



universidade
de aveiro

Annotation of Calibration Patterns for RGB-LiDAR Evaluations using Segmentation Models

Bruno Silva
Gonçalo Ribeiro
University of Aveiro
PhD. in Mechanical Engineering.

March 3, 2025

Table of contents

1. Introdução

2. Abordagens

3. Results

4. Conclusion

Definição do problema

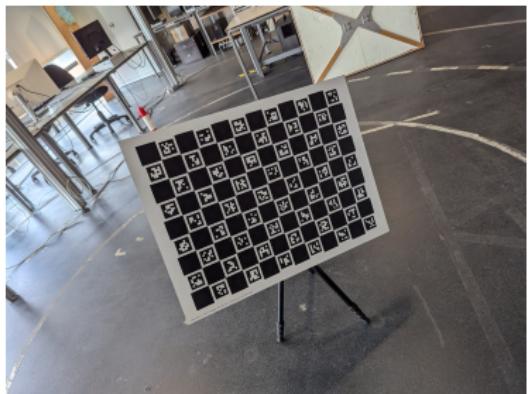
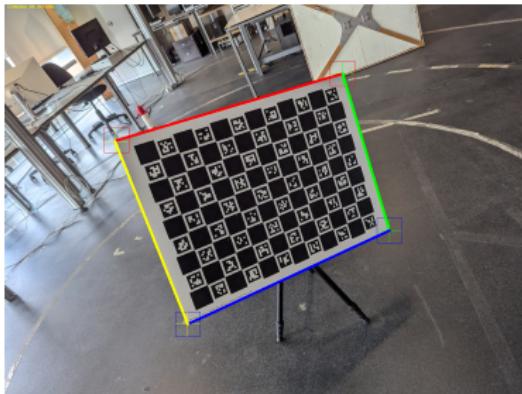


Imagen de entrada



Resultado esperado

Escolha do tipo de rede

Modelos de Segmentação

- Número de cantos variável visíveis na imagem;
- Possíveis obstruções parciais do padrão;
- Solução CNN + FC inviável por tamanho do output variável;
- Rede de segmentação evita todos os possíveis os edge cases.

Escolha do tipo de rede

Modelos de Segmentação

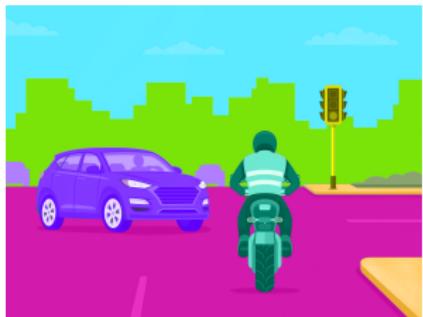
- Número de cantos variável visíveis na imagem;
- Possíveis obstruções parciais do padrão;
- Solução CNN + FC inviável por tamanho do output variável;
- Rede de segmentação evita todos os possíveis os edge cases.

Escolha do tipo de rede

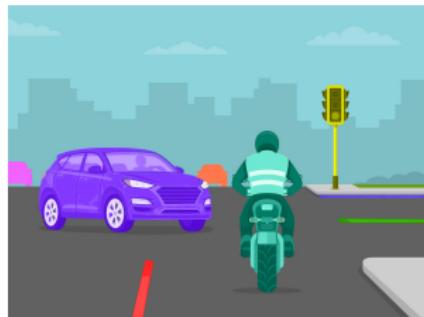
Modelos de Segmentação

- Número de cantos variável visíveis na imagem;
- Possíveis obstruções parciais do padrão;
- Solução CNN + FC inviável por tamanho do output variável;
- Rede de segmentação evita todos os possíveis os edge cases.

