



SUPERVISOR'S OPINION OF FINAL THESIS

I. IDENTIFICATION DATA

Thesis name:	Transformer-Based Robust Multi-Object Tracking using Historical Trajectories
Author's name:	Jan Frederik Meier
Type of thesis:	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Control Engineering
Thesis supervisor:	Prof. Dr. -Ing. Johannes Stegmaier
Supervisor's department:	RWTH Aachen University

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment <i>Evaluation of thesis difficulty of assignment.</i>	challenging
Explore new ideas in Transformer E2E Tracking, specifically incorporating historical trajectories. This is a very challenging task, requiring a lot of implementation effort and literature review.	
Satisfaction of assignment <i>Assess that handed thesis meets assignment. Present points of assignment that fell short or were extended. Try to assess importance, impact or cause of each shortcoming.</i>	fulfilled
Successfully accomplished all intended goals, implementing and testing them within the planned timeline. The Temporal Prediction Module still needs refinement.	
Activity and independence when creating final thesis <i>Assess that student had positive approach, time limits were met, conception was regularly consulted and was well prepared for consultations. Assess student's ability to work independently.</i>	A - excellent.
Exhibited a highly independent and curiosity-driven work style, characterized by extensive literature review and exploration. Highly motivated and actively engaged, consistently preparing weekly presentations to showcase progress.	
Technical level <i>Assess level of thesis specialty, use of knowledge gained by study and by expert literature, use of sources and data gained by experience.</i>	A - excellent.
Demonstrated strong technical expertise and developed a comprehensive understanding of the entire tracking domain.	
Formal and language level, scope of thesis <i>Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.</i>	A - excellent.
Demonstrated good writing skills but required assistance and guidance, particularly in crafting the introduction.	
Selection of sources, citation correctness <i>Present your opinion to student's activity when obtaining and using study materials for thesis creation. Characterize selection of sources. Assess that student used all relevant sources. Verify that all used elements are correctly distinguished from own results and thoughts. Assess that citation ethics has not been breached and that all bibliographic citations are complete and in accordance with citation convention and standards.</i>	A - excellent.
Conducted exceptional literature research, even extracting ideas from 3D end-to-end tracking approaches and adapting them for implementation and testing in our specific case.	
Additional commentary and evaluation <i>Present your opinion to achieved primary goals of thesis, e.g. level of theoretical results, level and functionality of technical or software conception, publication performance, experimental dexterity etc.</i>	
Demonstrated strong technical expertise and developed a comprehensive understanding of the entire tracking domain.	



SUPERVISOR'S OPINION OF FINAL THESIS

III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

Jan Frederik Meier successfully finished his Master's thesis on the challenging topic "Transformer-Based Robust Multi-Object Tracking using Historical Trajectories" at the Institute of Imaging and Computer Vision at RWTH Aachen University in a dual degree program with CTU Prague. He successfully employed a diverse skillset and could reach all posed goals of the thesis in an excellent manner. Programming was performed on a high level, and he could easily get into implementational details of repositories containing state-of-the-art computer vision algorithms for end-to-end tracking. The thesis is very well written, nicely illustrated and at an excellent level regarding technical depth, language, and scientific standards. Finally, Mr. Meier exhibited a very high motivation, was always well-prepared in meetings with his supervisor and came up with creative ideas. I have no reservation of rating the thesis with the best possible grade.

Possible questions for the defense:

- How did you approach a systematic selection of the methods you investigated?
- The developed methods are not yet consistently surpassing the state-of-the-art. What would be next steps or potential improvement ideas that you'd follow to further improve?
- Do you think that the involved validation metrics are capable of faithfully assessing the pros and cons of your methods? Any blind spots in the metrics that would require the development of additional / new metrics?
- What would be your guess on the generalization capabilities of your method? Do you expect it to work as a general object tracking pipeline irrespective of the underlying video data? Any hurdles you may see here?

I evaluate handed thesis with classification grade **A - excellent**.

Date: **6.1.2025**

Signature:

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Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Control Engineering
Thesis reviewer:	Jan Čech, Ph.D.
Reviewer's department:	Cybernetics

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	challenging
<i>Evaluation of thesis difficulty of assignment.</i>	
The assignment is rather challenging as it includes an open research problem and requires the author to acquire a broad knowledge in modern architectures and be well familiar with the most recent state-of-the-art approaches in multi-object tracking.	

Satisfaction of assignment	fulfilled
<i>Assess that handed thesis meets assignment. Present points of assignment that fell short or were extended. Try to assess importance, impact or cause of each shortcoming.</i>	
Fulfilled undoubtedly.	

Method of conception	correct
<i>Assess that student has chosen correct approach or solution methods.</i>	
The proposed modification of the multi-object tracker is sensible and the architecture and implementation are elegant.	

Technical level	A - excellent.
<i>Assess level of thesis specialty, use of knowledge gained by study and by expert literature, use of sources and data gained by experience.</i>	
The thesis is of a very good technical quality and reports on solid research.	

Formal and language level, scope of thesis	A - excellent.
<i>Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.</i>	
The thesis reads very well. I have only minor comments on typography: Commas should be part of equations, while the commas usually start the text after the equations, e.g. in Eq. (3.6). Additionally, there should be left and right apostrophes 'word' and not 'word', e.g. in the first sentence after the subsection title on page 13.	

Selection of sources, citation correctness	A - excellent.
<i>Present your opinion to student's activity when obtaining and using study materials for thesis creation. Characterize selection of sources. Assess that student used all relevant sources. Verify that all used elements are correctly distinguished from own results and thoughts. Assess that citation ethics has not been breached and that all bibliographic citations are complete and in accordance with citation convention and standards.</i>	
The review of related work is detailed and helpful. Citations are correct.	

Additional commentary and evaluation	
<i>Present your opinion to achieved primary goals of thesis, e.g. level of theoretical results, level and functionality of technical or software conception, publication performance, experimental dexterity etc.</i>	
The thesis reports on a commendable piece of research. The idea to improve and model trajectories of tracked objects using a trained model is valid. The approach to the problem is elegant and meaningful. A lightweight model was proposed, implemented, and tested. The experimental section compares the proposed modification with state-of-the-art methods.	

Moreover, an excellent ablation study showing the impact of many design choices was carried out. The only drawback is that the results are rather negative. In other words, the proposed modification does not improve the baseline method. This conclusion complicates the publication of the main contribution of the thesis in a conference or journal. Nevertheless, the thesis clearly opens a new research direction, and with further elaboration, the results could be improved and the research published.

III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

Summarize thesis aspects that swayed your final evaluation. Please present apt questions which student should answer during defense.

Quality of the thesis is clearly above average.

I evaluate handed thesis with classification grade **A - excellent**.

Questions for the defense:

1. The trajectory prediction module (TPM) is implemented by a neural network and is trained from data. This is perhaps close to optimal when enough data is available, but it lacks interpretability. Did you consider modeling object trajectories using conventional numerical models, such as differential equations?
2. Did you consider any kind of test-time adaption? The TPM is pre-trained offline, however it could potentially be adapted online during tracking.
3. Can you comment on the number of historical frames n as input. There is no ablation on this, but is there any trade-off or sweet spot in theory?

Date: **2.1.2025**

Signature: