Generalizing Object Detection by Encoding Projection Properties to Image Representations

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KI DATA TOOLING
The Data Kit for Automotive AI

Need for Sensor Independent Object Detection

When working with data from LiDAR or Camera Sensors, objects can be represented differently in sensor data depending on distance and perspective. Projection characteristics of the sensors themselves extend this.

If trained on data from a unique sensor source, this can bias an object detector and limit the transferability to novel sensor types and models.

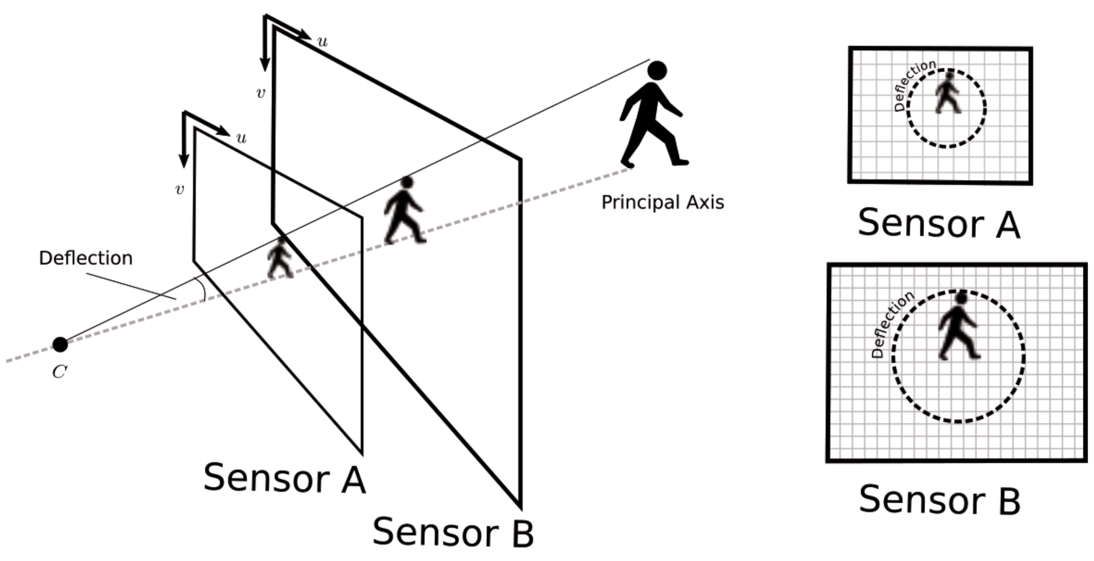

Fig. 1: Scale Arbitrarity

The pedestrian in Fig. 1 is represented at different scales and resolutions in sensor data depending on the sensor used, requiring object detectors to be scale equivariant.

Encoding Projection Properties

By encoding a deflection angle α (Fig. 2) to each pixel (u,v), the scale arbitrarily is resolved [1], allowing object detectors to learn scale equivariance from the data.

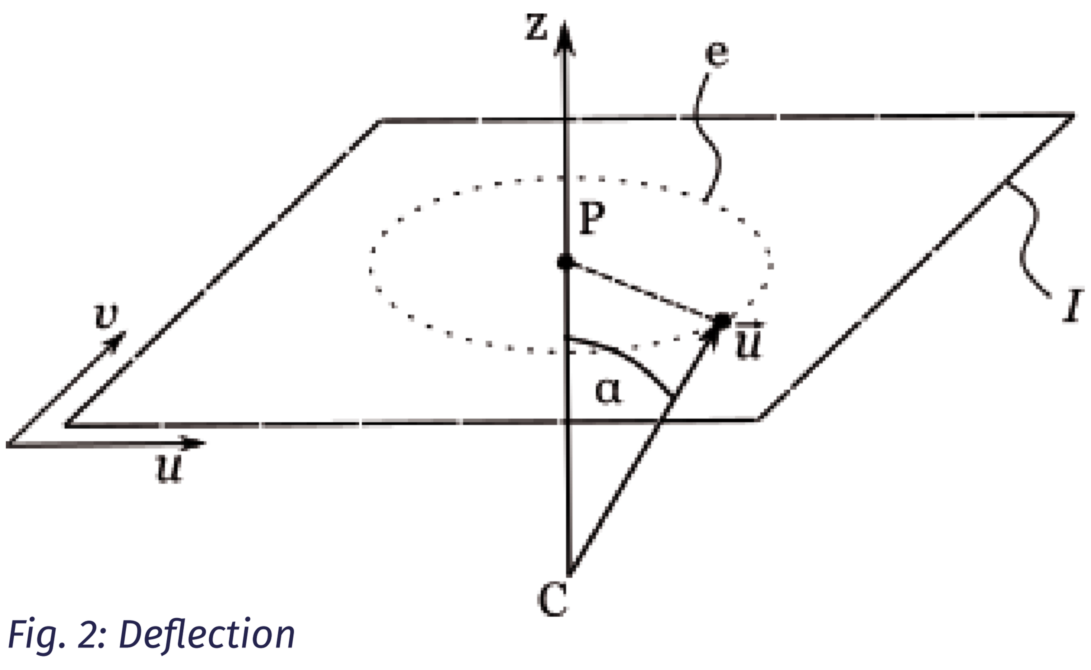

Fig. 2: Deflection

We use a Backbone with Feature Proposal Network (FPN) for processing. Using FPNs is an additional step towards scale equivariance.

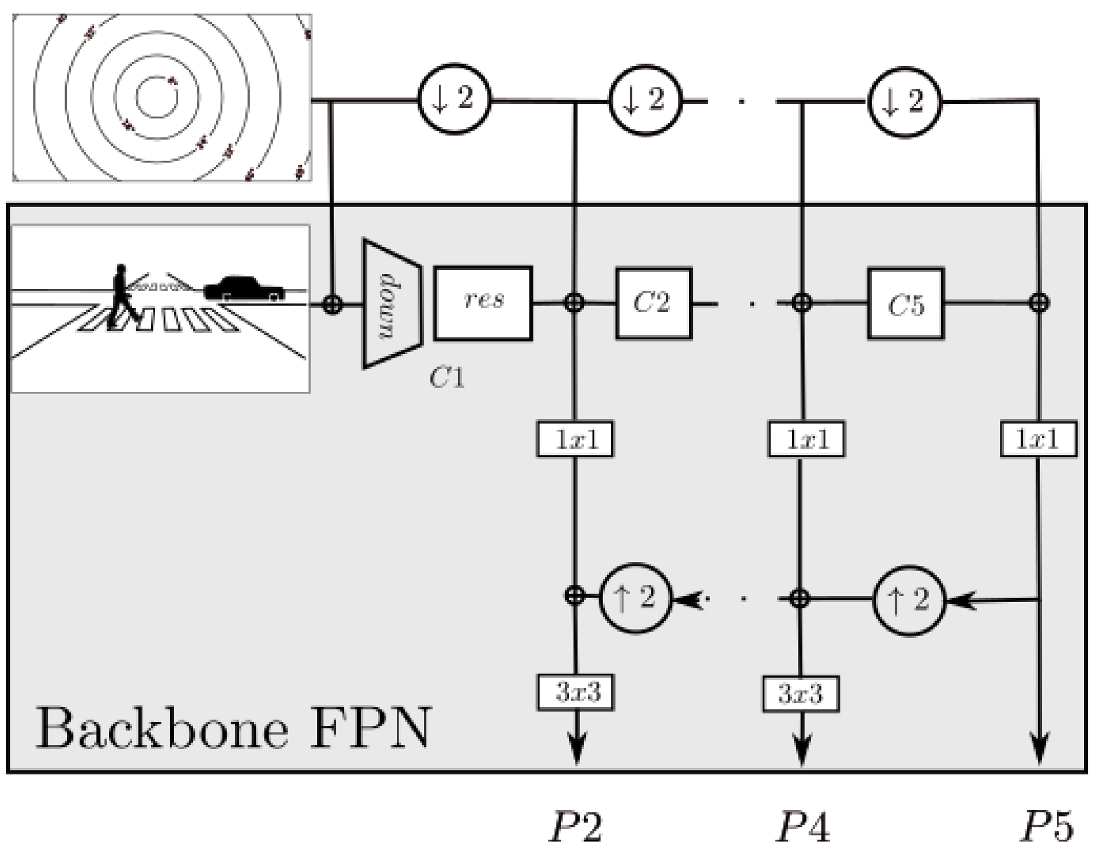

Fig. 3: Backbone architecture

We concatenate the deflection channel to the image and features at ResNet stages C, allowing the object detector to learn if the deflection is helpful at a certain point.

