Computer Vision for Vehicle Panel Gap Inspection

24-678 Final Presentation

Team Philadelphia

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The Problem: Car Quality Assurance Inspection
-- Panel Gaps --

- Panel Gaps are the thin black gaps between two sheets of metal on a car's exterior
- People generally consider a uniform, clean panel gap as making sure that the car was manufactured correctly.
- We developed a computer vision system that can detect the width of panel gaps for defects using just a camera.

Why does this matter for OEMs?

Uniform panel gaps:

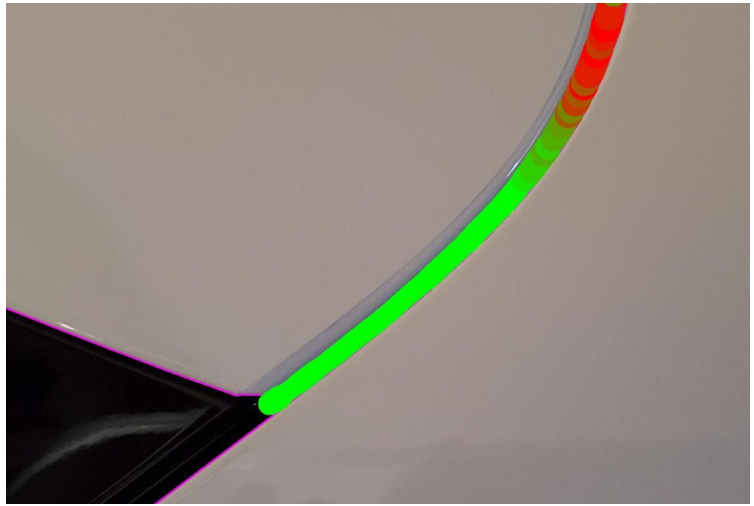
High quality assembly

Sloppy panel gaps:

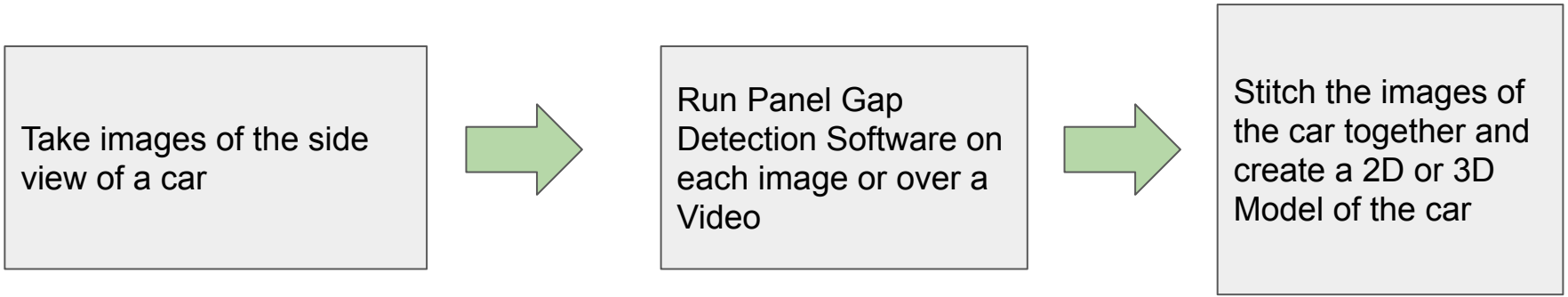
Other possible issues in manufacturing assembly

Solution

- Our product will use a camera take pictures and depth measurements so that we can analyze the panel gaps of a car using close up images.
- By measuring the width of the panel gap, we can check them versus expected values and check for any manufacturing defects or damage.



