

*The contribution of the Research Group to the HU-MATHS-IN Collaborative Project with BOSCH

H2020 SOCIETAL CHALLENGES

Safe and collision-free driving

The Industrial Problem

Given an RGB bitmap, the end-goal is to generate a modified version of the original bitmap with photo-realistic fog applied. To this end, we need to extract as much information as possible from the original image such as the scene geometry, the illumination of the scene, etc.

Automotive Industry and Manufacturing

**Budapest University of
Technology and Economics**



Our group provide industrial mathematics solutions including modeling, algorithm design, programming and consulting.

Robert Bosch Ltd.



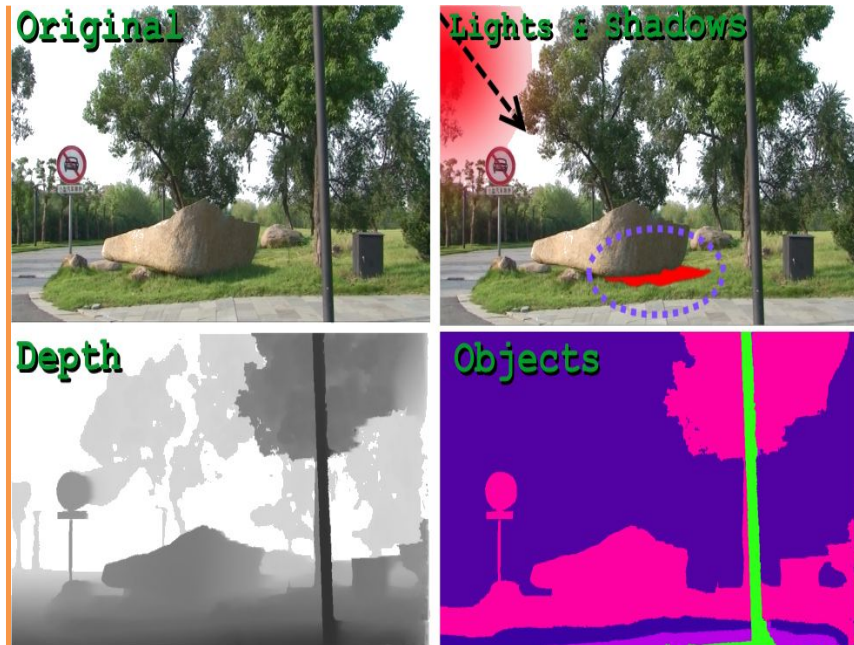
BOSCH
Invented for life

The Bosch Group is a leading global supplier of technology and services

SZÉCHENYI 2020

Challenges & Goals

- Generate physically accurate fog on a single RGB image.
- The generator should be parametrizable to a maximum extent.
- The program has to run under a second.
- All information should be inferred from pixel data.
- Only publicly available datasets could be used.



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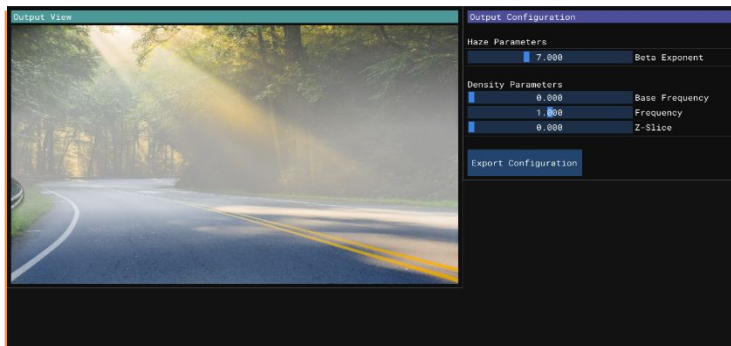
Safe and collision-free driving



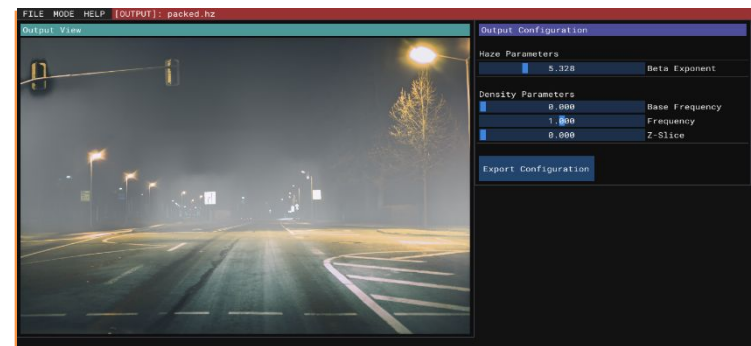
Fog with different visibility range (above), information we have to extract from a single image (left).

Mathematical and computational methods and techniques applied

- Convolutional neural networks were used to extract depth map from pixel data.
- For calculating the illumination of the fog, we designed an algorithm using image based lighting (IBL) and cube map hallucination feasible for handling nighttime cases and halo effect.
- Heterogeneous density of the fog was modeled by simplex noise making the fog extremely parametrizable and keeping our algorithm fast in the same time.
- A new physical fog model was developed. The new model can count with non-constant air light and thus taking account the effect of shadow cones which results a more realistic output.



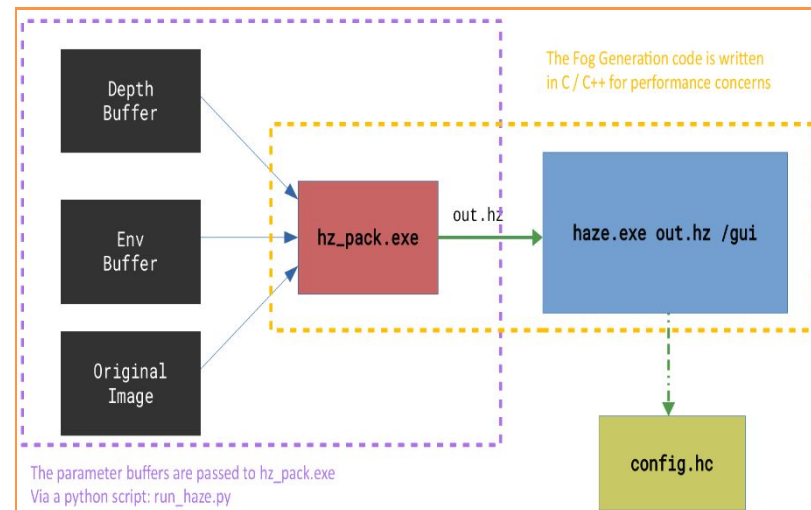
Simulation results in daytime



Simulation results in nighttime

Results & Benefits to the company

- A fog new model which gives more realistic results than other state of the art models.
- A new efficient data-driven algorithm capable of inferring all the necessary input data from a single image.
- A fast, highly parameterizable and flexible C++/Python API.
- Our program reaches ~15 FPS on PC, CPU only and ~60 FPS is possible on GPU.
- The company with our software in hand can generate synthetic training data for machine learning algorithms processing camera signals.



The current project pipeline.

The company has an application which can generate synthetic training data by simulating photo-realistic fog with adjustable homogeneity on single images.

