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Electronic speed bump for vehicles with autonomous driving capabilities

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ABSTRACT

Successfully and smoothly navigating a speed bump requires a vehicle to slow down to an appropriate speed, pass over the bump, and speed up afterward. Such slow-down and speed-up increases the wear and tear of the vehicle suspension and chassis, reduces fuel efficiency, and results in higher traffic latency. This disclosure describes an electronic speed bump devised for calming traffic in presence of vehicles capable of driving autonomously. Communication between the electronic speed bump and the vehicle in autonomous driving mode includes an offer by the vehicle to respect the desired driving parameters in the section of the road covered by the electronic speed bump. If the autonomously driving vehicle is compliant with the required driving parameters, the electronic speed bump is withdrawn.

KEYWORDS

- Autonomous vehicle
- Semi-autonomous vehicle
- Self-driving car
- Automated driving
- Speed bump
- Speed limit
- Traffic compliance
- Ride comfort
- Ride safety
- Ride smoothness

BACKGROUND

Vehicles with autonomous driving capabilities, such as self-driving modes, need to handle speed bumps on the road autonomously when operating in a self-driving mode. Successfully and smoothly navigating a speed bump requires the vehicle to slow down to an appropriate speed, pass over the bump, and speed up afterward. Such slow-down and speed-up increases the wear and tear of the vehicle suspension and chassis, reduces fuel efficiency, and results in higher traffic latency. An alternate approach for managing vehicle speeds is to use a radar to impose appropriate speed limits and corresponding speed bumps within a given section of the road. However, neither standard speed bumps nor radar-imposed speed restrictions are currently based on industry standards pertaining to their operation and handling by vehicles driving in autonomous modes.

DESCRIPTION

This disclosure describes an electronic speed bump devised for calming traffic in presence of vehicles capable of driving autonomously. The operation of the electronic speed bump involves communication with the vehicle driving in an autonomous mode. Communication between the electronic speed bump and the vehicle in autonomous driving mode includes an offer by the vehicle to respect the desired speed limit in the section of the road covered by the electronic speed bump. The speed of the vehicle is then checked to verify whether it is at or below the speed limit prescribed for the speed bump. When the speed of the autonomously driving vehicle is compliant with the speed limit set by the electronic speed bump, the electronic speed bump is withdrawn. Communication with the speed bump and the subsequent action to check the speed is performed with user permission, e.g., the user of the vehicle can configure the

vehicle to allow such communication, or can deny the permission, in which case no communication occurs and the speed bump remains in place.

The communication protocol used to indicate and ensure compliance with the requirements of the electronic speed bump can include additional factors apart from the speed of the vehicle. For example, the speed bump requirements can be based on aspects such as the overall quality of the autonomous driving and the corresponding risk profile. Further, these aspects can be used to set a dynamically customized speed limit for each vehicle crossing the section of the road covered by the electronic speed bump.

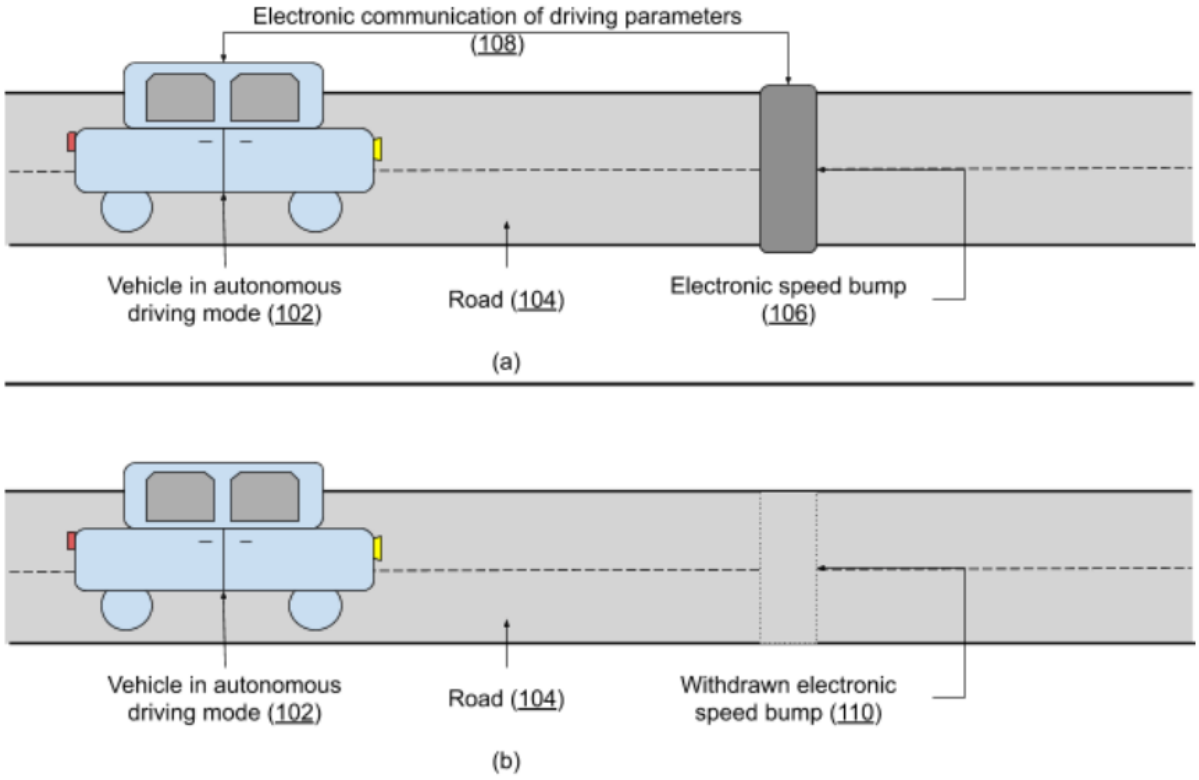

Fig. 1: Operation of an electronic speed bump for vehicle in autonomous driving mode

Fig. 1(a) shows a vehicle in autonomous driving mode (102) driving on a section of a road (104) and approaching an electronic speed bump (106). Communication between the electronic speed bump and the vehicle (108) is used to convey driving parameters, such as speed,

for the section of the road covered by the electronic speed bump. The vehicle in turn signals the intention to comply with the specific parameters. If the vehicle is then found to be driving in a manner compliant with the intended driving specifications, the electronic speed bump is withdrawn (110) as shown in Fig. 1(b). The vehicle can then drive smoothly through the section of the road covered by the speed bump without needing an excessive and abrupt slow-down followed by acceleration.

While a radar based speed bump provides somewhat similar functionality, the electronic speed bump described in this disclosure is more fine-grained and selective in its operation. Moreover, the communication protocol used by the speed bump can be designed and developed to be an industry standard, thus allowing wide-scale deployment that covering diverse kinds of vehicles with autonomous driving capabilities.

Since the electronic speed bump is automatically withdrawn for compliant autonomous vehicles, it is unnecessary for the vehicle to abruptly reduce speed followed by accelerating as is typical when driving over a conventional speed bump on the road. As a result, a vehicle operating in autonomous mode can provide a smoother and more comfortable ride while staying within the bounds of the ride safety parameters prescribed for the section of the road covered by the speed bump.

The techniques described above are independent of specific operational details of the manner in which autonomous mode is implemented in a vehicle. As such, with user permission, the described electronic speed bumps can support any vehicle that has autonomous driving capabilities, including those that feature semi-autonomous and/or assisted driving modes that involve human supervision and interaction and/or limited set of self-driving scenarios.

The potential increase in ride comfort and safety resulting from the described electronic speed bumps has the potential to accelerate and expand the adoption of vehicles with autonomous driving capabilities. It can allow automated or semi-automated cars to provide a more comfortable ride to their passengers which can lead to earlier adoption. All cars on the road with some driving assistance can include the protocol for automated speed bumps.

CONCLUSION

This disclosure describes an electronic speed bump devised for calming traffic in presence of vehicles capable of driving autonomously. Communication between the electronic speed bump and the vehicle in autonomous driving mode includes an offer by the vehicle to respect the desired driving parameters in the section of the road covered by the electronic speed bump. If the autonomously driving vehicle is compliant with the required driving parameters, the electronic speed bump is withdrawn. The communication protocol used by the speed bump can be an industry standard, thus allowing wide-scale deployment that covering diverse kinds of vehicles with autonomous driving capabilities.

REFERENCES

1. Rajani, Mohammed Shakir. "Smart Speed Bumps" (2015) available online at https://rc.library.uta.edu/uta-ir/bitstream/handle/10106/26723/Rajani_uta_2502M_13161.pdf?sequence=1&isAllowed=y