

Polarization-Based Counterfeit Detection System

Team 14 | Oracle Lens | Prof. Michael Kozicki

Ting-Jui Chang | Avishek Gomes | Fuad Hossain | Ahmed Naser | Ishayat Sayeed

Problem Statement

- Counterfeit parts are a growing threat to global supply chains
- Existing anti-counterfeit systems can be replicated easily and can cause system failures or malicious functionality.
- Standard identifiers like QR codes and barcodes are easily copied, making secure digital systems unreliable

Solution: Optical Fingerprint (Dendritic / Polarization-Based)

- The project develops an unclonable identifier using a unique, multi-layered optical fingerprint.
- This fingerprint is created using special inks containing microscopic reflective flakes and captured using a polarization camera.
- These polarization-based textures provide a unique identifier that is extremely difficult to replicate.



Stokes Parameters, DoLP, and AoLP

- Stokes Parameters:** describe the polarization of light. S_0 represents total intensity, S_1 and S_2 describe linear polarization, and S_3 represents circular polarization.
- DoLP:** measures the strength of linear polarization, showing how strongly each pixel is polarized.
- AoLP:** measures the orientation of linear polarization, showing the dominant polarization angle at each pixel.

$$S = \begin{bmatrix} S_0 \\ S_1 \\ S_2 \\ S_3 \end{bmatrix} = \begin{bmatrix} P_0 + P_{90} \\ P_0 - P_{90} \\ P_{45} - P_{135} \\ P_R - P_L \end{bmatrix}$$

$$DoLP = \frac{\sqrt{S_1^2 + S_2^2}}{S_0}$$

$$AoLP = \frac{1}{2} \tan^{-1} \left(\frac{S_2}{S_1} \right)$$

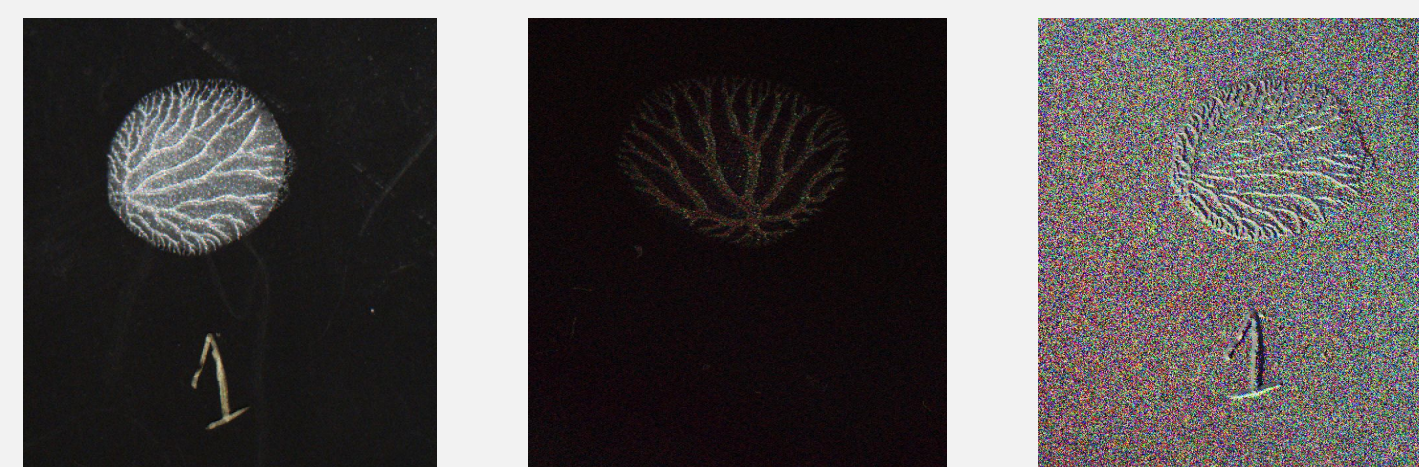
Designs and Prototype

- Prototype development focused on designing a testing rig using a 3D-printed mount to achieve precise optical alignment.
- The setup includes a FLIR Blackfly polarization camera and controlled LED illumination to ensure consistent image capture conditions.
- Testing was performed to optimize exposure and gain settings for reliable data acquisition.

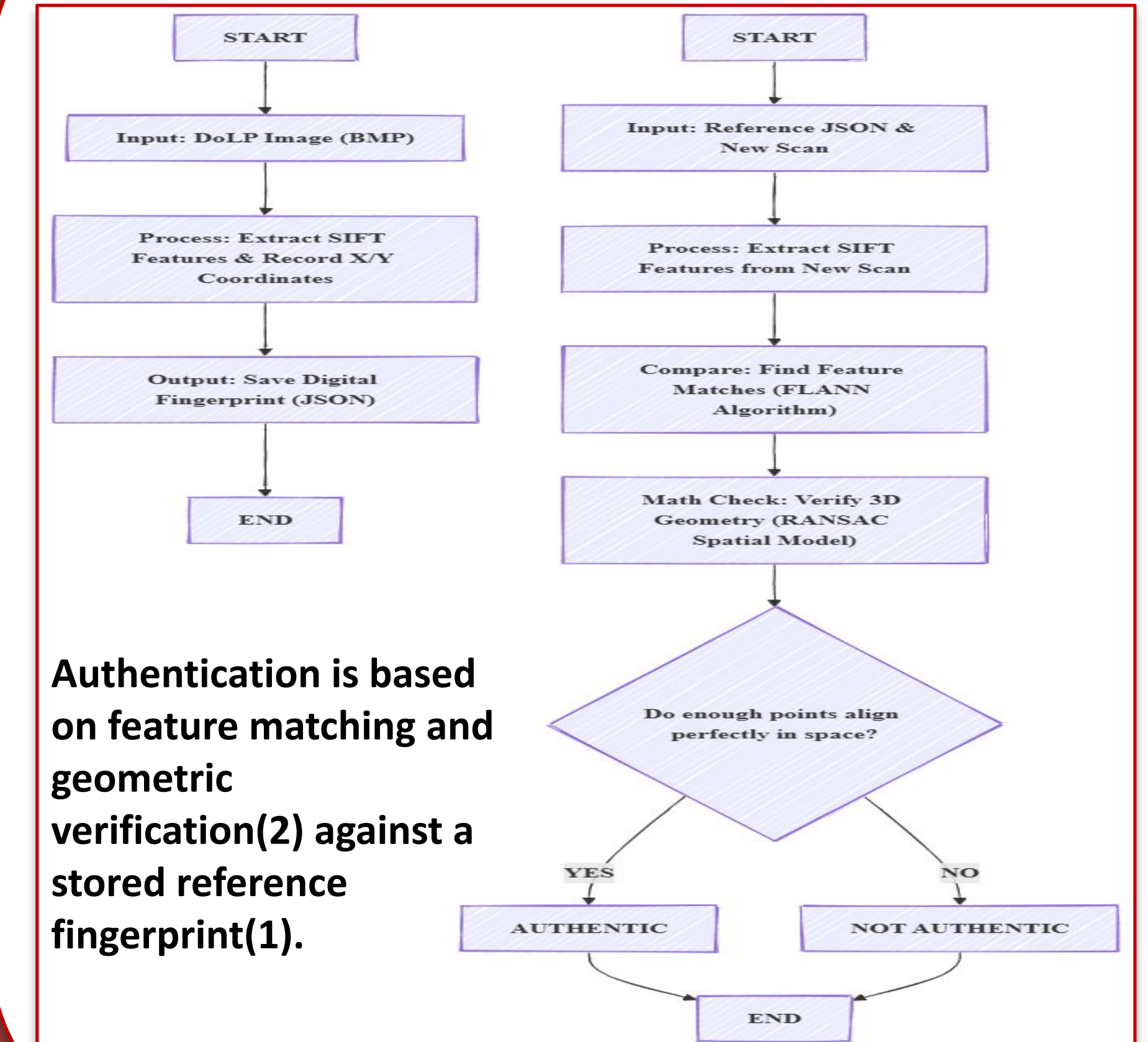


Image Capture

- Polarization images are captured using the camera under controlled lighting conditions.
- These images are standardized through preprocessing steps and used to generate reference fingerprints.
- The dataset of captured images allows comparison between genuine and test samples during verification.



1 Image Authentication Workflow



Concluding Remarks

- The project successfully demonstrates that polarization-based optical fingerprints can be used to authenticate components.
- Research into polarization imaging confirms that dendritic patterns provide unique identifiers
- The system integrates imaging, processing, and verification into a working framework.