Tipos de redes de segmentação



Semântica



De instâncias



Panóptica

Aquisição do dataset

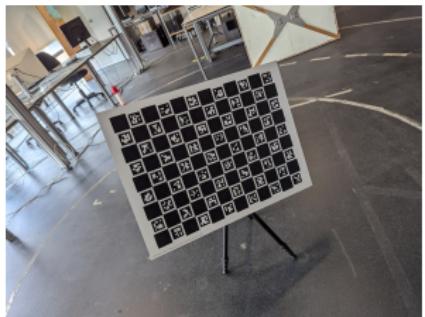
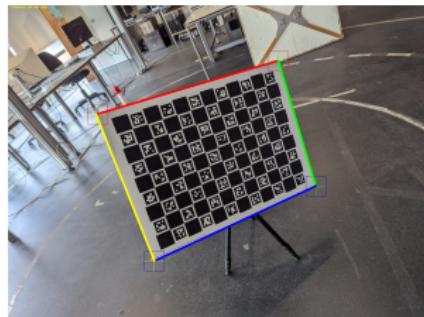
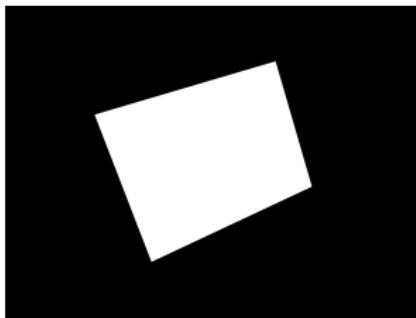


Imagen original



Anotações no ATOM



Conversão das linhas de contorno para uma máscara

Seleção de modelos

- Modelos pre-treinados do PyTorch
 - DeepLabV3
 - Fully Convolutional Network for Semantic Segmentation
 - LRASPP
- U-Net

Setup de treino

- Loss function: Binary cross-entropy loss
- Optimizer: Adam
- Batch size: Máximo possível para a GPU
- 200 épocas por treino

DeepLabV3

Com backbone Resnet50

- 41M Total Parameters
- 17M Trainable Parameters
- Model did not converge
- Complications with training

