COMPARATIVE ANALYSIS OF EXISTING ROAD SIGN RECOGNITION SYSTEMS IN VEHICLES

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Abstract. Road sign recognition systems have become an essential safety feature in modern vehicles, aiding drivers in identifying and complying with traffic rules. This paper compares several prominent road sign recognition systems employed by major automotive manufacturers, including Opel Eye, Mercedes-Benz Speed Limit Assist, Volvo Road Sign Information, and Volkswagen Sign Assist. The analysis evaluates the declared and actual recognition accuracies, illumination requirements, and the ability to recognise different types of road signs. The findings reveal that while these systems claim high recognition rates, their performance can be compromised by sign condition, illumination, and occlusion factors.

Keywords: road sign recognition, advanced driver assistance systems, computer vision

Introduction and problem statement. Road sign recognition systems have become a crucial component of advanced driver assistance systems in modern vehicles. These systems aim to improve road safety by assisting drivers in identifying and adhering to traffic rules and regulations. By automatically recognising and displaying relevant road signs, such as speed limits, prohibitions, and warnings, these systems can enhance driver awareness and help prevent unintended violations.

Results. The road sign identification information system consists of the following hardware and software components: optical camera for image capture; hardware capture module; detection module; classification module; database.

First, the camera image is sent to the system. A specific algorithm is then used to determine the location of the road sign. After that, the recognition software performs the sign recognition. The structure of the database can vary depending on the tasks assigned to the system.

The Opel Eye system is an innovative technology used in Opel cars (Vauxhall in the UK) to improve safety and help drivers while driving [1]. It includes a variety of functions and sensors to monitor the road environment and provide important information to drivers.

Fig. 1. Example of Opel Eye operation

The main functions of the Opel Eye system include:

1. Road sign recognition – the system can automatically recognise road signs such as speed limits, overtaking bans, etc. The system can display the relevant information in the instrument cluster.

2. Adaptive cruise control – this function allows the car to automatically maintain a safe distance from other vehicles by adjusting the speed.

3. Lane departure warning – the system can detect when the car is moving out of its lane without the turn signal and warn the driver.

4. Blind spot monitoring system – the Opel Eye system sensors can detect vehicles in blind spots and warn the driver to avoid danger when changing lanes.

5. Automatic emergency braking system – in some models, the system can automatically activate the brakes to avoid a collision when a collision is detected.

Speed Limit Assist (SLA) is a system available in specific Mercedes-Benz models designed to help you comply with the speed limits on the road [2]. The system helps drivers to be aware of road signs and speed limit indications, helping to avoid unintended speeding. The main functions of SLA include:

1. Road sign recognition – the system can use built-in cameras and sensors to detect speed limit signs. It can determine the valid speed limits and display them on the instrument cluster or the trip computer.

2. Driver warning – if a road sign with a change in speed limit is detected, the system can provide an appropriate warning to the driver, helping to avoid unexpected speeding.

3. Adaptive cruise control – in some models, SLA can be integrated with adaptive cruise control, which allows the car to automatically maintain a safe distance from other vehicles on the road, taking into account speed limits.

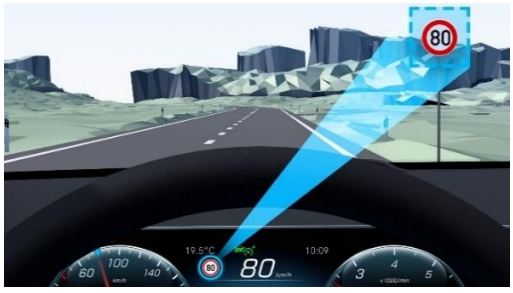

Fig. 2. Speed Limit Assist

Volvo offers road sign information (RSI) safety features in many of its vehicles. It uses cameras and sensors to recognise road signs and provides drivers with real-time information about the road signs they encounter [3]. This system helps to increase driver awareness and compliance with traffic rules.

Fig. 3. An example of RSI operation

The main features of road sign information in Volvo vehicles include:

1. Sign recognition – the system can recognise various road signs, such as speed limits, no-entry, and stop signs. It identifies these signs with visual cues from the onboard cameras.

2. Display for the driver – when a road sign is detected, the relevant information is often displayed on the dashboard or the vehicle's head-up display, providing the driver with easy access to information without taking their eyes off the road.

3. Speed limit warning – the system can compare the detected speed limit with the current vehicle speed and warn the driver if the speed limit is exceeded, helping the driver maintain a safe and legal speed.

4. Dynamic updates – some Volvo models with RSI can update real-time road sign information to reflect changing conditions, such as variable speed limits in construction or school zones.

5. Road sign memory – Some Volvo models equipped with RSI can store and display the most recent road sign information in the driver's display, helping the driver to stay informed even if the sign is no longer visible.

Volkswagen Sign Assist is a technology system used in Volkswagen vehicles to recognise road signs and display information about them on the dashboard [4]. This system helps drivers to be more aware of the road environment and to comply with traffic regulations.

Fig. 4. An example of Volkswagen Sign Assist

The main functions of Volkswagen Sign Assist include:

1. Traffic sign recognition – the system uses a camera, usually located near the interior rear-view mirror, to detect various road signs such as speed limits, prohibitions and others.

2. Information display – information about the detected road signs is displayed on the dashboard or the vehicle's onboard screen. Drivers can see up-to-date information about speed limits and other signs without paying attention to road signs on the side of the road.

3. Additional warnings – in some cases, when speeding is detected, the system can provide the driver with a warning, such as a visual or audible alert.

4. Relevance of information – information is displayed in real-time, allowing drivers to react in time to changes in road restrictions.

A comparative description of existing recognition systems is shown in Table 1.

Table 1

Comparative characteristics of road sign recognition systems

Parameter	Opel Eye	Speed Limit Assist	Road sign information	Volkswagen Sign Assist
Declared recognition accuracy	90%	95%	96%	95%
Sign illumination not less than	50	50	50	50
Recognition of speed limit signs	Yes	Yes	Yes	Yes
Recognition of other prohibitive signs	Yes	No	Yes	Yes
Actual recognition accuracy	75%	70%	75%	95%

Table 1 shows that separately implemented information systems for road sign recognition are rare, and most systems are not a separate feature but are mostly part of the vehicle's factory equipment. This means that their commercial cost needs to be lowered. All installed systems show a small percentage of road sign recognition, and the recognition percentage drops if the road sign is not in ideal conditions (tilt, partial overlap, dirt on the sign), as the images are subject to structural distortion. During testing, only clean signs are reliably and accurately recognised. Only clean signs with a contrasting outline are reliably and accurately recognised. Finding out what algorithms underlie these systems is impossible, as this information is not freely available.

Conclusions. The analysis highlights the need for continued research and development efforts in road sign recognition systems. Improving recognition accuracy, robustness to various sign conditions, and expanding the range of recognisable signs are essential to enhancing road safety and driver assistance capabilities.

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