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User Interface For SAE Level 2 Autonomy

1.Rohini Hongal,, Dept of Electronics and Communication, KLE Technological University, Hubli
rohini_sh@kletech.ac.in
2. Dr. Rajashekar B. Shettar, Dept of Electronics and Communication, KLE Technological University, Hubli.
raj@bvb.edu
3. Suganda P, Dept of Electronics and Communication,Rural Engineering college Hulkoti
suganda_p@yahoo.co.in

ABSTRACT— The project focuses on Vehicle-to-device(V2D) com- munication is a particular type of vehicular communication system that consists in the exchange of information between a vehicle and any electronic device that may be connected to the vehicle itself.And also focuses on Autonomous Vehicles (AV) promise exciting opportunities for societal benefits including improved road safety, reduced congestion and accessible mobility. To achieve these benefits and move from research prototypes and trials to full commercial deployments requires comprehensive and robust processes for system verification and validation (VV).

INDEX TERMS- **Vehicle-to-device (V2D, Autonomous Vehicles (AV)**

1. INTRODUCTION

While self-driving cars have recently become a hot topic, the technology behind them has been evolving for decades, tracing back to the Automated Highway System project, and before. Since those early demonstrations, the technology has matured to the point that Advanced Driver Assistance Systems (ADAS) such as automatic lane keeping and smart cruise control are standard on a number of vehicles. Beyond that, there are numerous different fully autonomous vehicle projects in various stages of development, including extended on-road testing of multi-vehicle fleets .

Driver assistance systems and automated systems reachingSAE Levels 1 and 2 have already been introduced tothe market. Level 3 (conditional automation) and 4 (highautomation) systems are announced to follow (Audi trafficjam pilot or Waymo self driving cars). A challenge- for the introduction of higher levels of automation is to assurethat these vehicle systems behave in a safe way. For driverassistance systems, this proof is furnished by driv- ing manytest kilometers on test grounds and public roads. However, forhigher levels of automation a distance-based validation is notan economically acceptable solution.

Vehicle-to-device (V2D) communication is a particular type of vehicular communication system that consists in the exchange of information between a vehicle and any electronic device that may be connected to the vehicle itself.

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2. PROBLEM STATEMENT

In this era of automation, passengers are entitled to possess the premium experience while travelling at the fullest without compromise with aesthetics and safety feature, our project also aims at providing the validation of sensors for autonomous functionality.

3. OBJECTIVES

The project focuses on Vehicle-to-device (V2D) communication is a particular type of vehicular communication system.

The project also focuses on Autonomous Vehicles (AV) promise exciting opportunities for societal benefits including improved road safety, reduced congestion and accessible mobility.

4. COMPONENT UTILISED

A. Radar AWR1642

- Four Receive Channels
- Two Transmit Channels
- Supports Automotive Temperature Operating Range
- On-Chip Memory: 1.5MB
- Cortex-R4F Microcontroller for Object Tracking and Classification, AUTOSAR, and Interface Control

Fig. 1. Radar AWR1642

B. Intel RealSense Depth Camera D435

- Approx. 10 meters. Accuracy varies depending on cali- bration, scene, and lighting condition.
- Depth Output Resolution Frame Rate: Up to 1280 x 720 active stereo depth resolution. Up to 90 fps
- RGB Sensor FOV (H x V x D): 69.4° x 42.5° x 77° (+/- 3°)
- Mounting Mechanism: One 1/4-20 UNC thread mounting point. Two M3 thread mounting points.

Fig. 2. Intel RealSense Depth Camera D435

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C. Raspberry Pi

- Operating system : FreeBSD, Linux, NetBSD, OpenBSD Plan 9, RISC OS, Windows 10 ARM64, Windows 10 IoT core
- System-on-chip used Broadcom BCM2711
- CPU1.5 GHz 64/32-bit quad-core ARM Cortex-A72
- Cortex-A72Memory1, 2, or 4 GB LPDDR4-3200 RAM

Fig. 3. Raspberry Pi 3B

5. VERIFICATION AND VALIDATION

Verification and validation are independent procedures that are used together for checking that a product, service, Or system meets requirements and specifications and that it fulfills its intended purpose. These are critical components of a quality management system such as ISO 9000. The words ”verification” and ”validation” are sometimes preceded with ”independent”, indicating that the verification and validation is to be performed by a disinterested third party. ”Independent verification and validation” can be abbreviated as ”IVV”. In practice, as quality management terms, the definitions of verification and validation can be inconsistent. Sometimes they are even used interchangeably. However, the PMBOK guide, a standard adopted by the Institute of Electrical and Electronic Engineers (IEEE), defines them as follows in its 4th edition:

Validation. The assurance that a product, service, or sys- tem meets the needs of the customer and other identified stakeholders. It often involves acceptance and suitability with external customers. Contrast with verification.

6. AUTOMOTIVE GRADE ELECTRONICS

Automotive electronics are specially-designed electronics intended for use in automobiles. Automotive electronics can be subjected to, and are therefore rated at, more extreme temperature ranges than commercial (i.e. normal) electronics. Most electrical devices are manufactured in several temper- ature grades with each manufacturer defining its own tempera- ture ratings. Therefore, designers and engineers must pay close attention to the actual specifications on product datasheets. The list below is an example of temperature ratings/grades. Note that the automotive grade is second only to the military grade (in terms of extreme temperature ratings):

Commercial: 0°C to 85°C

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Industrial: -40°C to 100°C
Automotive: -40°C to 125°C
Military: -55°C to 125°C

The first use of computer in a car was for engine control. It was called the ECU computer, or the Engine Control Unit. The year was 1968 when the first ECU appeared in a Volkswagen to perform one specific function: EFI (electronic fuel injection). Automotive market trends toward advanced driver assistance systems (ADAS), automated driving systems (ADS), and autonomous vehicles (AV) are fostering innovation and fueling a relentless increase in the amount of software content incorporated into advanced electronic control units (ECUs), sensors, actuators, and other onboard hardware. This has resulted in dramatic spikes in the amount of data flowing throughout vehicle electrical/electronic (E/E) systems. Meanwhile, to meet the auto industry's in- creasingly stringent requirements relative to time, budget and quality, achieving effective verification and validation (VV) has become paramount – especially in light of the mass adoption that many experts predict for these transportation technologies in the years and decades ahead.

As automated and autonomous drive technologies grow substantially more complex, developers face new challenges in verifying and validating the safety and security of next- generation E/E systems. In the process of addressing these challenges, engineers are being bombarded with an expanding number of new, specialized software tools from different vendors, all of which must somehow work together.

A common and quite significant challenge facing today's automotive engineers is dealing with the massive number of VV cycles now required, including testing that spans across the many gaps in the tiered development ecosystem. The vast amount of software and mountains of data flowing within and between all system hardware creates very complex interactions. E/E systems are inherently multi-ECU distributed systems, which means that the ideal VV infrastructure must support the ability to mix the level of accuracy (or fidelity) within the system model in order to realistically cover the amount of testing scenarios required.

While ECU hardware is quite accurate, and verification equipment allows engineers to test systems using actual ECU targets, cost and maintenance complexity factors limit the number of hardware-based verification systems available in a typical project. Access to these systems is often sched- uled, and not every software engineer on a project can use them, especially when they are most needed. Further, physical hardware has a limited ability to be predictably controlled, and visibility into the system's signals for tracing and failure injections is not always possible. Perhaps even more limiting is the fact that actual ECU hardware requires environment models that execute in real-wall-clock-time. This limits their fidelity on one end, and on the other end means time cannot be accelerated for tests that must account for long-term effects within shortened verification cycles.

7. SAE LEVELS OF AUTONOMY

Level 0 – No Driving Automation The performance by the driver of the entire,

DDT. Basically, systems under this level are found in conventional automobiles.

Level 1 – Driver Assistance A driving automation system charac- terized by the sustained and ODD-specific execution of either the lateral or the longitudinal vehicle motion control subtask of the DDT. Level 1 does not include the execution of these subtasks simultaneously. It is also expected that the driver performs the remainder of the DDT.

Level 2 – Partial Driving Automation Similar to Level 1, but characterized by both the lateral and longitudinal vehicle motion control subtasks of the DDT with the expectation that the driver completes the object and event detection and re- sponse (OEDR) subtask and supervises the driving automation system.

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Level 3 – Conditional Driving Automation The sustained and ODD-specific performance by an ADS of the entire DDT, with the expectation that the human driver will be ready to respond to a request to intervene when issued by the ADS.

Level 4 – High Driving Automation Sustained and ODD-specific ADS performance of the entire DDT is carried out without any expectation that a user will respond to a request to intervene. Read more at the ANSI Blog: SAE Levels of Driving Automation https://blog.ansi.org/?p=158517

Level 5 – Full Driving Automation Sustained and unconditional performance by an ADS of the entire DDT without any expectation that a user will respond to a request to intervene. Please note that this performance, since it has no conditions to function, is not ODD-specific.

8. METHODOLGY

In this proposed work, the application and services for V2D communication are only based on simple cost reduced and network free architecture which do not require any infrastructure. The proposed model consists of input devices which are connected to a interface. The sensors are mounted on the dash- board of the vehicle. A micro-controller is connected to the receiver, a transmitter and along with an output interface. User can access the control of applications which is present in his vehicle.

- Because system-level testing can't do the job, more is required. And that is precisely the point of having a more robust development framework for creating safety critical software.
- In general, the V model represents a methodical process of creation followed by verification and validation. The left side of the V works its way from requirements through design to implementation. At each step it is typical for the system to be broken into subsystems that are treated in parallel . The right side of the V iterative verifies and validates larger and larger chunks of the system as it climbs back up from small components to a system-level assessment.
- Mounting Mechanism: One 1/4-20 UNC thread mounting point. Two M3 thread mounting points.
- Python offers multiple options for developing GUI (Graphical User Interface). Out of all the GUI methods, tkinter is most commonly used method. It is a standard Python interface to the Tk GUI toolkit shipped with Python. Python with tkinter outputs the fastest and easiest way to create the GUI applications. Creating a GUI using tkinter is an easy task.To create a tkinter:
- Importing the module – tkinter
- Create the main window (container)
- Add any number of widgets to the main window
- Apply the event Trigger on the widgets.
- Importing tkinter is same as importing any other module in the python code. Note that the name of the module in Python 2.x is 'Tkinter' and in Python 3.x is 'tkinter'.

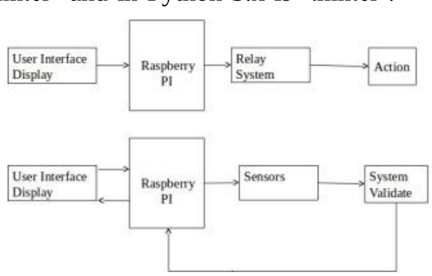

Fig. 5. Block Diagram

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Because system-level testing can't do the job, more is re- quired. And that is precisely the point of having a more robust development framework for creating safety critical software. The "V" software development model has been applicable to vehicles for a long time. It was one of the development

reference models incorporated into the MISRA Guidelines more than 20 years ago [5, 6]. More recently, it has been promoted to be the reference model that forms the basis of ISO 26262.

10. LINUX CONCEPTS USED

A. Inter process communication (IPC)

Inter process communication (IPC) is a mechanism which allows processes to communicate each other and synchronize their actions. The communication between these processes can be seen as a method of co-operation between them. Processes can communicate with each other using these two ways: Shared Memory, Message passing.

B. Linux Commands for file and process management

The commands described are entered via the command line interface. Simply open a terminal (all-text) window to access this interface. It may look basic, but it's actually very powerful and flexible – just the thing for keeping all those processes in line.

C. Files and Directories

A file is a collection of data that is stored on disk and that can be manipulated as a single unit by its name.A directory is a file that acts as a folder for other files. A directory can also contain other directories (subdirectories); a directory that contains another directory is called the parent directory of the directory it contains.A directory tree includes a directory and all of its files, including the contents of all subdirectories. (Each directory is a "branch" in the "tree.") A slash character alone ('/') is the name of the root directory at the base of the directory tree hierarchy; it is the trunk from which all other files or directories branch.

11.RESULTS

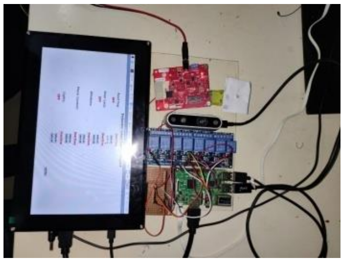

Fig. 6. GUI

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Our implementation for level 2 autonomy as defined by SAE has been successfully interfaced with GUI and has been tested for the same successfully.

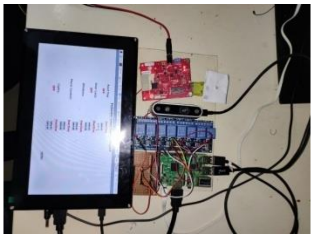

Fig. 7. GUI

11. CONCLUSION

VV forms part of a robust, requirements driven, systems engineering methodology. Challenging to adequately de- fine scenarios that reflect the real-world and to define acceptable levels for test coverage. All test activities have limitations and dependencies, which need to be addressed collectively.

The ever-increasing tendency of developing applications for our everyday use has ultimately entered also the au- tomotive sector. Vehicle connectivity with User interface have the great potential to offer a better driving experi- ence, by providing information regarding the surrounding vehicles and infrastructure and making the interaction between the car and its driver much simpler.

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