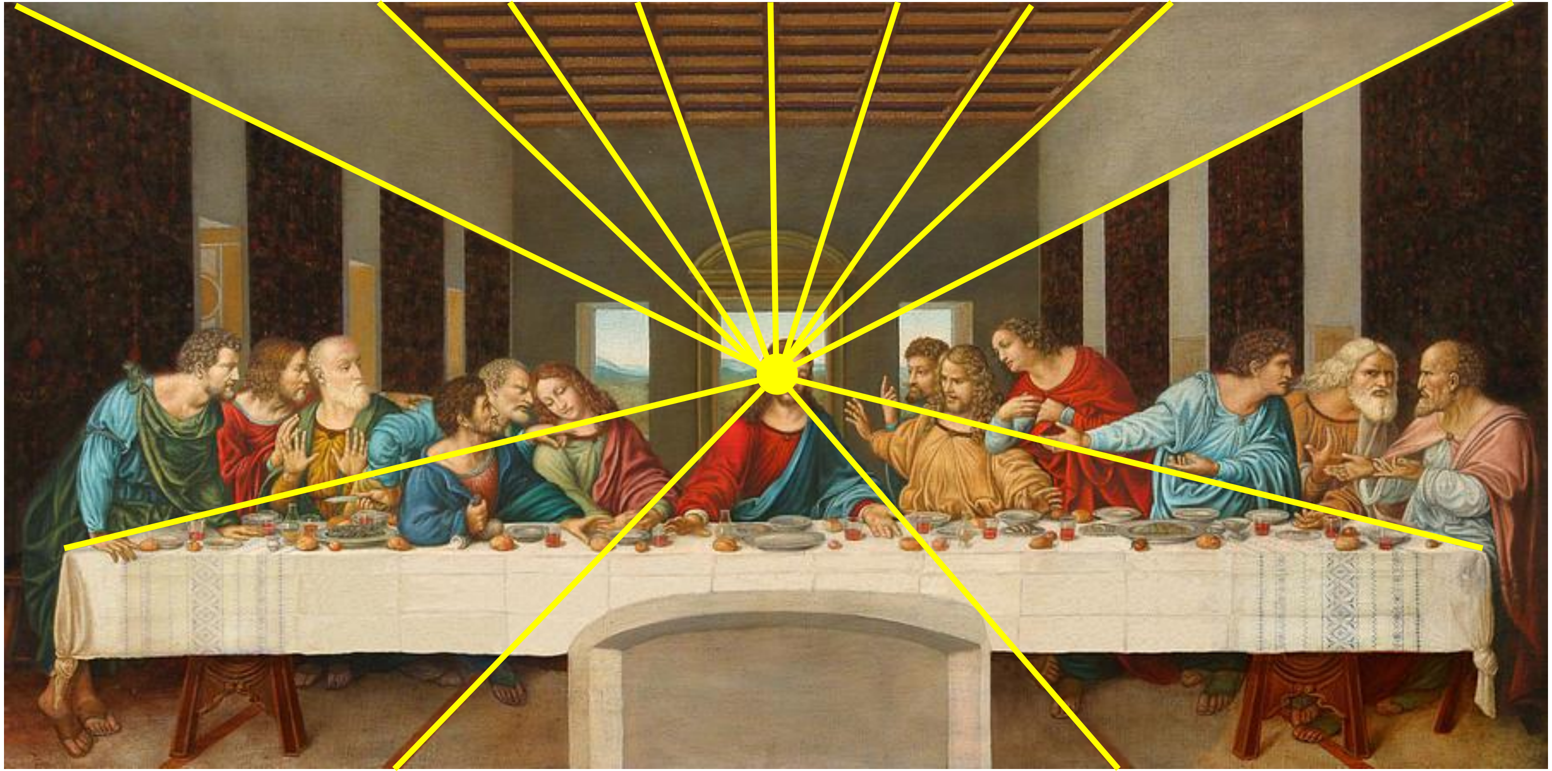
FakeVP

Jonathan Mey-Tal   Itay Katav   Shahar Azoulai

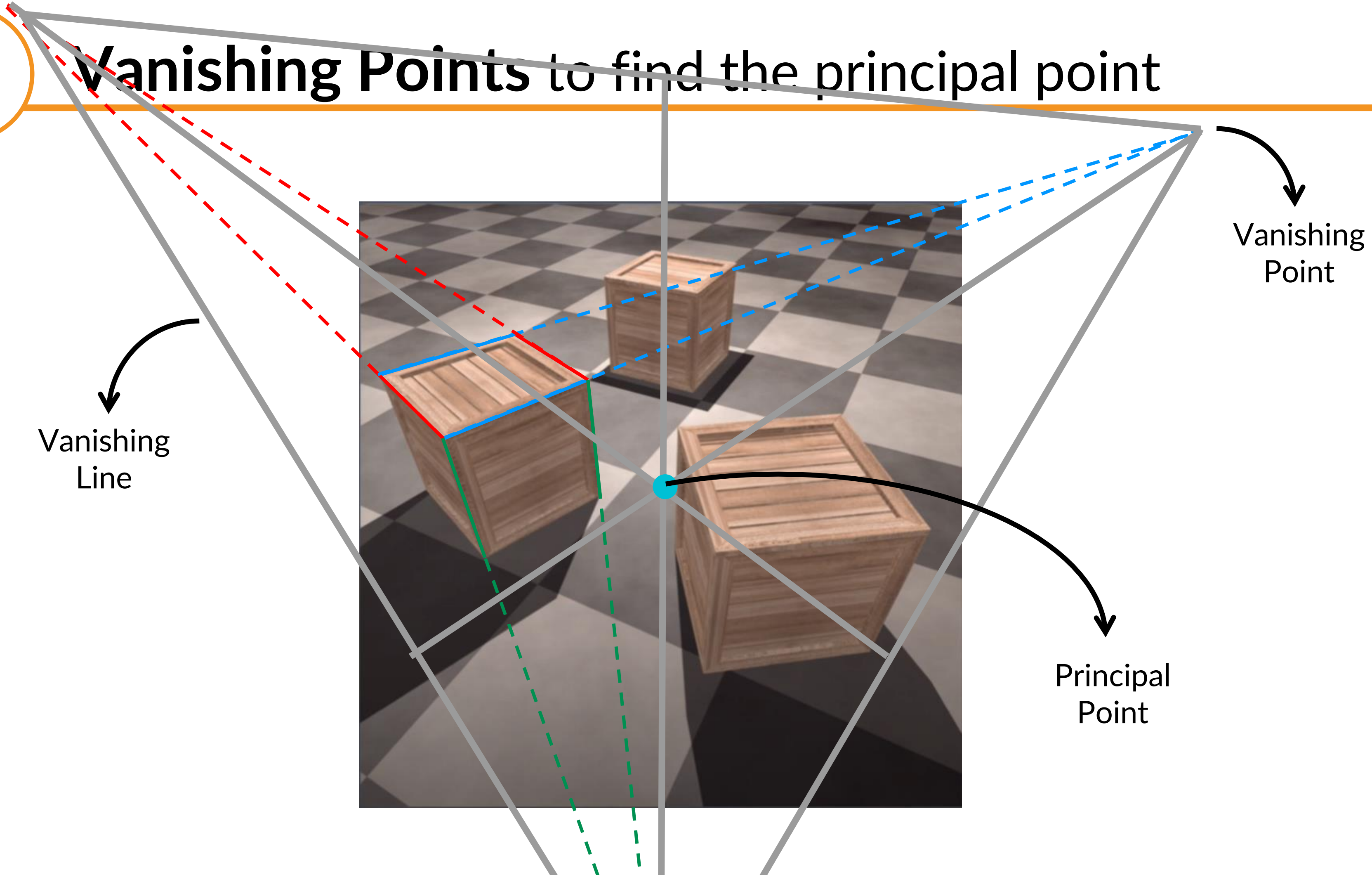
The Problem: Fake Photos

Vanishing Points | What is it?

