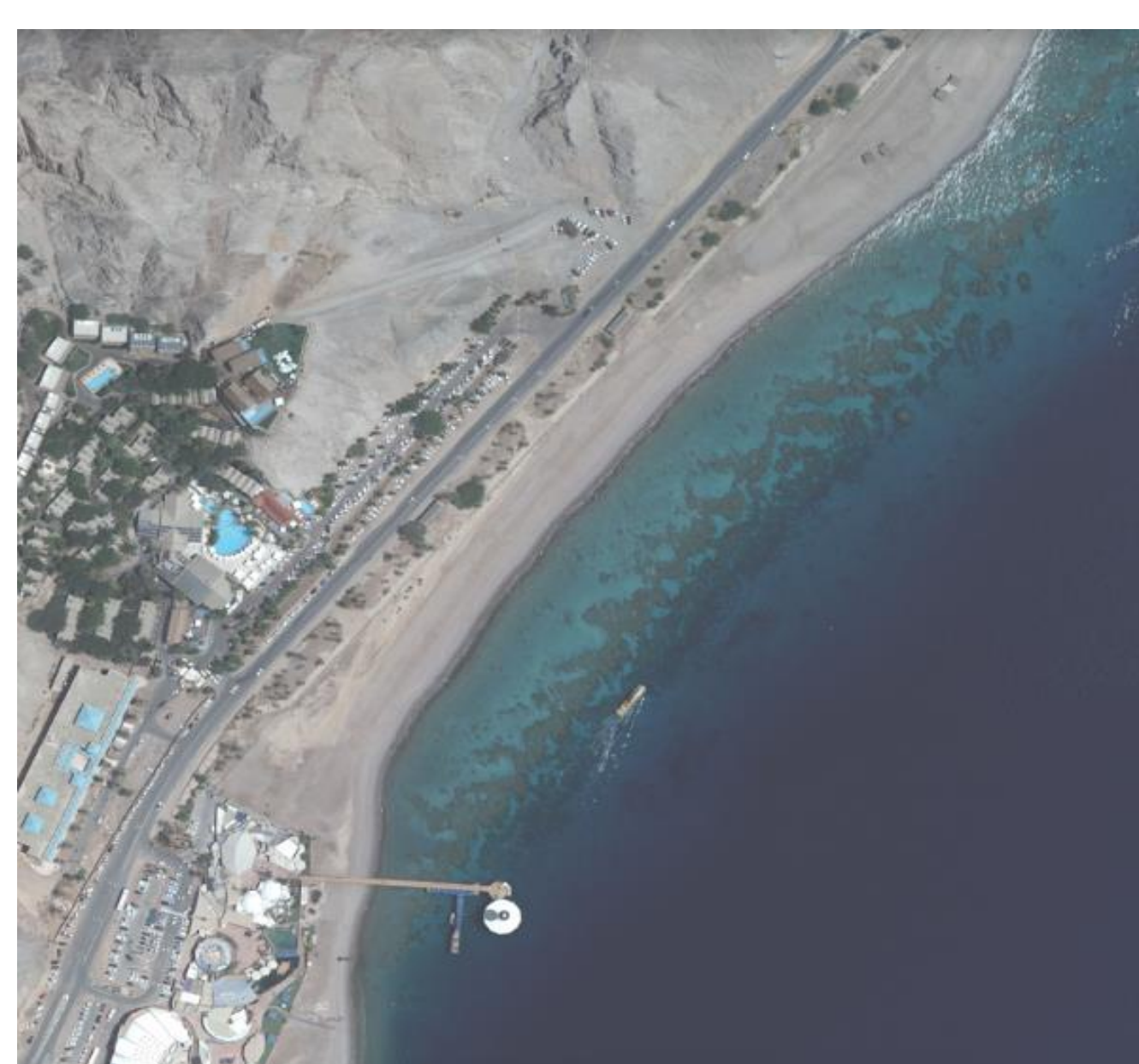


Coloring Grayscale Aerial Images of Eilat's Coral Reef

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Introduction

- Eilat's coral reef is degrading slowly over time
- Two main indicators for reef health are the reef area over time and the coral's color
- Haifa university has grayscale aerial images of the reef from the 1950s to the 1990s
- Colorizing the images can help understand the reef's degradation over time



