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TEXAS
The University of Texas at Austin

Image Segmentation and 2D to 3D point mapping for Object Detection

FRI I Final Project

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Introduction

Project goal: Map incoming 2D image data with point-cloud data, creating a correspondence between the two data formats

3 main steps to the process:

(1) Applying image segmentation on the 2D images

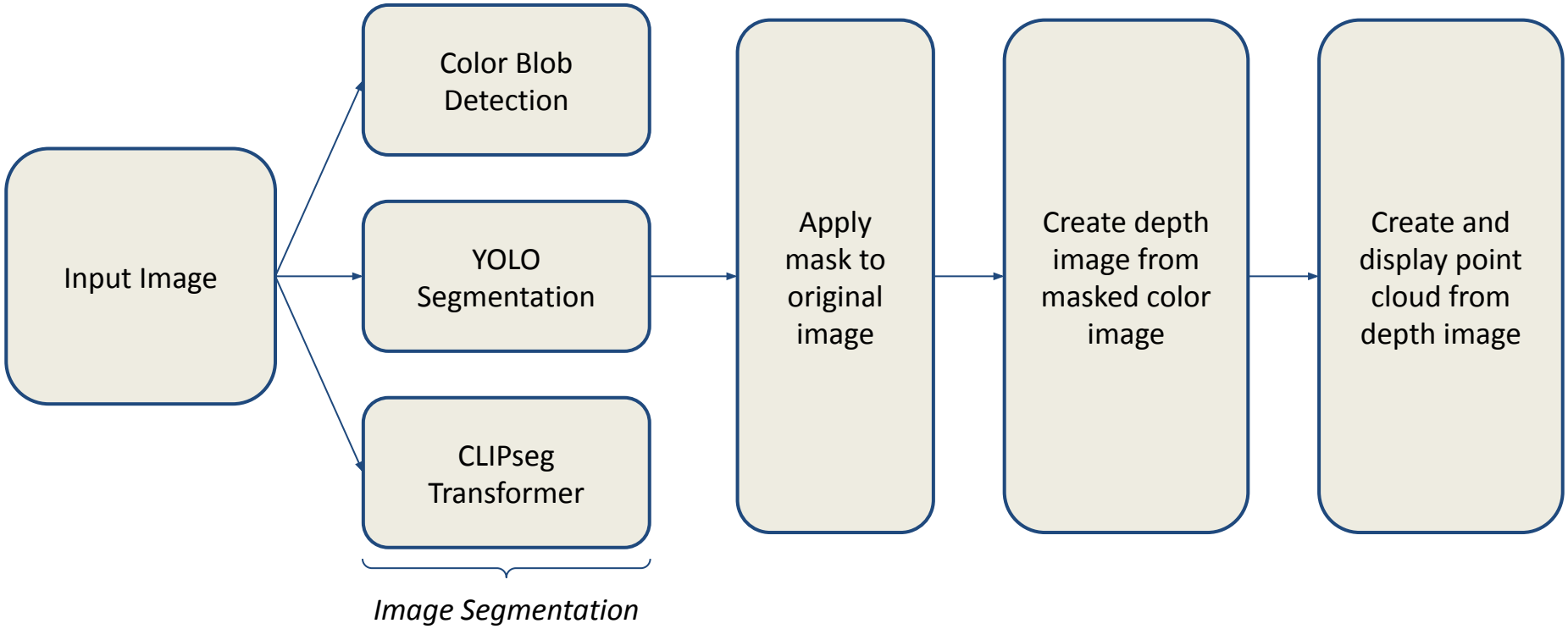
(2) Computing depth image from the segments

(3) Mapping the depth image to the point cloud

Background

- 2D image segmentation
  - YOLO v8 Resnet
  - CLIPseg vision transformer
- 2D-3D point mapping
  - I2P registration

Approach


Input Image
Color Blob Detection
YOLO Segmentation
CLIPseg Transformer
Image Segmentation
Apply mask to original image
Create depth image from masked color image
Create and display point cloud from depth image

Experimentation

- Setting evaluation
  - Black/noiseless background
  - Neat background with some noise(colored walls)
  - Noisy background(cluttered desk)
- View obstruction
  - Other objects or background
- Object color/pattern

