# DASA

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# DASA: An Open-Source Design, Analysis and Simulation Framework for Automotive Image-Based Control Systems

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## BACKGROUND

**Image-based control (IBC) systems**

- A class of data-intensive feedback control systems whose feedback is provided by image-based sensing using a camera [1].
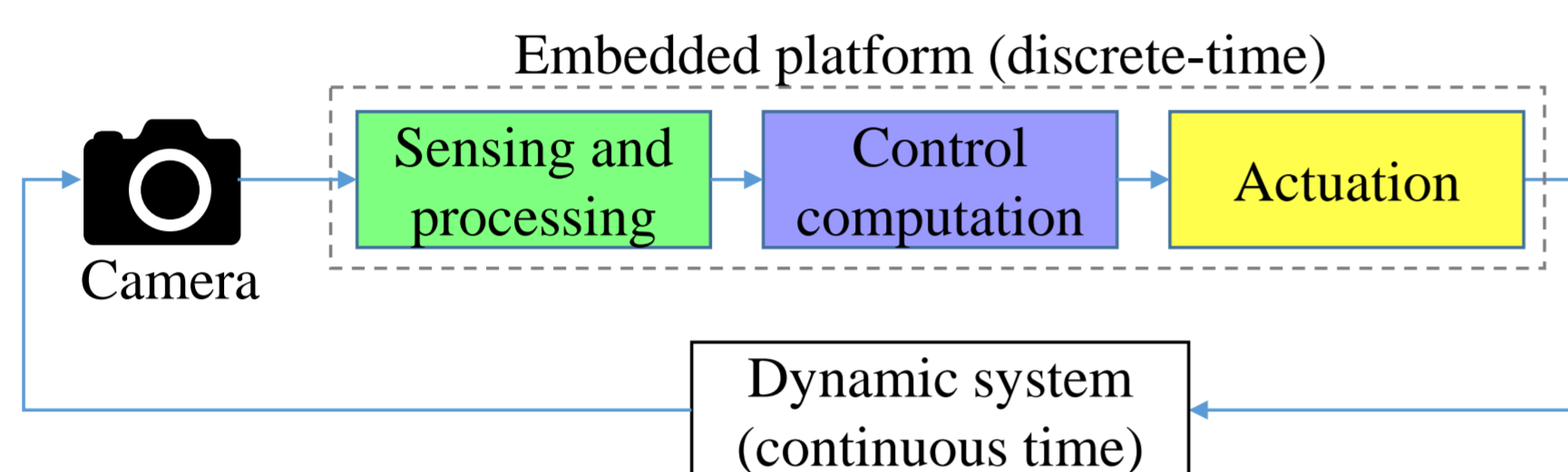


Figure 1. An image-based control system: block diagram

- Image-based sensing gives information on relative position, relative distance, depth perception and tracks object-of-interest.