Eilat's Reef Today

Goals

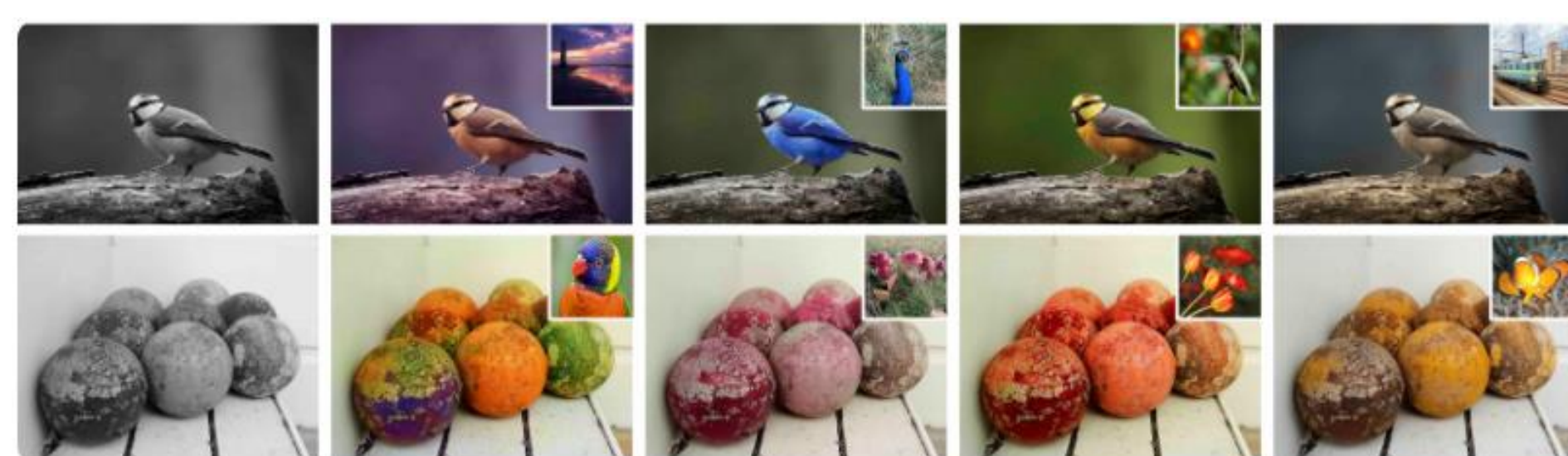
- Reconstruct color images out of grayscale images for coral aerial images
- Reconstructed image characteristics
 - Looks natural
 - Preserves texture
 - Reliably reconstructed

Challenges

- No ground truth for target images (sub constrained problem)
- Low color saturation in colorized images
- The bay area has changed dramatically since the 1950

Sub Constrained Coloring

- The colorizing problem is under constrained
- A grayscale image can have multiple colorizations that make sense
- Indicator for success – a human thinks he is looking at a natural image