Objects

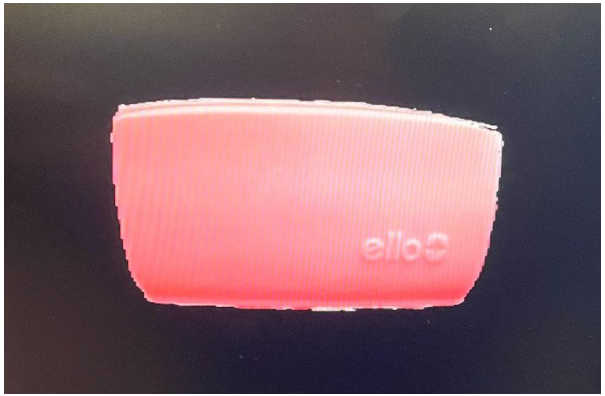

BURSTING WITH FLAVOR
PRINGLES
ORIGINAL

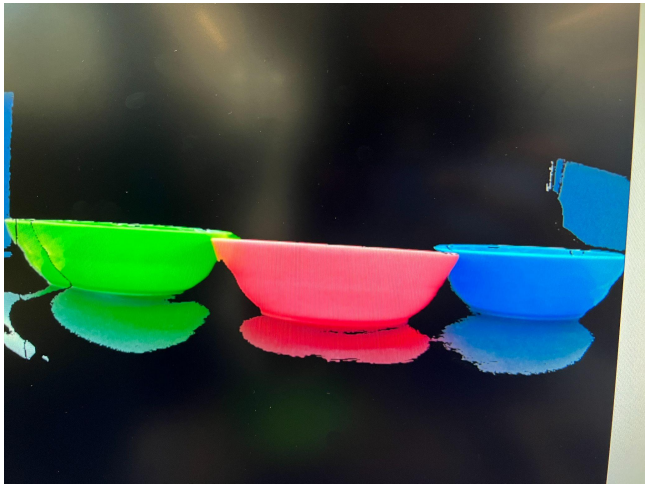

Magic
Scotch
3M


ello

Color blob Masks

- RGB Mask
- Specific color masks



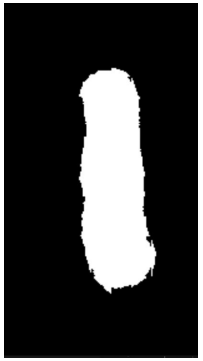


YOLO Masks

- Better than color blob
- Advantage: No color requirements
- Limitation: Need to specify the object of detection through predetermined classes

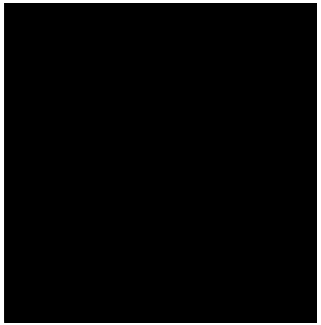
CLIPseg Masks

- Model detects object based on given prompts
- Sensitive to color objects as well (showing green bowl with prompt “purple bowl”)



Pringles can

Apple



Purple bowl

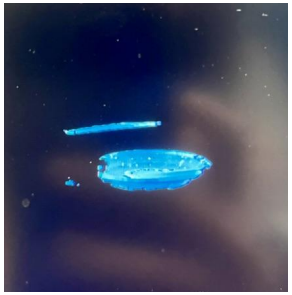
White cup with handle

Point Clouds

- Output from depth image to point cloud conversion process
- Lots of point cloud fragmentation despite color image covering entire object

Apple

Pringles Can



Blue Bowl

Tape Dispenser

Results/Evaluation

	Noiseless Background	Controlled Noise	Noisy Background/ Obstructions
Color blob detection	Mostly segmented correctly	Bled into same color background	Failed to detect only the object
YOLOv8 Resnet	Segmented correctly with some failures	Less bleeding (but still not perfect)	Failed to detect certain objects
CLIPSeg	Segmented correctly	Segmented correctly at some angles	Segmented correctly at some angles

Results/Evaluation

	Solid	Color-block (multiple colors)	Patterned
Colorblob detection	Segmented overall shape correctly	Segmented only the requested color	Segmented requested color outline (may leave out inside)
YOLOv8 Resnet	Segmented correctly	Segmented entire object (not color sensitive)	Segmented entire object
CLIPSeg	Segmented correctly	Segmented object outline (not internal holes)	Segmented object outline

Point Cloud Fragmentation

Conclusion

- Aim: Mapping 2D data to point clouds
- Uses object detection + depth to point cloud transformations
- Experimented with various segmentation algorithms
- Worked under specific circumstances

Issues/Improvements

- Point cloud fragmentation
- Segmentation aside from color blob