## MOTIVATION

- The state-of-the-art simulation and validation of IBC uses static pre-captured image streams and is decoupled from the controller.
- Controllers are designed, e.g. the choice of sampling period, for an estimated worst-case delay as shown in Fig. 2.
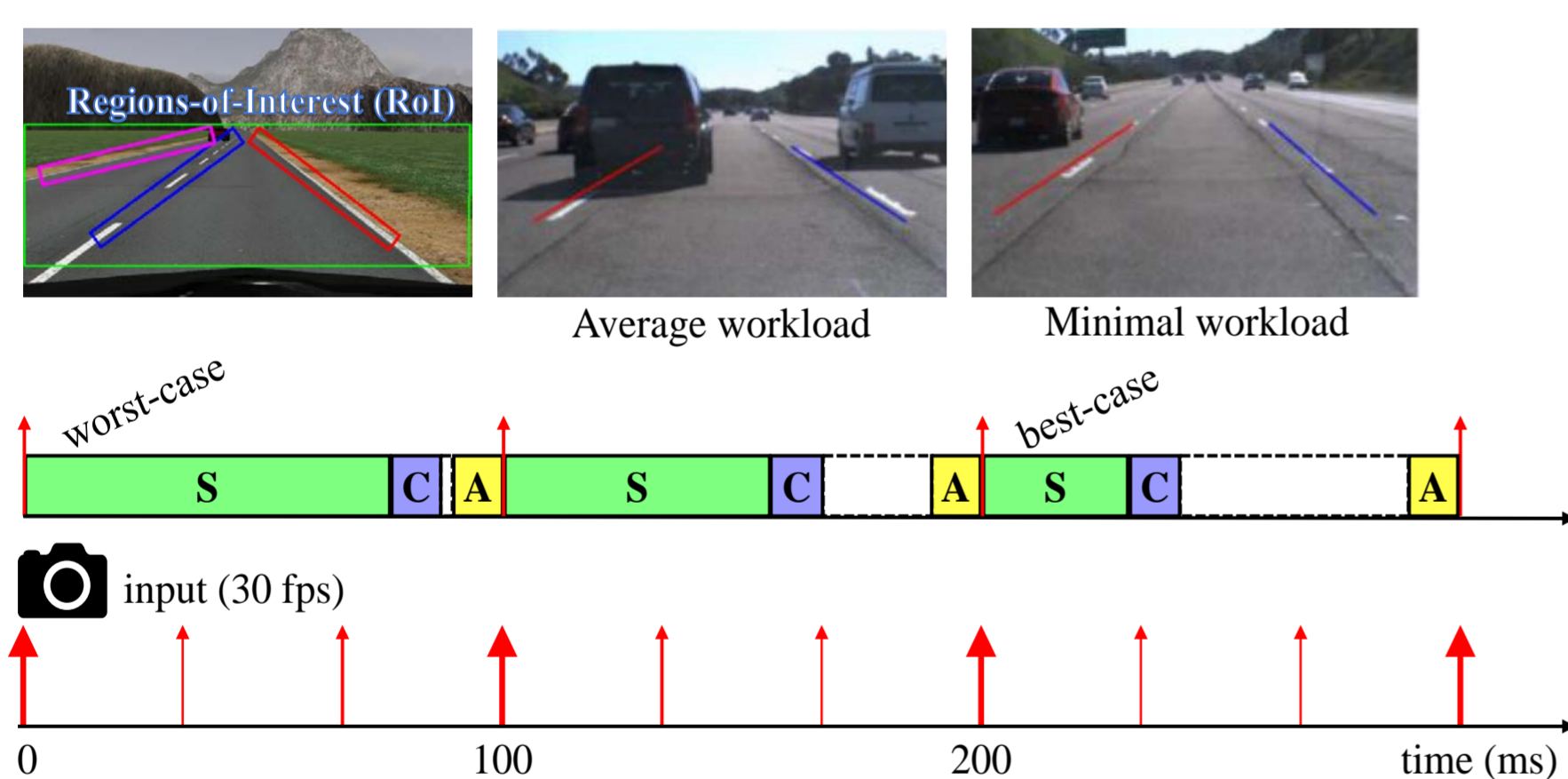


Figure 2. Control design for the worst-case delay. Sampling period here is 100 ms.

- In reality, the camera is fixed to the vehicle body (Fig. 3) and any steering change would affect the region captured by the image.
- This dynamism cannot be captured in a static image stream and a dynamic image stream that considers the change in vehicle dynamics due to IBC actuation is needed [2].

## REFERENCES

[1] S. Mohamed, D. Zhu, D. Goswami, & T. Basten, "Optimising Quality-of-Control for Data-intensive Multiprocessor Image-Based Control Systems considering Workload Variations." In 21st Euromicro Conference on Digital System Design (DSD), 2018.
[2] D. Zhu, "Simulation framework for design & analysis of vision-based lateral control of autonomous vehicles," M.Sc. Thesis, Eindhoven University of Technology, 2018.
[3] 3DS MAX, www.autodesk.com/education/free-software/3ds-max
[4] E. Rohmer, S.P. Singh, & M. Freese, "V-REP: A versatile & scalable robot simulation framework." In International Conference on Intelligent Robots & Systems (IROS), 2013.
[5] Matlab, www.mathworks.com/products/matlab.html