Vanishing Points to create depth



Vanishing Points to find the principal point



Fake Photos Detection Using Principal Point

So What’s the Plan

- Calculate the Principal point
  - Finding straight lines
  - Classify the lines
  - Choose three pairs of parallel lines
  - Extending each line to find the Vanishing points
- Do the same thing for the suspected object
- Compare the two Principal points

So What's the Plan

- Calculate the Principal point.
    - **Finding straight lines**
    - Classify the lines
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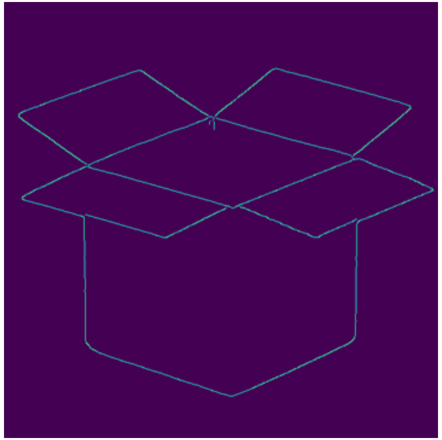
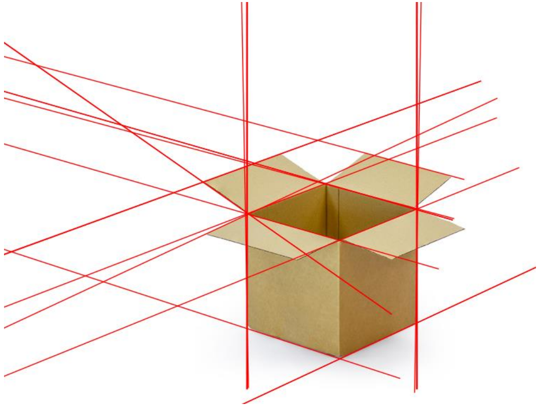
Detecting Straight Lines

- Gaussian Smoothing + Canny + Hough Transform

Canny Output



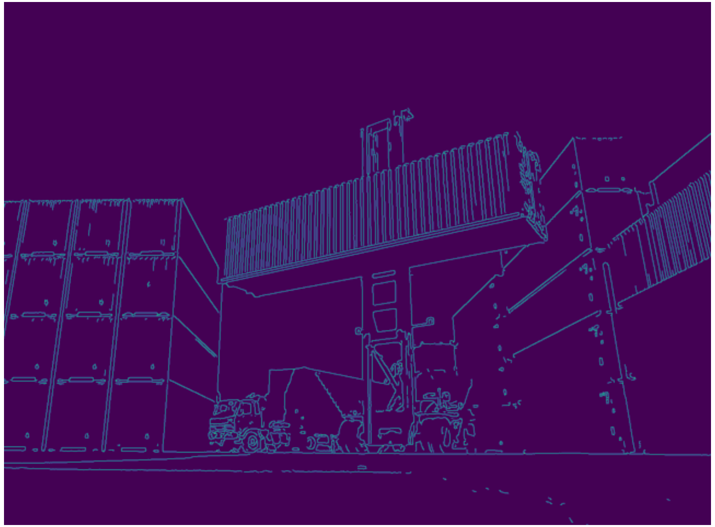
Hough Transform



Post Processing

Detecting Straight Lines

- Gaussian Smoothing + Canny + Hough Transform



Detecting Straight Lines

- LSD (Line Segment Detector)

So What's the Plan

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    - **Classify the lines**
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    - Extending each line to find the Vanishing points
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First, we looked for papers and works in the area of vanishing points detection

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A new approach to vanishing point detection in architectural environments

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Received 10 June 2001; received in revised form 6 February 2002; accepted 14 March 2002

Abstract

A man-made environment is characterized by many parallel lines and orthogonal edges. In this article, a new method for detecting the three mutually orthogonal directions of such an environment is presented. Since real-time performance is not necessary for architectural applications, such as building reconstruction, a computationally intensive approach was chosen. However, this enables us to avoid one fundamental error of most other existing techniques. Compared to theirs, our approach is furthermore more rigorous, since all conditions given by three mutually orthogonal directions are identified and utilized. We assume a partly calibrated camera with unknown focal length and unknown principal point. By examining these camera parameters, which can be determined from orthogonal directions, falsely detected vanishing points may be rejected.

Keywords: Vanishing points; Vanishing lines; Geometric constraints; Architecture; Camera calibration

1. Introduction

The analysis of vanishing points provides strong cues for inferring information about the 3D structure of a scene. With the assumption of perfect projection, e.g. with a pin-hole camera, a set of parallel lines in the scene is projected

detecting the three mutually orthogonal directions of a man-made environment has raised considerable interest [6,8,16].

After a discussion of existing vanishing point detection methods in Section 2, our method is presented in S
Section 4 demonstrates th
real ima

Vanishing Point Detection with OpenCV, Python & C++

Kedia Rahul · Follow

2 min read · Jun 7, 2021

73 2

Computer Vision Methods Ap
Forensic Science

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Abstract—Crimes in our society, increasing in volume and sophistication, have determined the need for knowledge and use of scientific methods to their prevention and investigation. This work presents three Computer Vision methods that can be applied in forensic investigations. In the first method, a new vanishing point detector facilitates the process of making measurements in a single 2D image, and is used to estimate the height of a person in an image, important measurement to corroborate pieces of evidence. In the second method, multiview stereo techniques are used to obtain a three-dimensional model from photographs taken from a footwear impression, evidence commonly found in crime scenes. In the third method, the need for reconstructing shredded images is explored. A photograph can be shredded in order to hide information and it is up to the field of Computer Forensics its automatic reconstruction. Experimental results are provided, showing the effectiveness of the proposed methods when compared to relevant work in the literature.

Keywords-vanishing point; footwear impression; image puzzle; computer forensics; computer vision;

I. Introduction

Forensic Science is the application of knowledge from several branches of science to answer questions relevant to a legal system. Due to the evolution of criminal activities, more specialized disciplines have been involved, such as Computer Science, Engineering and Economics.

The research field that unites the fields of Forensic Science and Computer Science is called *Computer Forensics* and encompasses the study of research methods, driven by hypothesis, of a specific problem, through the use of computers ... tional methods [1]. ... however, requires joint efforts from ... eral collaborations are ... Science [2],

methods that can assist traditional Forensic Science procedures. The methods are associated with three main forensic topics:

- Photogrammetry: When photographing a certain region of space, the three-dimensional (3D) points are projected to points in the two-dimensional (2D) image, which causes the loss of depth information. Rests with Photogrammetry the study and the proposition of methods to recover such information, allowing geometric measurements in the image plane.
- 3D reconstruction of impressions: Experts in different localities must collaborate to answer questions pertinent to an investigation and thus they need to share existing physical pieces of evidence. Such collaboration requires the transport of such pieces between several locations. This is an expensive process and fragile pieces can be damaged. It is up to this area of study to propose methods for scanning these pieces of evidence or new methodologies for capturing the 3D shapes directly at the crime scene.
- Reconstruction of fragmented documents and images: It is very common in forensic investigations that examiners depend on the quality of preservation of a document or image, for handwriting analysis or content identification. In some cases, however, these documents and images could have been damaged, torn or obliterated. The reconstruction process when they have been torn, for example, can be done manually, which suggests a tedious and time consuming work. It is up to this area of study to propose methods for the automatic reconstruction of such fragmented documents or images, improving the reconstruction accuracy and efficiency when compared to a manual process.

on the clustering of line segments in the image plane, which obviates the need for *a priori* camera calibration.

Our method for vanishing point detection is divided in three steps:

1) Extraction of line segments on the image plane.
2) Clustering of line segments converging to the same vanishing point (repeated until convergence):
   2.1. Selection of seeds.
   2.2. Grouping of segments based on the seeds and on the distance among intersection points and their corresponding lines on the projective space.
3) Detection of a vanishing point to each final cluster.

Fig. 1 illustrates the three steps to estimate the vanishing points, numerated as shown above.

Fig. 1. Steps of the proposed vanishing point detector.

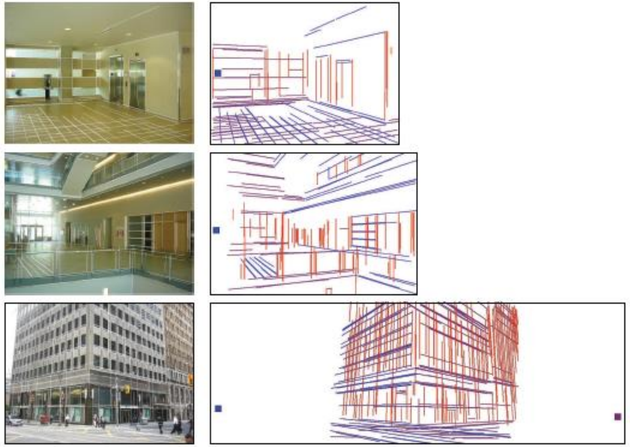


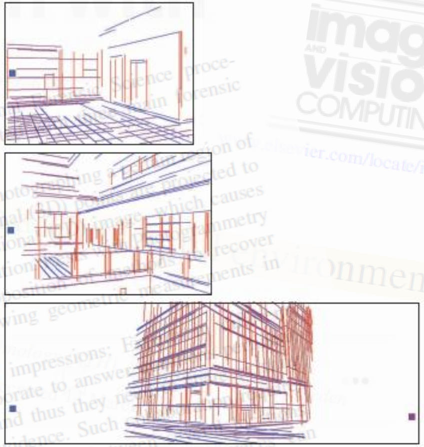
Fig. 2. The first column shows the input image and all detected segments. The second column shows the line clustering result and the detected finite vanishing points. Parallel lines with the same color are associated with a vanishing point at infinity; the other lines are associated with finite vanishing points.

