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# Change Detection of Marine Environments Using Machine Learning

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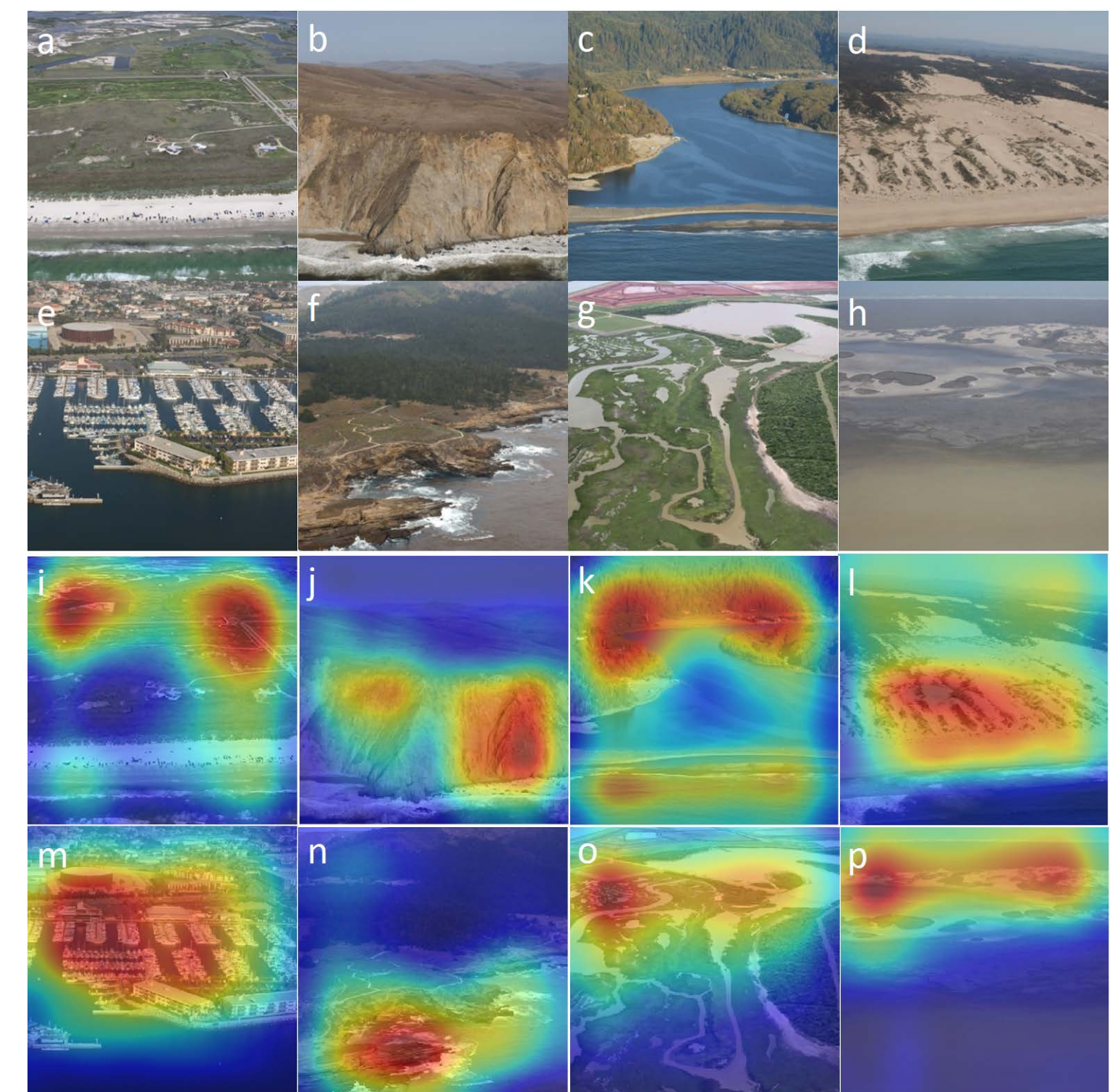
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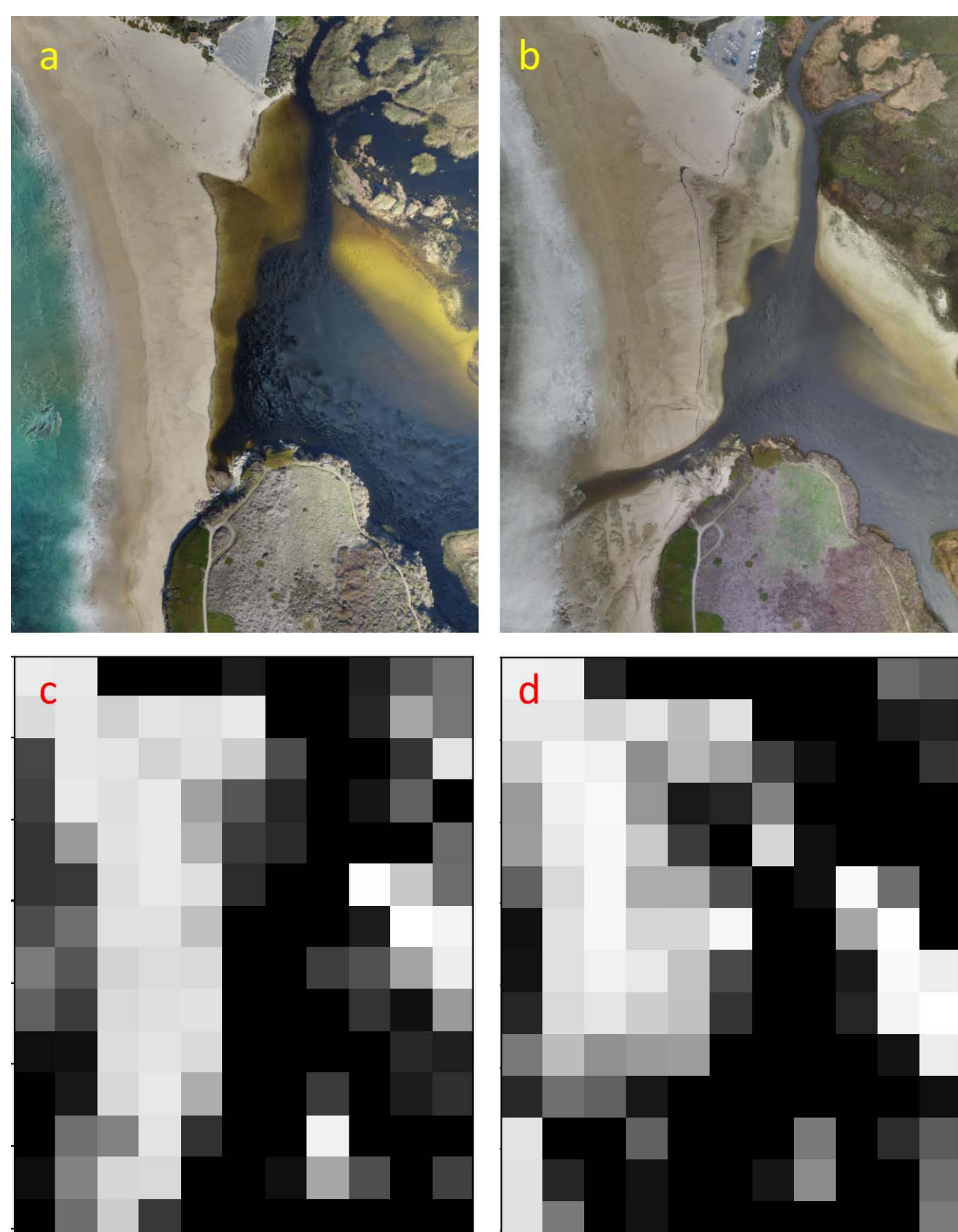


