A MATLAB Script for Visualizing and Processing BOREAS Dataset Road Driving Sensor Data: LiDAR, Radar, and Camera.

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***Abstract*—This study presents an alternative approach to accessing the BOREAS dataset by utilizing MATLAB's built-in functions. Recently, one of the most intriguing research areas has been vehicle perception and simultaneous localization and mapping (SLAM) for different weather conditions. To simplify the process of opening the dataset in a toolbox, we have developed this project to assist researchers. Now, instead of concentrating on how to open the dataset in MATLAB, researchers can concentrate on their main project work. MATLAB has impressive functionalities for manipulating data in an offline setting. In this work, we have used inbuilt commands to open the BOREAS Dataset in MATLAB and inspect the various LIDAR, RADAR, and Camera datasets for future applications. The data can be used in real and practical experiments in the field of autonomous driving. This thesis is divided into two parts: (i) to open the LIDAR, RADAR, and Camera datasets with individual plots, and (ii) to open the LIDAR, RADAR, and Camera datasets with concurrent plots. These datasets were obtained from the Boreas: A Multi-Season Autonomous Driving Dataset**

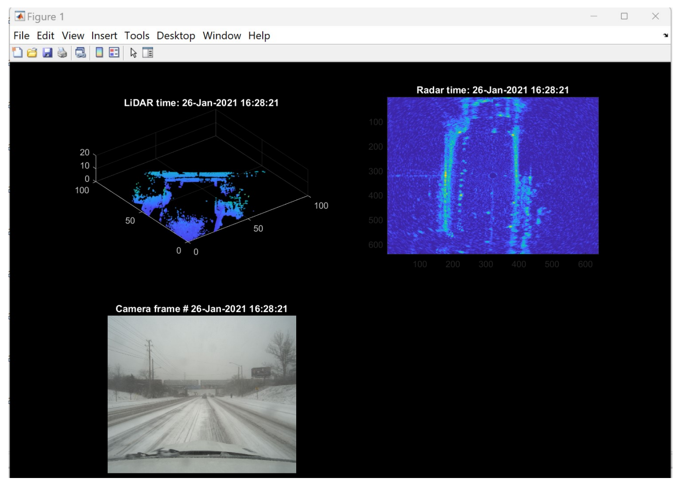

Fig. 1. Concurrent visualization of camera, liDAR, and radar

I. Introduction

Advanced Driver Assistance Systems (ADAS) are technologies that can aid automobile drivers by providing useful information, warnings of potential hazards, and taking corrective measures in specific situations. Autonomous cars depend on various sensors to collect data about their environment and decide on how to operate the vehicle. These sensors include cameras, lidar (light detection and ranging), radar, and ultrasonic sensors. Cameras capture visual information about the road, such as lane markings, traffic signals, and other cars. Lidar and radar sensors measure the distance and speed of the objects in the vehicle's surroundings, including pedestrians, other vehicles, and obstacles. Ultrasonic sensors are used for close-range sensing, such as when parking or manoeuvring in tight spaces. The sensors provide information to the car's ADAS system, which uses algorithms and artificial intelligence to interpret the data and decide how to operate the vehicle. For example, the ADAS system may use sensor data to detect the road without lane markers, or prevent an imminent collision and take evasive action as braking or steering to avoid the collision. ADAS can also assist with lane keeping, adaptive cruise control, and parking assistance. Autonomous car sensors and ADAS technology provide a safer and more efficient driving experience. ADAS technology has the potential to reduce accidents and make driving more accessible and enjoyable for everyone by gathering data about the environment and assisting drivers with critical decisions. Influence of Weather conditions on driving: This can significantly affect driving, and it is crucial to modify your driving behavior accordingly to ensure safety on the road. Rain, ice, and snow can make roads slippery, reducing traction and increasing the likelihood of accidents. Fog can also impair visibility, challenging spotting other vehicles, pedestrians, or road signs. It is also important to slow down and increase the distance between vehicles, as sudden stops may be difficult to see in low visibility conditions. In conclusion, adapting your driving behavior according to weather conditions is necessary to ensure safety on the road. By reducing speed, increasing the distance between vehicles, and taking other safety measures, you can minimize the risk of accidents and keep yourself and others safe. Boreas has done an amazing job capturing all these datasets.