U-net

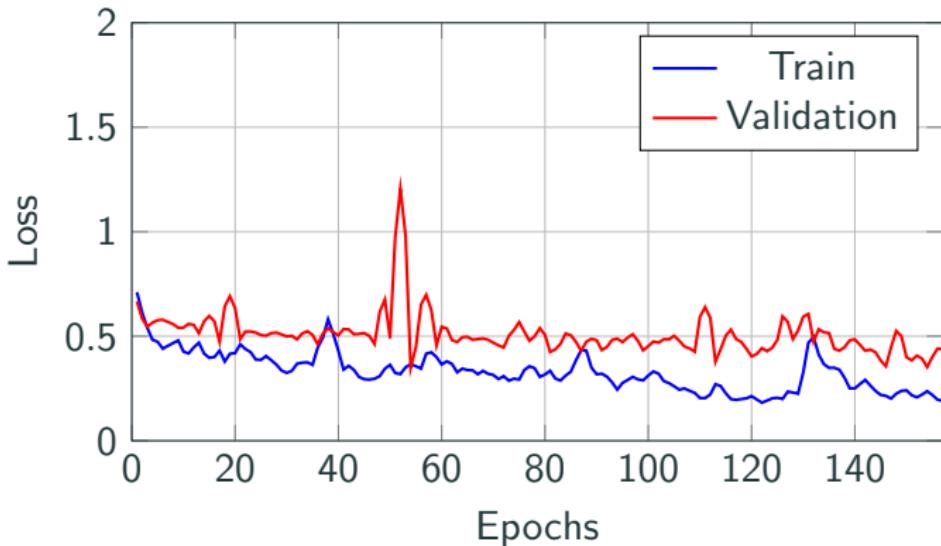
Treinada do raíz

- 33M de parâmetros
- 33M treinaveis
- Exatidão de 76%
Época 157

U-net

Treinada do raíz

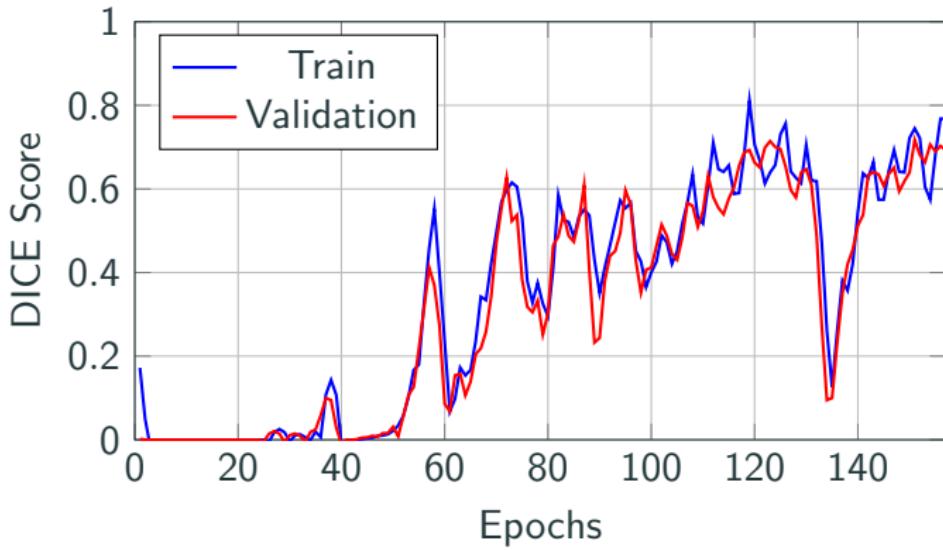
U-Net from scratch - Smoothed losses



U-net

Treinada do raíz

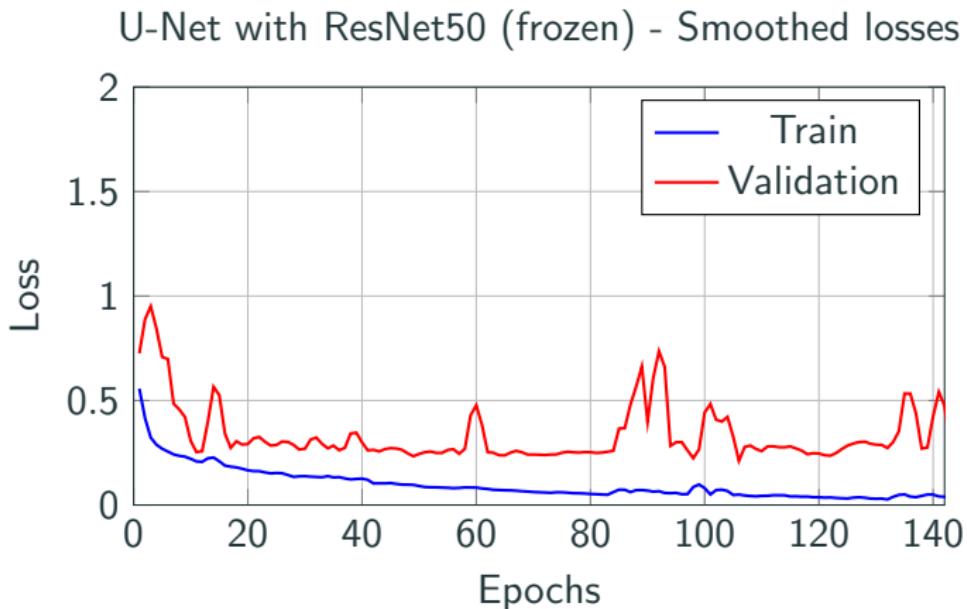
U-Net from scratch - Smoothed DICE scores



