TAP (Traffic Accident Prediction)

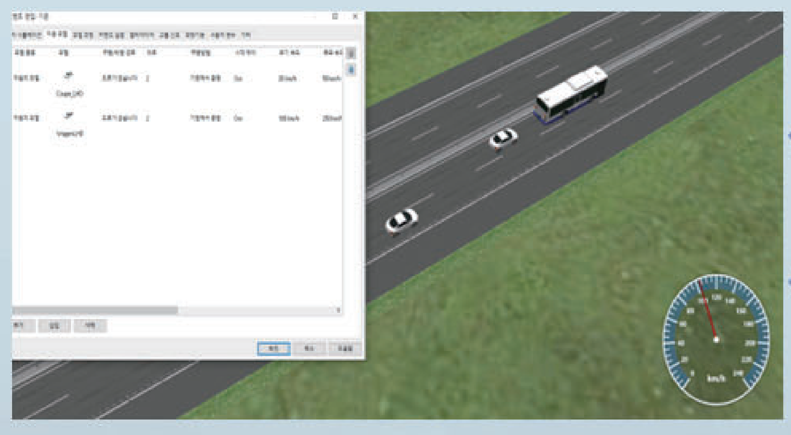
FORUM8
10th CPWC
KAAD

Background

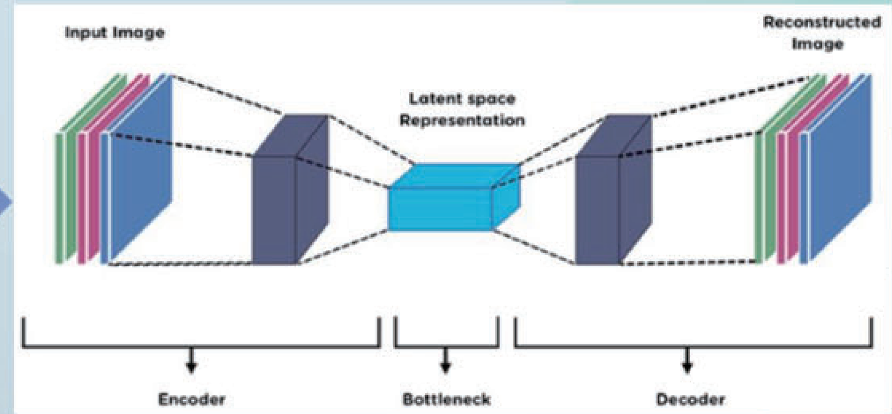
The most important factor in autonomous driving is safety.
Even if an unexpected situation occurs, a model should be prepared to recognize and cope with the situation. If a vehicle can predict anomalous object, it will be possible to minimize accident rate in traffic situations. Knowing where the diver's attention is being focused, vehicle can give an appropriate warning.

Concept

We build abnormal driving environment on UC-win and create future prediction model through deep learning. We can detect anomalous objects around us based on the predicted future. When the driver sees UC-win program in the driving simulator, a Bounding Box about anomalous object is projected on the screen.
Determine if the driver is detecting an anomalous object and deliver warning.



