

I. IDENTIFICATION DATA

Thesis title:	Offloading of road sign recognition from autonomous vehicle to edge servers in mobile networks
Author's name:	Ján Daněk
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Measurement
Thesis reviewer:	Prof. Ing. Juraj Gazda, PhD.
Reviewer's department:	Department of Computers and Informatics, Technical University of Kosice

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	challenging
<i>How demanding was the assigned project?</i>	
Bc. Jan Daněk's thesis presents a comprehensive and well-structured investigation into offloading road sign recognition from an autonomous vehicle to an MEC server using 5G networks. The work demonstrates a strong understanding of the problem and a significant effort to practical implementation and experimental validation. The thesis successfully addresses all the points outlined in the assignment.	

Fulfilment of assignment	fulfilled
<i>How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.</i>	
The student demonstrates commendable initiative by developing a custom dataset and a dedicated neural network for road sign classification, recognizing the limitations of existing resources. The performance evaluation is comprehensive, employing a range of metrics to assess both local and MEC-based processing. Results convincingly highlight the benefits of offloading, showcasing significant reductions in processing time and vehicle energy consumption.	

Methodology	correct
<i>Comment on the correctness of the approach and/or the solution methods.</i>	
This thesis tackles a relevant and challenging topic: offloading road sign recognition tasks from an autonomous vehicle to an edge server using a 5G network. While the work presents interesting findings and contributes to the field, several methodological shortcomings and potential improvements could strengthen its scientific rigor and impact.	
<i>Limited Dataset Size and Diversity:</i> The custom dataset, while a valuable contribution, is relatively small (1303 images). Expanding its size and including a broader range of road signs, lighting conditions, weather conditions, and viewpoints would improve the generalizability of the trained neural networks.	
<i>Single-Exit Architecture:</i> Relying on a single-exit architecture for the neural network pipeline may limit its efficiency. Exploring multi-exit architectures could potentially reduce processing time and energy consumption by exiting the pipeline early when sufficient confidence in the recognition is achieved.	
<i>Lack of Comparison with Existing Methods:</i> The thesis lacks a comparative analysis with other state-of-the-art methods for road sign recognition, particularly those employing alternative neural network architectures. Such a comparison would provide context and highlight the relative strengths and weaknesses of the proposed approach.	

Technical level	A - excellent.
<i>Is the thesis technically sound? How well did the student employ expertise in the field of his/her field of study? Does the student explain clearly what he/she has done?</i>	
The thesis generally demonstrates a solid understanding of the technical concepts involved, including:	

Mobile networks and MEC: The author correctly explains the role of 5G networks and MEC servers in offloading computational tasks from autonomous vehicles.

YOLOv3 and object detection: The implementation and explanation of YOLOv3 for road sign detection are well-presented, including the description of the loss function and the process of training and evaluating the network.

Distance estimation: The principle and implementation of distance estimation using camera data are clear and technically correct.

Energy consumption measurement: The methodology for measuring energy consumption is sound and provides valuable insights into the efficiency of local processing versus offloading.

Formal and language level, scope of thesis

A - excellent.

Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?

The thesis follows a logical structure, starting with background information, proceeding to system design and implementation, and concluding with performance evaluation and future work. The writing is concise and conveys the technical concepts effectively.

Minor comment: Figure 22: The legend labels "Local" and "MEC" are not very informative. More descriptive labels like "Local Processing" and "MEC Server Processing" would be helpful.

Selection of sources, citation correctness

B - very good.

Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?

The selected sources are mostly relevant to the research topic and include a mix of journal articles, conference papers, technical reports, and online resources. The bibliographic citations meet the academia standards.

III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

Summarize your opinion on the thesis and explain your final grading. Pose questions that should be answered during the presentation and defense of the student's work.

- 1) You briefly dismissed partial offloading in your thesis. Could you elaborate on the challenges and potential benefits of implementing partial offloading for road sign recognition, considering various splitting points within the neural network architecture?
- 2) Your work focuses on a single autonomous vehicle. How could your system be scaled to handle multiple vehicles simultaneously offloading data to the MEC server, considering potential resource contention and communication bottlenecks?

Otherwise, the presented work is excellent and I really enjoyed reviewing it.

The grade that I award for the thesis is **A - excellent**.

Date: 10.6.2024

Signature:

