Review
of
Amr Mohamed Abdelhameed Nagy Abdo's
thesis work titled
"Recognition of Objects and Their Defects"

Final review

10. 11. 2022

1. Format

The format of the thesis work is OK, the language is clear, the pages look well organized. I found it very useful that the research questions, the used data sets, the essence of the results, and the own contributions were clearly described.

2. Content

In the thesis work the Candidate introduces the combination of different neural and traditional methods to solve important application problems from the field of machine vision.

First thesis group

The addressed problem here was the enhancement of the accuracy of the classification in a situation, when a machine has an opportunity to look at an object multiple times from different view angles with a camera, which is equipped with an IMU sensor as well. The Candidate proposed using Hidden Markov Model for this multi-modal data fusion, where the hidden states were the objects in a particular pose, and the emission probability was provided by a trained VGG16, and the transition probabilities were derived from the angular information provided by the IMU. The maximum 4 steps sequence was evaluated by a Viterbi algorithm.

The Candidate showed that the proposed method performs significantly better for the second and the third step than the simple averaging of the classification results. For the fourth step, both methods reached close to 100% accuracy.

The method was further improved with an active vision approach, where the camera movement orientation was decided based on the maximization of the recognition probability. The Candidate showed that the VGG16 neural network can be replaced with a computationally lightweight, color similarity based global object classification method (CEDD). As it turned out, the recognition worked OK even for partially occluded objects as well. The Candidate even compared the results to a Convolutional LSTM, however as it turned out the active vision with HMM approach performed better.

I have three questions here:

- Did the system propose always single steps (either 5 degrees to the left or 5 degrees to the right)?

- The color based CEDD method is expected to be sensitive for introducing a large foreign color object, which partially covers the target object. How do you comment on it? When you used partially occluded images, did you use the same occlusion object in the entire sequence?
- The LSTM is designed for long sequences. Did the advantage of the LSTM come out in short (4 steps) sequences?

As a summary, I found this thesis group strong.

Second thesis group

In this thesis group the aimed problem was the enhancement of the detection of the traffic sign defects. The Candidate proposed an improved VGG16 based siamese network (FCSNN-VGG16), which was extended with multiple fully connected layers. The results were quite OK for the faded traffic sign, but performed poorly for the others.

To fix this problem, the Candidate applied a support vector machine after the siamese net (FCSNN-VGG16-SVN). The performance was quite OK now, however as it turned out, the performance increase was marginal compared to the original VGG16 (without siamese).

In this section I missed the comparison with results from other teams. Since the Candidate used open databases there should be other works, which could have been used as the baseline.

In summary I do not feel that this thesis is strong.

Third thesis group

In this thesis group the Candidate addressed the Zero and Few-Shot Learning problems on steel surface defects. First he trained the largest EfficientNet, which generated the best ever published results. Then, based on this, he introduced few shot learning by modifying the network. The modification was either fine tuning the entire network, or by introducing random and a directly calculated fully connected layers after the feature map, or by fine tuning the fully connected layers only.

As it turned out, the random layer plus computed weights were practically the best between 5 and 10 shots, though the computational burden was minimal for this training method.

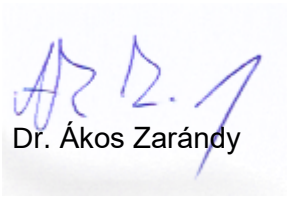
It was also a good feature of the introduced method that it could avoid catastrophic failure. Moreover, with 20 new samples, it could reach above 95% accuracy.

The Candidate has also introduced zero shot learning as well, which could identify new classes of defects by using siamese network. The Zero-Shot Learning seems to work fine in a fault database. However, in real life, when the detector picks up detected objects from the steel surface, which are not necessarily faults, just darker areas, the Zero-Shot Learning will detect it as a new fault class.

I found this thesis group strong.

3. Conclusion

In general, I think there are new scientific results described in the thesis work. Therefore I suggest having the final defense. Moreover, I recommend awarding the PhD degree.



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