Assessment of Masters' Thesis as an External Examiner

Title: **Relative localization of helicopters from an onboard camera image using neural networks**
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Fulfillment of Assigned Tasks

The assigned tasks are of high technical level and require a large amount of work. The student did more the fulfilling the assigned task because the system was fully implemented on the MAVs and tested on a real experiments, whereas the assignment required solely to test the algorithms on a dataset.

Resolution Methods

The student appropiately based its neural network on an existing one based on the similarity of the task at hand and its relatively small demand on computational resources. The adaptation of this network by the student is very well described in Section 2. The student then classically trains the network on simulated data and then on a dataset. The training seems to be successful, however, there is no word about the tuning of the hyperparameters. Some sets of hyperparameters are mentioned in Table 2 but overwise the values of the hyperparameters seem to be set arbitrarily.

One of the evoked reasons for the failure of the first experiment with the linear leader trajectory is the double detection. In the same vein, as when the student admits that some details were overlooked, it would have been interesting to understand why the solution taking the detection with the highest confidence was not taken directly.

In general, the applied method and the used ascending complexity sounds very reasonable and led to applicable results.

The student proposes a method that can be used on-board an MAV with a latence which is under one second. There is a misused, though, of the term real-time, which only denotes an algorithm that runs within a predictable time interval.

Obtained Results

As already stated, the neural network was implemented in real experiments, which is a big bonus not planned in the assigned tasks. The results show that the system sometimes fails and that the obtained accuracy is in the order of meters, which is probably not precise enough for some MAV tasks, but the most important thing is that the student analyzes thoroughfully each of the results, also the bad ones. At p. 25, the student explains that a simplification was made by error, which led to a systematic error non neglictible for the detection at short distances. However, it would have been useful to state when this error was discovered. The error being systematic it is unclear for what reason it was not compensated a posteriori.

During the reduction of the size of the input image, a linear interpolation was used. It looks that this downsizing is important, why, in such case, not use a better interpolation

method, such as a bicubic interpolation.

Practical Requirements

The thesis is written is a very good English, only a few classical stylistic mistakes usually done by Czech people could be noticed. Appart from a single found "doesn't" the used style is formal. I found a single sentence with a missing word at the end of page 41. The whole thesis is particularly well typeset. Figures and bibliography are of very high quality and I particularly appreciate the fact that even the graphs and the figures use the same font style as the rest of the text. The thesis cites a large number of references.

A few details that are noticed are:

- in Eq. (27) the variables a_1 and a_2 are not explained, rather, they are noted a_r and a_l in the figures,
- in Eq. (27) the function acos should be written with the mathematical notation arccos,
- the learning rate step s_i in Table 2 does not seem to be explained nor used anywhere.

General Comments and Conclusion

The thesis is of a very high level as much from the results as from its presentation. The student analyses all presented results and gives some non-trivial directions for future work. I have a question though. How well would the neural network adapt to other drones with the same parameters or with a new training phase? It is a pity that the student did not experiment with this because it is easy to find images on MAVs on internet and test the neural network on them, at least for the detection without considering the localization.

As a conclusion, I advise the commission to evaluate the presented Masters' thesis with the grade

A - Excellent.

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