

Horizontal traffic signs anomalies and their classification

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Abstract: In addition to the traffic signs, the road markings are those that help to control the traffic with of paint and other materials in the road surface. The general requirements and standards contained in this specification apply to daytime, night time visibility, distance, quality and usability. The significance of road markings is essential in terms of driving and helping traffic participants in the possible directions of travel. The traffic lanes give a sense of security to the drivers and passengers, as they are less visible for certain reasons (light, quality, and visibility) instantly appear insecurity, which in turn increases the risk of an accident. These signs are not only of great importance but also provide a basis for the development of both traffic trends and vehicle technology. Everywhere they are present in traffic, they are already used in the early stages of autonomy (parking, track tracking), and likely the road markings will be used and on the road in the future. But it often happens that traffic lanes and road markings quality is deteriorating and less visible, making it difficult to recognize and interpret human drivers and autonomous vehicles. That's why need to classify the mistakes which can use to the test later.

1. INTRODUCTION

This is only possible if autonomous cars can perceive the environment with the correct accuracy. In many cases, human drivers cause accidents because they cannot see the signs or they cannot properly interpret them. The recognition problem can be solved by autonomous systems.

This article draws attention to the anomalies of traffic lanes and road markings currently used. Weather, environmental effects, and traffic situations all have an impact on recognizability, these factors cause difficult recognition ability on autonomous systems. To improve the errors, need to gather situations that are causing problems in detecting the environment in your systems. Horizontal and vertical signals are provided on roads with many information, and the article pay attention to the horizontal signs.

2. IMPORTANCE OF HORIZONTAL SIGNS

Horizontal signals are always needed as long as the old vehicles are present in traffic. Horizontal signs include traffic lanes and other road markings. The lanes help drivers and later autonomous vehicles stay on track and follow the trajectory. The traffic lanes and the road markings used by them provide a wealth of information on the road. They have different colors, materials and shapes with special information content. For their correct use a standard book is considered, which the *Road Technical Specifications* for the road is. (Fig.1.)



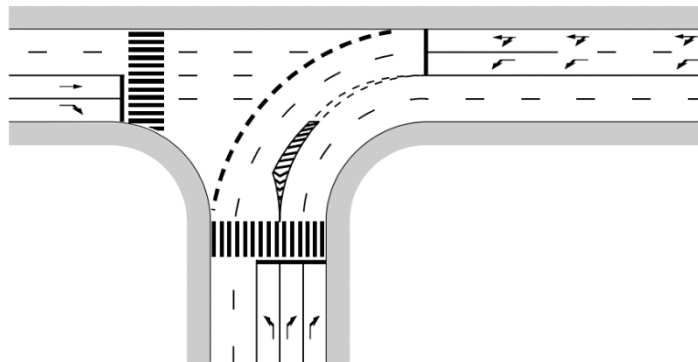


Fig. 1. Complete crossroads with Different type of road markings.

Road Technical Specifications e-UT2-1.113-2001-Design of road markings

It contains all the sizes, colors and materials which need to use on the roads. Completed crossroads can also be found in finds that help later designers work and show how need to plan a crossroad or construction area. (Fig.2.)

Traffic participants receive a lot of information and external stimulation while traveling, so be sure to place as many traffic signs in order in which the drivers are able to interpret and reaction.

If the traffic lanes with their length, shape, colours help to define the track what autonomous vehicle can follow. Use different type of the lane and road markings to the road construction. (Fig.2.)

These factors can be of great help to the autonomous systems in the perception of the traffic signs later.

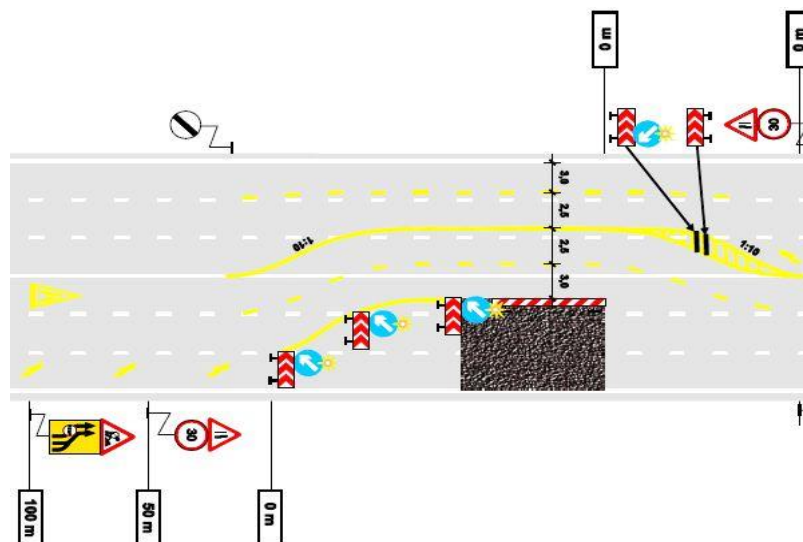


Fig. 2. Different type of road markings.

