International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 06 | June 2020 www.irjet.net p-ISSN: 2395-0072

Simulation of Advanced Driver Assistance Systems Using Radar and OpenCV Library

Catherine Monisha.M[1], Muthukumaran.K[2]

[1]*PG Scholar, Dept of ECE, St.Joseph's College of Engineering, Chennai, India*
[2]*Assistant Professor, Dept of EIE, St.Joseph's College of Engineering, Chennai, India*

Abstract - *In order to make sure the protection of drivers, Advanced driver assistance system has drawn increasingly more consideration. Automotive adaptive cruise control and lane detection system are the key highlights of Advanced Driver Assistance Systems(ADAS).While the aggregate of these features creates a semi autonomous vehicle, most require the driver to persist in control of the vehicle while it is in use. In this paper, Automotive adaptive cruise control system using the 77GHz Frequency Modulated Continuous Wave(FMCW) radar to performs range and Doppler estimation of a vehicle and root multiple signal classification is an algorithm to extricate both the beat frequency and the Doppler shift . The Fast Fourier Transform is acted in both range and Doppler to draw out the beat frequency as well as the Doppler shift. This system has been simulated by using Matlab software. Then the OpenCV Python has been used to detecting the lane lines. The OpenCV tools like the region of interest selection, gray scaling, Canny Edge Detection, and Hough Transform line detection are being utilized.*

Key Words: Adaptive Cruise Control, Hough Transform, OpenCV, NumPy, Matplotlib.

1. INTRODUCTION

Advanced Driver Assistance Systems (ADAS) is defined as set of frameworks developed for vehicles in order to robotize, adjust or upgrade vehicle systems for safety purpose and better driving. These systems comprises of safety features that are designed to avoid collisions and accidents by offering technologies to alert the driver to possible and or avoid collisions by implementing safeguards and taking over control of the vehicle. An introduction of ADAS system is the necessity of the hour for a secure and safer experience of the roads. The majority of the cases have indicated humans at fault. In fact, human blunder represents for 95% of all road accidents. ADAS helps drivers behind the wheels in making a judgement so as to avoid mishaps.

2. ADAPTIVE CRUISE CONTROL USING FMCW RADAR

Frequency modulated continuous waveform (FMCW) radars are getting progressively famous, particularly in automotive applications such as Automotive Adaptive Cruise Control (ACC). The transmitter of an FMCW system sends a chirp signal with high frequency and large bandwidth. The transmitted signal hits the target and is reflected back toward the receivers with a time delay and a frequency shift that depends on the target distance and relative speed. By blending the transmitted and the received signal, the time delay relates to a frequency difference that produces a beat frequency. In FMCW radar, the beat frequency is used for the target recognition and the velocity estimation. The beat frequency comprises of the range beat frequency and the Doppler frequency.

In FMCW, the received signal is a time-delayed copy of the transmitted signal where the delay, Δt, is related to the range. Because the signal is always sweeping through a frequency band, at any moment during the sweep, the frequency difference f_b is a constant between the transmitted signal and received signal. f_b is usually called the beat frequency.

3. THE ALGORITHM USED IN ACC

There are three types of algorithms has been employed in adaptive cruise control system. There are range and velocity detection, Two dimensional Fast Fourier Transform(FFT) and Root multiple signal classification.

3.1 Range and Velocity Detection

We know that Radar transmits a signal to the target and accordingly the target sends an echo signal to the Radar with the speed of light, C. Let the time taken for the signal to travel from Radar to target and back to Radar be 'T'. The two way distance between the Radar and target will be 2R, since the distance between the Radar and the target is R.

$$R = \frac{c T_s f_b}{2 B_{sweep}}$$

Where T_s is the sweep time; f_b is the beat frequency; B_{sweep} is the sweep bandwidth.