For validation purposes, we compared the obtained results to those of other relevant methods [12], [13], [14]. The first experiment consisted in computing the *orthogonality error* of the detected vanishing points: how much the more orthogonal vanishing points deviate from the real orthogonality on the image plane. The second experiment consisted in computing the *focal length error*: how much the focal length computed from the more orthogonal vanishing points deviates from the

Detecting the vanishing point in one-point perspective images using Computer Vision algorithms

Kuoyuan Li · Follow
8 min read · Dec 27, 2021

An image or photograph is called **one-point perspective** when it contains one and only one **vanishing point.** All parallel lines extending into the distance would converge to this vanishing point. This type of perspective is very easy to be found in images of roads, railway tracks or buildings.



CONSAC: Robust Multi-Model Fitting by Conditional Sample Consensus

Florian Kluger[1], Eric Brachmann[2], Hanno Ackermann[1], Carsten Rother[2], Michael Ying Yang[3], Bodo Rosenhahn[1]
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Abstract

We present a robust estimator for fitting multiple parametric models of the same form to noisy measurements. Applications include finding multiple vanishing points in man-made scenes, fitting planes to architectural imagery, or estimating multiple rigid motions within the same sequence. In contrast to previous works, which resorted to hand-crafted search strategies for multiple model detection, we learn the search strategy from data. A neural network conditioned on previously detected models guides a RANSAC estimator to different subsets of all measurements, thereby finding model instances one after another. We train our method supervised as well as self-supervised. For supervised training of the search strategy, we contribute a new dataset for vanishing point estimation. Leveraging this dataset, the proposed algorithm is superior with respect to other robust estimators as well as to designated vanishing point estimation algorithms. For self-supervised learning of the search, we evaluate the proposed algorithm on multi-homography estimation and demonstrate an accuracy that is superior to state-of-the-art methods.

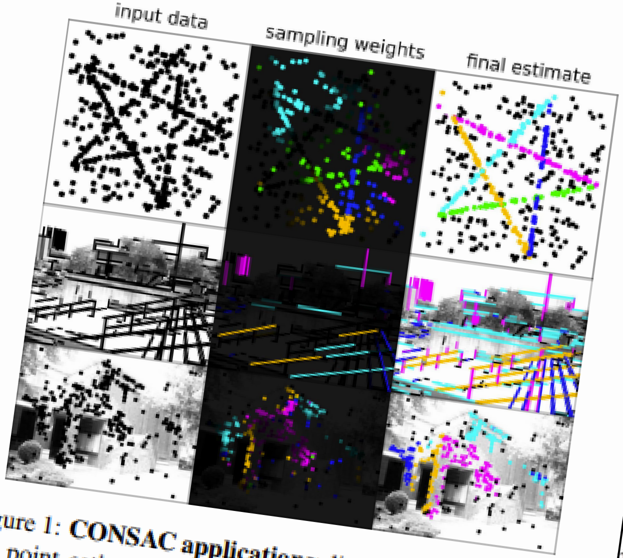

Figure 1: **CONSAC applications:** line fitting (top), vanishing point estimation (middle) and homography estimation (bottom) for multiple instances. Colour hues in column two and three indicate different instances, brightness in column two varies by sampling weight.

Finding Vanishing Points via Point Alignments in Image Primal and Dual Domains

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Abstract

We present a novel method for automatic vanishing point detection based on primal and dual point alignment detection. The very same point alignment detection algorithm is used twice: First in the image domain to group line segment endpoints into more precise lines. Second, it is used in the dual domain where converging lines become aligned points. The use of the recently introduced PClines dual spaces and a robust point alignment detector leads to a very accurate algorithm. Experimental results on two public standard datasets show that our method significantly advances the state-of-the-art in the Manhattan world scenario, while producing state-of-the-art performances in non-Manhattan scenes.

1. Introduction

Under the pinhole camera model, 3D lines are transformed into 2D lines. Moreover, parallel lines in 3D are projected into lines that converge on a point (perhaps at infinity) known as a *vanishing point* (VP). In the presence of parallel lines, as is common in human-made environments, VPs provide crucial information about the 3D structure of the scene and have applications in camera calibration, single-view 3D scene reconstruction, autonomous navigation, and semantic scene parsing, to mention a few.

There is a vast literature on the problem of VP detection, starting with the seminal work by Barnard [5] and leading to high-precision algorithms in recent works [20, 21]. Typically, a method starts by the identification of oriented elements, which are then clustered into groups of concurrent ... and finally refined to get the corresponding ...

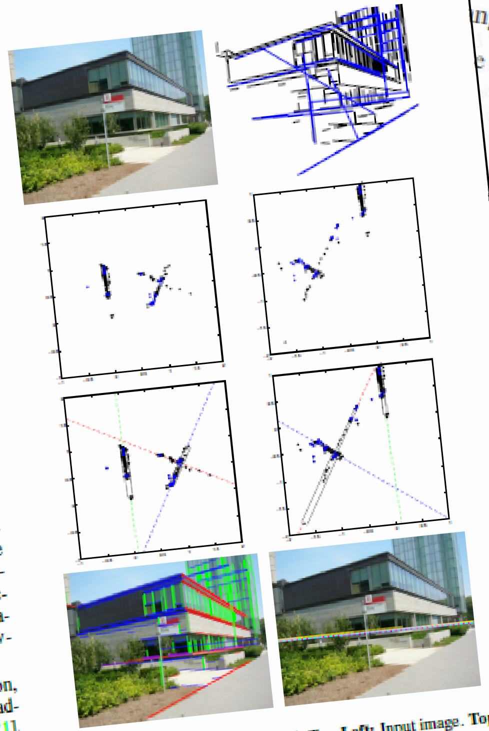

Figure 1. Main steps of our method. **Top-Left:** Input image. **Top-Right:** Line segments (black) and alignments of line segments endpoints (blue). **2nd Row:** Lines as points in *straight* (left) and *twisted* (right) PClines spaces. **3rd Row:** Aligned points detections ... and the ground truth (dashed lines). Some ...

Non-Iterative Approach for Fast and Accurate Vanishing Point Detection

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Abstract

We present an algorithm that quickly and accurately estimates vanishing points in images of man-made environments. Contrary to previously proposed solutions, ours is neither iterative nor relies on voting in the space of vanishing points. Our formulation is based on a recently proposed algorithm for the simultaneous estimation of multiple models called J-Linkage. Our method avoids representing edges on the Gaussian sphere and the computations and error measures are done in the image. We show that a consistency measure between a vanishing point and an edge of the image can be computed in closed-form while being geometrically meaningful. Finally, given a set of estimated vanishing points, we show how this consistency measure can be used to identify the three vanishing points corresponding to the Manhattan directions. We compare our algorithm with other approaches on the York Urban Database and show significant performance improvements.