Application: Camera Object Detection

This allows training object detectors independent of the camera's field of view for camera data since the deflection can be built for every projection model.

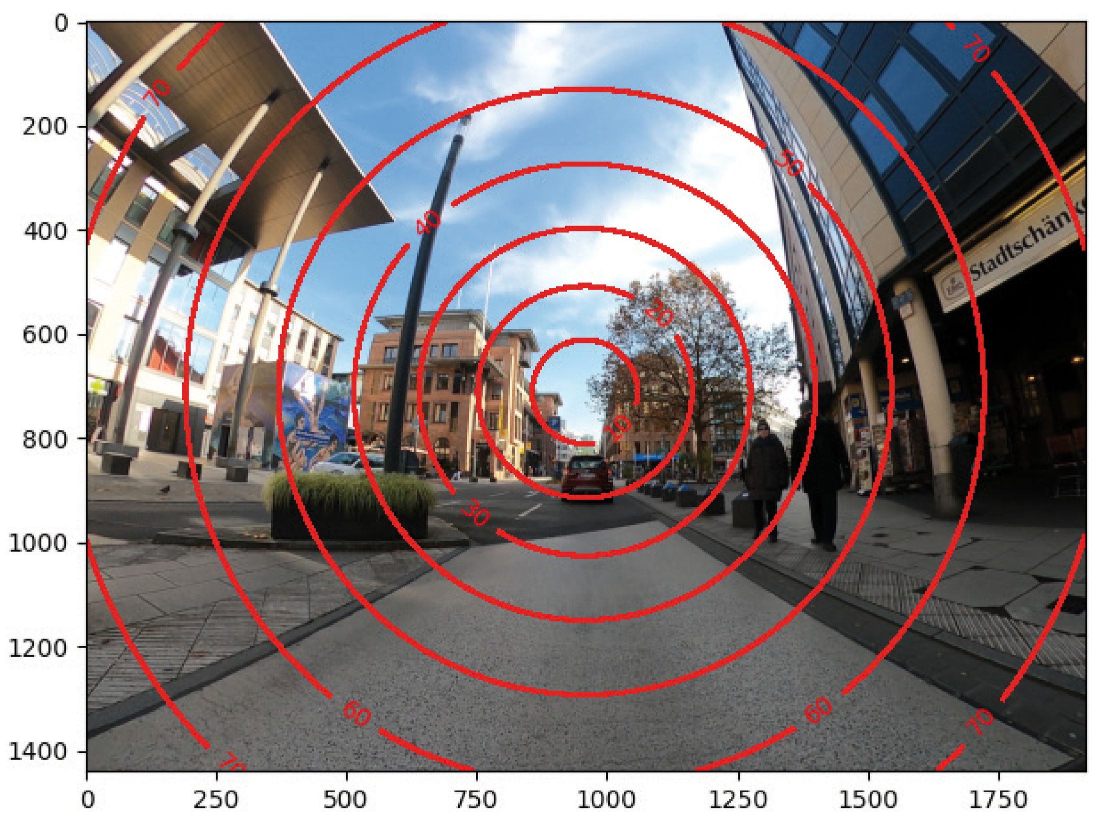

Fig. 4: Deflection for wide angle camera

Application: Local 3D reconstruction

When used with a depth-sensing device like LiDAR or stereo cameras, the deflection channel can help to recover 3D information utilizing local operations like convolutions. In addition, this enables the processing of 3D data by image processing methods.

References:

[1] An image encoding method for recording projection information of two-dimensional projections, Hannes Reichert, Konrad Doll, EPO patent application.

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KI Data Tooling is a project of the KI Familie. It was initiated and developed by the VDA Leitinitiative autonomous and connected driving and is funded by the Federal Ministry for Economic Affairs and Climate Action.

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Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag

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