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# Depth Map Compression using Deep Learning Techniques

Work in Progress

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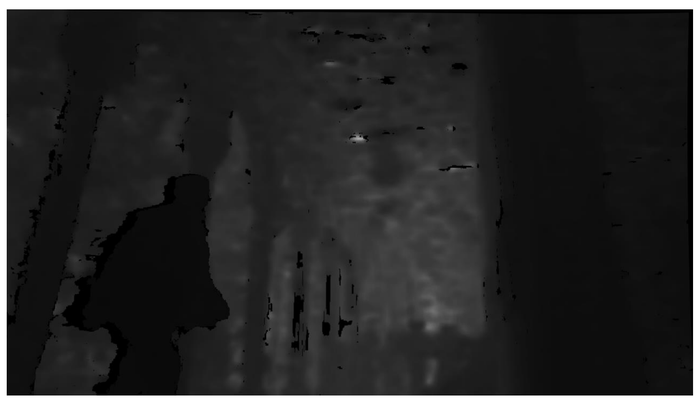
## Introduction

- Depth maps are a useful tool in many applications: segmentation, autonomous devices, etc.
- Efficient compression of depth maps is of high importance.
- Using Deep Learning for depth maps compression has not been tested.



Typical depth map, captured by Intel RealSense D435

## Goal

- Compressing depth maps in high quality, while trying to achieve the following goals:
  - High compression ratio.
  - Low distortion.
  - Maintain depth maps' special features.

## Challenges

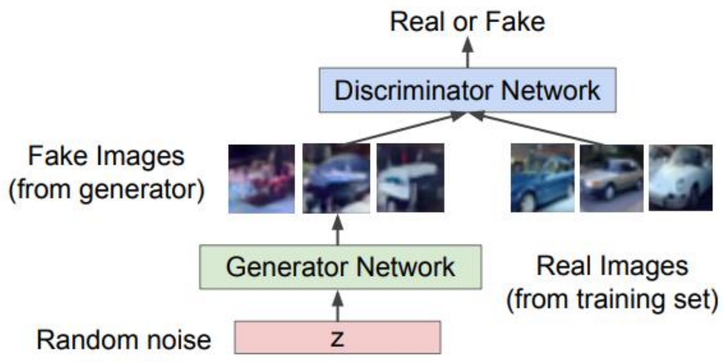
- Training generative models (GAN).
- Converting from natural images solution to depth maps solution.

Original Reconstructed

- Preserving non-valid pixels in depth maps.

## GANs

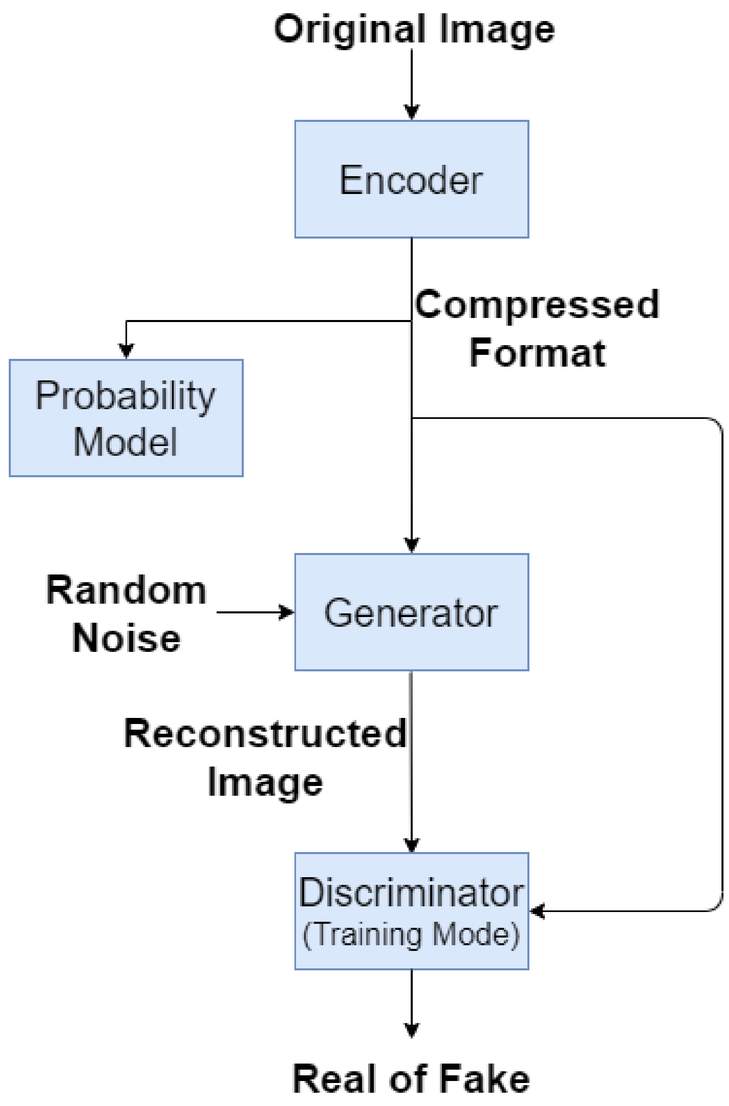
- Generative Adversarial Network.
- Unsupervised learning method, allows to generate new data.




- Conditional GAN architecture allows to reconstruct the original depth map rather than generate a new one.

