Driver Monitoring System (DMS)

Ensuring safe Operations outside and inside

INTRODUCTION

A DMS is a Safety functionality that continuously checks the driver's attention towards the road and the steering controls of the car. It addresses the driver's state of distraction, inattention or even sleepiness. In case the system detects the inability of the driver to cope with unexpected and sudden road events, it reacts with consecutive stages.

Step one is to get the driver's attention back by means of vibration and/or sound effects. When the attention of the driver cannot be acquired anymore, the DMS would apply step two by actively taking control over the Safety systems of the car, e.g. applying brakes in order to slow down the motion of the vehicle.

TECHNICAL REALIZATION

A DMS consists of a camera system that observes the driver's face, especially with a focus on the eyes. In order to have a clear sight in dark situations, the cameras are supported by LED illumination or even low-powered lasers. The level of the stimuli applied to the drivers depends on the background noise and vibration inside the vehicles. Therefore, a DMS retrieves additional information from various engine parameters, such as gearing, rotary speed, vehicle speed and the driving noise as experienced in the car interior.

If the DMS decides to take control of the Safety systems, it interacts with additional sensors to the outside world, such as external cameras, radar and lidar in order to cope with the current road situation. In case the vehicle is equipped with self-driving functionality, the DMS needs to cooperate with that system as well. Therefore, from a technical perspective, the hardware requirements are pretty low or even present already, while the software part does the heavy lifting. The algorithms for face detection and analysis are playing the major part in a DMS.

SAFETY CONSIDERATIONS

The existence of a DMS increases the Safety of the driver and passengers. However, a malfunction system may have negative impacts. Especially, a false alarm may:

- Scare the driver in a critical situation, in particular when the level of the stimulus is not calculated adequately.
- Make the driver get used to false alarms and therefore effectively nullifying the impact of a DMS.
- Access a critical system for no reason. An unexpected emergency brake or evasion maneuver may cause a dangerous situation.

As a consequence, the development of a DMS must follow Safety certification standards such as ISO 26262 at high Safety levels, up to ASIL D. This also implies requirements to the underlying operating system, e.g. an non-certifiable Linux system is considered to be unsuitable.

DMS ALGORITHM

An ADAS system is constantly providing new solutions for non-trivial real-world problems like automated freeway driving addressed by lane detection algorithm, pedestrian detection, road signs recognition, automated parking or driver fatigue detection. Driver monitoring has a special place among these algorithms as it is addressing the driver's fatigue problem, which is responsible for a serious number of road accidents. The driver's face and eyes positions are used for detecting if he is paying attention. The implemented algorithm is based on a Viola-Jones object detection framework normally. The algorithm is suitable because it can be implemented in a real-time fashion and was specially motivated by frontal face detection.
For driver fatigue detection the reading from multiple sensors is needed, mostly from the driver seat (e.g. heart rate) or cameras in the car to detect the eye lid level. Conclusions are drawn using a fusion of collected data and computer vision algorithms to detect where the driver is looking and if he pays attention to the road. Additionally, there are methods that consider driving patterns as a main indicator of driver tiredness. When detecting long term drowsiness, it is more suitable to use sensor or pattern methods.
The next technology step is to include the detection of other environment sensors, to detect cigarette smoke, strong smelling substances or including the sensor data of personal phones or personal Fitbits (as presented by the company Gentex at CES 2022). OEMs also think about how to use the internal view camera for other applications, such as video conferencing or e-call with visual doctor surveillance.

SOFTWARE ARCHITECTURE

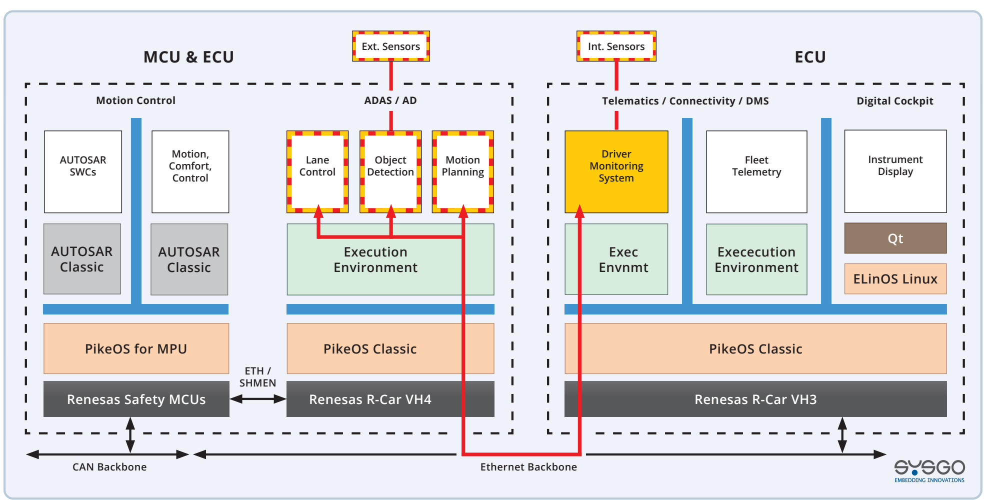
The DMS' focus lies on image analysis algorithms. However, there are best practices to consider. Like many Automotive systems, a DMS periodically repeats the following cycle: Sensor input – Calculation – Actuator output. The time delay between input and the output is critical to the DMS system and must not exceed a certain value. Therefore, the algorithms should respect a defined worst case execution time. This should be backed up by the configuration of the underlying operating system, e.g. by means of time partitioning.

To reduce ECUs on the same vehicle, it is recommended to execute multiple applications on the same hardware, side-by-side to the DMS implementation. Virtualization enforces system independence in terms of Safety aspects as well as the ease and reliability of a direct communication when needed, e.g. in case of an emergency situation. Resource partitioning supports the right amount of separation between the systems for this use case. Figure 1 displays an advanced sample software architecture with multiple vehicle systems sharing hardware platforms.

LEGISLATION

It is expected that by 2026 the EU requires automakers to implement driver monitoring systems in all new cars, no matter whether the vehicle comes with a driver assistance system or self-driving functionality.

PIKEOS "CLASSIC" & PIKEOS FOR MPU SOFTWARE ARCHITECTURE



Our real-time operating system PikeOS meets the requirements that a DMS has for an OS:

It provides real-time capability, time and resource-partitioning and certifiability.

PikeOS can be certified according to ISO 26262 up to ASIL D.

www.sysgo.com/certkits

Founded in 1991, SYSGO became a trusted advisor for Embedded Operating Systems and is the European leader in hypervisor-based OS technology offering worldwide product life cycle support. We are well positioned to meet customer needs in all industries and offer tailor-made solutions with highest expectations in Safety & Security. More information at www.sysgo.com/automotive

SYSGO Headquarters
+49 6136 9948 500

SYSGO France
+33 1 30 09 12 70

SYSGO Czech Republic
+420 222 138 111

sales@sysgo.com
www.sysgo.com