The BOREAS dataset: This dataset [1] has been compiled by driving along the same route repeatedly for an entire year. It exhibits significant fluctuations due to various seasonal and weather changes, such as precipitation and snowfall. The dataset comprises more than 350 kilometers of driving data, and precise ground truth postures have been post-processed with centimetric accuracy. It is accompanied by a 128-channel Velodyne Alpha Prime lidar, a 360-degree Navtech CIR304-H scanning radar, and a 5-megapixel FLIR Blackfly S camera. The dataset also provides up-to-date leaderboards for odometry, metric localization, and 3D object detection.

TABLE I
SENSORS USED TO COLLECT THE BOREAS DATASET

Sensors Used for the Boreas Data Acquisition	
Sensor Name	Specification
Applanix POSLV 220 Navtech CIR304-H Radar	200Hz,0.0438 m range solution,0.9° horizontal resolution,250m range,4 Hz
FLIR Blackfly S,2448 $\times$ 2048(5MP) Camera(BFS-U3-51S5C)	2448 $\times$ 2048 (5 MP) 81° HFOV $\times$ 71° VFOV, 10 Hz
Velodyne Alpha-Prim Lidar	128beams,0.1°vertical resolution(variable),360°HFOV $\times$40°VFOV,300m range(10 % reflectivity), 2.2M points/s, 10 Hz

Boreas code on Github: According to their GitHub directions, the Boreas dataset can currently be viewed only through some Python scripts. Several scripts interface with each other to view the LIDAR, RADAR and CAMERA Data. We have replicated the same Python scripts using MATLABs inbuilt functions for a better pre and post-processing of the data. MATLAB is a well-known tool for all the functions it has, and the AI processing for offline Data-Processing. MATLAB code to visualize three sensor modalities: When you run the script, the code iterates through a FOR loop for LIDAR RADAR and CAMERA. Inside the FOR loop, some commands point MATLAB to a directory which contains the BOREAS data. It then iterates through these files in a synchronous order. Now the naming convention followed for the file names is a UNIX timestamp, which is in an ascending order. We have made use of the time gap method to show the matching frames. When its time to show an image, MATLAB goes through each file, opens it, does the processing, shows the figure to the user and then swaps the old image with a new one. This creates a continuous visualization for each time stamp as MATLAB iterates over these files from start to end.

II. MATLAB: PSEUDU CODE FOR VISUALIZATION

The above process can be enhanced by utilizing MATLAB functions and AI technologies for offline data processing;

```
%% close figures, delete variables
%% Define sensor sub-folder paths: LiDAR, RADAR, and Camera
%% Read sensor frame files: LiDAR, RADAR, and Camera

%% Find EARLIEST sensor time
% Define display loop START time

%% Find LATEST sensor time
% Define display loop END time

%% Time-based display loop of frames
% Set list index of starting frames to 1.
% Set time_presicion: when to plot frames
% Set time_step
% FOR loop from START time to END time
    % LiDAR frame reading
    % LiDAR frame time extraction

    % RADAR frame reading
    % RADAR frame time extraction

    % Camera frame reading
    % Camera frame time extraction

    % Plot lidar frame if the time within the precision
    %  --> increment lidar frame index.
    % Plot radar frame if the time is within the precision
    %  --> increment radar frame index.
    % Plot camera frame if the time is within the precision
    %  --> increment camera frame index.
%% End time-loop
```

Fig. 2. MATLAB visualization script pseudo code

The RADAR, LIDAR, and VISION data on MATLAB are imported from the BOREAS directory. The RADAR and VISION data are images in the PNG format. But for LiDAR, we have to process and visualize the data using the Point Cloud Processing Toolbox. We have done the signal processing, through MATLAB's plotting tools, such as plot() and imshow(). MATLAB is helpful for academics and engineers working with autonomous cars or similar subjects since it offers many tools and functions for processing and visualizing RADAR, LIDAR, and VISION data.

III. CODE AVAILABILITY AND LICENSE

The MATLAB script 'Show_BOREAS.m' and some of the sample BOREAS data files can be downloaded at Nathir Rawashdeh's Digital Commons page at Michigan Tech at https://digitalcommons.mtu.edu. Extract the ZIP file, open MATLAB, and run the script.

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REFERENCES

[1] Keenan Burnett, David J Yoon, Yuchen Wu, Andrew Z Li, Haowei Zhang, Shichen Lu, Jingxing Qian, Wei-Kang Tseng, Andrew Lambert, Keith YK Leung, et al. Boreas: A multi-season autonomous driving dataset. *The International Journal of Robotics Research*, page 02783649231160195, 2023.