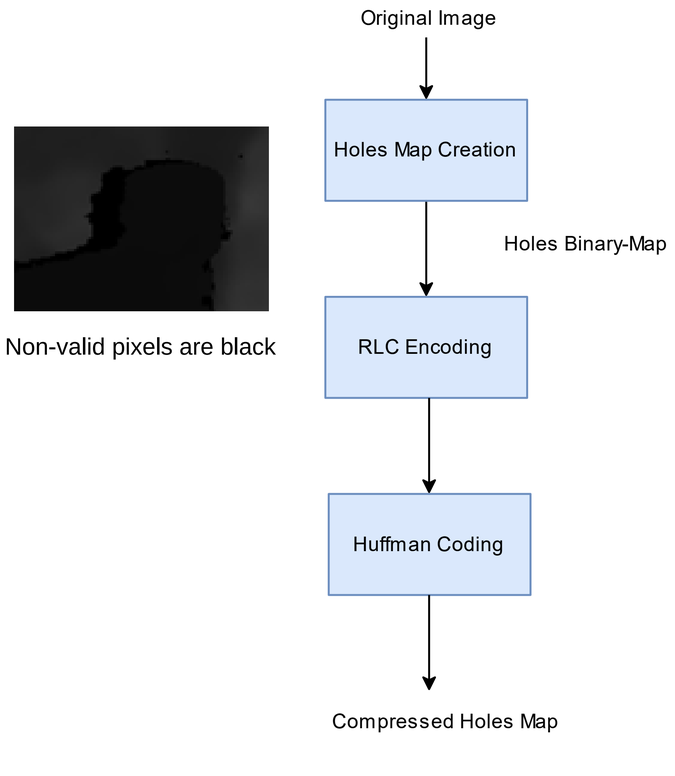
## Compression Model

- Deep learning based solution.
- Originally proposed for **natural images** compression.
- Based on "High-Fidelity Generative Image Compression" by Mentzer et. al.
- Each module consists of several neural layers, mainly convolution layers.




## Holes Preservation

- Extracting non-valid pixels (holes) location map.
- Holes map is compressed lossless.
- Holes pre-processing diagram:

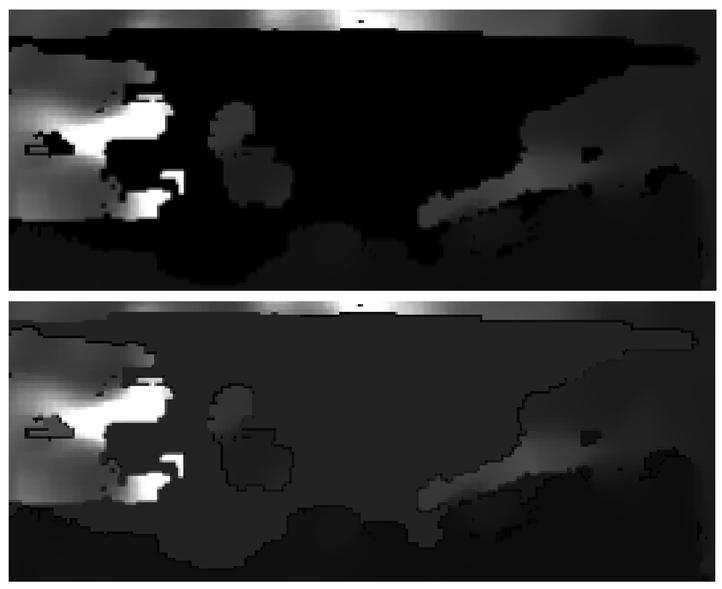



Non-valid pixels are black

- Map compressed to ~0.06 bpp.

## Pre-Processing

- Holes locations are known to the decoder using the map.
- Holes values can be changed in the depth map to benefit the compression.
- A simple method is filling the holes with a constant similar to the hole neighborhood.



Above Image: Original Hole
Below Image: Constant-Completed Hole

- Leads to better compression ratio on modified depth maps.

## Results

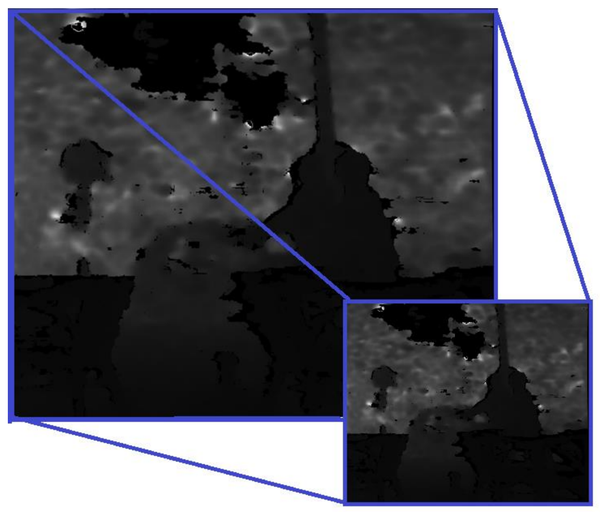
- Standard quality measurements of compression are represented in the following chart:
  (1) Original net, quantized depth maps (16 bits ➡ 8 bits).
  (2) Original net, fitted to 16 bits depth maps.
  (3) Fitted net, fully trained on ~80K depth maps.

| | PSNR | MAE | BPP |
|---|---|---|---|
| **(1)** | 21 | 5953 | 0.08 |
| **(2)** | 23 | 4159 | 0.09 |
| **(3)** | **50** | **97** | **0.32** |

- Fitted net produce high quality depth maps with compression ratio of ~50.

## Conclusion

- Working solution that preserves quality and correctness of depth maps.
- Better results than original network.



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