The HawkEye Dataset

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Abstract

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

1 Introduction

Since there is no publicly available mmWave radar dataset, we collect our own dataset using a custom-built data collection platform as shown in Fig. 1. It consists of a custom-built mmWave imaging system using 60 GHz radios and a SAR (Synthetic Aperture Radar) platform, as well as a custom-built stereo camera system using iPhone XR camera on a linear slider.

2 RGB Camera Image

In this section, we list the details of RGB camera data and the parameters of the camera used:

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

3 Stereo Camera Depth-map

This section, we describe our custom-built stereo camera system and the details of the depth-map data.
We mount an iPhone XR camera on a linear slider with sub-mm accuracy to capture images of the scene at 9 positions with 5cm spacing in between. We 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

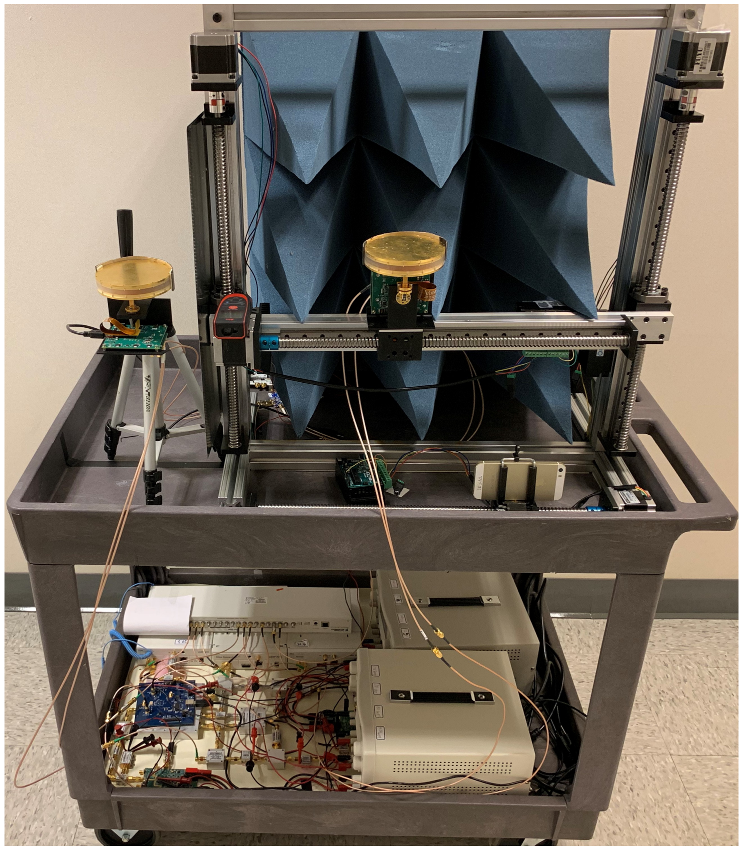

Figure 1: Data Collection Platform

vehicles of interest using labeled object masks generated from Mask R-CNN [2].

Depth-map data 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

In this section, we describe our custom-built mmWave radar imaging system and the details of the 3D mmWave heatmap data.

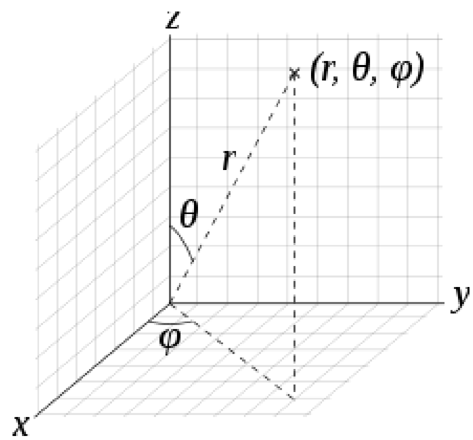

Figure 2: Radar heatmap voxels in the spherical coordinates

4.1 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.

4.2 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.

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.

[2] K. He, G. Gkioxari, P. Dollr, and R. Girshick, "Mask r-cnn," in *2017 IEEE International Conference on Computer Vision (ICCV)*, Oct. 2017, pp. 2980–2988.