Detecting truck driver's fatigue and distractions using Convolutoinal Neural Networks

***Abstract*—Driving a truck when the driver is experiencing fatigue and distractions is considered unsafe. Therefore, controlling the driver's in-cabin behavior is an important task (for example at mines and on roads). Once the event is detected the system can send a sound alert to the truck driver and notify site operations that unsafe driving behavior was detected.**

In this document, we describe a prototype implementation of a simple solution that detects fatigue and distractions events and notifies the control center. Our solution is based on convolutional neural networks (CNN) combined with a regular neural network to detect distractions and fatigue instances. Apart from the image recognition we also wrote a simple backend that is capable of collecting GPS coordinates, short video clips, and actual events in the database (fatigue and distraction). The user interface allows the controller to confirm and, if necessary, correct the events for further updating the CNN model. All events are displayed on the map for analysis. Historical data browsing is also possible for more in-depth analysis of the driver's behavior.

We have trained the neural network with 500 labeled images (we had three categories or classes in our dataset: distraction, fatigue, and regular, normal operation), and verified the accuracy of the solution using another 500 images (unlabeled). The validation was performed by visually inspecting 500 images and comparing them to the predicted result. The CNN, apart from classification, was also outputing a bounding box.

I. Introduction

Safe driving is an important thing: a lot of incidents are due to distractions and fatigue. Therefore, it is important to keep the driver alert and focused on driving a car or a truck. This is especially important during long distance and night drives.

In this work we investigate a simple solution that constantly monitors the in-cabin driver's behavior and notifies it via sound alarms about the fatigue and distraction event occurrences.

As part of the prototype implementation we have also implemented the simple backend that keeps track of GPS coordinates, stores short video clips (when fatigue and distraction is detected) and event types in the database (although this part of the project is not exposed in the public Git repository).

The application are of this solution is broad: from improving the safety at mines to safety on city roads.

II. CNN architecture

We have chosen a CNN network for the classification task with 3 convolutional layers (with 8, 16, and 32 feature maps), one flatten layer, one fully connected (or dense) regular NN layer, and output layer with two heads: one head for bounding box detection and one head for classification. We have used RELU function as the activation function, 4x4 max pooling layer, and 4x4 kernels. We have used mean square error as the loss function for the regressor and categorical crossentropy for the classifier. For the classifier we have used softmax activation function, other layers were using RELU activation function. High level view of the architecture is shown in Figure 1.

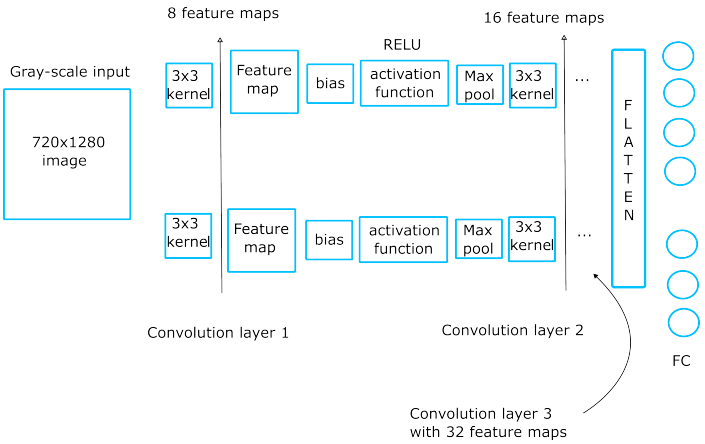

Fig. 1: Convolutional neural network architecture

(a) Fatigue detection

(b) Distraction detection

(c) Normal behavior

Fig. 2: Examples of different events

III. Experimental results

We have captured 1000 images using a IR-capable camera, converted the images to single channel images (gray-scale)

and labeled 500 images manually. That became our training dataset. Using these 500 images we have trained the CNN, and then performed validation using remaining 500 images. Finally, we have calculated the accuracy for our model: we have obtained 79.9% accuracy on training dataset, which is rather good for such a small dataset (we assume that the weights of the CNN are updated on the backend once new labeled images become available). The examples of the classifications are shown in Figure1 2.

IV. Discussion

We believe that there is a magnitude of application use cases for the developed prototype: from driving trucks in hazardous environments such as mine, to improving safety on regular roads.