Evaluation of ML-object-detection architectures for drone-based hamster hole detection

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Agricultural food production is necessary for providing food security. Additionally, rodents play a key role in the agricultural ecosystem. However, a too-large population can eliminate farmers' yields and scrutinize that food security. Manual pest control in agricultural fields is resource-intensive. This study helps researchers in replacing these methods with fundamental new technologies.

Introduction and Objective

In the case of the German region of Sachsen-Anhalt, a field mouse species is damaging the corps of farmers with the negative result of a harvest loss of up to 80%. Farmers can protect their fields against the field mice if there is no protected hamster residing on that field. Currently, resource-expensive and manual techniques are applied to check the population of rodents in agricultural fields. A German research group under the lead of the association "Landschaftspflegeverband Grüne Umwelt e. V." is currently working on a substitution for this process. The novel system will use a drone to take images of affected farmland and use AI-based image classification to count borrows. This research supports the image processing part of the study. It compares neural network architectures to find the best-suited model for the case.

Research Design

In this study, several pre-trained models from the popular TensorFlow (TF) object-detection model-zoo are compared. TensorFlow is a deep learning framework developed by Google. The model-zoo is a library of pre-trained models. During the project, different hardware solutions for the given Machine Learning task were compared. Additionally, it is a key challenge to have the correct software environment set up in order for the system to work. The image data was supplied by the study group and doesn't need processing. Before starting experiments, suitable model parameters had to be identified. Therefore, Hyperparameter tuning selects the best learning-algorithm-parameters. The model cannot learn these parameters, so they must be defined. After training and evaluation, the model results can be compared. Finally, the good-performing models can be used as stand-alone applications.

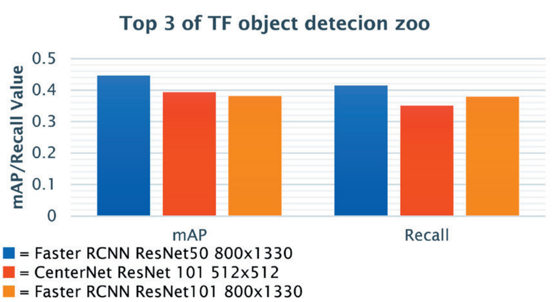

Figure 1: The three best models in comparison.

Results

After comparing different hardware and software environments, a local desktop machine with a powerful GPU, namely the NVIDIA GeForce RTX 2060 super, was selected to conduct the experiments. Several different model-experiments have been conducted during the study. It has been shown that parameter adjustment for the models is extremely sensitive. In the end 32 of the models have been compared. Figure 1 presents the best three model architectures. Compared to the other models in the experiment, the three models performed well. To compare the operating performance, the models were exported to apply them to images. Regarding the visual control, there were almost no differences recognizable.

Implications and Recommendations

The limitations of the study are caused not just by the limited data basis, but also by the hardware that has reached its limits. As an example, the quality of the trained model suffered from the low batch size. This parameter was forced to be set that low in order to have an executable model on the machine. Nevertheless, based on the findings of this study, this paper suggests a selection of models from the model-zoo to the research group. In the end, it was hard to improve the already well-trained models. Nevertheless, the study claims that for hamster hole detection the three proposed models are well-suited. For further studies, it is recommended to use more computational power and a Linux environment for easier integration. More comprehensive data is a major factor for improvement. The latest point can be improved by techniques such as cross-validation.

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