THESIS REVIEWER'S REPORT

I. IDENTIFICATION DATA

Thesis title:	**Human motion modeling and data generation tool for tracking algorithms development**
Author's name:	**Silvia Goldasová**
Type of thesis :	bachelor
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Measurement
Thesis reviewer:	RNDr. Zuzana Kúkelová PhD.
Reviewer's department:	Department of Cybernetics

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment **challenging**

How demanding was the assigned project?

The topic of Silvia Goldasová's bachelor thesis is to study different approaches to human motion modeling in order to generate data for training and testing human motion tracking algorithms. This is an important problem since acquiring real data (e.g., using motion capture) can be costly, hard to perform (privacy issues, availability of suitable environments, etc.). and sometimes almost impossible (e.g., for certain scenarios like building evacuations). An alternative approach is to model human motion and generate synthetic data instead. However, modeling human motion is a challenging problem as many aspects of human behavior must be considered (avoiding obstacles, interactions with other people and the environment, path planning, etc.). Therefore, there exist multiple approaches for modeling human behavior and motion, e.g., based on multi-agent systems, machine learning, (social) forces, etc. The goal of the thesis was to study such different approaches, select a suitable model, and propose and implement a new simulation environment (including configurable behaviors and a graphical visualization of the generated data). The thesis addresses a challenging problem worthy of being studied.

Fulfilment of assignment **fulfilled**

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.

The thesis fulfills the given tasks. The student provides a nice review of different approaches to human motion modeling, identifies the strength and limitations of these approaches, and clearly explains her motivation for the selected model (a social force model). The social force model is described in detail. The student designed a simulator that combines the selected headed social force model with a probabilistic algorithm for global path planning and a finite state machine modeling human behavior. The student also provides graphical visualizations of the generated data (4th task of the thesis). My only (minor) objection is that the description of the implementation feels incomplete. I am missing a description of the simulation environment, for example, whether the student implemented an interface for setting input parameters and a description of details on the visualization tool. It seems that information was supposed to be provided in Sec. 3.5 (implementation specification), which only includes one table without any description.

Methodology **correct**

Comment on the correctness of the approach and/or the solution methods.

The student nicely reviewed different methods, identified their strengths and weaknesses, and clearly explained the motivation for the selected headed social force model [5]. Moreover, she combined the social model (which describes local behavior) with a probabilistic road map algorithm for global path planning. She extended [5] by the functionality of generating points of interest that are visited in a given order, generating maps with obstacles, a finite state machine for modeling the agent's behavior, and path smoothing via B-spline interpolation. The student suggested three types of evaluation: simulation, comparison with data generated by other models, and a user study. All these experiments are well-designed. In the simulation, the student evaluated the human motion model in four different scenarios to simulate, e.g., collision avoidance, crowded corridors, open spaces, and cluttered spaces.

In general, the selected methodology is suitable for the task and technically correct. In addition, the student nicely summarized the obtained results from the evaluation, the current limitations of the method, and proposed possible improvements.

Technical level **A - excellent.**

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?

The thesis is technically sound, and the student demonstrated a suitable background. The detailed description of the social force model and its components shows a good understanding of the student of this complex model. Unfortunately, the thesis is not always clear about which parts already existed/were already used in combination with the headed social force model and which parts are new extensions suggested by the student. In conclusion, these extensions are summarized, but the other parts of the thesis do not explicitly highlight novel contributions. For example, it is not clear whether smoothing trajectories via B-spline interpolations or whether probabilistic road maps were not used before together with the social force model. I assume that these are novel contributions, but this has to be better highlighted. E.g., it would have been nice to show results of simulations with and without these extensions.

Formal and language level, scope of thesis **C - good.**

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 is organized in a logical way, and the problem setting (simulating human motion) is well-motivated. My main concern is the language and many missing descriptions. The presentation of the thesis can be significantly improved:

- There are many typos (e.g., "model with be presented" (instead of will be) and "the walkers just to the dynamics" (instead of adjust), "has were changed", etc.).
- Some sections are incomplete, e.g., the end of Sec. 1.4 is missing, Sec. 3.5 is nearly completely empty and contains only a single table without any description. Some figures are not clearly described. For example, do Fig. 4.8 and 4.9 show results of the simulation using the proposed method or from motion capture data as written in the figure description. It is also not clear what the difference between Figs. 4.5 and 4.6 is. Fig. 4.10 also lacks a description of the abbreviations of the evaluated methods. Fig. 4.12 and Fig. 4.14 are unclear to the reader since it does not contain trajectories.
- The language used in the thesis is sometimes overly complex, and some sentences contain grammatical errors. Otherwise, the level of English is satisfactory.

Selection of sources, citation correctness **A - excellent.**

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 references provided by the thesis are satisfactory, and the review of the literature is highly detailed with discussions of the advantages and disadvantages of the individual methods.

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.

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Overall, the thesis is an excellent submission for a Bachelor's project. The student clearly showed a deep understanding of the topic and not only implemented existing methods but also suggested improvements and built a larger system. Moreover, she evaluated the proposed model in different scenarios that are well-motivated and are nicely showing different properties of this model. Unfortunately, the thesis gives the impression that it was written in a rush. As such, it contains many typos, mix-ups of words, and hard-to-read sentences. More importantly, the thesis lacks some details about the designed user interface/simulation environment, a description of some figures, and a clear description of the contributions of the thesis compared to existing work. Given a clearer presentation, this thesis would have deserved an A grade. In its current form, I recommend the thesis for defense and propose a grade of B (very good).

Additional comments and questions:

1. How long does it take to compute one simulation / one frame?
2. Is it possible to easily choose different parameter settings in the simulation environment/user interface?
3. Can you show the user interface and its functionality during the presentation?
4. How many users participated in the survey? Can you show some results of the user study?
5. Do you have an intuition for solving the issue in Fig. 4.7 (collision caused by path smoothing)?
6. What is the difference between Figs. 4.5 and 4.6?
7. How was the visualization implemented?

The grade that I award for the thesis is **B - very good.**

Date: **2.6.2022** Signature: