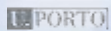
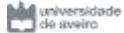


# Automatic Skin Lesion Detection

Lucas Thomaz, Sérgio Faria

Instituições Associadas



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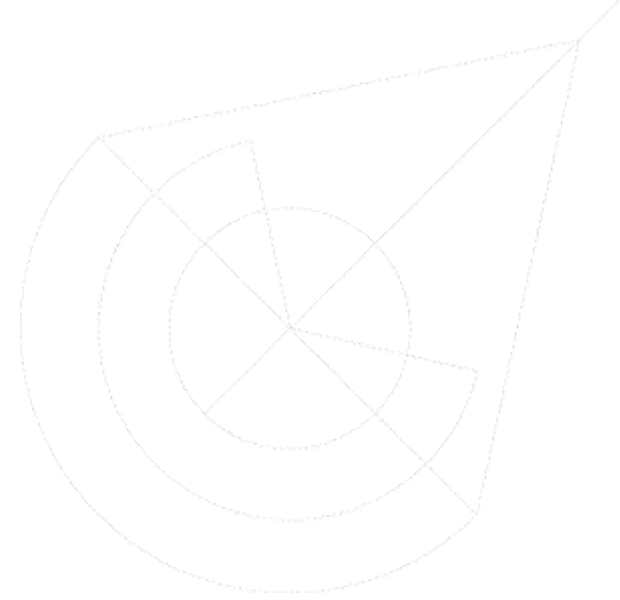
Encontro Ciência '19, Lisbon, 8-10 July 2019



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# Outline

- Introduction
- Objectives
- SKINL2 Dataset
- Depth map estimation
- Lossless light field compression (M-MRP)
- Skin lesion segmentation and classification
- Conclusions and future work



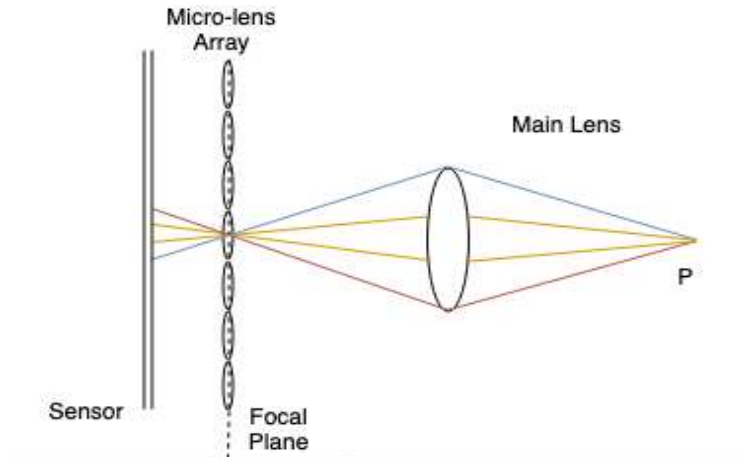
# Introduction

- Plenoptic cameras were recently made available in the market.
- Light field imaging can capture both intensity and direction of light.
- Light field content and dataset are still scarce for research purposes.
- There is potential to be used in medical imaging like dermatology.
- It is possible to refocus an image after the acquisition.
- Allows the 3D reconstruction of the scene.

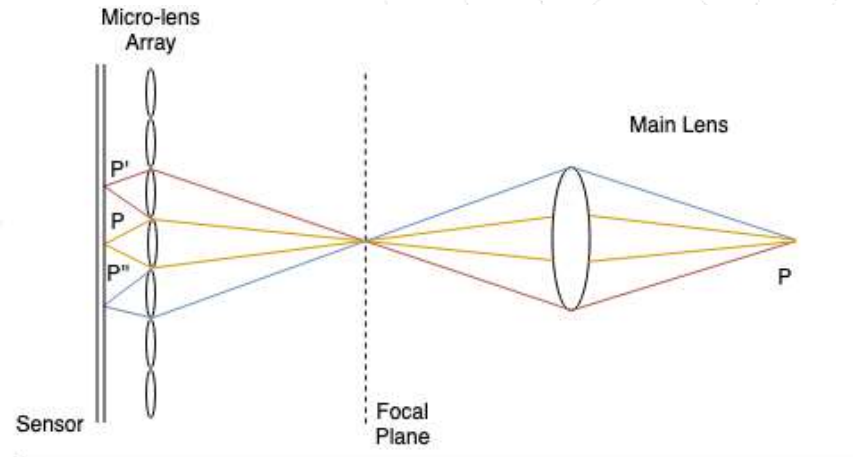
# Plenoptic Cameras

## 1.0 and 2.0 technology

Plenoptic Imaging – technique to capture all the information conveyed by the light rays from a visual scene: light intensity + light rays direction.



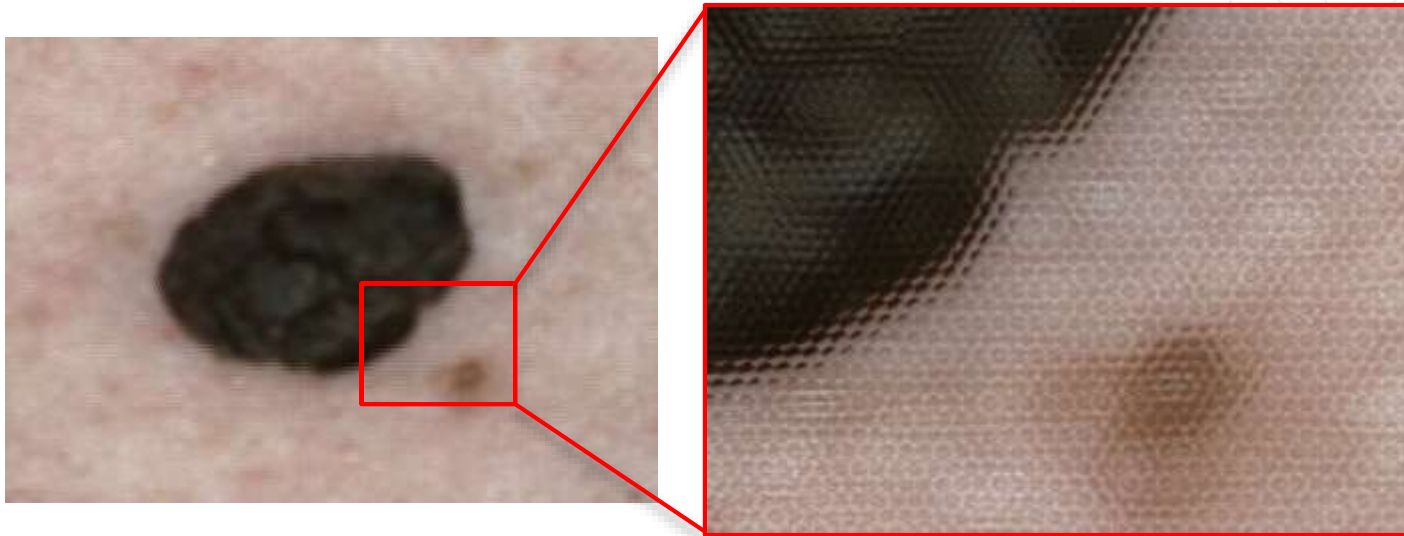
Plenoptic Camera 1.0



Plenoptic Camera 2.0

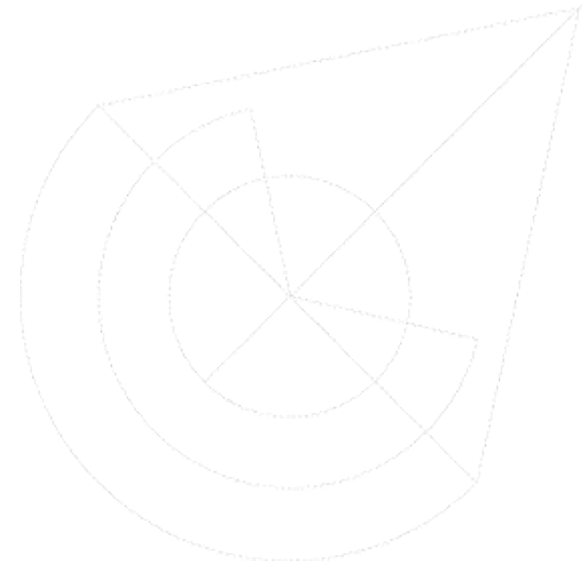
# Plenoptic Cameras

1.0 and 2.0 technology



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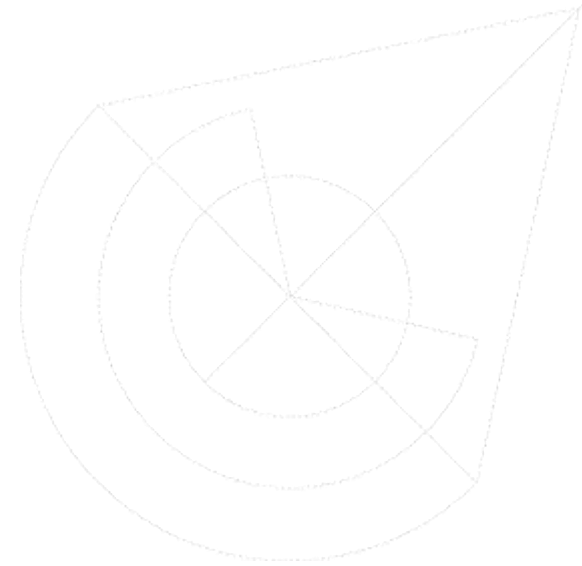


# Objectives

- Create the first publicly available light field image dataset of skin lesions.
- Generate depth (disparity) maps from the light fields.
- Develop algorithms for lossless compression of light field data.
- Find new features and improve segmentation and classification algorithms, namely for melanoma detection, based on machine learning approaches.

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# Acquisition Setup and Methodology

## Setup

- **Camera:** Raytrix R42 Galilean.
- **Lens:** Ricoh - 25mm f/1.8.
- **System Housing:** Acrylic cylinder with opaque finishing.
- **Illumination:** 5 neutral white 5050 LEDs (controlled by computer).
- **Shutter Control:** Two push-buttons and a microcontroller.



Acquisition Scenario



Acquisition Setup

# SKINL2 Dataset

## Version 1.0

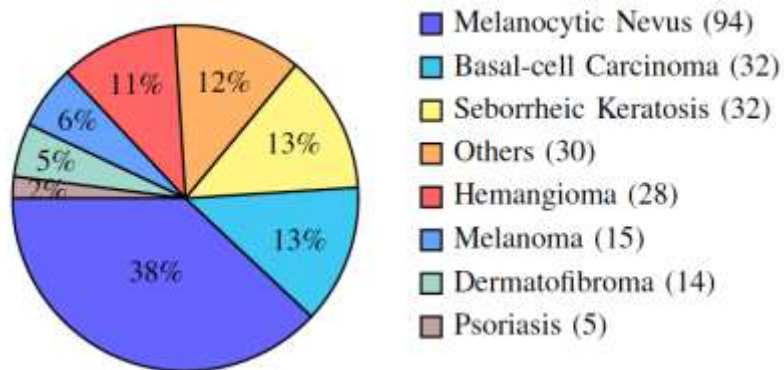
- Dataset composed by 250 light field images.
- Fit into 8 categories (type of skin lesion).
- Includes various skin tonalities, lesion sizes and shapes, amount of hair and other marks.

## Version 2.0

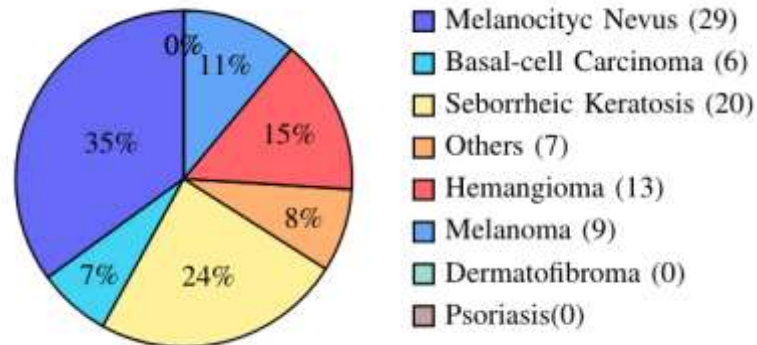
- Dataset composed by 84 light field images.
- Fit into 8 categories (type of skin lesion).
- Includes various skin tonalities, lesion sizes and shapes, amount of hair and other marks.
- Reduced skin area by 30% compared with SKINL2 v1.0 images.
- Some classification results are still to be confirmed by histopathological analysis.

# SKINL2 Dataset

## Version 1.0

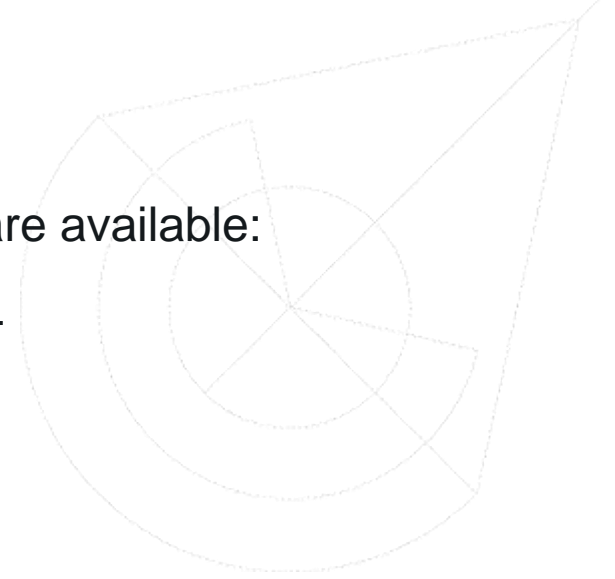


## Version 2.0



# SKINL2 Dataset

- For each skin lesion the following image types are available:
  - **Lenslet** – 7716 x 5364 pixels, 8-bit RGB + Calibration File.
  - **Views** – Matrix of 9x9 views, 3858 x 2682 pixels.
  - **Central View** – 3858 x 2682 pixels.
  - **Depth Map** – 1929 x 1341 pixels.
  - **Dermoscopic Image** – 1920 x 1080 pixels, 8-bit RGB.
- SKINL2 dataset is available at <http://on.ipleiria.pt/plenoisla>.

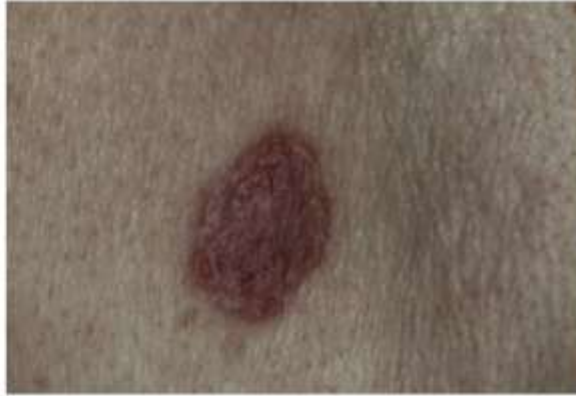


# SKINL2 Dataset

## Sample images



Hemangioma



Basal-cell Carcinoma



Melanocytic Nevus



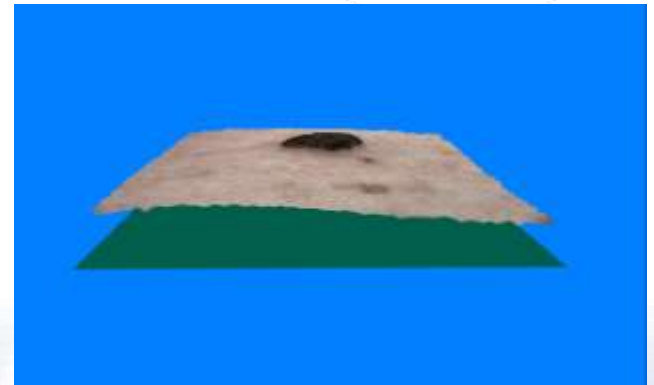
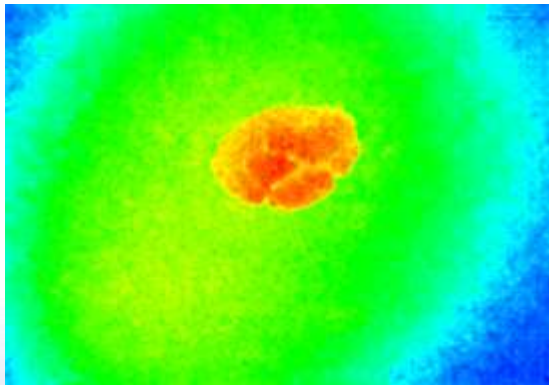
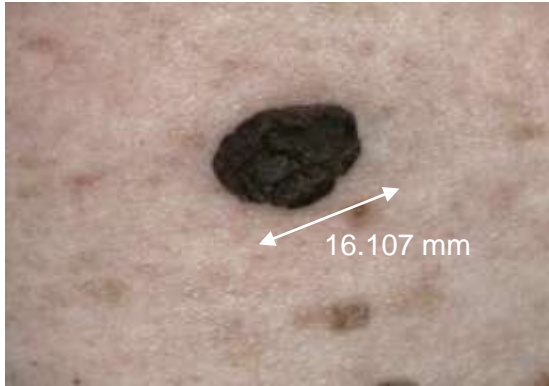
Melanoma



Seborrheic Keratosis

# SKINL2 Dataset

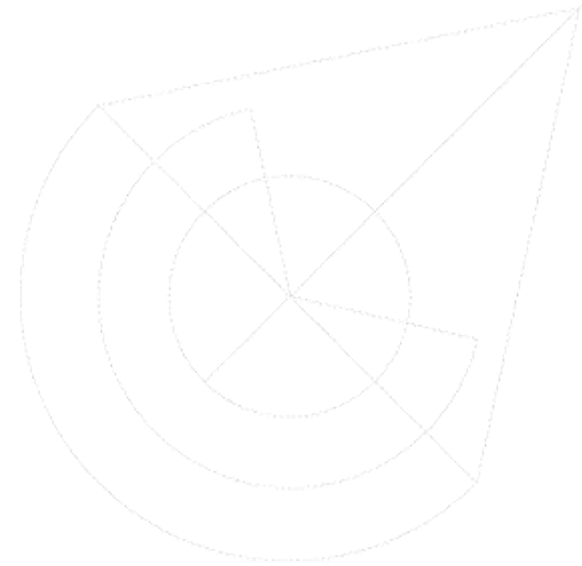
## Some Results



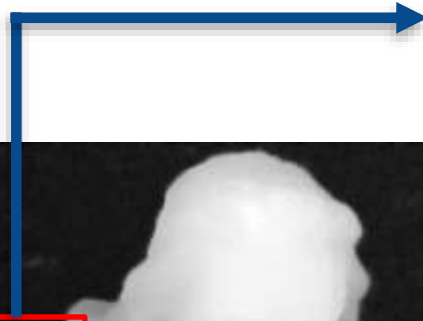


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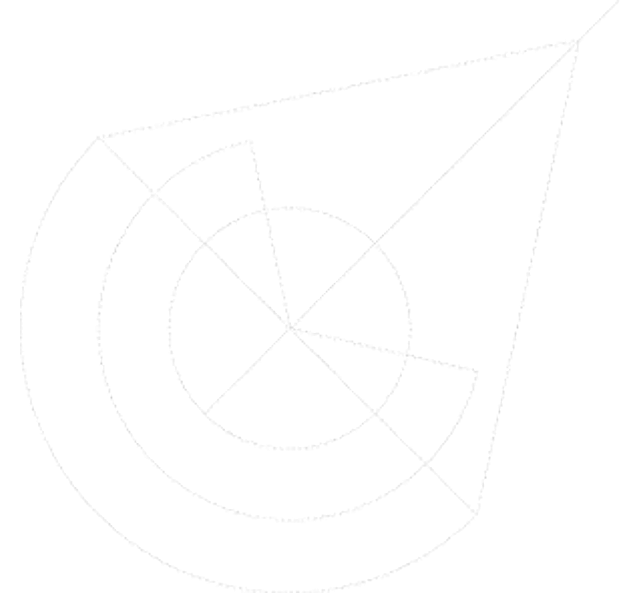
# Depth Map Estimation



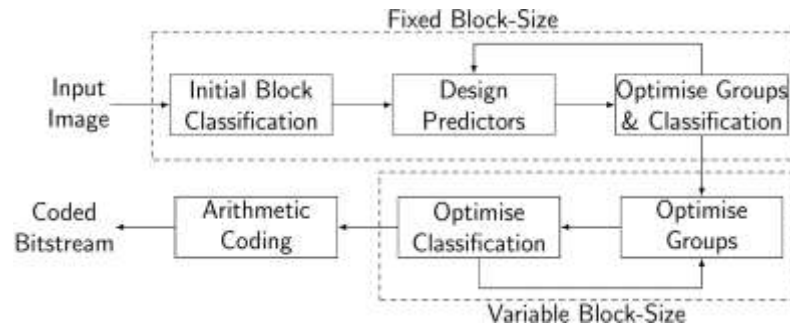


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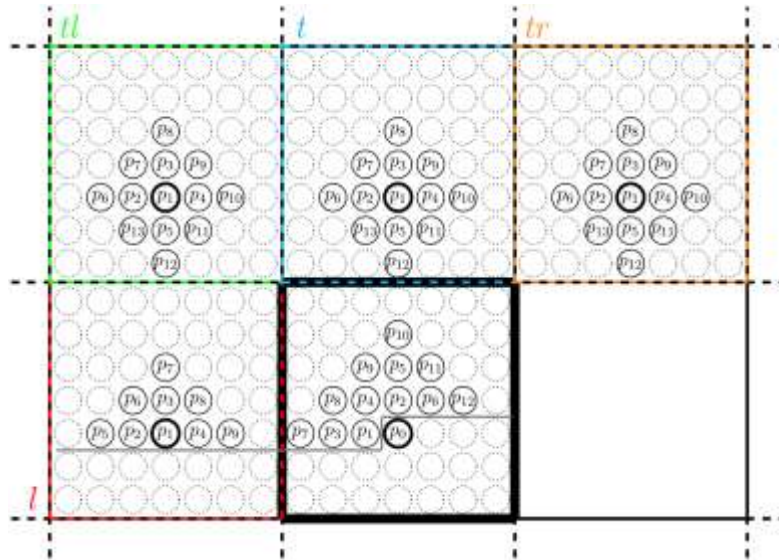


# Lossless light field compression (M-MRP)



- The Minimum Rate Prediction (MRP) minimizes the coding rate of the prediction error.
- The MRP algorithm estimates the amount of information conveyed by prediction errors and then designs the predictors with the goal of minimising the rate.
- MRP performs the search for linear predictors, seeking to minimize the number of bits required to encode the prediction residues.

# Lossless light field compression (M-MRP)



- The MRP algorithm was extended to exploit the inherent redundancy of the LF images.
- This is achieved using inter prediction specifically designed to use multiple references, such as the neighbouring MI or SAI.
- Due to the high cross-correlations of the light field data, efficient prediction is achieved between spatially close MI or SAI images.
- To accomplish such prediction approach the M-MRP prediction uses the nearest four MI or SAI.

# Lossless light field compression (M-MRP)

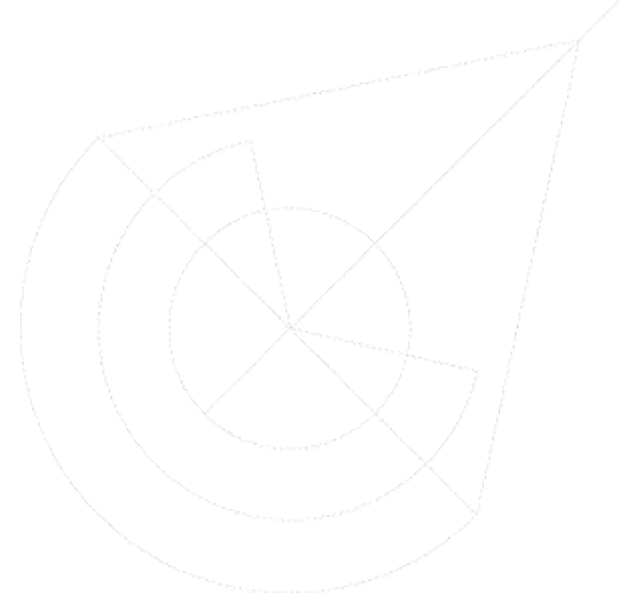
- **Light Field image compression**
  - Contribution to “JPEG Pleno” standardization with **Proposed** algorithm.
  - Lossless and Visually Lossless compression, namely for medical images.

Lossless compression ratio (bits per pixel)

Light Fields	HEVC	JPEG-LS	MRP	Proposed
Mel_C	11.62	10.75	11.32	<u>9.80</u>
Seb_A	11.50	10.71	11.64	<u>9.70</u>
Seb_B	12.49	11.58	11.40	<u>10.64</u>
Average	<b>11.87</b>	<b>11.01</b>	<b>11.45</b>	<b><u>10.05</u></b>

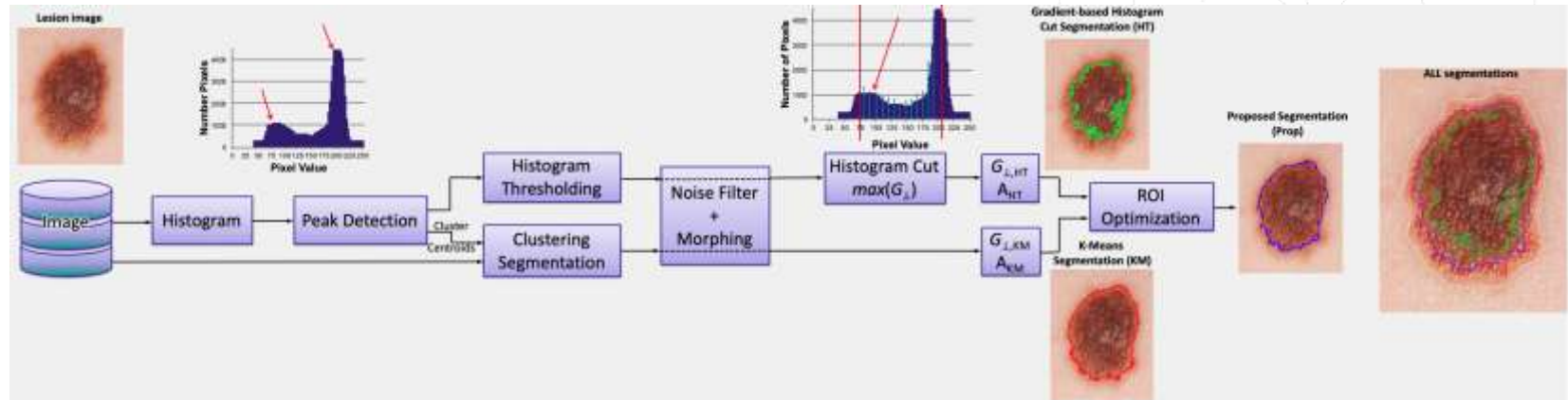
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# Skin lesion segmentation and classification