The received signal is a time delayed copy of the transmitted signal where the delay, t_d is related to the range.

$$t_d = \frac{2R}{C}$$

A moving target induces a doppler frequency shift with the radar wavelength λ. The beat frequency is not only related to the range of the target, but also to its relative radial velocity.

$$f_D = \frac{2V_r}{\lambda}$$

Where f_D is the doppler frequency; V_r is the radial velocity; λ is the radar wavelength.

3.2 2D FFT

The waveform generator produces the FMCW signal. Then the transmitter antenna amplify the signal and radiate the signal into the free space. The signal propagates to the target vehicle, gets reflected by the target, and goes back to the vehicle with radar mounted on it. Then the receiving antenna gathers the signal. The received signal is dechirped and stored in a buffer. Once a certain number of sweeps fill the buffer, the 2D FFT is acted in both range and Doppler to extricate the beat frequency as well as the Doppler shift.

3.3 Root MUSIC Algorithm

A root multiple signal classification(MUSIC) is an algorithm utilized for frequency estimation and radio direction finding. The spectral density characterizes the frequency content of the signal. One cause of estimating the spectral density is to detect any periodicities in the information. A radio direction finding, is the measurement of the direction from which a received signal was transmitted. By consolidating the direction information from two or more suitably spaced receivers, the source of a transmission is found via triangulation.

4. LANE DETECTION USING OPENCV

The project involves detection of lane lines in an

image using Python and OpenCV. OpenCV means "Open-Source Computer Vision", which is a package that has many useful tools for analyzing images. The python OpenCV tools like Region of interest, Grayscale conversion, Canny edge detector and Hough line transform has been employed.

4.1 Region of Interest

This step is to take into account only the region covered by the road lane. A mask is made here, which is of the same dimension as our road image. Moreover, bit-wise AND operation is performed between each pixel of our canny image and this mask. It ultimately masks the canny image and shows the region of interest traced by the polygonal contour of the mask.

4.2 Grayscale Conversion of Image

The road image is in RGB format, RGB is changed over to grayscale because processing a single channel image is quicker than processing a three channel colored image.

4.3 Canny Edge Detector

The canny edge detector is an edge detection operator that utilizes a multi stage algorithm to recognize a wide range of edges in images. It computes gradient in all directions of our obscured image and traces the edges with large changes in intensity.

4.4 Hough Line Transform

The Hough Line Transform is used to detect straight lines. The Probabilistic Hough Line Transform is utilized here, which gives output as the extremes of the detected lines.

5. LIBRARY AND TOOLS USED

Several tools and libraries are used such as OpenCV, NumPy and Matplotlib.

5.1 OpenCV

OpenCV is an open-source library for the computer vision, which is defined as a field of study that helps computers to understand the content of the digital images such as photographs and videos. The purpose of computer vision is to understand the content of the pictures. It extricates the description from the pictures, which might be an object, a text description, and three-dimension model, etc.

5.2 NumPy

NumPy is a Python package which means 'Numerical Python'. It is the core library for scientific computing, which contains a powerful n-dimensional array object provide tools for coordinating C, C++ and Fortran code. It is additionally valuable in linear algebra, Fourier transform, and random number capabilities.

5.3 Matplotlib

Matplotlib is a Python library that helps in envisioning and examining the data and helps in better understanding of the data with the help of graphical, pictorial representations that can be simulated using the matplotlib library.

6. RESULTS

The adaptive cruise control system is implemented by using Frequency modulated continuous wave(FMCW) Radar and MATLAB software. The image results are shown in the figure below:

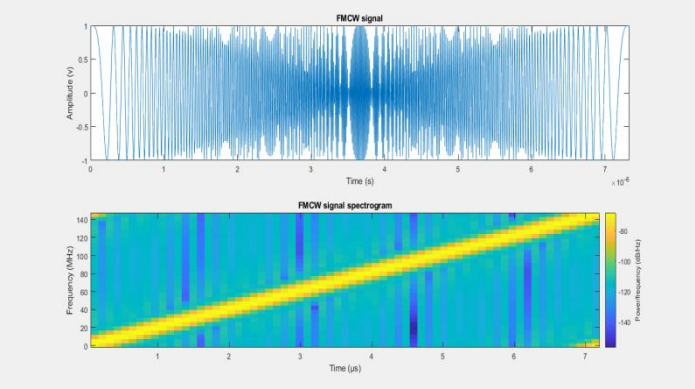

Fig -1: FMCW waveform

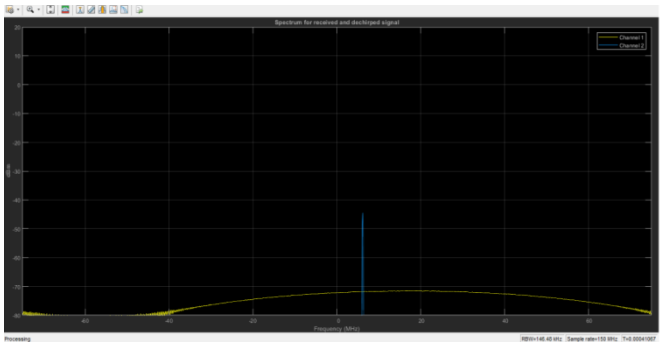

Fig -2: Transmitted and received signal

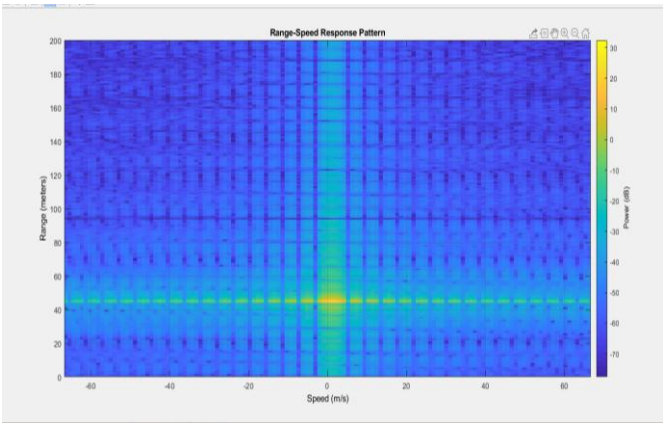

Fig -3: Range and velocity output

Then the lane detection system is implemented by using Python and OpenCV. The screenshot results are shown in the figure below:

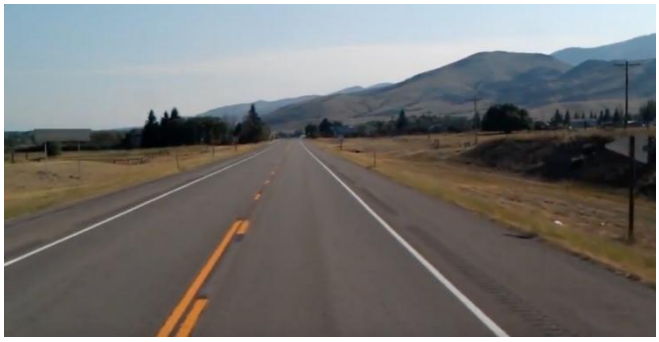

Fig -4: Input image

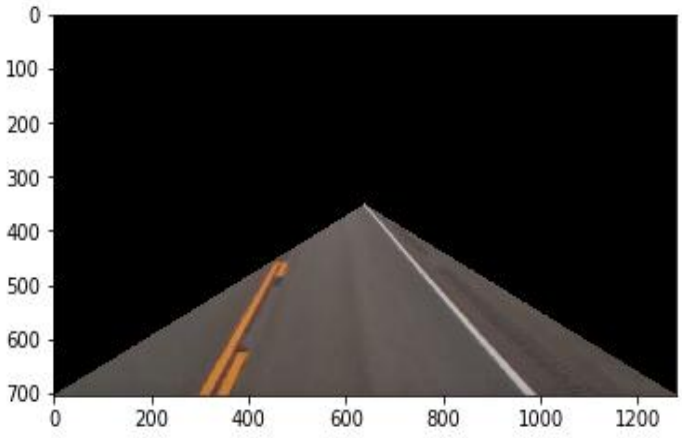

Fig -5: Region of interest

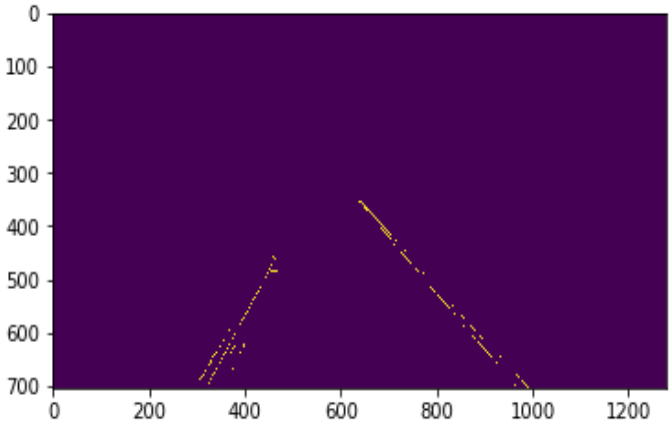

Fig -6: Canny image

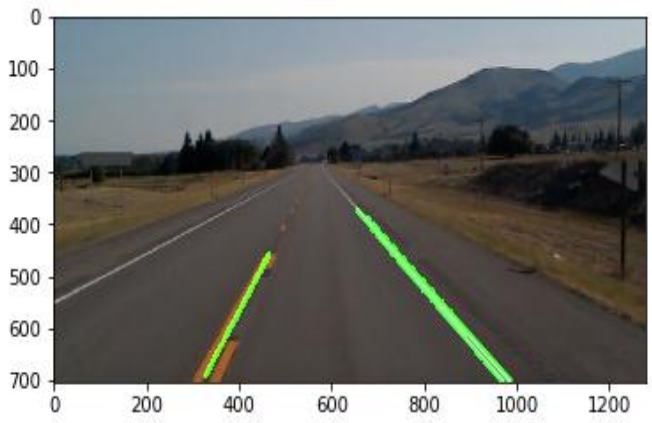

Fig -7: Output image

7. CONCLUSION

In this methodology, the FMCW radar can be utilized for detecting range and velocity of the vehicle. This system gives high precision and simultaneously measure the target range and its relative velocity. Then to identify lane lines on the road OpenCV is used. The canny edge detection along with hough line transform is used for detecting lanes from an input road image .This system ensures drives don't move out of their lanes.

REFERENCES

[1] M. Rajanikantha, Basavaraj. G. Kudamble, "Advanced Adaptive Cruise Control System for an Automobile", International Journal of Engineering and Management Research(IJEMR), Volume 5, Issue 04, August 2015.

[2] Roshan Jahan, Preetam Suman, Deepak Kumar Singh, "Lane Detection Using Canny Edge Detection and Hough Transform on Raspberry Pi", International Journal of Advanced Research in Computer Science, Volume 9, Issue 02, April 2018.

[3] Ammu M Kumar, Philomina Simon, "Review of Lane Detection and Tracking Algorithms In Advanced Driver Assistance System", International Journal of Computer Science & Information Technology (IJCSIT), Volume 7, Issue 04, August 2015.

[4] G. Ajeetha Apparna, A. Aishwarya, "Adaptive Cruise Control for Vehicle Modelling using Matlab", IOSR Journal of Electrical and Electronics Engineering(IOSR-JEEE), Volume 12, Issue 02, April 2017.

[5] Shiuh-Jer Huang, Chien-Chang Tsai, "Vehicle Lane Detection and Following Based on Vision Systems and Laser Scanner", IEEE International Conference on Applied System Innovation, pp. 1446-1449, 2017.

[6] Yang Ying, Ogunleye Odunayo Solomon, "Research on Adaptive Cruise Control Systems and Performance Analysis using Matlab and Carsim", pp. 249-253, 2017.

[7] https://www.wikipedia.org/-Wikipedia.