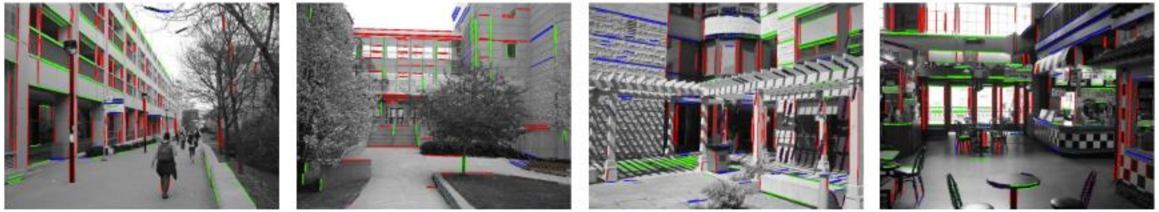
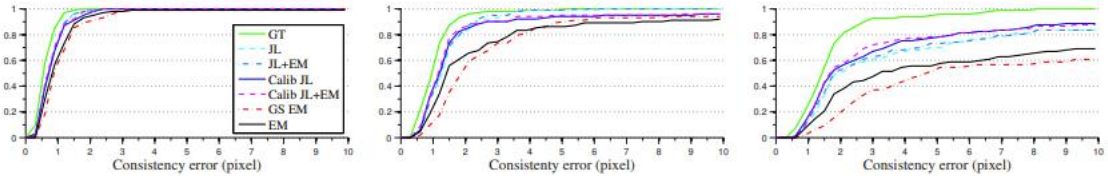
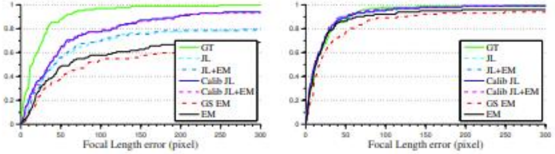


Figure 6. Results given by our algorithm on four images of the York Urban Database [11].



(a) $S_{i,1}$ (b) $S_{i,2}$ (c) $S_{i,3}$

Figure 7. Cumulative histograms of the error for three groups of ground truth edges (See text for details). The vanishing points were estimated using edges automatically detected.



(a) Edges automatically detected (b) Ground truth edges

Figure 8. Cumulative histograms of the error on the focal length

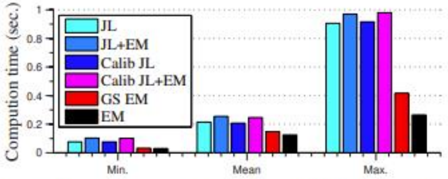


Figure 9. Computation time of the tested algorithms.

VPDETR: End-to-End Vanishing Point DEtection TRansformers

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Abstract

In the field of vanishing point detection, previous works commonly relied on extracting and clustering straight lines or classifying candidate points as vanishing points. This paper proposes a novel end-to-end framework, called VPDETR (Vanishing Point DEtection TRansformer), that views vanishing point detection as a set prediction problem, applicable to both Manhattan and non-Manhattan world datasets. By using the positional embedding of anchor points as queries in Transformer decoders and dynamically updating them layer by layer, our method is able to directly input images and output their vanishing points without the need for explicit straight line extraction and candidate points sampling. Additionally, we introduce an orthogonal loss and a cross-prediction loss to improve accuracy on the Manhattan world datasets. Experimental results demonstrate that VPDETR achieves competitive performance compared to state-of-the-art methods, without requiring post-processing.

et al. 2022; Lin et al. 2022) have shown great potential in this task. Some of the most recent state-of-the-art works suffer from some problems. NeurVPS (Zhou et al. 2019a) and Lin et al. (Lin et al. 2022) need to sample a large number of candidate points in the Gaussian sphere and classify whether they are vanishing points which is slow during inference. TLC (Tong et al. 2022) uses Transformer to classify straight lines into four categories, requiring additional line category annotations. Post-processing is also required to enhance performance. Although these works are capable of end-to-end training, they still require additional post-processing steps to produce the vanishing point as the final output. In other words, they are not entirely end-to-end because the vanishing point is not directly predicted when an image is inputted.

DETR (Carion et al. 2020) is a highly influential work in the field of object detection. It uses a transformer encoder-decoder architecture for end-to-end object detection. In

2-Line Exhaustive Searching for Real-Time Vanishing Point Estimation in Manhattan World

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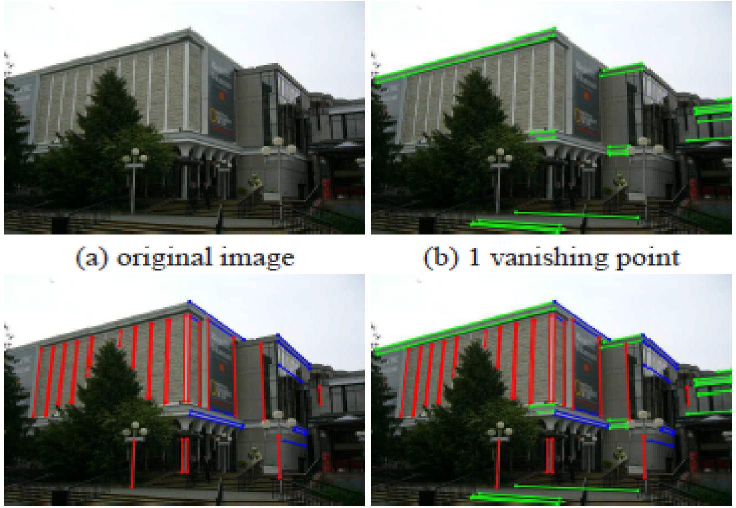
Institute for Photogrammetry, University of Stuttgart, Stuttgart, Germany

Abstract

This paper presents a very simple and efficient algorithm to estimate 1, 2 or 3 orthogonal vanishing point(s) on a calibrated image in Manhattan world. Unlike the traditional methods which apply 1, 3, 4, or 6 line(s) to generate vanishing point hypotheses, we propose to use 2 lines to get the first vanishing point $\mathbf{v}_1$*, then uniformly take sample of the second vanishing point* $\mathbf{v}_2$ *on the great circle of* $\mathbf{v}_1$ *on the equivalent sphere, and finally calculate the third vanishing point* $\mathbf{v}_3$ *by the cross-product of* $\mathbf{v}_1$ *and* $\mathbf{v}_2$*. There are three advantages of the proposed method over traditional multi-line method. First, the 2-line model is much more robust and reliable than the multi-line method, which can be applied in the scene with 1, 2 or 3 orthogonal vanishing point(s). Second, the probability of the 2-line model being formed of inner line segments can be calculated given the outlier ratio, which means that the number of iterations can be determined, and thus the estimation of vanishing points*

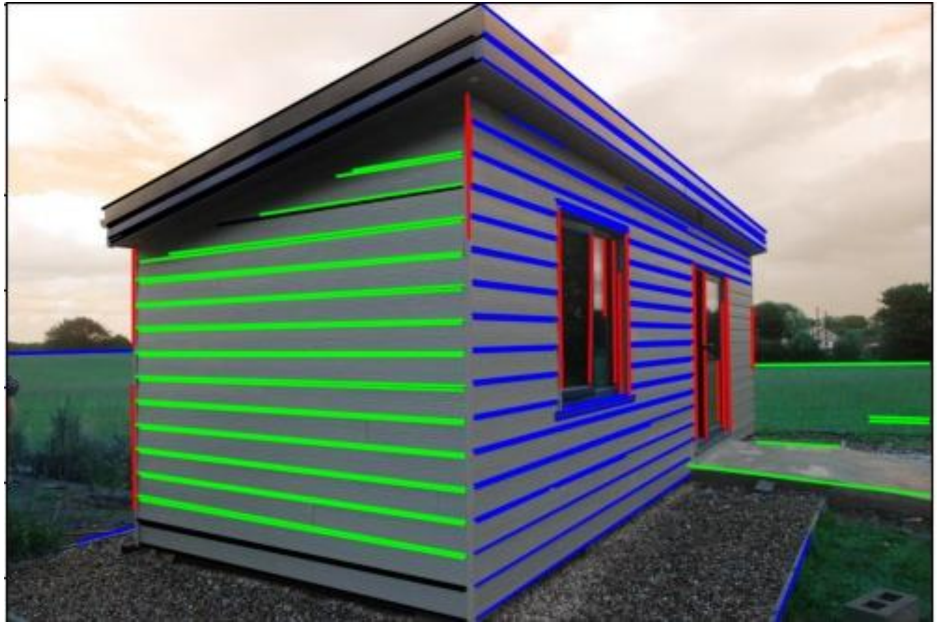


(a) original image (b) 1 vanishing point

(c) 2 vanishing points (d) 3 vanishing points

Figure 1. An illustration of vanishing point estimation results of the proposed method in the cases of 1 vanishing point (b), 2 van-

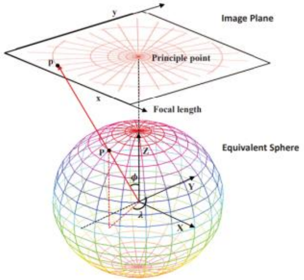
What do they do?



