The HawkEye Dataset

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Abstract

This report describes the HawkEye Dataset of paired 3D mmWave radar heatmaps and stereo camera depth-maps of cars. It includes 286 pairs of images.

1 Introduction

Since there is no publicly available mmWave radar dataset, we collect our own dataset using a custombuilt mmWave imaging platform.

2 RGB Camera Image

Directory: './Dataset/camera'
Camera: Apple iPhone XR
Dimensions: 4032 x 3024
Resolution: 72 dpi
Focal length: 4mm

3 Stereo Camera Depth-map

To capture the corresponding high resolution 2D depth maps for ground truth, we build a custom wide baseline stereo camera system. We mount an iPhone XR camera on a linear slider with sub-mm accuracy to capture multiple images of the scene, and apply a standard stereo image processing algorithm [1] to extract 2D depth maps. In the stereo camera depth-maps , we filter out pixels that do not belong to the vehicles of interest using labeled object masks generated from Mask R-CNN.

Directory: './Dataset/stereo camera'
Dimensions: 256 x 128
Field of view: [58,121] in azimuth and [75,106] in elevation.
Mapping from pixel value of distance (unit:mm) is stored in "./Dataset/stereo camera/ItoD_table.mat"

4 mmWave Radar Heatmap

4.1 3D Radar Heatmap

Directory: './Dataset/radar'
File type: '.mat' MATLAB binary data container format.
Variable name: 'sph_pwr'
Dimensions: 96 (range), 64 (azimuth angle), 32(elevation angle)
Field of view and resolution:
Range r [3,15) meters field of view with resolution of 12.5 cm.
Azimuth ϕ [58°,121°] field of view with 1° resolution.
Elevation θ [76°,107°] field of view with 1° resolution.

4.2 Radar Configuration

We leverage Synthetic Aperture Radar (SAR) to emulate a 2D antenna array by mechanically scanning a single mmWave radio.
We build a 2D SAR platform shown in Fig. 1 using three FUYU FSL40 linear sliders. We mount a Pasternack 60 GHz radio front-end on the SAR platform as the receiver, and another radio on the side as the transmitter. We use omni-directional antennas for both the transmitter and receiver to have a maximum field-of-view of 180° in azimuth and 35° in elevation. The horizontal slider scans the mounted receiver radio along the X-axis, while two vertical sliders scan along the Z-axis. We scan a fraction of $10cm \times 10cm$ area to emulate a 40×40 array at 60 GHz, which provides $\sim 8°$ angular resolution along azimuth and elevation axes.
We send FMCW (Frequency Modulated Continuous Wave) radar waveform with a bandwidth of 1.5 GHz sweeping at a center frequency of 60.15 GHz.
After aligning the received radar signal to the antenna positions in the array, we apply Fast Fourier Transform and conventional beamforming in sequence to estimate the reflected signal power from every voxel (ϕ, θ, ρ) to generate the 3D mmWave radar heatmap.

References

[1] H. Hirschmuller, "Stereo processing by semiglobal matching and mutual information," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 30, no. 2, pp. 328–341, Feb. 2008.

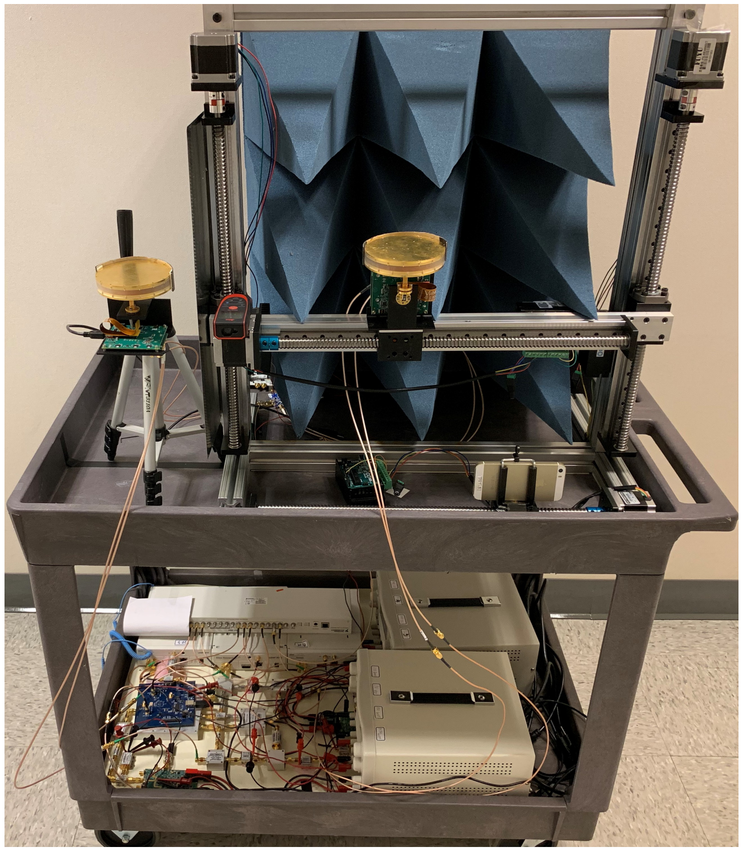

Figure 1: Data Collection Platform

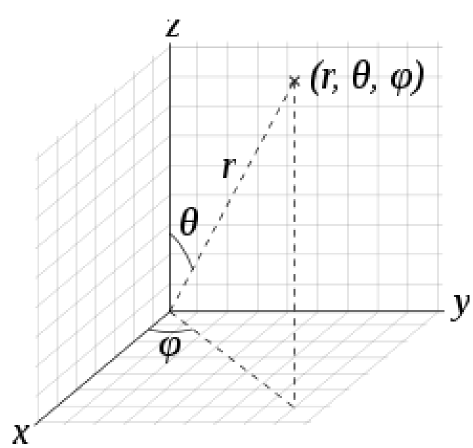

Figure 2: Radar heatmap voxels in the spherical coordinates