Road Technical Specifications e-UT2-1.113-2001-Design of road markings

3. DIFFICULTIES OF TRAFFIC LANES AND ROAD MARKINGS

In general, circumstances in the environment significantly influence the visibility of the signs. In addition to this, the natural wear, and fault of the signs makes it more difficult to recognize by the recognition systems and drivers. However, recognition systems can only solve the situations for which they are prepared and taught.

In addition to common errors, the most critical are traffic restrictions. The shape of the temporary road markings must be the same as the shape, color, dimensions and, in some cases, the intended arrangement of the permanent signals. Temporarily used cover road markings can show the track with two types. Depending on the type, budget, length, and duration of the work, which ones are used. Signs can be applied to the road surface by painting or glued pre-fabricated elements. It is permissible to deviate from the individual symbols (arrows, inscriptions) in case they can be solved with fastenable tapes for faster and more economical execution.

In vain, it is expensive to buy, but in the case of long-lasting work, it is a more durable and reliable solution. The advantages of glued symbols are that they are more economical, faster and easier to apply to the surface, but have a significant disadvantage that they are move away from the original place more frequently due to the road surface and weather conditions. In many cases, it may cause an accident if all lanes and road markings are "slip" from the original place. (Fig.3.)



Fig. 3. Traffic lanes and road markings are "slip" from the original place

It is important that car drivers notice the traffic lanes and road markings changes in time. The sooner the drivers are placed in the right lanes, the less chance of sudden moves in the place. Often found on the roads that these were not started early enough or the signs were unclear and visible, so the information about the traffic situation was unexpected for the drivers.

Removing temporary signs when painting will also cause problems. The natural wear is not expected by the workers handling the restrictions, but they are blown in a gray color that does not completely delete the provisionally used signal. This often causes misunderstandings for the drivers and other traffic participants, which can disturb the band sensors. (Fig.4.)

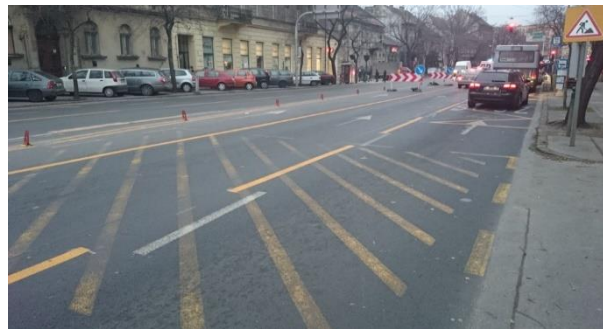


Fig. 4. Use two types of traffic lanes and cause misunderstandings

These many reasons why we started to collect cases from various traffic signs anomalies that can be integrated into the simulation phase of the test, autonomous systems could be prepared. For the teaching, the first step is classifying the mistakes, the visibility, clarity, recognizability, position and complexity of the boards at the permitted speed.

The visibility means when a traffic lanes and road markings cover by other one. The clarity when you can see a clean traffic lanes, or a very dirty one. Recognizability is when you watch a traffic markings and the size, form, faults and worn is acceptable. The position means that the sign is not at the right place. Simplicity when too much or opposite information should be observed.

In daytime conditions, there were several examples of the fact that the temporary burglary was difficult to notice due to the sun. At limited visibility (rain, fog) and at night, even greater difficulty in detecting the new lane created by them.

Autonomous vehicles have to recognize the signs when it comes to camera recognition, and to other support systems. They must be helped to secure access to the area.



Fig. 5. Use glued traffic markings on the road but can see the old ones

The interpretation of traffic signs for people and systems is not an easy task, so there will be continuous improvements in the future so that no further accidents occur.