Pipeline


Take images of the side view of a car
Run Panel Gap Detection Software on each image or over a Video
Stitch the images of the car together and create a 2D or 3D Model of the car

Technical method overview

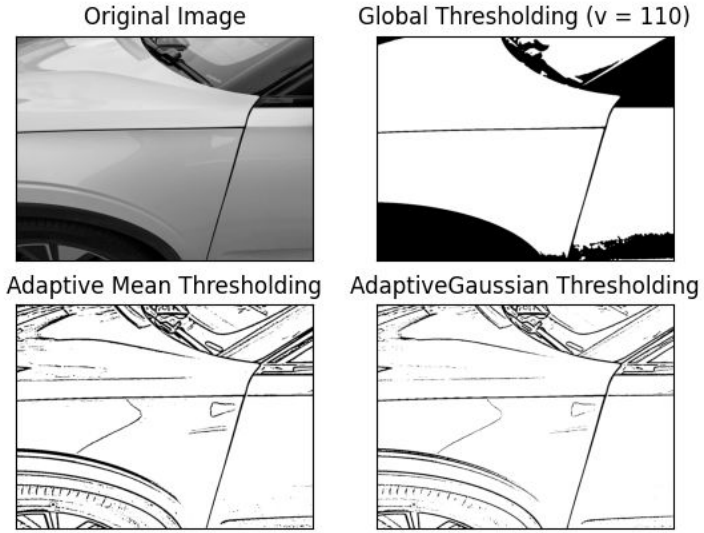
Code Design Choices:

- Global thresholding
- Contour method for detection
- Measurements
- Image masking
- Structure from motion
- Point cloud coordinate logging

Engineering Design Choices:

- Lighting Conditions
- Paint Considerations/Limitations

Panel Detection - Thresholding and Contours



Thresholding

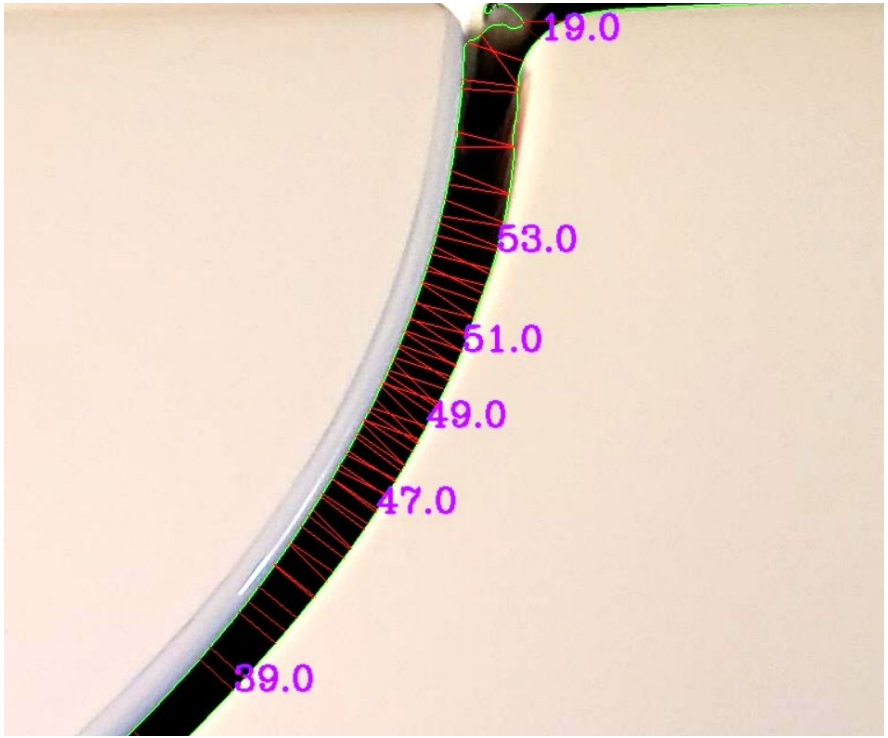
Contouring

Why Contours? ->

Vectors for gap Measurements

- Find the tangent
- Rotate unit vector to normal direction
- Loop increasing vector magnitude until pixel value change
- Associate depth data to find proper units