## DASA FRAMEWORK

- An open-source design, analysis, and simulation framework.
- Considers the change in vehicle dynamics in real-time and produces real-time dynamic image stream as per the vehicle model (see Fig. 3) and control algorithm.
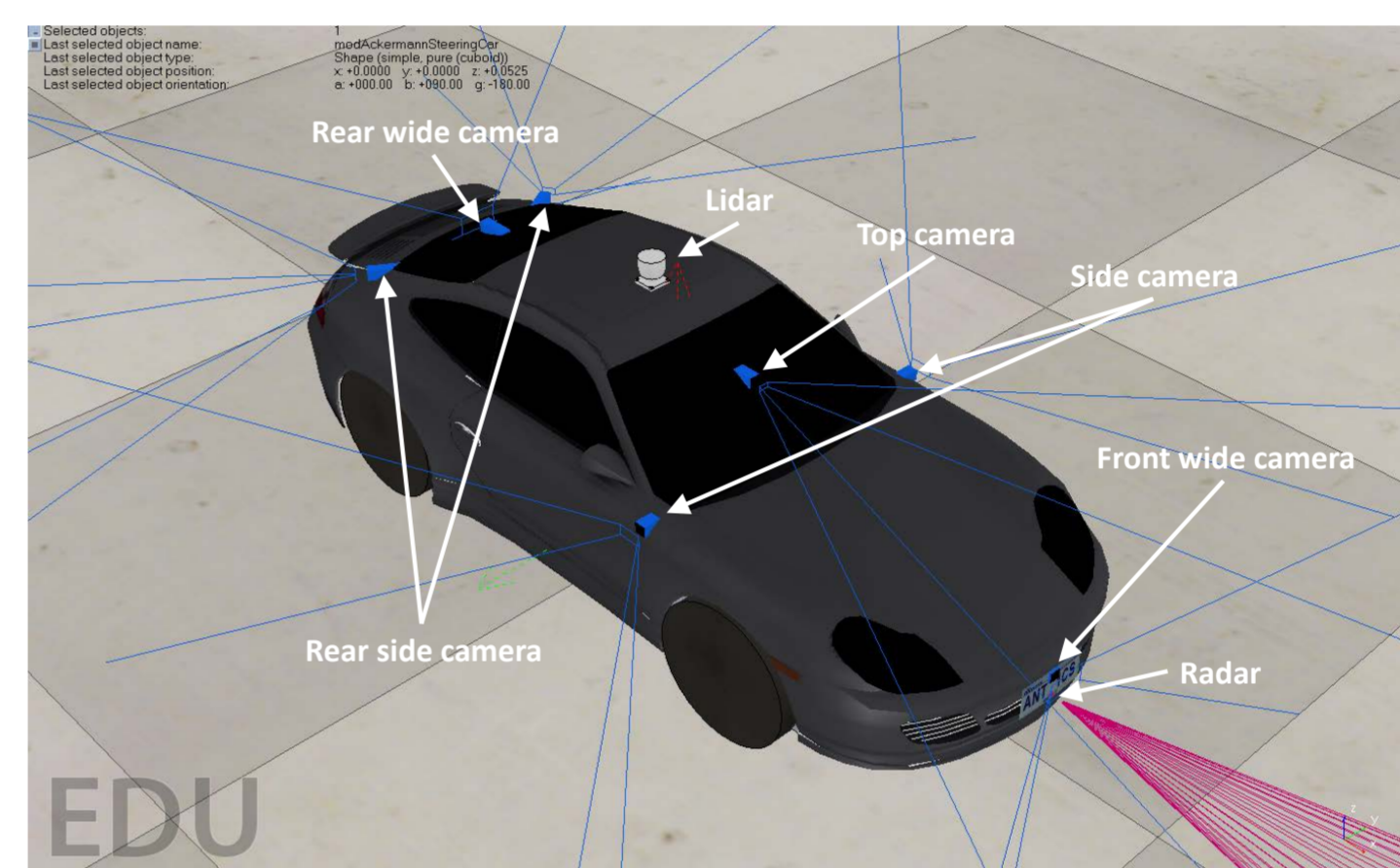