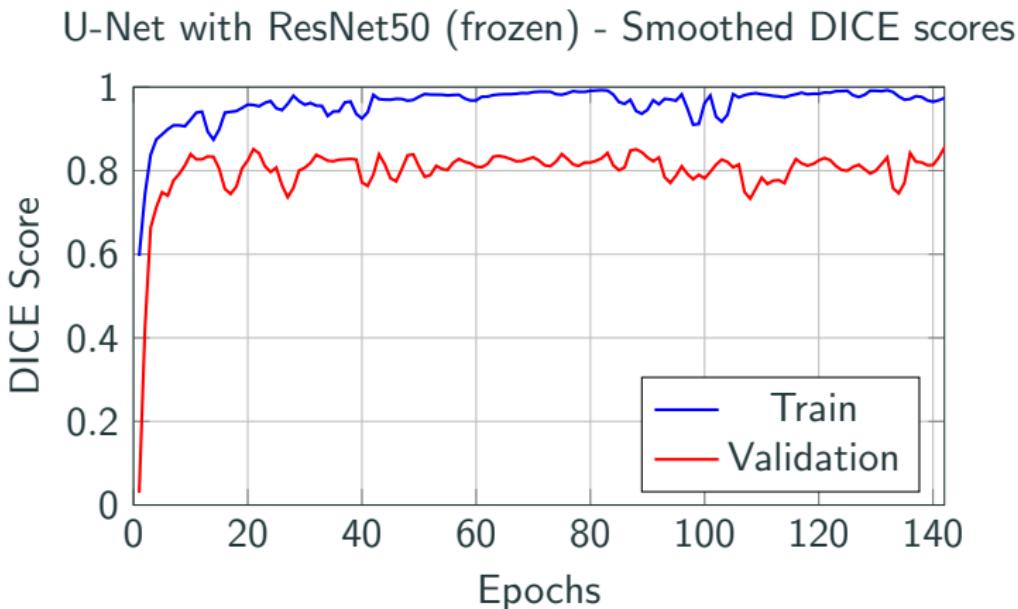
U-net Com Resnet50 Backbone

- 148M de parâmetros
- 124M treinaveis
- Exatidão de 85%
Época 142

U-net Com Resnet50 Backbone



U-net Com Resnet50 Backbone

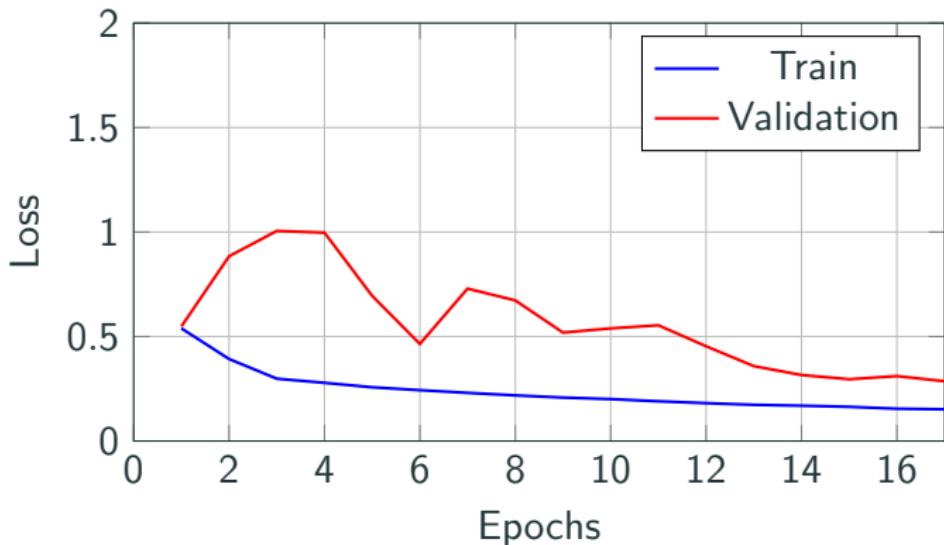