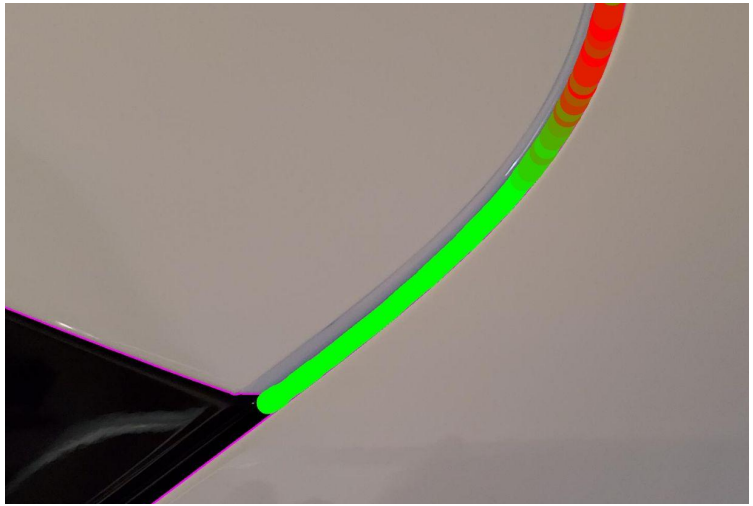
- Pixel width



Color Mapping

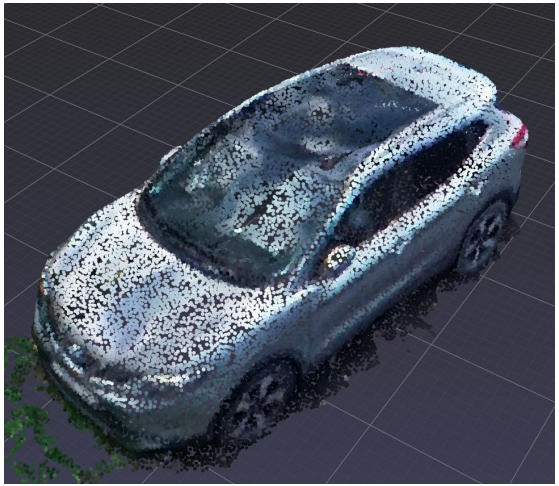
- Color Mapping helps to visualize how the width of the measurements change.

- We allow the user to set a predetermined nominal value + bounding quality assurance tolerances




HYBRID

Future technical Goals:



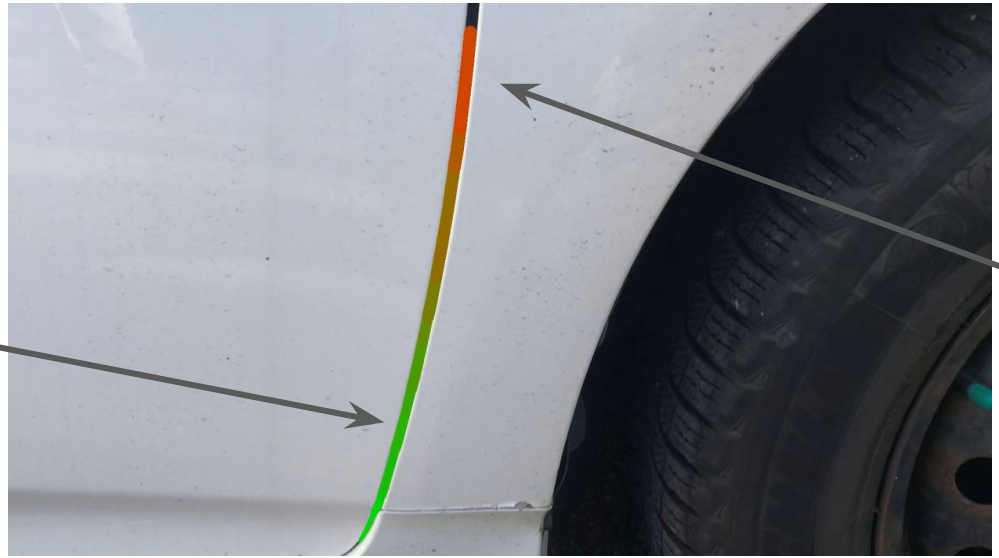
- Active stereo dot projection
- High quality Depth Mapping
- High quality point cloud generation

- Textured Structure from motion
- Part error identification and action procedure generation

- Environment lighting Control

Classification of Panel Gap Defects

Green indicates Gap within Tolerance



Red indicates Gap outside Tolerance

When is a Panel Gap acceptable?