## Automate Classification of Littoral Waters with Deep Neural Networks

- Can coastal change (resulting from extreme events) be automatically detected and classified?
- Over 11,000 images of US coastline (West, East, and Gulf coasts) were categorized
- Training of complex neural networks (VGG19)



Coastal landscape classes (a-h) and their corresponding heat maps (class likelihood) for VGG16 (i-p). The corresponding confusion matrix is below, indicating high accuracy for class detection.



Aerial images (a-b) of Carmel River State Beach showing two river configurations. Corresponding mapped class likelihood (c-d) for "beach" where white = 100% likely and black = 0% likely.

Confusion matrix, with normalization

| True label \ Predicted label | Cliffs | Rocky | WaterWay | Dunes | Structures | Salt Marshes | Sandy Beach | TidalFlats |
|------------------------------|--------|-------|----------|-------|------------|--------------|-------------|------------|
| Cliffs                       | 0.98   | 0.02  | 0.00     | 0.00  | 0.00       | 0.00         | 0.00        | 0.00       |
| Rocky                        | 0.04   | 0.96  | 0.00     | 0.00  | 0.00       | 0.00         | 0.00        | 0.00       |
| WaterWay                     | 0.00   | 0.02  | 0.94     | 0.00  | 0.02       | 0.02         | 0.00        | 0.00       |
| Dunes                        | 0.00   | 0.00  | 0.00     | 1.00  | 0.00       | 0.00         | 0.00        | 0.00       |
| Structures                   | 0.01   | 0.01  | 0.01     | 0.01  | 0.91       | 0.01         | 0.01        | 0.01       |
| Salt Marshes                 | 0.00   | 0.00  | 0.02     | 0.00  | 0.02       | 0.88         | 0.02        | 0.06       |
| Sandy Beach                  | 0.00   | 0.00  | 0.00     | 0.00  | 0.02       | 0.04         | 0.90        | 0.04       |
| TidalFlats                   | 0.00   | 0.00  | 0.00     | 0.00  | 0.00       | 0.05         | 0.01        | 0.94       |

## Results

- Demonstrated transfer learning approach using object detection works for coastal landscapes
- Developed ontology for coastal landforms that are identifiable and sufficiently different for classification
- Developed a "heat map" algorithm for detecting change of landscape type

## Student thesis research

- LCDR Young (June 2018)
- LCDR Herrmann (December 2018)
- LT Coughlin (June 2018)
- LT Mielke (December 2019)
- Capt Ayoub (March 2020)



DJI Inspire with Micasense RedEdge-M 5-band camera, currently being used to gather data over water



Students conducting field measurements during beach breaching (LCDR Herrmann, LCDR Young)

## Summary:

- Developed a neural network with 5-band imagery
- Developed a Siamese network for change detection to compare with heat map algorithms
- Tested 13 neural network architectures for transfer learning to coastal landscape classification