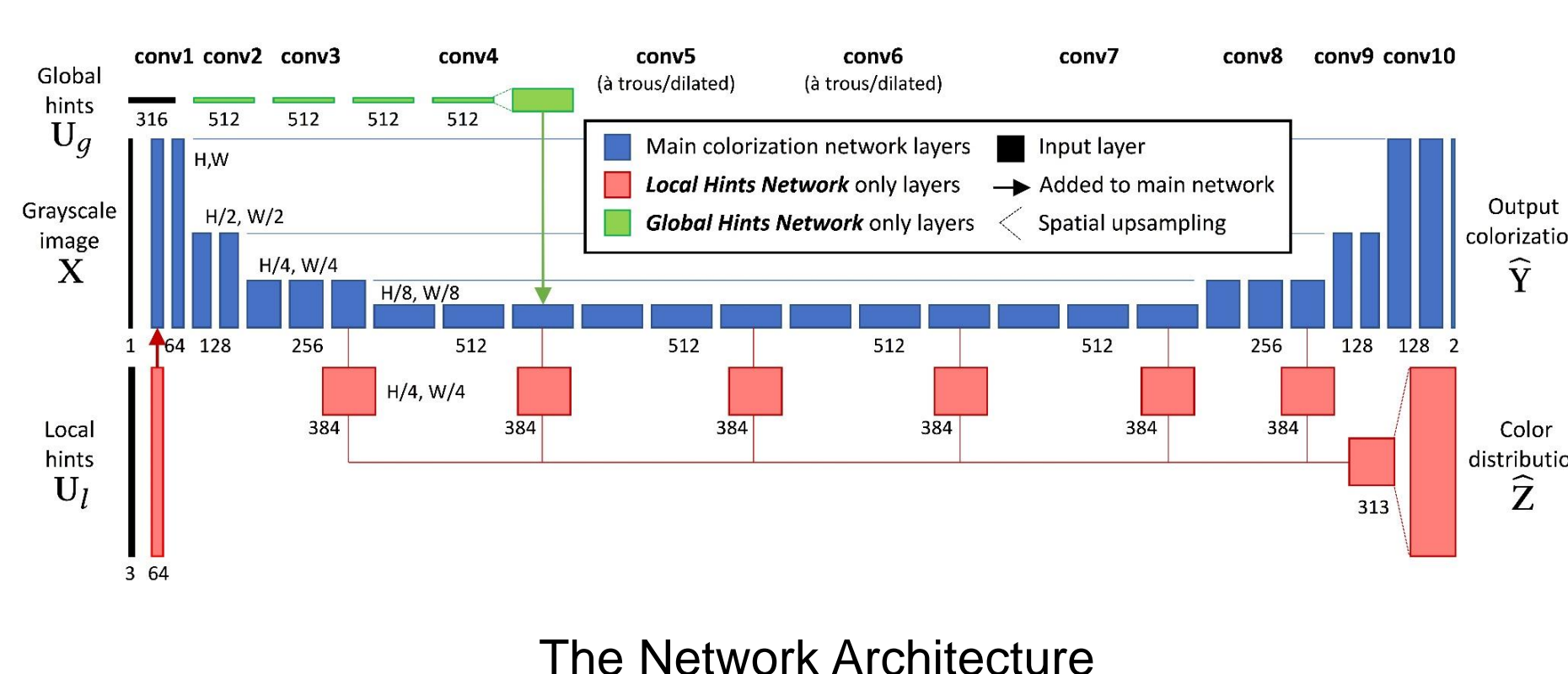


Grayscale image (left) has multiple probable colorizations

- Our solution – allow the user to change the color of an object interactively

Colorizing Model

- Real-Time User-Guided Image Colorization with Learned Deep Priors Model architecture
- Consists of Hints network and Colorization network – both train and work as one network



