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Design and Modelling of Wrong Way Warning

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Abstract: ***Driving through the wrong way on road has been a constantly harassing traffic safety issue everywhere in the world. Wrong way or Ghost drivers cause hundreds of fatalities each year in Europe or North America. Often these drivers are not conscious of their dangerousness. The best way to prevent accidents is to warn these drivers once they enter a wrong way. This paper talks about the architecture and functional flow of a warning generating system which detects the entry of vehicle into a road where a 'No Entry' sign is kept and provides an acoustic warning. The system is modelled in Matlab-Simulink. This model takes input data from different ECUs in the vehicle and checks whether the vehicle entered a wrong way or not.***
Keywords: Advanced Driver Assistance System (ADAS), WWW (Wrong Way Warning), No Entry Sign, NE gate, Subsystem

I. INTRODUCTION

Most road accidents occurred due to the human error. Advanced driver-assistance systems (ADAS) are systems developed to automate, adapt and enhance vehicle systems for safety and better driving [1]. The automated system which is provided by ADAS to the vehicle is proven to reduce road fatalities, by minimizing the human error. Safety features are designed to avoid collisions and accidents by offering technologies that alert the driver to potential problems, or to avoid collisions by implementing safeguards and taking over control of the vehicle. Systems such as electronic stability control, anti-lock brakes, lane departure warning, adaptive cruise control and traction control are some available features of ADAS. ADAS relies on inputs from multiple data sources, including automotive imaging, LiDAR, radar, image processing, computer vision, and in-car networking. Additional inputs are possible from other sources separate from the primary vehicle platform, such as other vehicles, referred to as Vehicle-to-vehicle (V2V), or Vehicle-to-Infrastructure (such as mobile telephony or wifi data network) systems.

Wrong way crashes are often head-on collisions that are more likely to produce serious injuries and fatalities. Typically, offenders are confused, distracted, or intoxicated drivers who tend to keep their eyes on the road directly in front of them often not seeing roadside warning signals and signs. Drivers who are tired, confused by poor road signs, or driving in bad weather can take the wrong turn, only to find they have put themselves and other people on the motorway in real danger Driving the wrong way in one-way traffic or on the wrong side of the road factored into over 3 percent of all fatal crashes in the US [3]. Wrong Way Warning or WWW is a warning/alert system which notify the driver in case he or she drives in wrong way road. Thus, WWW can also be added as a new feature in the ADAS technology as it also assists driver for safe driving. In the case of signs imposing access restrictions, through the wrong-way driver warning function an acoustic warning is emitted together with a visual warning in the instrument cluster – making an effective contribution towards helping to prevent serious accidents caused by wrong-way drivers. system relies on a windshield-mounted camera to pick up Do Not Enter or Wrong Way signs and pairs it with data from the car's navigation system. If the car starts driving against the flow of traffic, it fires off visible and audible warnings for the driver [2]. Unfortunately, the system stops short of intervening or stopping the car from traveling the wrong way. As in starting stage, the system is modelled to react to the sign conventions in European countries like Austria, Germany, Switzerland etc.

In following sections, the architecture and functional flow of the WWW model is explained.

II. MODAL ARCHITECTURE AND FUNCTIONAL FLOW

Top level of the model consists for four main subsystems as shown in Fig. 1.

