

## Motivation & Goal

The **detection of hazardous conditions** near public transit stations, such as snow coverage on sidewalks near bus stops, is necessary for ensuring the **safety and accessibility of public transit**. Smart city infrastructures aim to facilitate this task among many others with computer vision. However, most state-of-the-art computer vision models require thousands of images in order to perform accurate detection, and there do not exist many images of hazardous conditions as they are generally rare.



Our method provides a **generalizable, less data-intensive solution** to this problem. We detect a particular hazardous condition, snow-covered sidewalks, by combining Structure from Motion (SfM) with a segmentation model instead of gathering annotated data. Specifically, our approach learns the expected location of the sidewalks and compares later snow coverage to the expected locations.

## BusEdge

The BusEdge platform is the system deployed on our bus that captures images on-board and sends them with live GPS information to a server where we collect and analyze<sup>2</sup>.

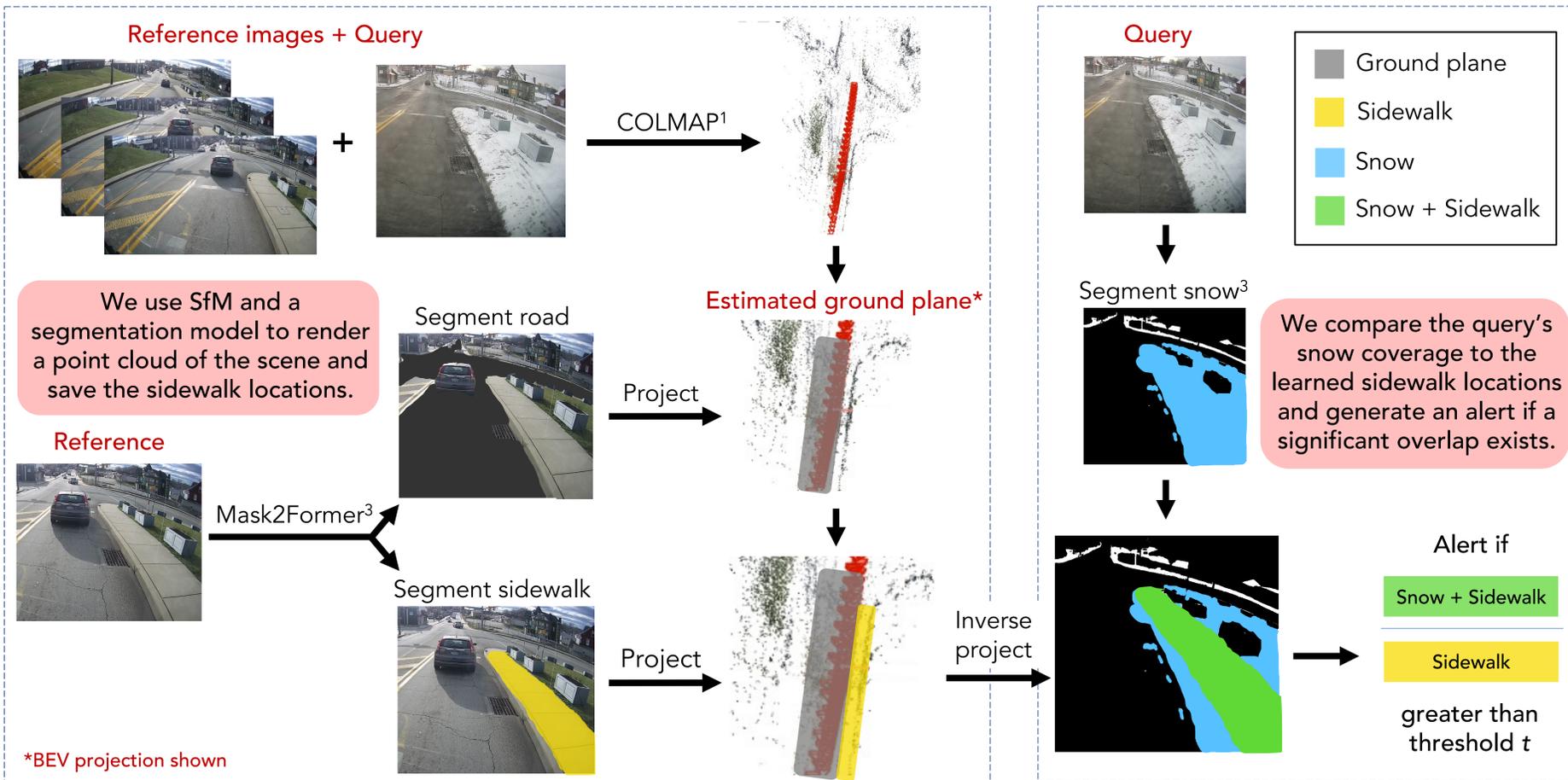


The bus is equipped with 5 cameras, 4 of which are mounted on the outside of the bus. We use the dash cam which is mounted inside to avoid foggy images that may appear in wintry weather.

## Acknowledgment

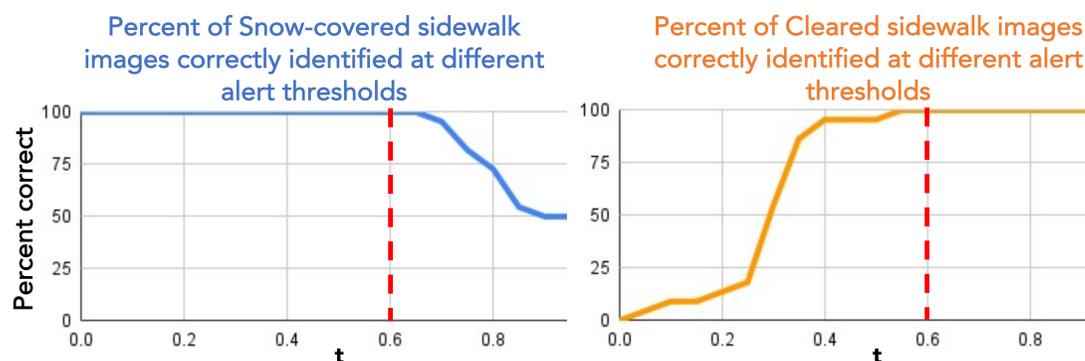
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## Method



## Results

- Evaluated on 66 images, split into 3 categories containing 22 images each.
- Categories: clear on a different day from reference images, snow-covered, or cleared (sidewalk is surrounded but not covered by snow).
- Test alert threshold  $t$  from 0 to 0.95 at increments of 0.05.



## Conclusion & Future Work

We present and demonstrate a method that uses Structure from Motion rather than annotated data to localize sidewalks when occluded with snow. Our approach can generalize to other hazardous conditions, such as snow covering bike lanes. The next steps for extending this process would be to:

- 1) Extend to the full bus route  
We demonstrate with two stretches of road; an extension would incorporate GPS information to form a full route.
- 2) Focus on the sidewalk closest to the bus  
This method could be adapted to analyze the sidewalk closest to the bus.

## References

- [1] J. L. Schönberger et al. "Structure-from-Motion Revisited". CVPR 2016.
- [2] C. Ye. "BusEdge: Efficient Live Video Analytics for Transit Buses via Edge Computing". Master's thesis, CMU, 2021.
- [3] B. Cheng et al. "Masked-attention Mask Transformer for Universal Image Segmentation". CVPR 2022.