class Balance:** Perfect 50/50 split (Benign/Malignant).
- **Resolution:** Generated @ 1024px → Resized to 224px.



Image 1



Mask



Image 2

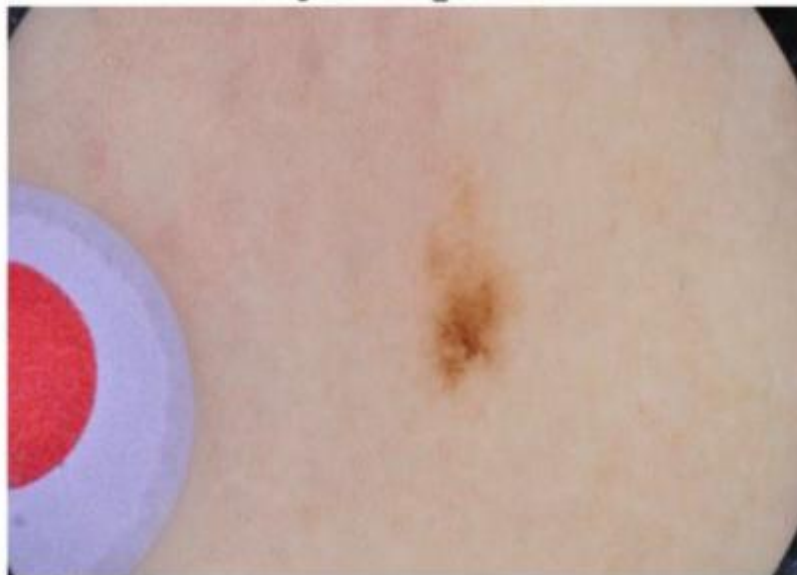
Original: ISIC\_00000...



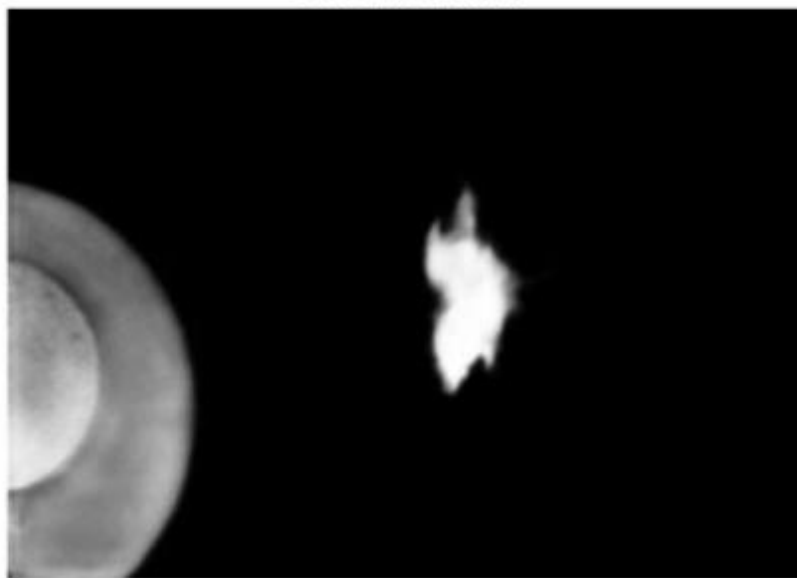
Generated Mask



Original: ISIC\_00098...



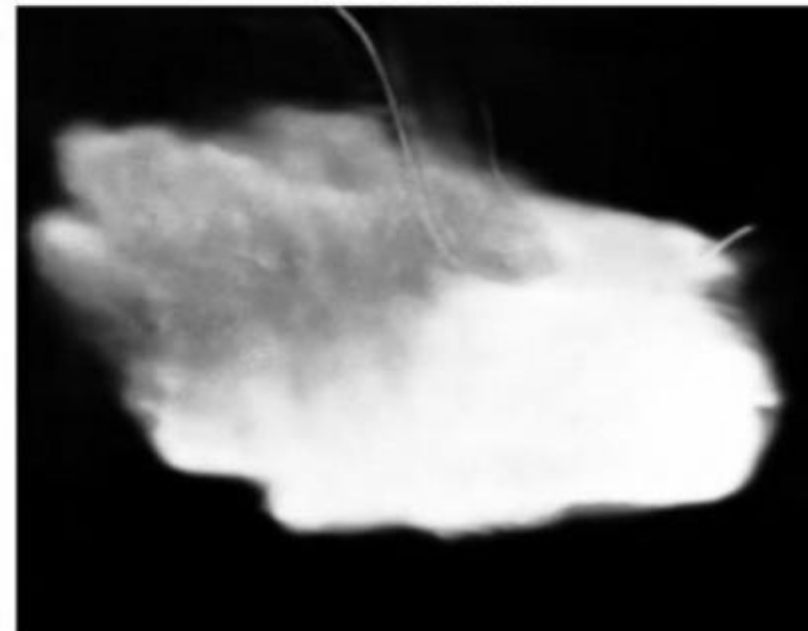
Generated Mask



Original: ISIC\_00100...



Generated Mask



# Evaluation Results: Dark Skin Test Set

Metric	Biased Model (Standard)	Diverse Model (Ours)	Improvement
Accuracy	46.7%	98.1%	+51.4%
Recall (Safety)	64.4%	97.1%	+32.7%
Precision (Trust)	60.2%	96.5%	+36.3%
F1-Score (Balance)	45.9%	96.8%	+51.0%

## ⚠ The Baseline Failure

The Standard Model collapsed on dark skin, achieving only **46.7% accuracy** (worse than a coin flip). It failed to generalize features learned from light skin, resulting in unreliable diagnoses.

## ✅ The Diverse Success

Our model achieved a **97.1% Recall**, meaning it successfully identified almost all malignant cases. The high F1-Score (96.8%) proves it balances safety with precision effectively.

# Project Roadmap & Plan

Step	Description / Scope	Status	Outcome
1. Bias Replication	Train standard ResNet50 on ISIC 2016 (Light Skin) and validate failure on dark skin test set.	Done	Baseline Metrics
2. Data Generation	Generate synthetic Fitzpatrick Type VI skin using <b>SDXL</b> . <i>Scale up from pilot sample to full dataset.</i>	In Progress	Full Synthetic Dataset
3. Training & Optimization	Train Diverse Model on mixed dataset using <b>Class-Weighted Loss</b> to penalize false negatives.	Next Step	Robust Model
4. Final Evaluation	Head-to-Head Comparison (F1-Score, Recall) on held-out Dark Skin Test Set.	Next Step	Final Proof Graph
5. Final Delivery	Prepare final presentation, documentation, and code delivery. Due: [Insert Date]	Pending	Project Completion

**Technical Scope & Models:** PyTorch Framework • ResNet50 (Binary Classification) • Stable Diffusion XL (SDXL 1.0) for Texture Generation • U<sup>2</sup>-Net (Rembg) for Segmentation • OpenCV (Seamless Clone) for Image Compositing • Weighted Cross-Entropy Loss.