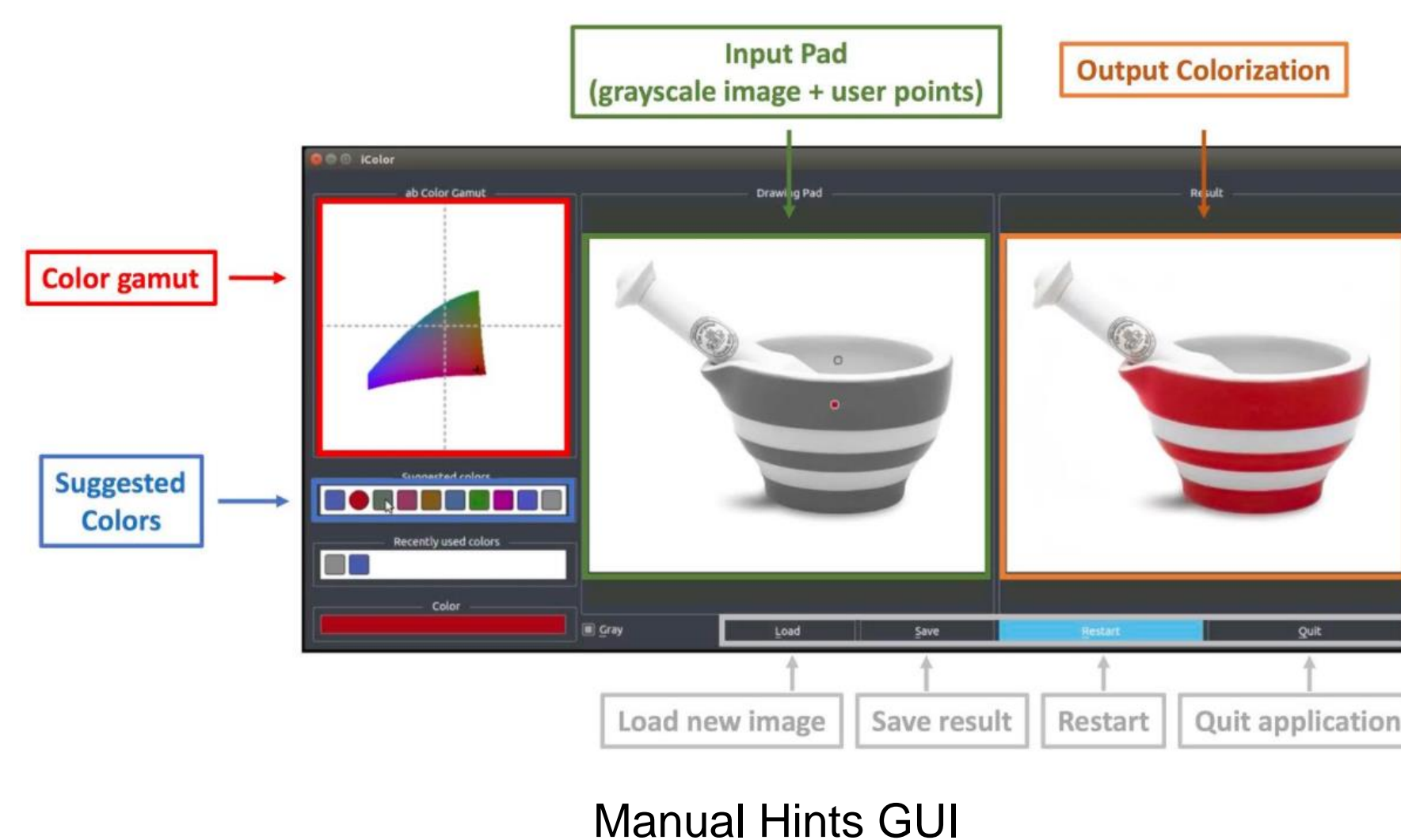
- Hints Network
 - Gets "hints" for a color that is connected to an object
 - The user can choose to use the module at inference
- Colorizing Network
 - Performs colorization of grayscale images
 - Preserves texture
 - Can use hints if available