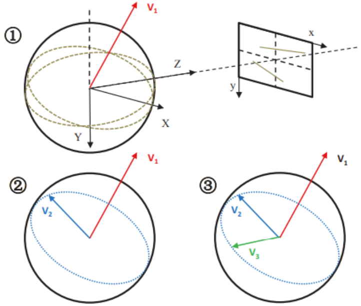
How they did it

Get the straight lines

Polar grid building



Find the points



Classify the lines

So What’s the Plan

- Calculate the Principal point
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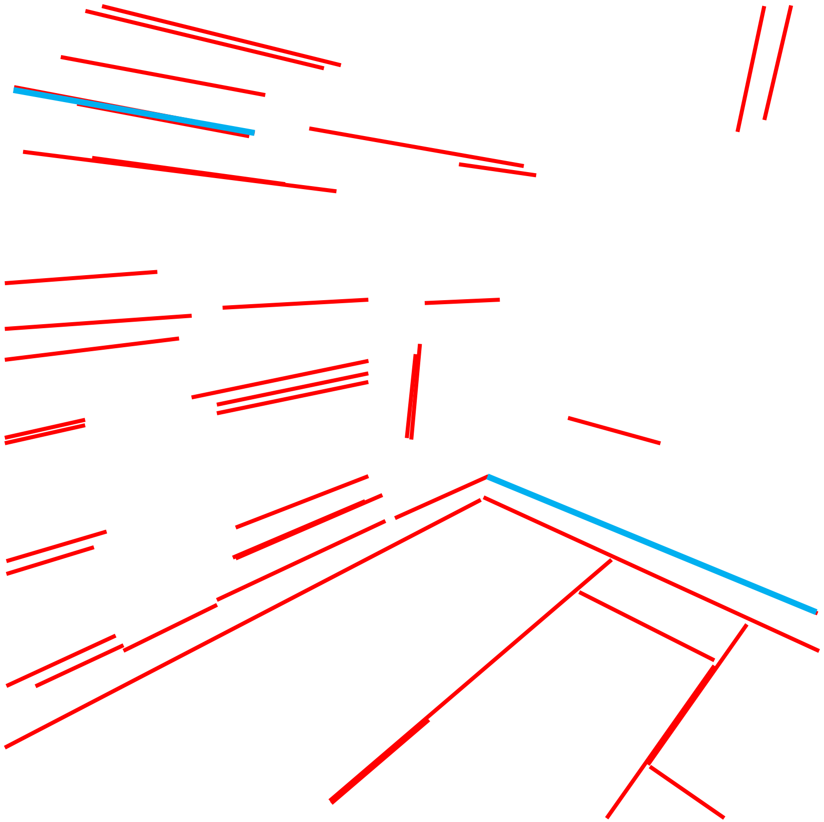
Filtering and Choosing the Best Lines



Filtering and Choosing the Best Lines

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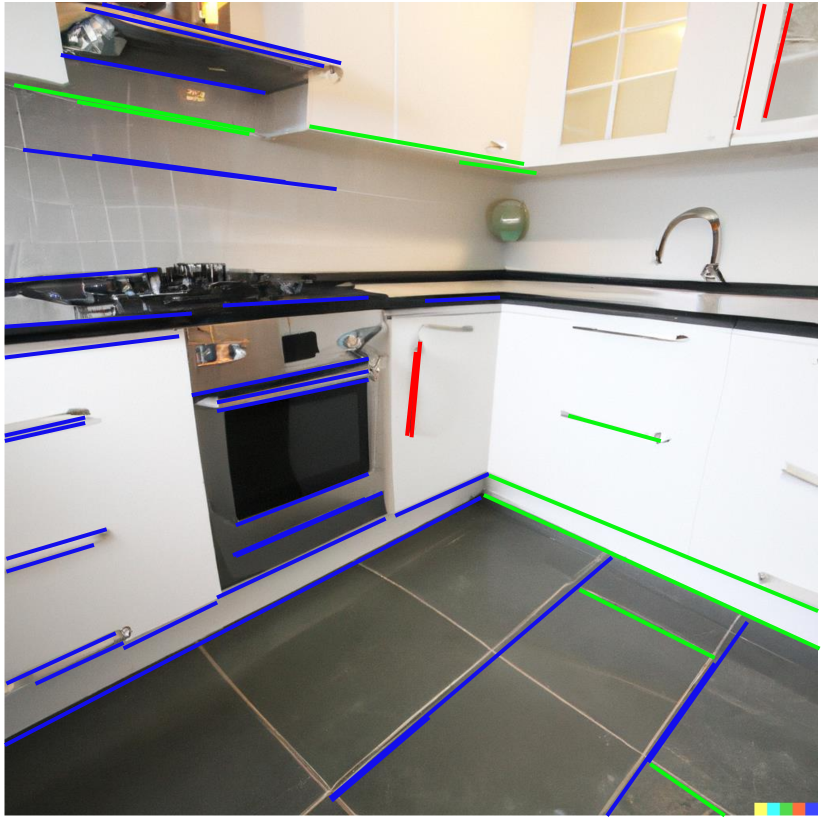

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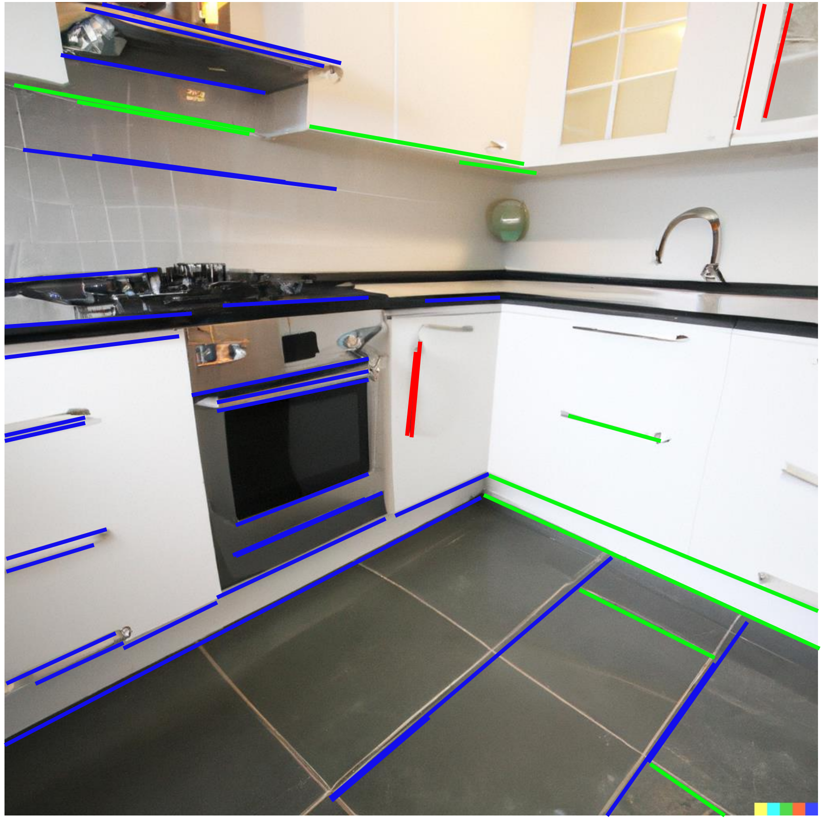

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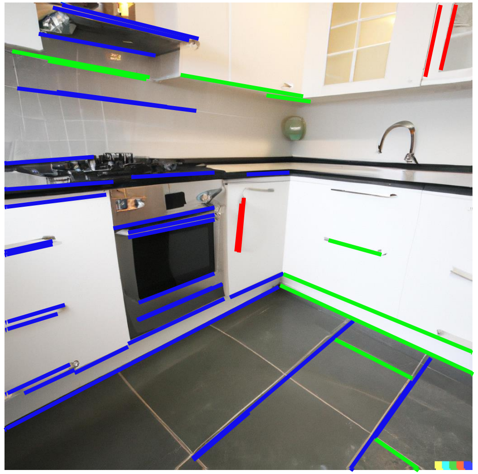

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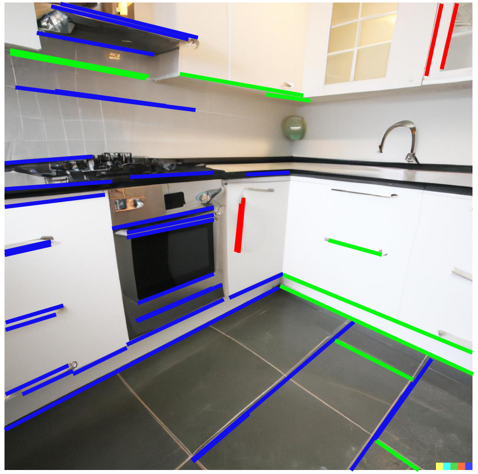