Figure 3. Vehicle model in V-REP simulating physical sensors and dynamics

- DASA models the 3D environment in 3ds Max [3], simulates vehicle dynamics, camera position, environment, and traffic in V-REP [4] and computes the control input in Matlab [5] (see Fig. 4).
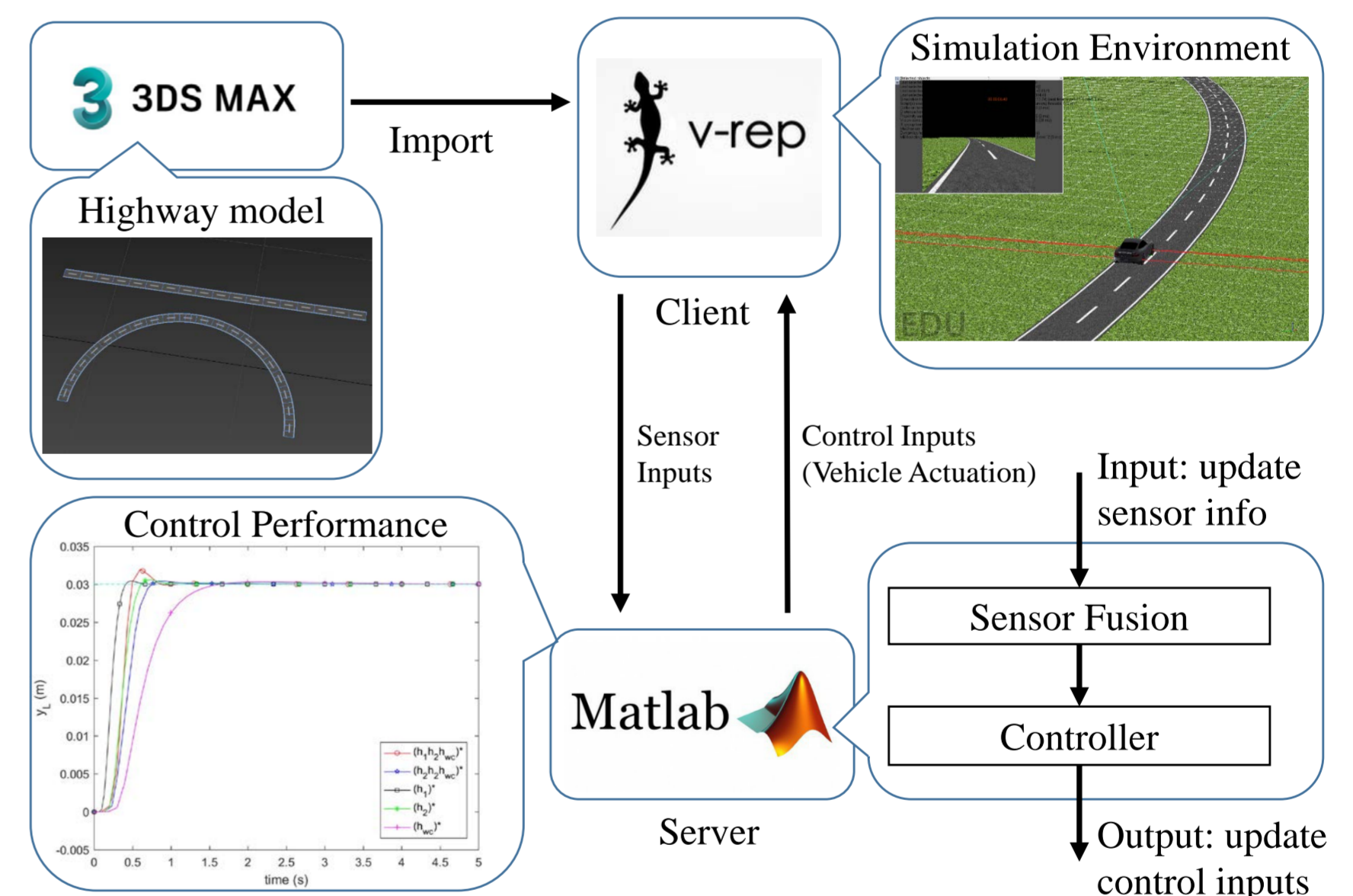


Figure 4. Overview: DASA framework

## RESULTS & CONCLUSION

- We show the effectiveness of our framework using a vision-based lateral control system [1], [2].
- A dynamic image stream considering vehicle dynamics, camera position, and control inputs is generated synchronously [2].
- Download DASA from: www.es.ele.tue.nl/cps/automotive/#dasa

## ACKNOWLEDGEMENT

**DEPARTMENT OF ELECTRICAL ENGINEERING / ELECTRONIC SYSTEMS GROUP**