MACHINE-ASSISTED ANNOTATION OF FORENSIC IMAGERY

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INTRODUCTION

Context: Datasets of images of human decomposition are essential to forensic research and to law enforcement, yet are scarce and hard to utilize if not annotated with relevant forensic classes

Problem: Annotating decomposition images requires experts, is expensive and time consuming

- Not clear which images have a specific feature
- Not clear where on the image the feature is located

Proposed solution: recommend annotations

- Sliding window generates synthetic data
- VGG trained on these synthetic images
- VGG predictions on regions of unlabeled images clustered into recommended annotations

DATASET

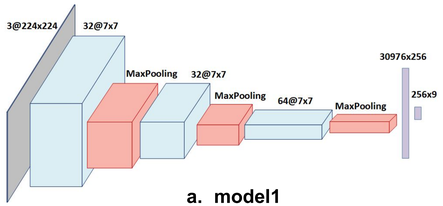
- Over 1 million images collected since 2011-present
- Images are taken from donors/individuals places at a body farm for studying human decomposition
- The image resolutions vary from 2400*1600 up to 4900*3200
- ~500 individuals in total and 4TB of storage

DATA PREPARATION

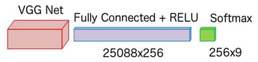
- Rectangular expert-annotated parts are cut out and considered as an image with that label
- A sliding window of 224×224 and stride 200 is used
  - When a window covers a labeled region it is considered as a new image with the label of that region
- Result: many training images for each forensic class
- Note: Due to the similarity between the background and the forensic classes, the background is considered as one class

METHOD

- **Classification**
  - Built model 1: from scratch, and model2: based on VGG16[1]
  - The generated data is used for train, validate and testing the models

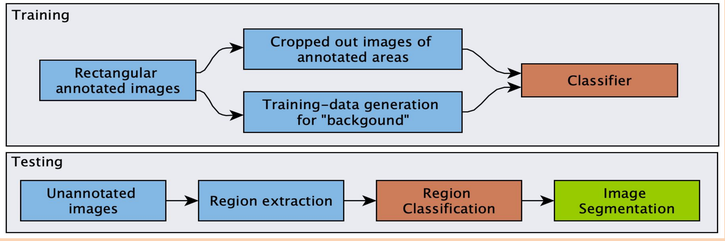


a. model1



b. model2

- **Semantic segmentation on unlabeled images**
  - For each image generate regions to be classified
    - Regions are generated by sliding a window of size 224×224
    - Classify the regions and store their coordinates and their predicted class label
    - For each class find all of the regions with that class label
    - Generate an adjacency matrix of the these regions
    - Create connected-components to group neighboring regions
    - Draw the convex hull of each group



The pipeline for generating annotations to be recommended to the annotators

RESULTS

- Recall more important than precision for recommending

- 9 classes (8 forensic classes + background) were analyzed
- Model2: fine-tuned pretrained VGG16 on Imagenet increased the accuracy of the classifier
- Transfer Learning using Model1 might result in higher recall

Method	Semantic Segmentation mAP	Semantic Segmentation mAR	Classification mAP
Model2-bg-tl	0.26	0.45	0.95
Model2-tl	0.15	0.59	0.92
Model2	0.30	0.28	0.79
Model1	0.16	0.32	0.84
Model1-bg	0.17	0.23	0.88

CONCLUSIONS

- We designed and developed an annotation assistance system that:
  - Proposes annotations
  - Provides the likelihood of an image containing a desired forensic class
- Our system is built based on a novel semantic segmentation done using
  - Region selection method
  - Region classification
  - Region agglomeration of neighboring regions sharing class labels

REFERENCES

[1] Karen Simonyan and Andrew Zisserman, "Very deep convolutional networks for large-scale image recognition,"arXiv preprint arXiv:1409.1556, 2014