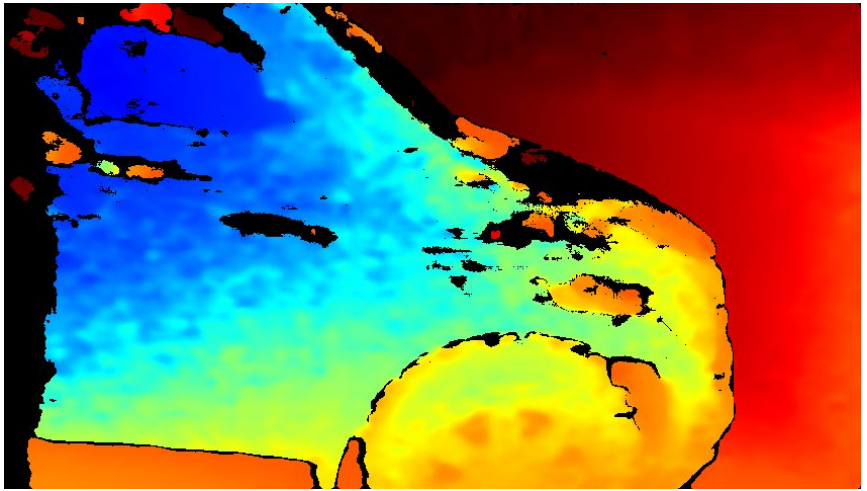
~ 1/32 inches

When is the Panel gap out of tolerance?

> 1/16 inches

Raw Input from the RealSense

RGB Module



Stereo Module

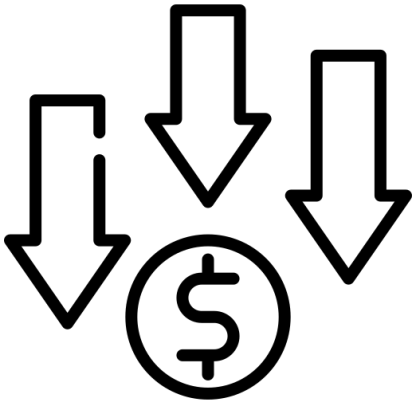
Consequences of Panel Gap Defects

Water Seepage

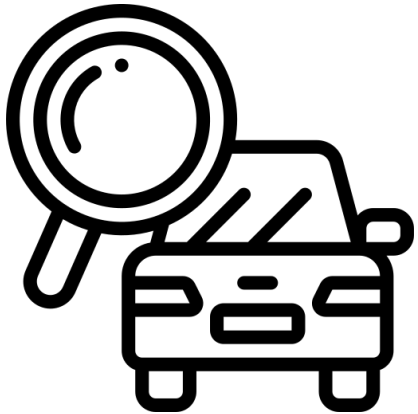
Wind Noise

Bad Aesthetics

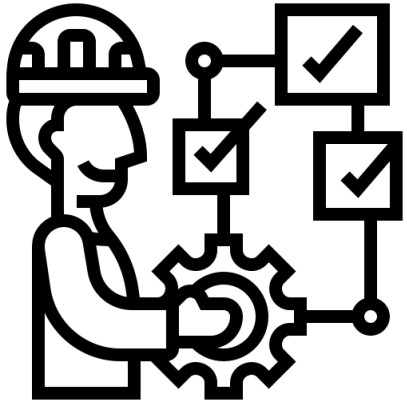
Why detect Panel Gaps early in the Production Line?



Cost Saving



Pattern Identification



Improving Production Process

Moving Ahead…

- Use the collection of images to create a 3D Point Cloud of the car that includes the color mapping
- Use disparity data to determine non-planar measurement adjusting
- Use one video camera that can travel around the car and upload images into the program
- Add Classification functionality to safely isolate non-panel gap features within the frame