SHORT TERM SCIENTIFIC MISSION (STSM)
SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CA15134
STSM title: Development of individual tracking to measure resilience in pigs
STSM start and end date: 25/11/2019 to 20/12/2019
Grantee name: Lisette van der Zande

PURPOSE OF THE STSM:

(max.200 words)

Resilience is defined as the time or ability to overcome a perturbation (Colditz & Hine, 2016). The time of recovery can be measured by activity (e.g. distance moved). Pigs have a distinct activity pattern over the day. Deviation from this diurnal pattern can indicate a perturbation or loss in resilience. The amplitude of deviation specifies the severity of the loss in resilience. The time it takes to restore this activity pattern indicates the recovery time. To obtain an accurate measure of resilience, activity needs to be measured as accurate and as frequent as possible. Human observations of activity can be done, however this is labour intensive and results in a less frequent sampling of activity. Computer vision can automate this process, resulting in an accurate and continuous sampling of activity in pigs.

The aim of the STSM is to investigate the possibility of using computer vision to track the individual activity of pigs. Dr. Oleksiy Guzhva at SLU Sweden has experience with computer vision for monitoring behavior of dairy cattle. Together we will implement computer vision algorithms for object detection and tracking in pig videos.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

(max.500 words)

Computer vision can be separated in several steps: annotation (1), object detection (training phase) (2), actual detection (testing on new/raw data) (3), and object tracking (4). These steps will be explained below.

1. The first step was to annotate video frames. Annotating is labelling of the pigs in the frame by drawing bounding boxes around the pig. Each and every pig in every single frame was manually annotated as a single object class (i.e. pig as a single object, without actual IDs). Video footage was available of two days. Frames were chosen based on activity in the pen and time of day. To assure detection quality for the trained model, frame variability is a necessity (i.e. different positions and locations of the pigs). A total of 1617 frames were annotated using labelimg.
2. A YOLO (You Only Look Once) model was trained to detect the pig (Redmon & Farhadi, 2018). YOLO is a state-of-the-art multi-layer neural network for real-time object detection. It divides the image into regions and predicts bounding boxes and probabilities for each region. The bounding boxes are weighted by the predicted probabilities. The annotated images are the input for the model, where 90% of the annotated frames were used for training and 10% were used for validation. It was

suggested to have 2000 iterations per class, but not less than 4000 iterations in total, to assure reliable model performance (Redmon & Farhadi, 2018). Since we have only one class, YOLO was trained for 4000 iterations.

3. A video was selected with movement of the pigs that were not used for annotation. This was done to test whether the detection would still work on a frames it was not trained for. For calculations, you need the ground truth (i.e. annotations). Therefore was the 10% validation set as described above used for calculations of mAP and IoU. So both a video as the validation set were used to test the detection model.
4. Tracking assigns individual tags to the bounding boxes, allowing for object identification over time. For tracking, the weights of YOLO were used as input for the SORT (simple online and realtime tracking) algorithm. This model has the best potential to be used in future applications. SORT is designed for fast and straightforward tracking where only past and current frames are available for the algorithm. In later phase of the research, the coordinates of the bounding boxes can be used to calculate activity.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

Detection

The trained YOLO model on pigs works really well in a video the model did not see before. Figure 1 shows a still image of the detection of an unknown video. There is only one bounding box per pig, and the probability that the bounding box is showing a pig is around 99%.

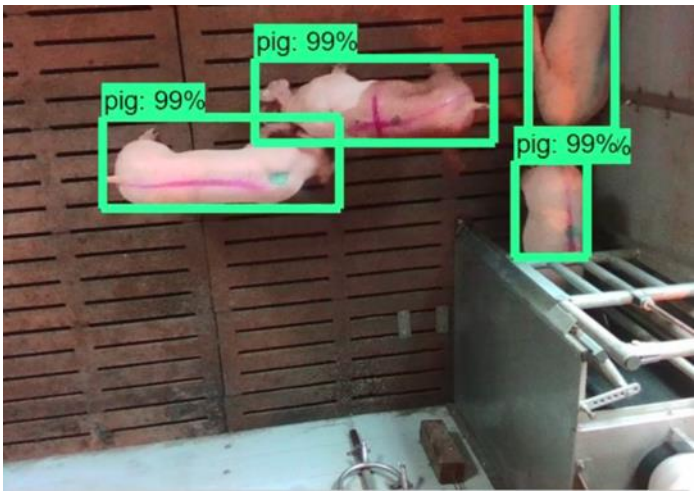

Figure 1 - Results of detections of custom trained YOLO model

The mAP (mean average precision) is 0.99. mAP combines precision and recall and can take values between 0 and 1. This value indicates a good detection of the pigs.
IoU (Intersection over Union) is 83.6%. IoU measures the overlap between the annotated dataset and the detection from the YOLO model. This value confirms the good detection found with mAP.

Tracking

The SORT algorithm uses the detections produced by trained YOLO model as an input. However, based on IoU, SORT can distinguish whether a pig in frame A is the same as in frame B. If the boxes overlap enough (IoU threshold is 0.3). SORT only uses the IoU, and is therefore not good for handling occlusions and cluttered scenes. When occlusions occur, the boxes of different identities overlap, causing identity switches. Figure 2 shows the case of occlusion in the video and SORT algorithm handled it rather well. No switches in identities occur in this part of the video and each pig has its own bounding box. However, mounting or more severe occlusions may give identity switches in the future. This could be avoided by extending the pool of annotated frames and variability in ground truth data.

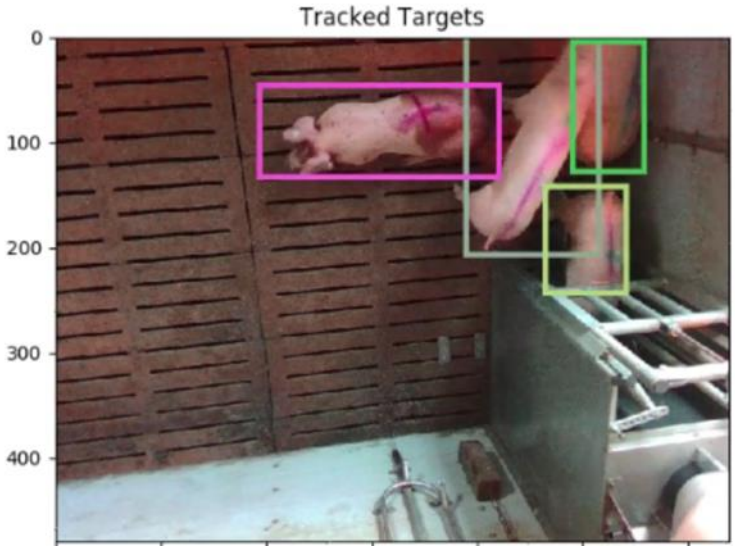

Figure 2 - Results of SORT algorithm using trained YOLO model. Each bounding box has its own colour for identification.

FUTURE COLLABORATIONS (if applicable)

Together with Oleksiy Guzvha, we will publish the results obtained during the STSM in a scientific paper. Oleksiy Guzvha will continue as a co-supervisor for the remaining of my PhD period. We will continue with homepen tracking of barren and enriched housing of existing data. These animals were challenged in their resilience, thus a link between activity and resilience can be made.

REFERENCES

Colditz, I. G., & Hine, B. C. (2016). Resilience in farm animals: biology, management, breeding and implications for animal welfare. *Animal Production Science, 56*(12), 1961-1983.

Redmon, J., & Farhadi, A. (2018). Yolov3: An incremental improvement. *arXiv preprint arXiv:1804.02767*.