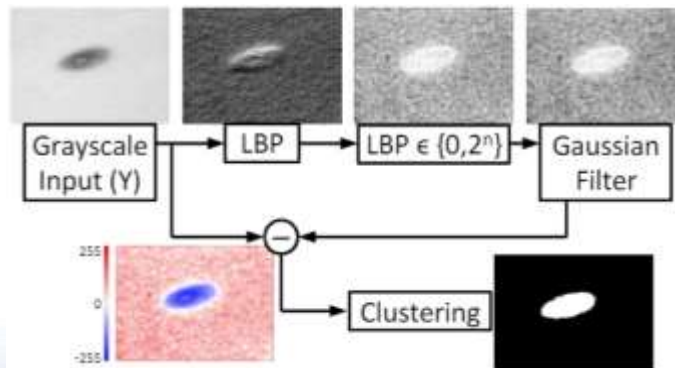
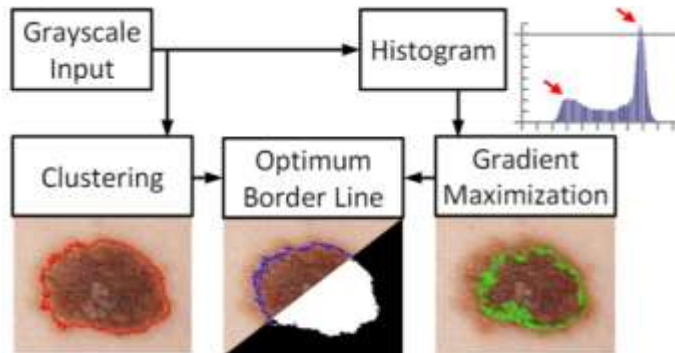
- Feature Extraction and Lesion Classification:
  - Gradient-based Histogram Thresholding for Skin Lesion Delineation.



- 3D features extracted from the estimated depth maps.
- Lesion classification with using neural networks .



# Skin lesion segmentation and classification

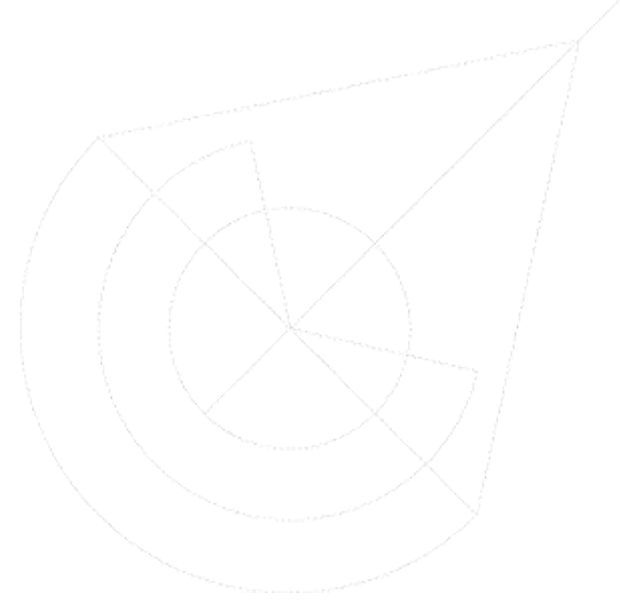


RESULTS FOR THE DERMOFIT DATASET

Seg.	#Fl.	SVM-SMO			SVM-ISDA			FFN		
		Acc.	SE	SP	Acc.	SE	SP	Acc.	SE	SP
GT	10	0,82	0,03	1,00	0,83	0,25	0,96	0,84	0,41	0,94
	32	<b>0,87</b>	0,45	0,97	<b>0,89</b>	0,64	0,95	<b>0,86</b>	0,43	0,96
GHT	10	0,83	0,09	1,00	0,89	0,54	0,97	0,86	0,49	0,95
	32	<b>0,87</b>	0,30	0,99	<b>0,91</b>	0,62	0,98	<b>0,89</b>	0,54	0,98
LBPC	10	0,81	0,01	0,99	0,83	0,17	0,98	0,87	0,54	0,95
	32	<b>0,87</b>	0,38	0,98	<b>0,89</b>	0,61	0,96	<b>0,91</b>	0,71	0,95

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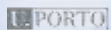




# Conclusions and future work

- A new publicly light field dataset is available with 250+80 skin lesions, classified according to ICD10 (<http://on.ipleiria.pt/plenoisla>).
- Depth map generation algorithm compatible with the state-of-the-art.
- Lossless algorithm form light field compression in collaboration with JPEG.
- Machine Learning algorithms for segmentation and classification of skin lesions.

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# Thank you!

## Questions?



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