U-net Com Resnet50 Backbone

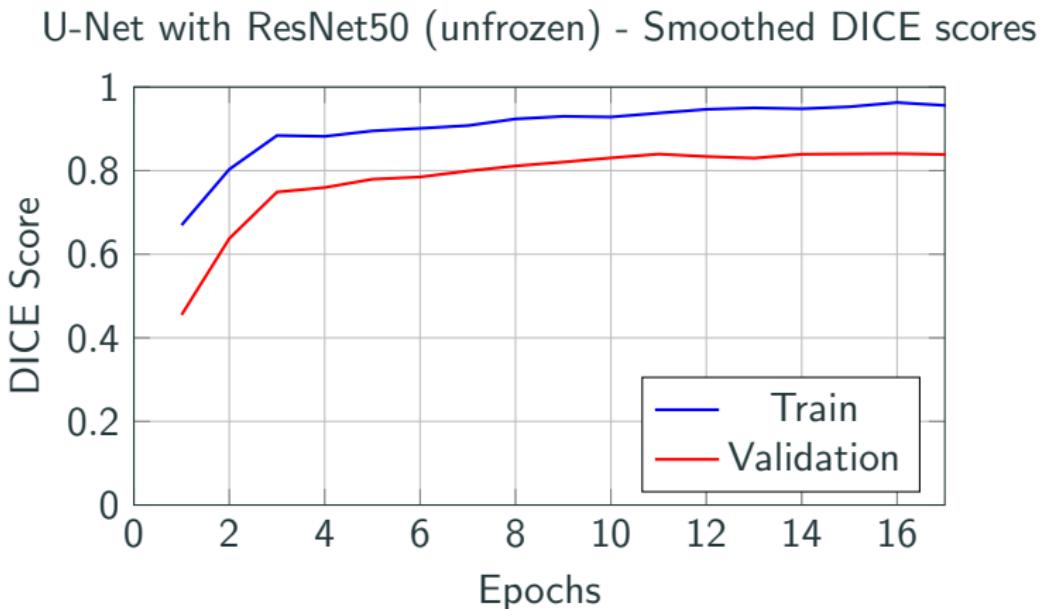
- 148M de parâmetros
- 148M treinaveis
- Exatidão de 85%
Época 17

U-net Com Resnet50 Backbone

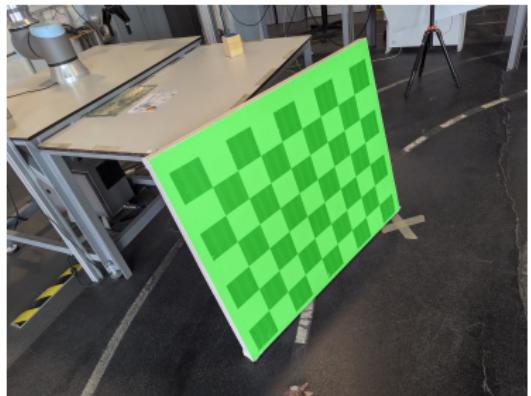
U-Net with ResNet50 (unfrozen) - Smoothed losses