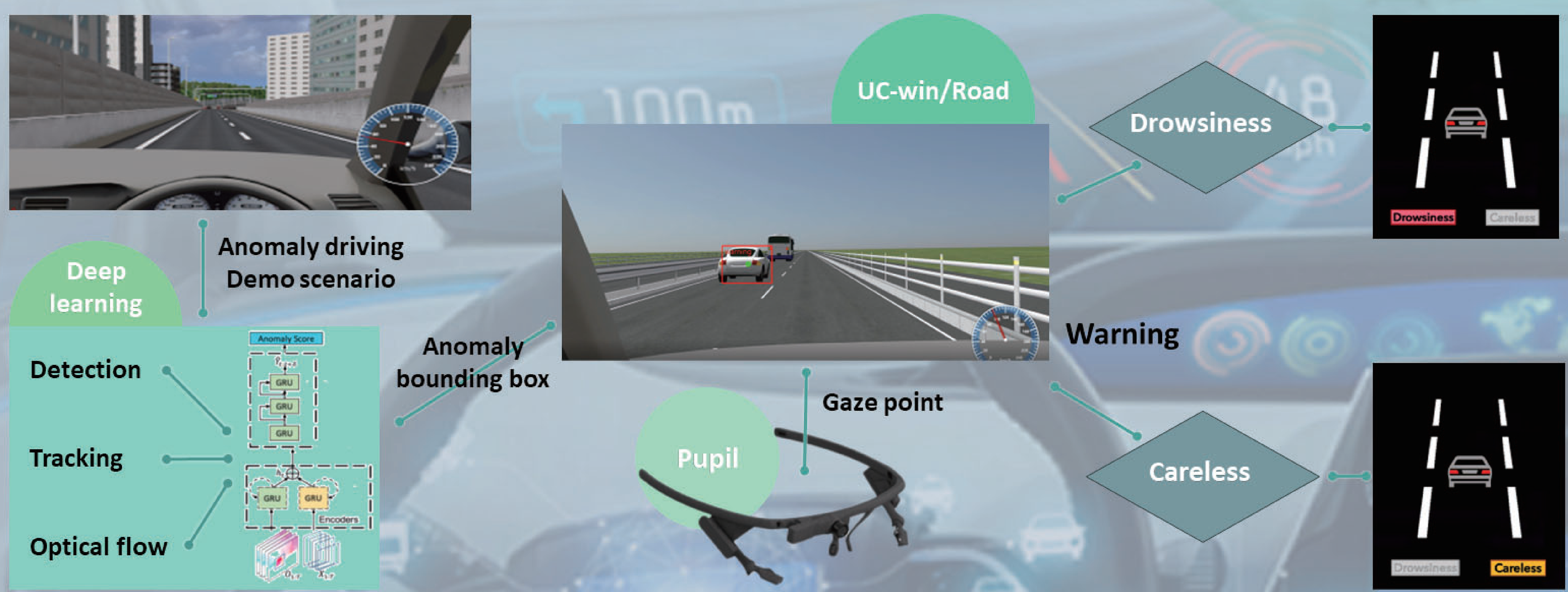
Build abnormal driving environment



Create future perfection model

Drive with Real-time warning system

System Architecture

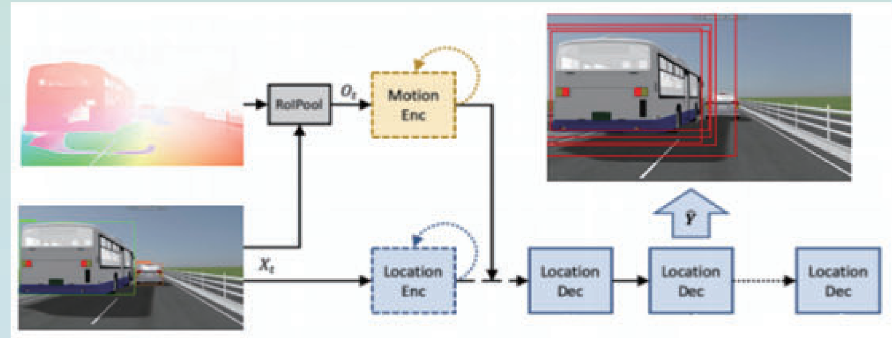


Deep Learning for Anomaly Detection

1. Image data from UC-win/Road is transmitted to two deep learning model at 0.1 second intervals in UC-win/Road.
2. Extract the optical flow vector and object information from two backbone model. We use 'YOLOv5' as detection model and 'flownet2.0' as optical flow model.
3. By referring to the information of each object in the past, the future object localization model returns prediction of the object location.
4. An anomaly score is derived by comparing the predicted value with the actual value.
5. Abnormal object information is transmitted to UC-win. Draw a bounding box of abnormal object to alert the driver.

Future Object Localization for Anomaly Detection

It is possible to cope with unlabeled risk situations through unsupervised learning methods. Future Object Localization Model consists of auto-encoder based on GRU(Gated Recurrent Unit). We used three methods as a measure of anomaly detection. (Bounding box accuracy, Masked box accuracy, Bounding box consistency)



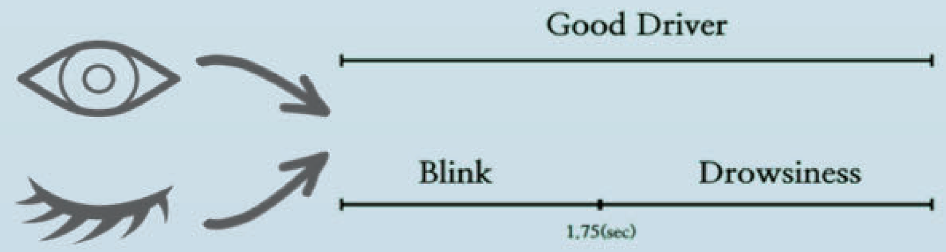
Drowsiness Detection

Drowsiness Detection

We use the Blink Detection plugin of Pupil Core to detect drowsiness. Pupil Core's Blink Detector leverages the fact that 2D pupil confidence drops rapidly in both eyes during a blink as the pupil becomes obscured by the eyelid, followed by a rapid rise in confidence as the pupil becomes visible again. Define the former state as "onset" and the latter as "offset".

Implementation

We first track the timestamp of the eye-closed state (onset) to warn of drowsiness if the onset state is greater than 1.75 seconds.