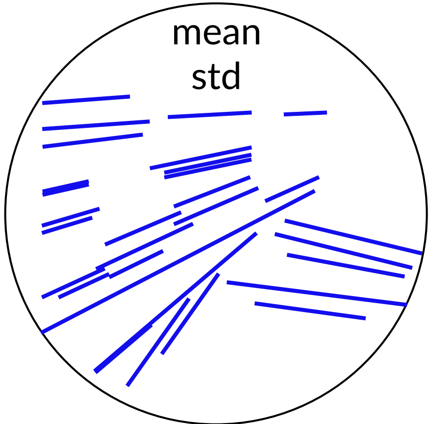

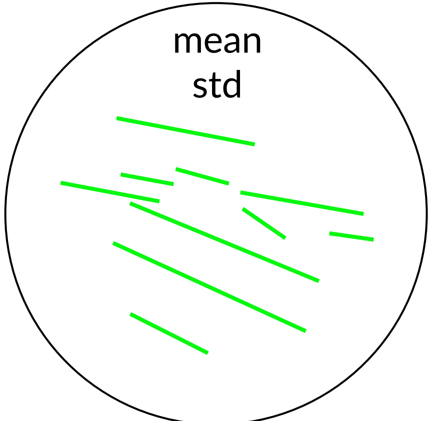

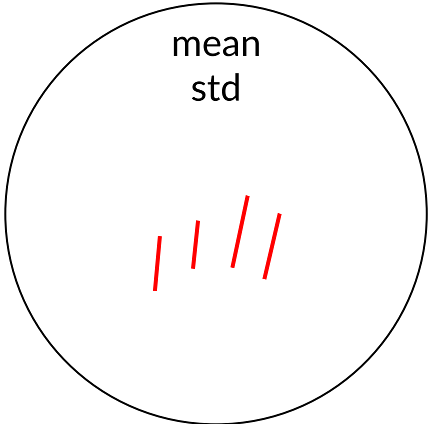

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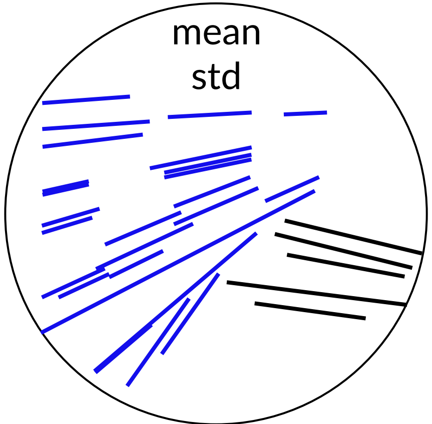

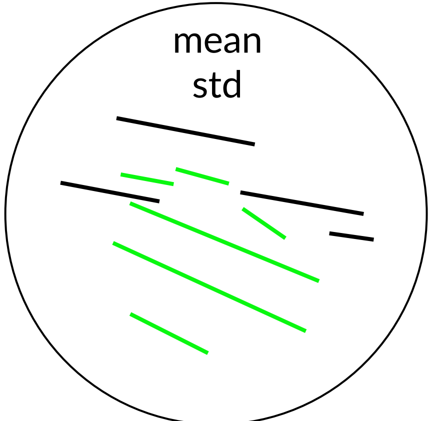

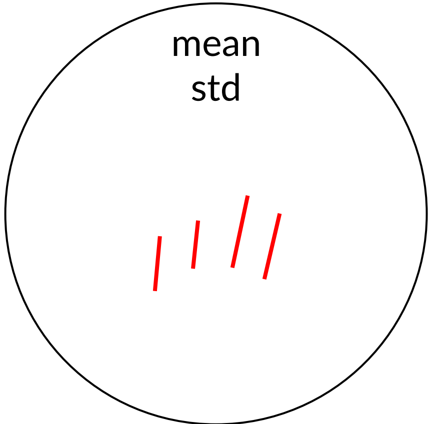

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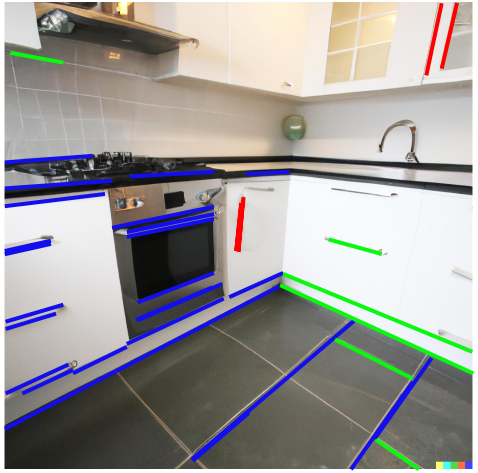

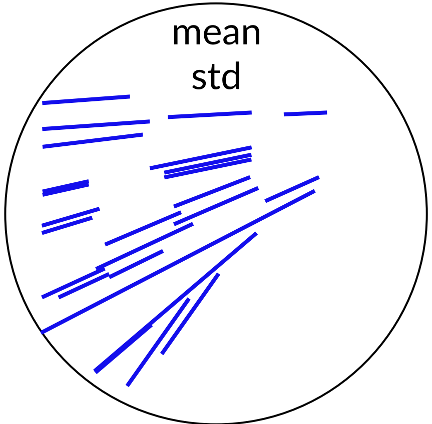

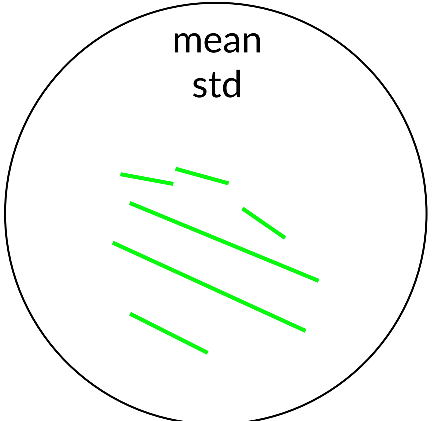

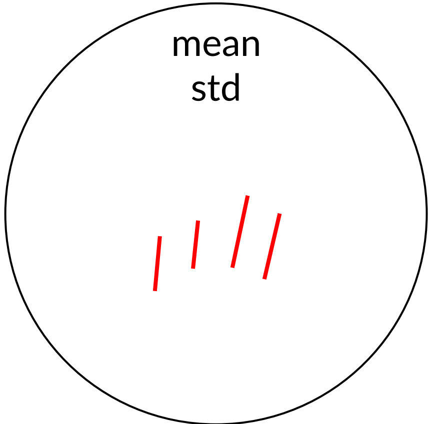

Filtering and **Choosing** the Best Lines

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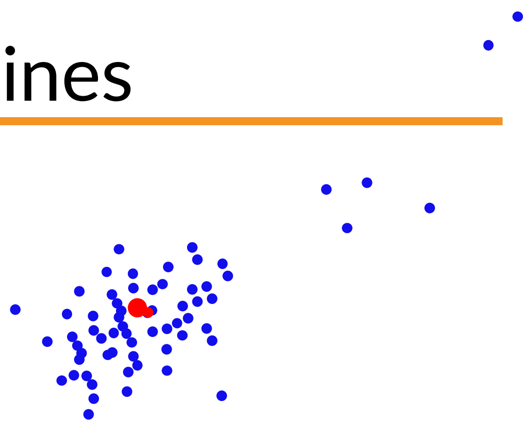