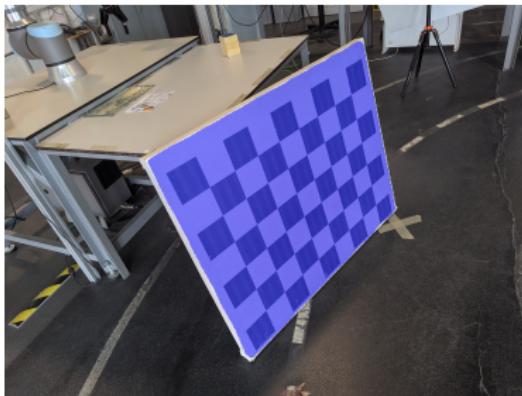
U-net Com Resnet50 Backbone



Alguns resultados do melhor modelo



Resultado esperado



Resultado obtido

Alguns resultados do melhor modelo

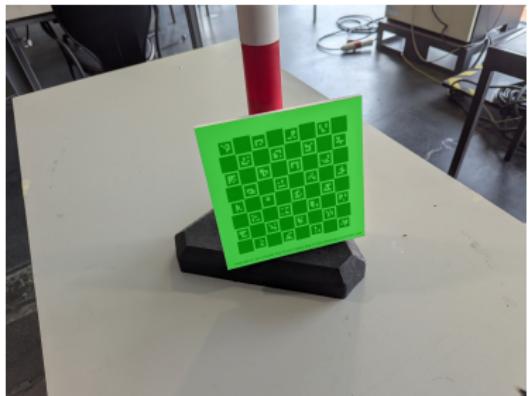


Resultado esperado

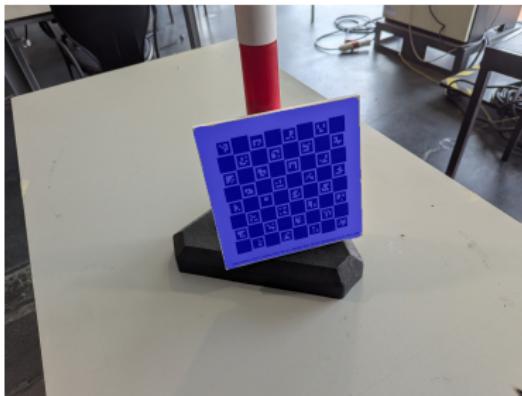


Resultado obtido

Alguns resultados do melhor modelo

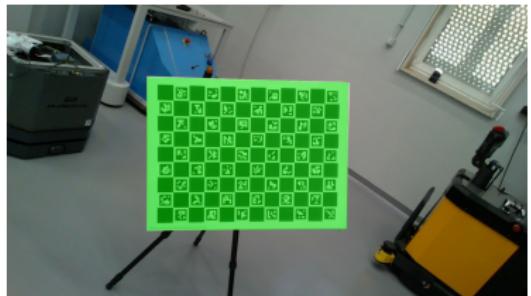


Resultado esperado

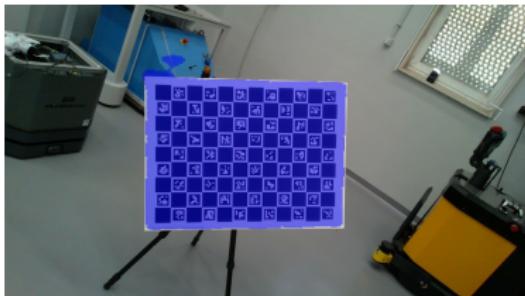


Resultado obtido

Alguns resultados do melhor modelo



Resultado esperado



Resultado obtido

Conclusion

- The segmentation mask approach effectively overcomes the challenges of variable outputs and occluded corners in calibration pattern detection.
- A U-Net model with a pretrained ResNet50 backbone delivered superior performance compared to more complex transfer learning models like DeepLabV3.
- This method streamlines the calibration evaluation process, reducing manual effort and improving overall usability.

Conclusion

- The segmentation mask approach effectively overcomes the challenges of variable outputs and occluded corners in calibration pattern detection.
- A U-Net model with a pretrained ResNet50 backbone delivered superior performance compared to more complex transfer learning models like DeepLabV3.
- This method streamlines the calibration evaluation process, reducing manual effort and improving overall usability.

Conclusion

- The segmentation mask approach effectively overcomes the challenges of variable outputs and occluded corners in calibration pattern detection.
- A U-Net model with a pretrained ResNet50 backbone delivered superior performance compared to more complex transfer learning models like DeepLabV3.
- This method streamlines the calibration evaluation process, reducing manual effort and improving overall usability.



universidade
de aveiro

Annotation of Calibration Patterns for RGB-LiDAR Evaluations using Segmentation Models

Bruno Silva
Gonçalo Ribeiro
University of Aveiro
PhD. in Mechanical Engineering.

March 3, 2025