SMART EYE **ANTISLEEP 2.0**

– MONITORING FATIGUE AND ATTENTION CUES IN AUTOMOTIVE APPLICATIONS

The gaze direction and eyelid closure are key components when estimating the alertness and attention of a driver. Camera-based systems with multiple cameras have successfully been used to provide such measurements. The Smart Eye solution is AntiSleep, a compact one-camera system that is specially designed for automotive in-cabin real-time measurements of driver head pose, gaze direction and eyelid closure

INTRODUCTION

Together with alcohol and speeding, driver fatigue and inattention are recognized to be the most causative factors of severe road accidents. Large research and development efforts are spent on finding efficient ways to monitor driver alertness in vehicles. There are many cues to driver alertness, ranging from heartbeat frequency to steering wheel motions and lane keeping, but far from all can be measured efficiently in a realistic automotive scenario.

Three of the major cues are driver eyelid closure, gaze direction and head motion. These cues can be measured non-intrusively using video camera-based systems, e.g. the Smart Eye Pro system. Video camera-based systems offer a number of advantages in comparison to other techniques. In addition to measuring all the abovementioned cues, the systems can be used to identify the driver for different purposes.

Old systems on the market use stereovision and require two or more cameras placed at a distance from each other. These multi-camera systems were originally mainly designed for laboratory settings, and they are less suited for large-scale in-cabin mounting with high costs of space and wiring. While a mono-camera system would be preferable for cost reasons, it is a technical challenge to construct such a system that can deliver the driver alertness cues with sufficient accuracy and reliability. Smart Eye AntiSleep 2.0 is such an eye tracking system.

SMART EYE ANTISLEEP

Smart Eye AntiSleep is designed and developed to meet the requirements of the automotive industry for cost and size of each unit. The system uses a single standard camera of VGA resolution together with IR flash illuminators. The camera and the IR flashes are mounted in a compact unit but can be placed separately if required. The IR illuminators and filters are tuned to frequencies with minimum interference of outdoor light. This means that the system uses its own light, making it highly robust to all natural illumination conditions in automotive applications.

Fully automatic initialisation

Smart Eye AntiSleep measures the driver's head position and orientation, gaze direction and eyelid opening, at a rate of 60 Hz. All delivered measurement data have confidence values based on the estimated quality of the measurements. The system detects generic and person-specific facial features and maps them to a generic 3D head model. The head model is then quickly adapted to the driver in real-time. This driver initialisation procedure is fully automatic and invisible to the driver.

Robust tracking

Special effort was put into robustness to different types of eyeglasses, in particular situations where the frames occlude parts of the eye. Reflections in glasses are efficiently eliminated using a patented illumination technique. Smart Eye AntiSleep is tested and adjusted to male and female drivers of a wide range of ages and ethnic groups.

Frontal position

In the standard version, the camera can be placed up to 15 degrees off the frontal direction of the normal driving position. This normally allows for mounting the unit in the dashboard, in the top section of center stack or at the A-pillar. The system can also be adapted to other camera positions on request.

AntiSleep 2.0 runs on a standard PC-laptop, and the software is prepared for an embedded DSP-implementation. Furthermore, it is compatible with CAN interface.

FEATURES OF ANTISLEEP 2.0

- Automatic driver initialisation and gaze calibration
- Handles all variations of natural illumination conditions
- Handles a large variety of eyeglasses
- Delivers output data at 60 Hz
- Delivers confidence values for all measurement data

TECHNOLOGY

- One standard CMOS camera, VGA resolution
- IR flashes for illumination, in compliance with the limits for light-emitting diodes Class 1, IEC/EN 60825-1:2001
- Size of Camera-IR unit (w*h, intersection): 44*29 mm (varies with different configurations)
- Platform PC-laptop, but also prepared for implementation on DSP

OUTPUT DATA

Head position

Measurement range relative to normal driving position:
X ± 200 mm, Y ± 150 mm, Z ± 200 mm
Accuracy: 10 mm

Head orientation

Measurement range relative to normal driving position:
Theta ± 30 degrees, Phi ± 20 degrees, Psi ± 30 degrees
Accuracy: 3 degrees

Gaze direction

Accuracy: 10 degrees

Eyelid opening

Accuracy: 2 mm (distance between eyelids)

AntiSleep 2.0 is developed by Smart Eye AB. The company was founded in 1999 with the business concept to provide the general public, industry and advanced research institutions with computer vision software that enables computers and machines to sense and make use of human face and eye movements. Today, Smart Eye AB provides an easy-to-use system that is used in a number of different applications..

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