User Hints



An Example Of User local Hints On An Image

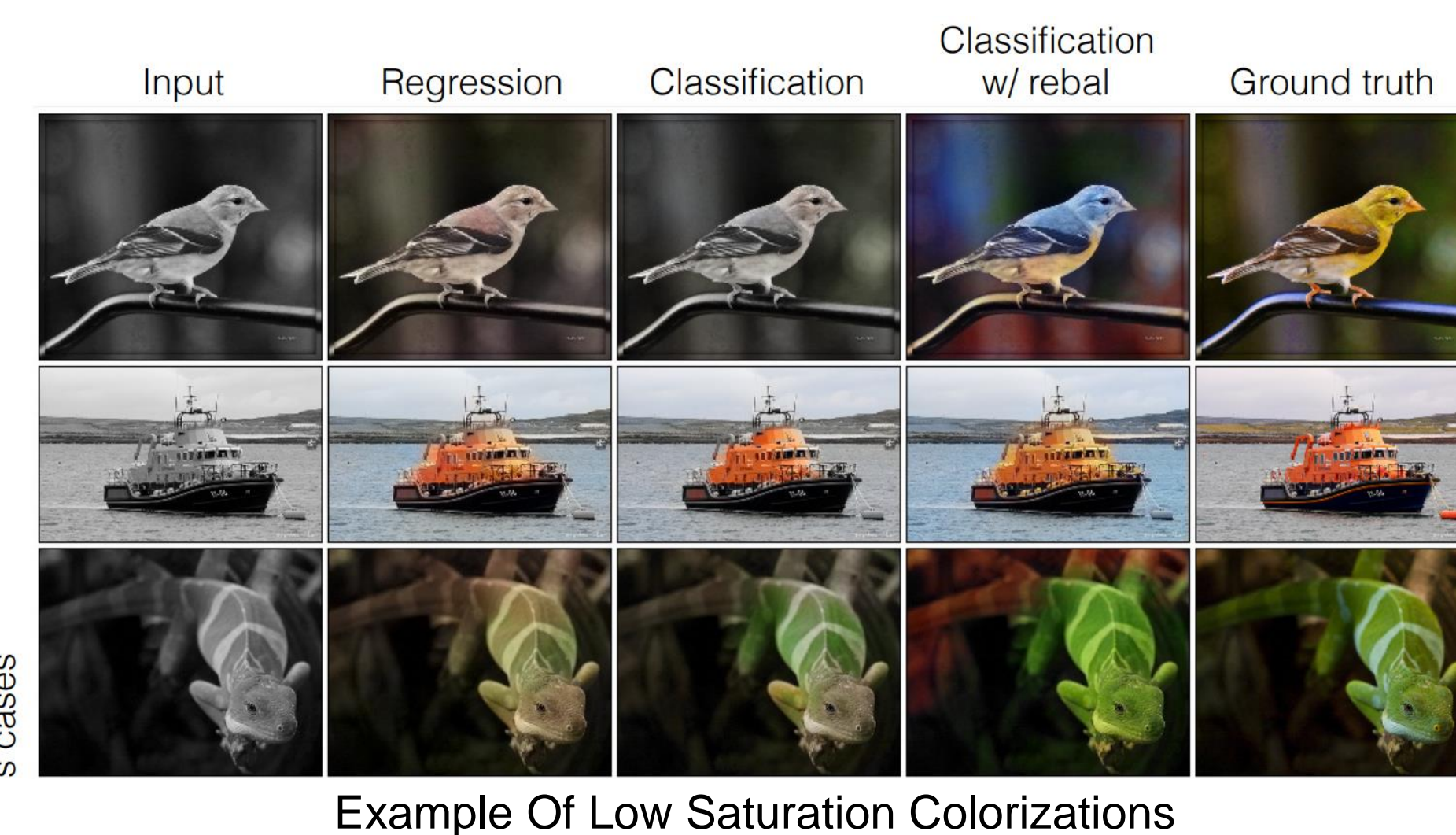
- At inference, the user can choose to give the architecture a local color hint - a point on the image and its expected color
- The user interacts with the model using a GUI



- Benefits of the hint's GUI
 - Allows for the accurate color reconstruction of the grayscale image
 - Solves the low color saturation problem – more colorful results

Low Saturation Problem

- The chosen solution is trained using a smooth L1 loss function
- The output has a potential to be less colorful as the minima is the color average (usually brown)
- Solved using the manual user hints



Data Set

- Very small data set
 - ~250 orthophoto images
 - ~800 drone images
- Training data set in different angles and resolution than target images
- Enriched with another ~100 images
 - Specific textures the model had issues with
 - Generalize the model for many cameras and resolutions



Results

- All the given target images were colorized
- Colorization makes sense and looks natural to our partners in Haifa University
- Colorizations can be used in the coral reef research

Conclusions

- Successfully colorized target images
- Reconstructed images
 - Look natural
 - Preserve texture
 - Are reliably reconstructed