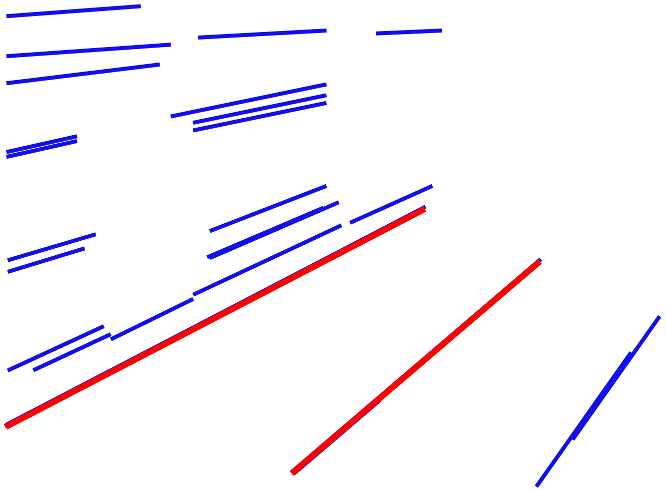

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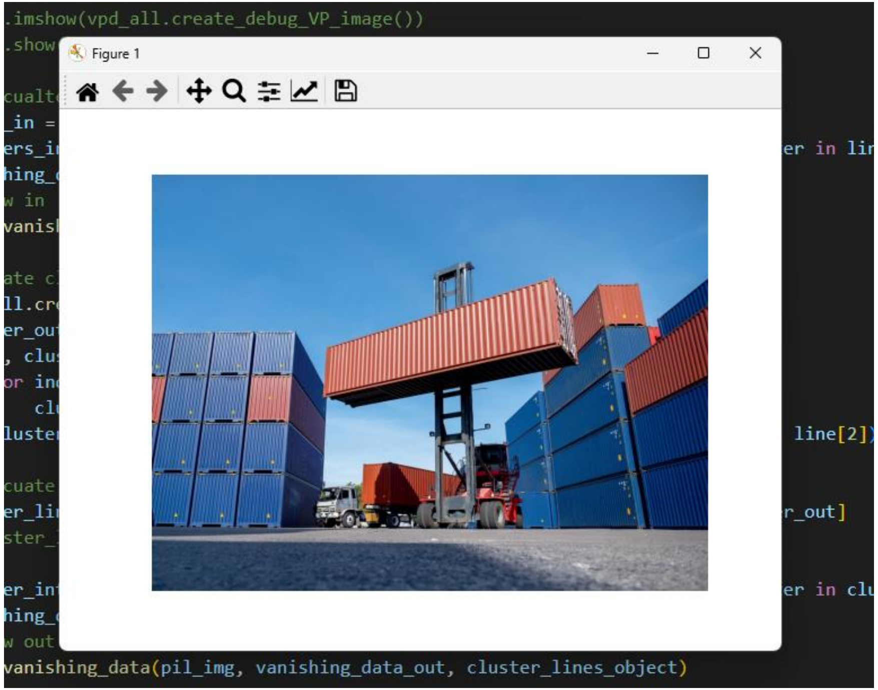
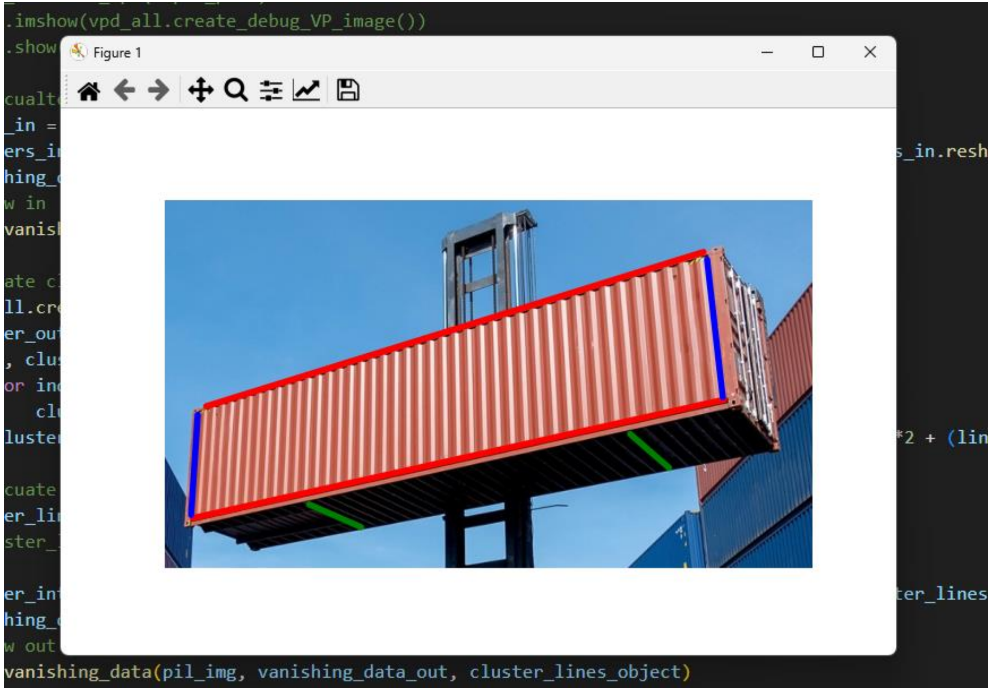
Simulation