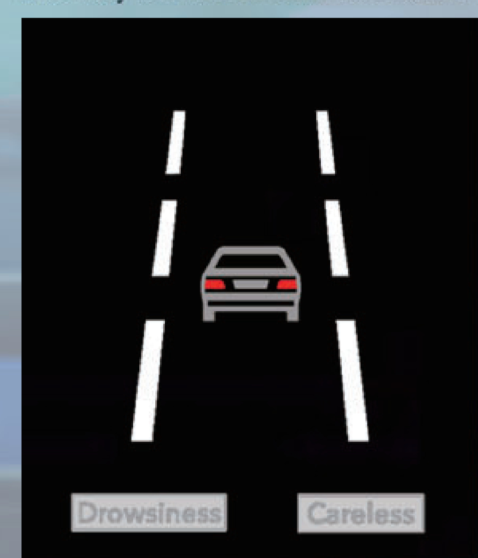


Onset

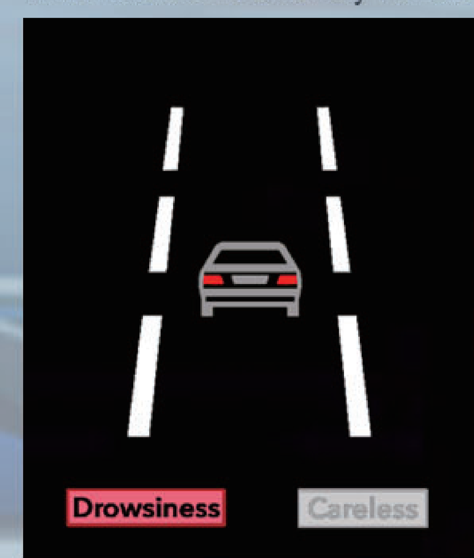
Offset

Warning User Interface

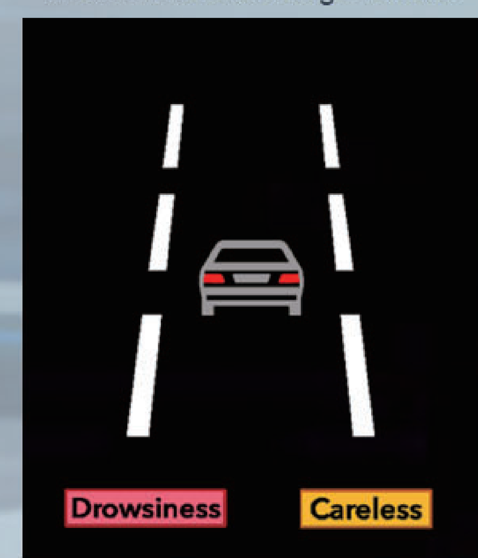
Careful
A situation in which the driver recognizes an anomaly vehicle or normal situation



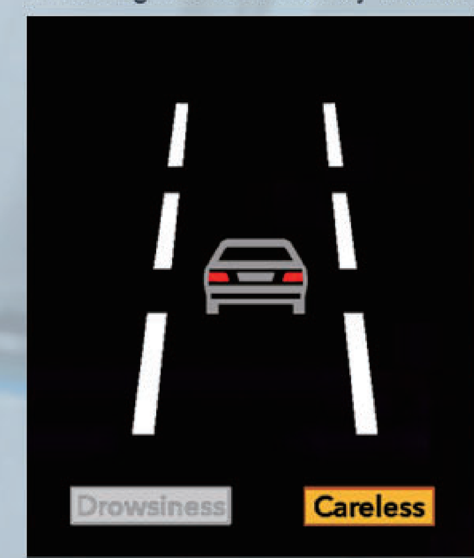
Drowsiness
Situation in which the driver is drowsy when there is no anomaly vehicle



Drowsiness in anomaly situation
Situation in which the driver is drowsy when there is a strange vehicle



Careless in anomaly situation
A situation in which the driver does not recognize the anomaly vehicle



Carelessness and drowsiness determined by the relationship between the bounding box and the gaze point are displayed on the GUI. The driver may quickly determine the abnormal situation by recognizing the warning phrase displayed on the GUI.

Future implementation plan

1. **Scenarios for autonomous and human-driven vehicles on the same road.**
   If an autonomous vehicle and a human-driven vehicle are driven together, an accident will occur due to the behavior of an unpredictable person. To prevent accidents, there is a need for a technology capable of quantifying anomalies in vehicle management.
2. **Multi-level occupant safety protection system**
   When the driver fails to detect a situation where an accident may occur, it is warned through sound and notification.
   If operations such as braking and avoidance are not performed, an accident is prevented by car's control.
   Avoidance and braking are determined in consideration of the path of the surrounding vehicle.
   The gaze estimation vector can be used to detect and warn behaviors that interfere with driving such as drowsy driving, phone calls, and text messages.