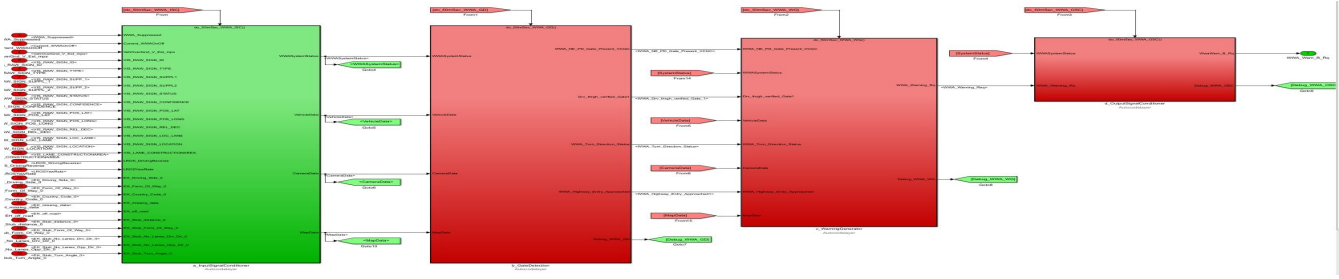


Fig. 1 First Level of WWW model having four main subsystems

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The model has 27 input signals and one output signal which is the warning signal which is of type Boolean. The input signals include camera data, vehicle data and GPS data. Camera data has all the signals providing several information regarding the traffic signs available in the camera field of view like sign id, sign type, sign lateral position, sign longitudinal position etc. Vehicle data include vehicle velocity, wheel yaw rate etc. GPS data include driving side information, country code, vehicle on the road or not, type of the road etc.
The model execution sequence is from left to right. Subsystems from left to right are briefed below.

A. Input Signal Conditioner

All inputs are first fed to this subsystem. This Subsystem converts the input raw data into the form the next subsystems require. Also, it maintains each signal value within the upper and lower limit along with the prescribed datatype [4]. Also, it finds the distance covered by vehicle from the vehicle velocity information.

B. Gate Detection

In European countries a No Entry road is identified by two No Entry signs placed on two sides of the road to make a No Entry gate. The NE (No Entry) gate is present at the beginning of a road if the road is a one way. The actual function of WWW model is to detect an NE gate and check whether the vehicle crossed the gate or not. So, this is the core subsystem of this model. The input of this subsystem is the output of Input Signal Conditioner. This subsystem has eight subsystems inside it and the functionality of each block is briefed below.

1) *Sign Type Filter:* The input is sign type signal information of different sign types like Speed limit, Stop sign, No entry etc. This subsystem checks for only the No Entry sign and passes all other information like position, status, sign confidence etc only for a NE sign. In a particular sample time, if there is no NE sign present, no calculations will be executed in the model and all the internal variables in the model will be set to zero [4].
2) *Gate Building:* This subsystem checks for pairs of NE sign and if an NE sign pair is available, it checks for the distance between the two NE signs based on the position information of the sign. If distance is within the prescribed limits, this functional block identifies that NE pair as an NE gate [4].
3) *Driving Path Memory:* Once a NE gate is detected, this subsystem will hold all the information related to both the NE signs till the vehicle covers a specified distance. This distance can be calibrated [4].
4) *Determine Quality:* This block will set the output if confidence value of both the NE signs is above 0.6. Confidence value varies from 0 to 1 which relates the clarity of the captured sign [4].
5) *Driving Path Calculation:* From the time ‘Gate building’ subsystem detects a gate this subsystem updates the current and previous position of the vehicle in every cycle till ‘Driving Path Memory’ subsystem resets its output [4].
6) *Vehicle Crosses Gate:* Based on the inputs from ‘Driving Path Memory’, ‘Determine Quality’ and ‘Driving path calculation’ subsystems, this subsystem will check every cycle that the vehicle crossed the NE gate or not [4].
7) *WWW Turn Detection:* The "Turn_Detection" uses the yaw rate to determine if the vehicle is currently driving in a left turn, straight or in a right turn and sends this information to the "Warning_Generator" subsystem [4].
8) *Street Type Detection:* This subsystem uses the GPS data to determine whether the vehicle has approached a highway entry and sends this information to the "Warning_Generator" subsystem [4]. An NE gate is expected to be present at beginning of a highway.

C. Warning Generator

Warning Generator subsystem [4] sets the Warning Required boolean output to one if the below conditions are true.

1) Vehicle crossed an NE gate.
2) Vehicle approached a high way entry.
3) WWW feature should be enabled by the user. This is an input signal to the model.
4) Vehicle should not be in a construction area.
5) Country code should be any one which is specified in the model.
6) Vehicle should not be driving reverse.

Information mentioned in point numbers 4 and 5 are available in the inputs provided by GPS.

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D. Output Signal Conditioner

Once a warning is generated by 'Warning generator', this subsystem will set the output to one and hold it either for a predefined time or until the user acknowledges it from the IPC (Instrument Cluster Panel). The resetting mode can be calibrated by boolean variable in the software. If calibration variable is 1, Reset from IPC mode will be active else Reset after specified time mode will be active [4].

III. FUNCTIONAL ANALYSIS

Keeping the WWW feature enabled, the model was tested in MIL testing environment by feeding two NE signs and vehicle allowed to cross the NE gate. The sign type value for NE sign is 18. So, a warning is expected to be generated once the vehicle crosses the gate. Model was calibrated to 'Warning Hold for Time' mode so that warning will sustain for 5 secs which is specified in the model. Test result is captured in Fig.2 .

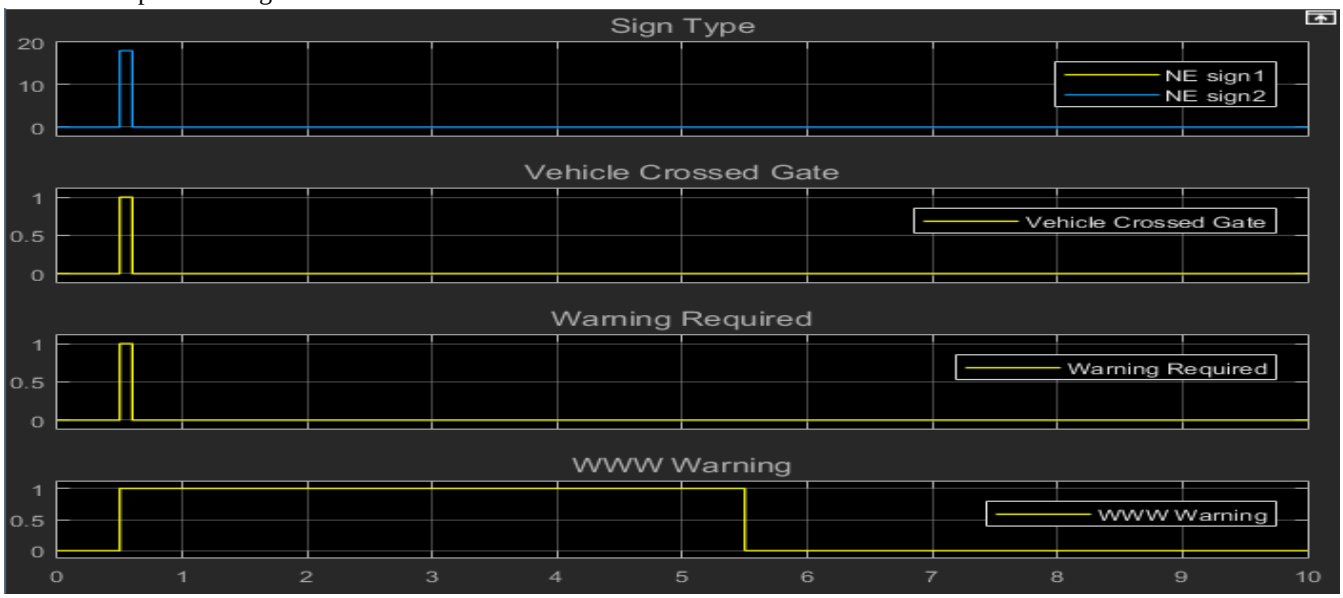


Fig. 2 Plot showing the input and output

As shown in the above plot, at time = 0.5sec vehicle crosses the NE gate formed by the two NE signs detected. This results in setting of the signal 'Warning Required' to one for that cycle. It triggered WWW warning output to one which is held for 5 secs as expected.

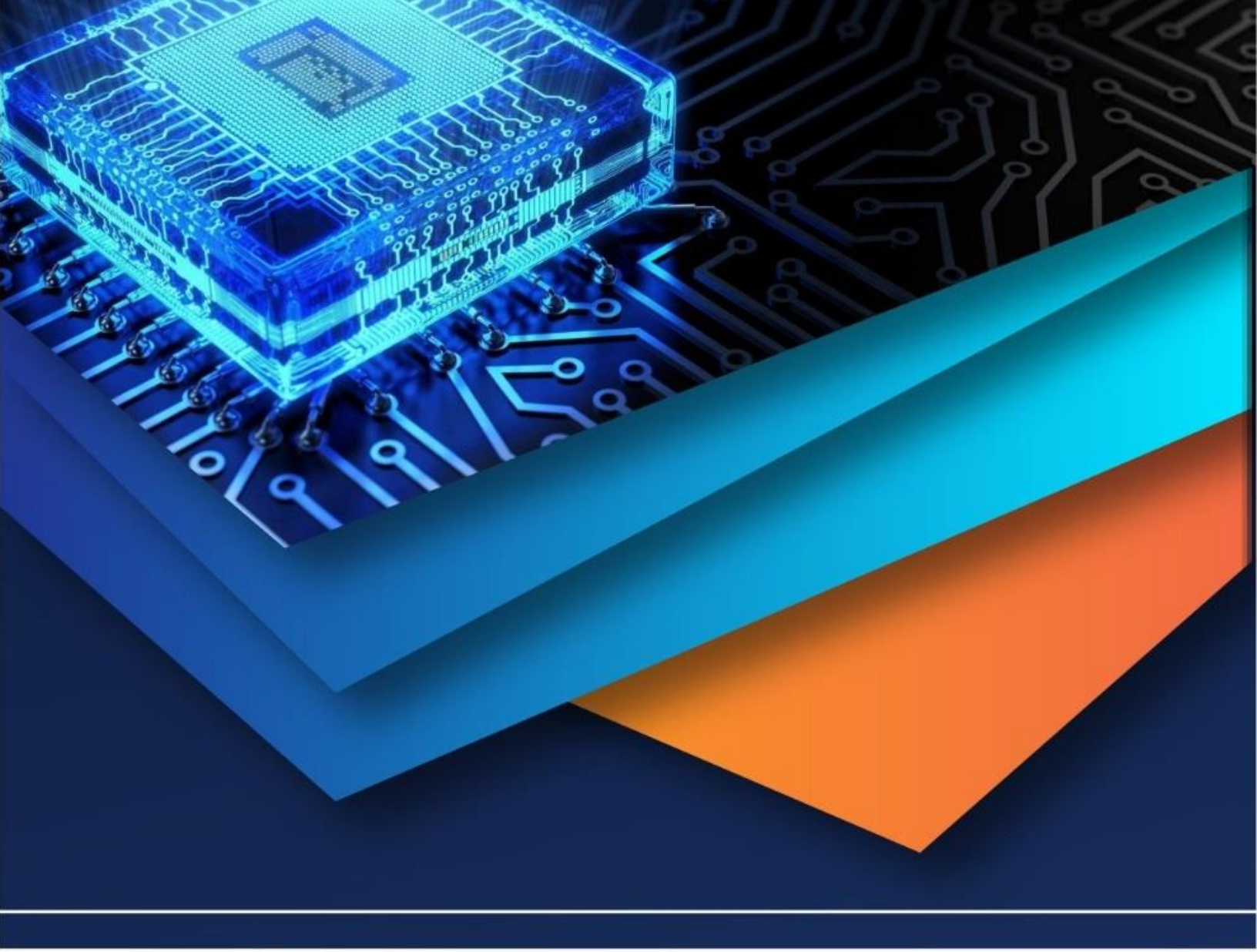
IV. CONCLUSION

Wrong Way Warning uses a wind screen mounted camera which look for the traffic signs and detects the No Entry signs. It also takes information from the car's navigation system. It provides visual and audible alerts to driver once the car goes into a wrong way. This system is aimed to warn drivers before they become a risk to themselves and others. For autonomous vehicles this technology can be extended so that the car should not enter a Wrong way.

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