Simulation

Input

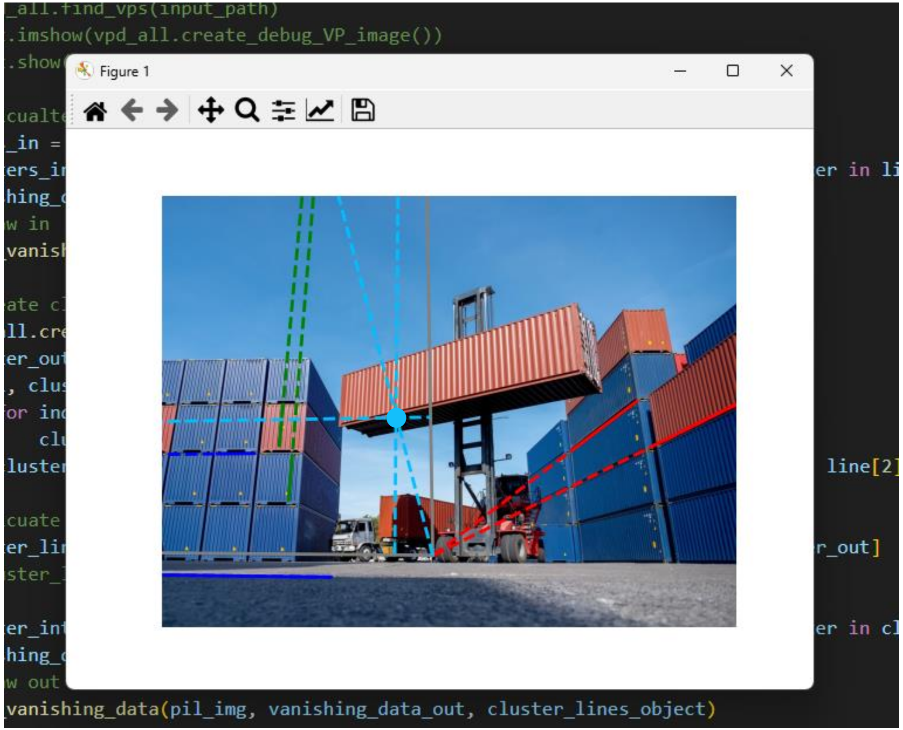


Zoom & Selection

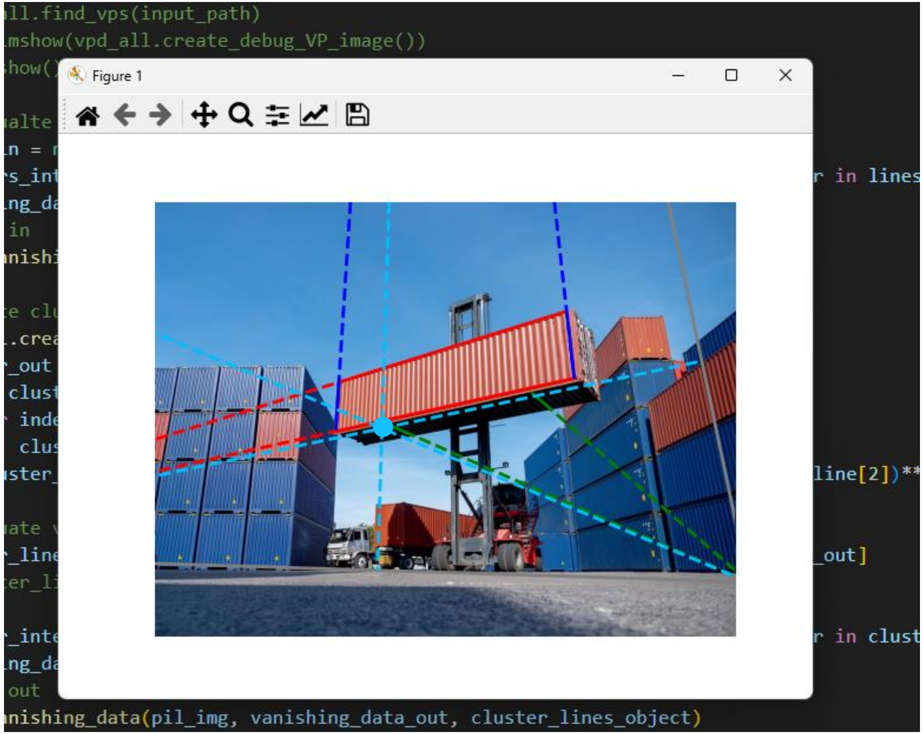


Simulation

Image PP

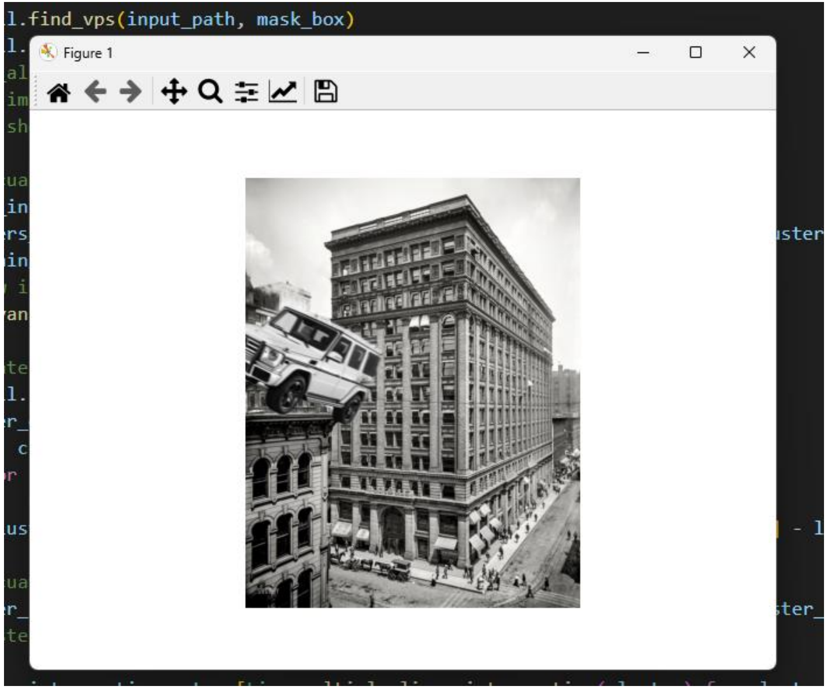


Container PP

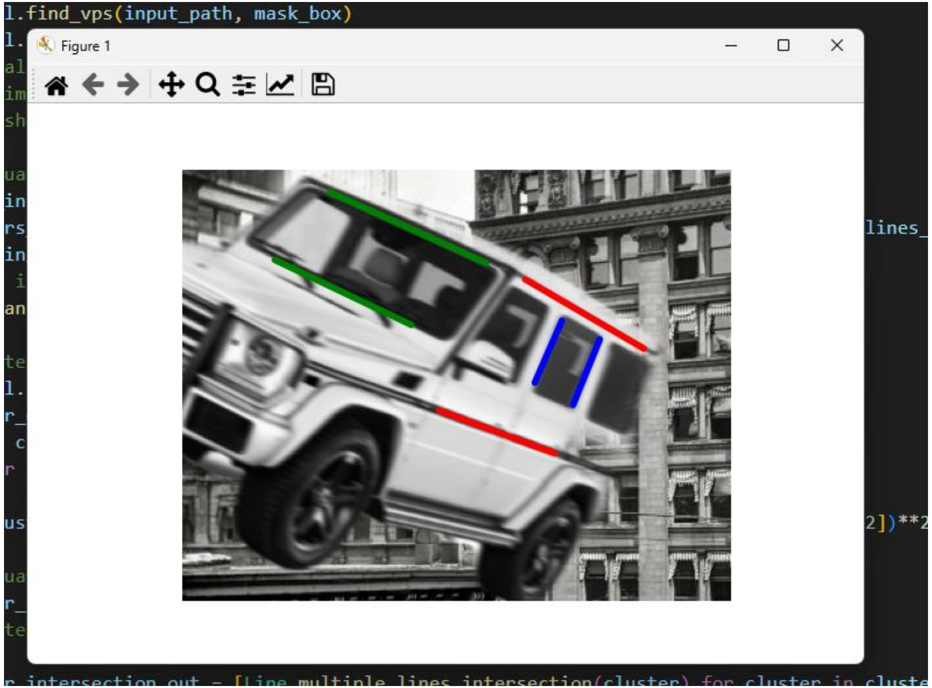


Simulation

Input

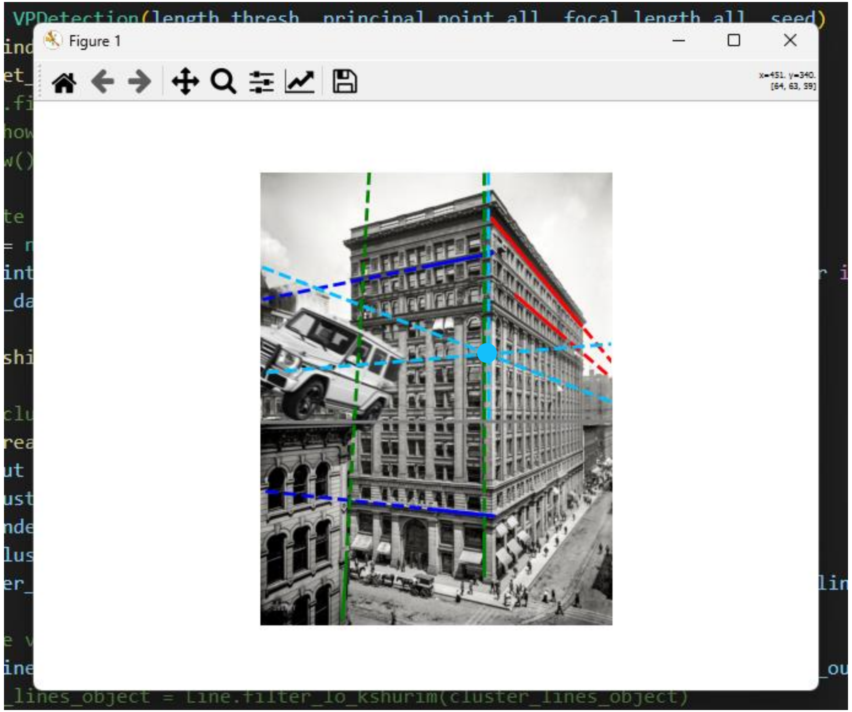


Zoom & Selection

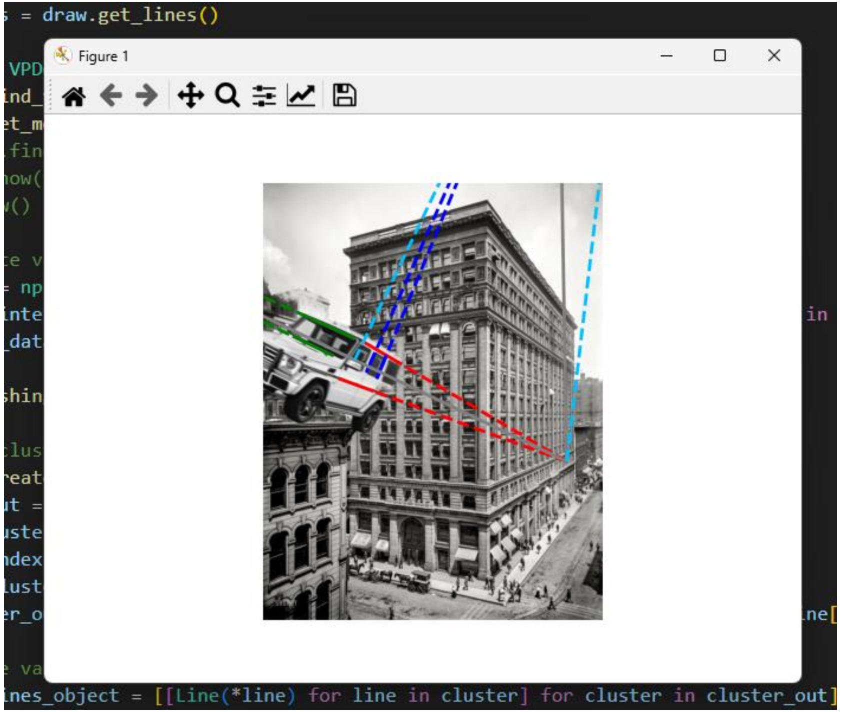


Simulation

Image PP



Fake object PP



Questions?