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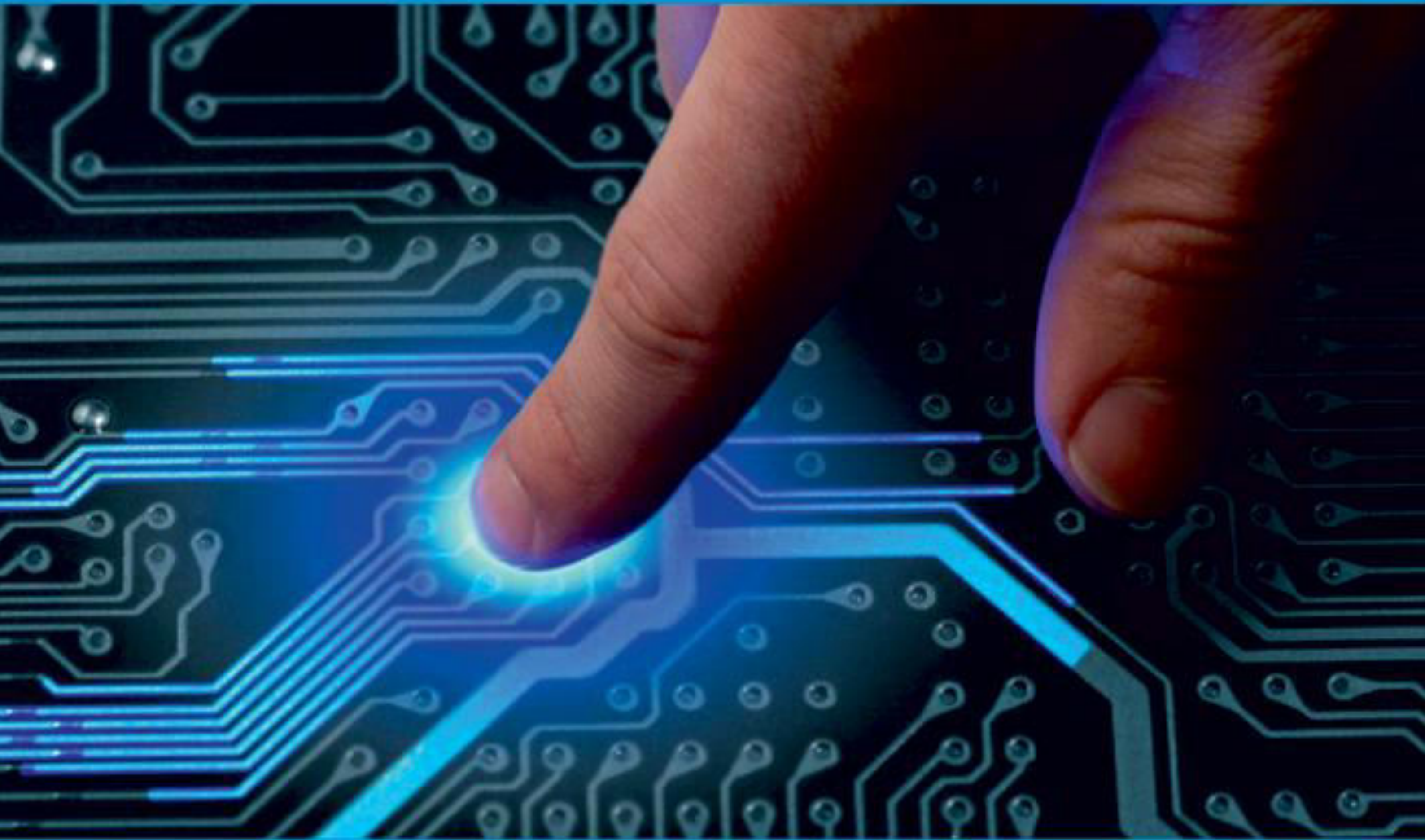

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Analysis and Processing of Vehicle Data using CAN Protocol of RADAR Sensors

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ABSTRACT: RADAR sensors are mostly used in an automated driving as it has contactless detection, tracking and emits electromagnetic waves that perform well in adverse conditions. In this work we are working on the functional testing for the RADAR sensor in vehicle with two RADAR sensor mounted on rear end of the bumper for LCA (Lane Change Assist), BSD (Blind Spot Detection) and RCTA (Rear Cross Traffic Alert) features. The work includes the data analysis of the recorded data from the sensor. This project has been done with industry support. The functional testing process takes place in real world environment with various scenarios.

Many automotive industries follow SDLC for developing effective software for vehicles and many systems. SDLC involves planning, analysis, design, development, implementation, testing and deployment. Testing plays vital role in qualification of the software. Testing plays vital role in qualification of the software. The testing starts with provided requirements and goes on till updating the matrices and bug fixes. Bug fix cycle tracks the defects, fixes the defects, and retested before deploying it to the OEMs. Testing has mainly two methods manual testing and automated testing. Manual testing is done through human - intervention and it's the oldest method for testing. This testing is done manually from the requirement stage till logging the results. Automated testing is automating the test execution process and logging results by writing the scripts and executing it through the testing tools. The scripts written for automated testing can be reused while testing various functionality. It almost reduces human intervention decreases the human prone errors. Adopting right tools and framework make the automation testing more reliable than the manual testing. It's a continuous process which involves various key features such as development, testing, integration, deployment, and monitoring.

KEYWORDS: BSD, LCA, Radar, sensors, Automotive

I. INTRODUCTION

The sensor is built with programmed with DevOps concept and flashed. DevOps it's the combination of Development and IT operations to make a SDLC faster and reliable. It's a continuous process which involves various key features such as development, testing, integration, deployment and monitoring to provide software in continuous basis by using various tools like Git, Ansible, Docker, Chef, Jenkins, an open-source server as the workflow of continuous integration (CI)/Continuous deployment (CD) pipeline to achieve Devops principles. Easy installation & configuration, thriving plugin system, easy distribution and open source have attracted most of the IT companies. In the automotive world, testing the automotive software has become a very difficult task. Therefore, it's important to improvise the existing software testing processes.

Many automotive industries follow SDLC for developing effective software for vehicles and many systems. SDLC involves planning, analysis, design, development, implementation, testing and deployment. Testing plays vital role in qualification of the software. Testing plays vital role in qualification of the software. The testing starts with provided requirements and goes on till updating the matrices and bug fixes. Bug fix cycle tracks the defects, fixes the defects and retested before deploying it to the OEMs. Testing has mainly two methods manual testing and automated testing. Manual testing is done through human - intervention and it's the oldest method for testing. This testing is done manually from the requirement stage till logging the results. Automated testing is automating the test execution process and logging results by writing the scripts and executing it through the testing tools. The scripts written for automated testing can be reused while testing various functionality. It almost reduces human intervention decreases the human

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prone errors. Adopting right tools and framework make the automation testing more reliable than the manual testing.

There are many automation tools to verify the functionality of software of the electronic control unit (ECUs) present in the cars. The vector provides numerous software tools for the automotive industries to adopt the SDLC. The main testing tools provided by the vector are CANoe and CANalyzer. These tools carry out the testing process for the ECU network effectively. To make testing of ECU software more reliable the testing tools are integrated into the Jenkins server. By automating the testing tools, the Jenkins allows the test engineer to carry out all the test management activities. It increases the productivity of the industry, and many more advantages are being discussed further in the project. The functionality of BSD and RCTA are being verified at the system functional level in various environment scenarios.

II. RELATED WORK

This chapter gives the literature survey inference for the selected area of interest which is data analysis of vehicle RADAR sensor in automobile domain for functional testing. The papers are taken from standard conference, journals, handbook, textbooks, and thesis. Few standard conferences and journals are mentioned in the research. Theodoros Alexakis, Nikolaos Peppes, et al[1] discusses on applying new technologies and techniques to provide efficient and reliable solutions to meet the transportation system's growing demands for data collection, storage and analysis. Today's roads and cars have a variety of sensors that collect a variety of highly variable data, such as speed, acceleration, direction, and more. The need to use big data techniques and analytics in the context of advanced intelligent transportation systems arises from the large quantity and diversity of this data. N. Andennour, T. Ouni et al [2] proposed in the paper about the idea that humans have distinctive driving styles that could be used as fingerprints to determine a driver's identity was put forward in a detailed report of several experiments. Research efforts to use markers of human driving style have expanded significantly with the increasing development of machine learning (ML). This feature can be a useful element for advanced driver assistance systems (ADAS) to ensure vehicle safety and security. Additionally, it increases ADAS fidelity and expands the system's capabilities by giving each driver access to a personalized profile tailored to their driving preferences. Tim Tiedemann, Christian Backe, et al [3] presents in the paper about automation is one of the most comprehensive instances of ubiquitous computing in use today. There are many, if not endless, sensors and individual computer systems in modern cars. Additionally, local and global IT equipment is used to deploy transportation infrastructure. In some countries, communication by the vehicle itself (e.g. to an emergency hotline) may soon become necessary. Finally, the driver adds a second processing device and a highly efficient sensor network to the car using a smartphone. Muhammed Syafrudin, Ganjar Alfian, et al [4] presents in the paper about Monitoring systems collect more data throughout the production process, playing a greater role in management decision making. Current technologies, such as IoT-based sensors, can be considered as solutions to ensure effective monitoring of production processes. This paper proposes a real-time monitoring system using big data processing, IoT-based sensors, and hybrid prediction model. First, an IoT-based sensor that collects data from accelerometer, gyroscope, humidity, and temperature sensors was created. IoT-generated sensor data from industrial processes is real-time, large, and unstructured. Lorenz Gorne, Hans-Christian Reuss, et al [5] this paper discuss about the Software complexity increases exponentially as the number of functions in modern vehicles increases. Using the right vehicle diagnostic systems is essential to ensure the accuracy and reliability of all components. The main function of these systems is to collect and analyze vehicle data. OEMs often have a development team of thousands of vehicles to detect problems during vehicle development. The challenge for the diagnostic system is to identify problems during this test while gathering as much information as possible about the events that led to the failure. Every month, a car generates hundreds of terabytes of data. Neither current mobile network subscriptions nor WIFI or cable infrastructure can provide the required data capacity. The amount of data that can be collected for field testing is limited, and analyzing big data for things like training or validating AI becomes more difficult. Zoltan Ferenc Magosi, Hexuan Li, et al [6] presents the state of the art in radar sensor modeling is summarized in detail. We propose a taxonomy of how these models are used in media development based on the V-model from software development, as opposed to the technology-based taxonomy as introduced in previous summary articles. Activity, function, technology, and individual sensor models are all types of models. A detailed summary sheet will be updated regularly summarizing the application and usage of these models throughout the development process to contribute to further research and development at the vehicle level. Premysl Hudec, Viktor Adler et al [7] discuss on the design, practical application, and system programming of complex sensor simulation configurations require in-depth analysis and breakdown of all key technological elements. The benchmark provides a lot of accurate information about the characteristics and operation of automotive radar sensors but lacks documentation on sensor simulation configurations. This article includes in-depth reviews of important RF parameters, with an emphasis on phase noise, and describes its analysis considering an even

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larger number of simulation targets. The derived analytical formulas allow systematic programming of many real-world experimental procedures as well as the construction of an ideal configuration. Marzana Khatun, Mark Liske, et al [8] discuss about the Construction of a HAD system is generally accepted and practical, including improving sensor performance, using simulation-based testing. It is important to thoroughly test these sensors in a variety of situations, including different road types, environments, and traffic situations, to identify functional deficiencies of these sensors that affect the safety of the HAD system. Based on this theoretical basis, the following are the main contributions of this article: First, a simulation-based test model for radar sensors is described, along with techniques for the SOTIF use case. To compensate and overcome the lack of sensor functionality, the specific radar effect is then evaluated through simulation-based tests of two separate radar models. Finally, filters should be developed to improve sensor performance while considering the multipath propagation effects that characterize radar. Stefan Wald, Torsten Mathy, et al [9] discusses about the Real-time environment of the vehicle and provide the system with more relevant data. Among the environmental sensors used in modern cars are radar, Lidar, and camera systems. In the future, the development of driver assistance technology and automated driving will be greatly supported by these sensors. A suitable test environment is required to ensure reliable operation of the radar sensors throughout the development and testing of the radar system. An improved technique created at the Fraunhofer FHR (Fraunhofer Institute for High Frequency Physics and Radar Engineering) and implemented with the ID ATRIUM radar target simulator will be discussed in this article

III. METHODOLOGY

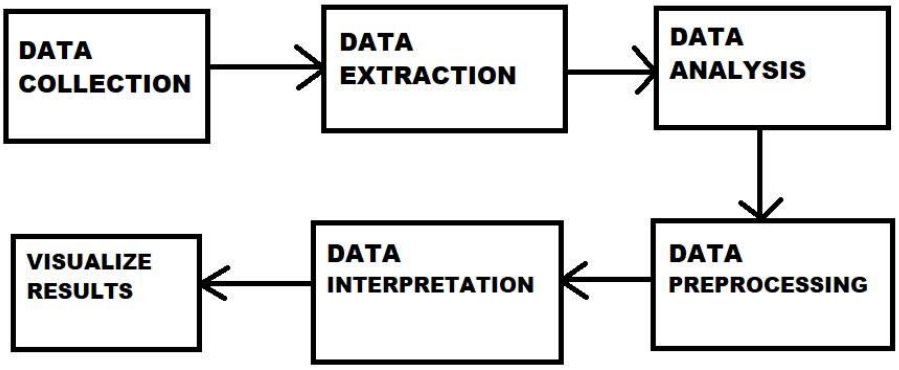

Fig.1. Flowchart

The RADAR sensor ECU are placed on the vehicle on rear corner of the bumper. The test is being carried out by performing the vehicle on the proving and public road. The Analysis of the vehicle testing begin with Data collection on the controlled and uncontrolled environment with various scenarios carried out for the performance of the sensor. Here there are two RADAR sensors being used placed on two rear corners of the vehicle on the bumper. The collected data is being tapped from the vehicle CAN data that is in the form of system data that is to be extracted in the user understandable data from the CAN bus that is the mediating form for the communication between the vehicle and the sensor ECU.

The CANoe/CANalyzer tool would be used for the reading of the CAN data and a personalized tool is being used for the recording of the event that is being taken while the data collection. The data that is being utilized for analyzing the performance of the RADAR sensor. The main feature that are being monitored in the session is the BSD, LCA and RCTA feature from RCR sensors. The extracted data is being used for the plotting of the Data for understanding the performance of the RADAR sensor ECU. The plotting of the data after the analysis is taken in MATLAB software from the decoded Data the plotting of the performance of the sensor is being noted.

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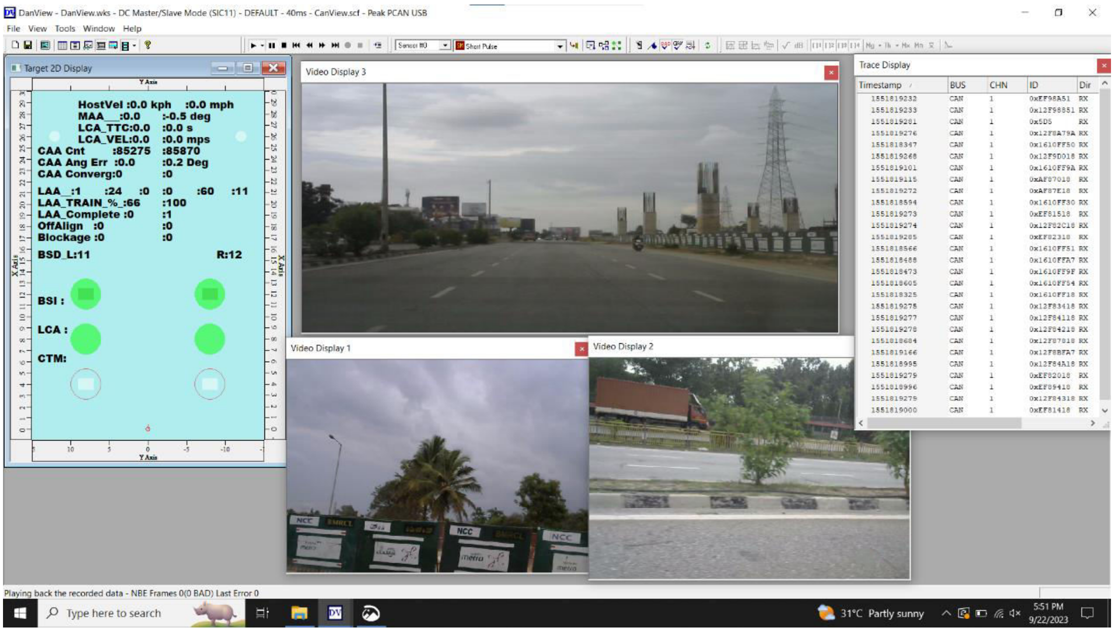

Fig.2. Recording of the data on public road

The above shown figure is of the tool that is being used for vehicle test recording of the data for the two 24 GHz Radar sensors placed on the rear corner of the vehicle bumper on the left and right side, it is being monitored with the cameras installed on the rear side centre, left and right. The vehicle PC is being setup with the CAN signals being tapped from vehicle and the PC has the sensor CAN data which through a medium of CANoe tool is used for the communication of the vehicle and the sensor data is recorded and the data is in for CAN signals that is being used for analysis of the performance of the Radar sensor. For reference the camera is used as to check the accuracy of the radar sensor and the data is interpreted and plotted.

IV. EXPERIMENTAL RESULTS

This Chapter presents the obtained results that are plotted after the analysis of the data from the functional testing of the radar sensor on the real-world environmental scenarios for the performance of the features of the sensor like BSD, LCA and RCTA. The feature has been plotted with consideration of the velocity of the vehicle, time to Collision (TTC), and the range for which the vehicle is detected and created an alert with various scenarios like rear entry, front entry and side entry on various conditions like in public roads, proving grounds and controlled environment.

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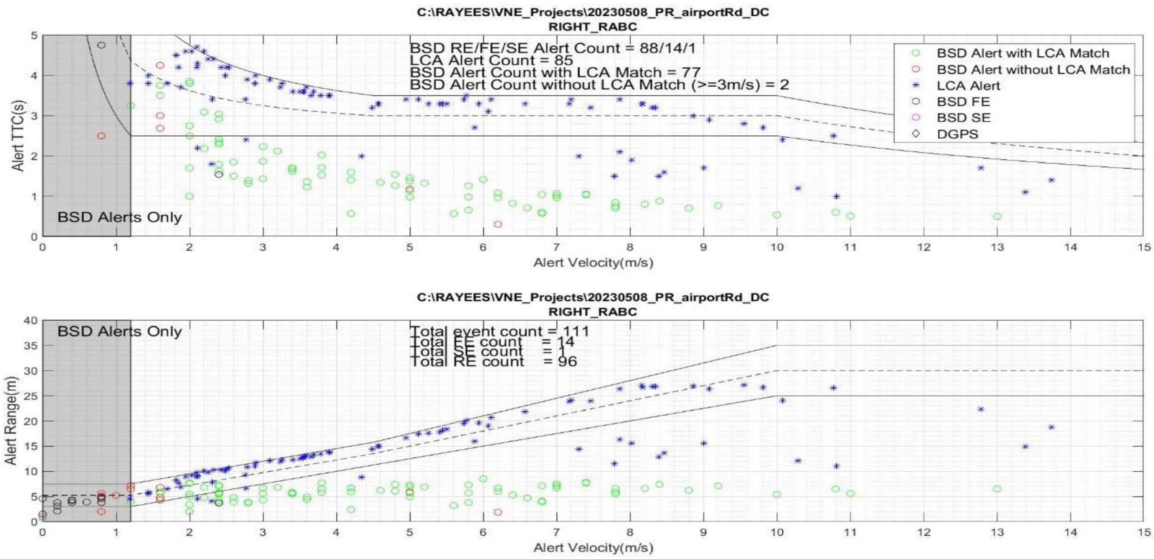

Fig.3. Right Radar result on public road

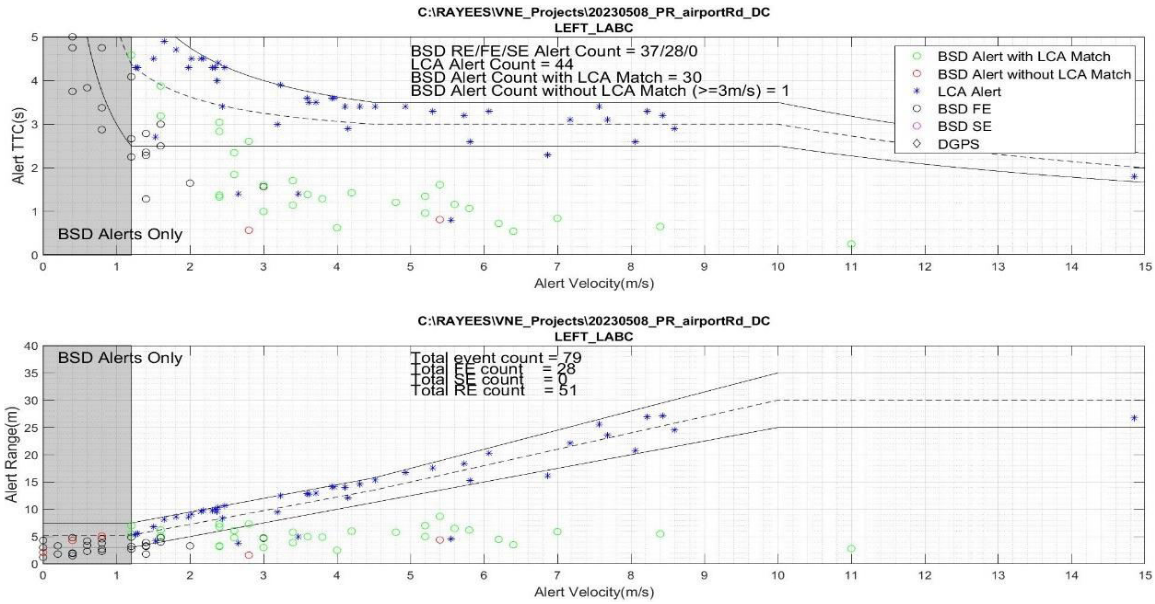

Fig.4 Left Radar result on public road

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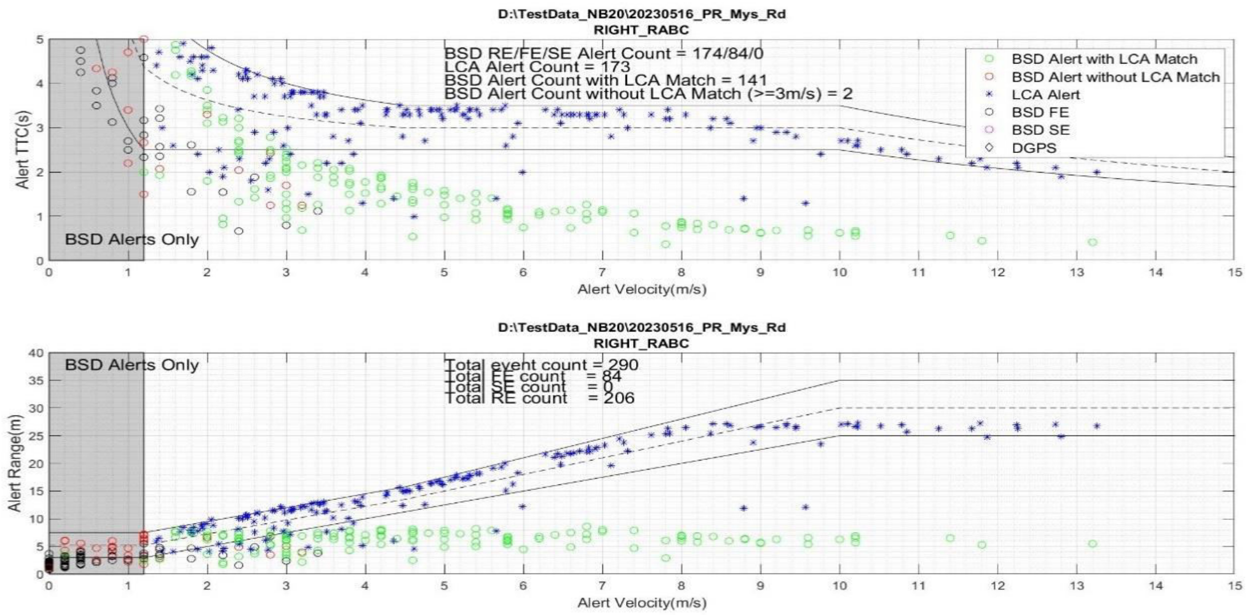

Fig.5 Right Radar result on controlled environment

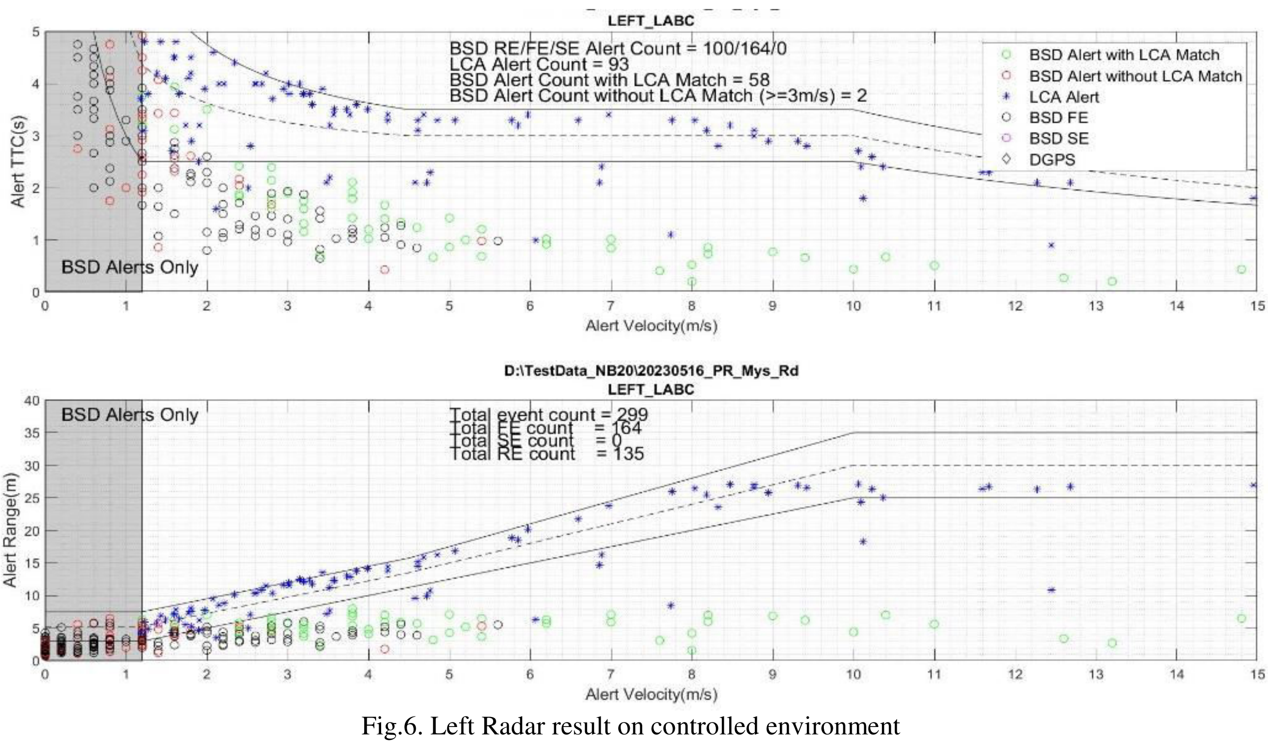

Fig.6. Left Radar result on controlled environment

The above shown figure are the obtained result that has been taken placed with various scenarios in various conditions on the different road conditions in real world environmental condition for more accurate results. The fig.3 is the result taken on the public road for the right corner Radar sensor, that has the BSD alert with LCA match, BSD alert without LCA match, LCA alert, BSD FE alert, BSD SE alert. The fig.4 is the result of the left radar sensor on the public road with real world environmental scenario. Fig 5 is the result of the Right corner Radar sensor on controlled environment. Fig 6 is the result of the Left corner Radar sensor on controlled environment conditions.

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V. CONCLUSION

Every automotive industry will face a lot of challenges to deliver a software the industry will adopt many different technologies. The project aim is to develop a methodology for making the software testing method more reliable and the functional testing. The objectives were formulated keeping this in mind and further, software and hardware requirements were discussed in detail used to design the project. The proposed system is incorporating the CI/CD pipeline into the testing environment to achieve all the test management activities. The test cases execution to verify the functionality of BSD & RCTA features and for test result updating.

The various test scenario has been completed with a successful result on the features of BSD, LCA and RCTA features that the method of vehicle testing is done with most accuracy and precession. The detailed analysis of the plotted data is shown in the result for the performance of the Radar sensors.

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