4. POSSIBILITIES OF TRAFFIC SIGNS BY RECOGNITION SYSTEMS

Many factors and effects make it difficult to track traffic lanes and recognize road signs. All of these make it difficult for the detection systems to function properly and may lead to an accident in case of erroneous interpretations. Road markings are part of the currently used road signaling systems. Recognizing their travels can provide great help and security for the drivers. The most common cause of an accident is that they lose their bands from fatigue or inattention. [14]

The essence of the system is to keep track of the signals on the road. The **Lane Keeping Assist** warns the driver of the steering wheel vibration when the vehicle accidentally slides off its tracks to prevent accidents. The road markings are scanned with a "camera" on the inside of the front windscreen. An electronic control unit can detect boundary lines with contrast differences. It determines the position of the vehicle during the unit, so it can even more accurately determine whether to leave the track. In the Mercedes vehicles, lane departure warning is shown in (Fig.6.) [18] [17]



Fig. 6. Lane Keeping Assist show the traffic lanes in the Mercedes

Unlike conventional systems, this system also has the ability to monitor driver behavior and activity while driving. With this feature, you can distinguish between intentionally or accidentally leaving the track. If it feel that the driver wants to go over the midline for stopping or overtaking, it does not intervene and does not give a warning vibration. You can sense the unit even if a vehicle is moving on a continuous or dashed line.

The lane system has additional built-in ancillary assistants in the vehicle. This is the **Active Steering Assist**, which helps the steering torque, so that the driver can keep the vehicle in the track on a straight or bendy road. The system uses orientation for the vehicles in front and the traffic lanes. The signals are progressively evaluated by senses of a stereo camera, which is located behind the windshield, near the rear-view mirror. The assistant switches on when the driver starts lane change with a direction indicator and the system does not detect another vehicle.

In the event that the system detects that the lane change is unsafe, the driver does not react or act in the correct manner and does not seize the steering wheel despite the warning, the system will slow down the vehicle. The active steering system itself can be activated up to 210 km/h. The system is already included in several car brands in new generation driving packages. This option is already at the lower level of autonomy, which allows for comfort and safety. [19]

The system works perfectly when the road markings are correctly positioned on the road. Particular attention should be paid to what happens if the individual signs change their color or shape.

From a road safety point of view pedestrian crossings are the most vulnerable places. In order to reduce the number of accidents, the route of pedestrian crossing has to be drawn with a variety of indications for road users. Already doing tests to help them better draw drivers attention to seeing the pedestrians as soon as possible. This is a great example of the use of multiple markers, since they use markers for signaling, which can be used for further travel, with reflective properties. There was an opportunity to consider what happens when manipulated by the shape of the crossing point to force the driver to slow down to avoid collision. Earlier, they had been trying in China, and recently two Indian artisans first came up with the idea of what would happen when 3D-acting crossings were painted. (Fig.7.) Their effect is from the perspective of the motorists as if they were a physical obstacle to them,

so they would certainly slow down or stand in front of the pedestrian crossing. But other signaling can be applied to the autonomous vehicles, for example LEDs. [21]



Fig. 7. Lane Keeping Assist show the traffic lanes in the Mercedes





There is a need to prepare for this, so there is a need for combined systems. When testing autonomous systems, it is important to address them in such a way as to detect shortcomings and malfunctions as soon as possible.

5. EXPLANATION OF CLASSIFICATION PROCEDURE BY EXAMPLES

The classes of the mistakes: *the quality, status, quantity, visibility, perception, recognizability, clarity, and interpretability of the boards at the permitted speed.*

In order to prevent accidents, the classification system would help to evaluate traffic signals based on different aspects. Each attribute gets a grade and based on the scale created in the developed system,. This evaluation system would be applicable to any signal. The next table include the attributes, values and grades.

Table 1. Traffic signs anomaly classification

		Visibility 1= not visible 5= visible	Clarity 1= dirty 5= clear	Recognizability 1= not recognizable 5= recognizable	Position 1= Improper 5= standard	Simplicity 1= complex 5= simply
Figure 3.		2	2	1	1	3
Figure 4.		2	2	1	4	1
Figure 5.		5	5	3	5	5
Figure 7.		5	5	2	4	3

This procedure can be developed to configure anomalous traffic lanes and road markings installation into an autonomous vehicle test environment. This system help to find the weaknesses of recognition systems.

6. CONCLUSION

The difficulties of recognizing traffic signs and road markings will probably still be up for a while. The solution is that the recognition systems must be taught and prepared for possible errors. The other, which promotes the development of systems, is testing that specifically points to existing errors.

For this reason, the tests can show to errors in systems that can still be eliminated, thus reducing accident accumulation on the roads. And the classification method can help to find the weaknesses of recognition systems.

Zalaegerszeg is currently building a test track for the highly automated and autonomous vehicles (ZalaZONE). Our anomaly classification about the horizontal traffic signs are contribute to this implementing of such test environment. Where traffic sign recognition systems can be effectively tested and safely validated. After the protocols the systems will allow safe traffic in the future. [10]

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