

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: Automatic detection of tail biting

Synergy for preventing damaging behaviour in group housed pigs and chickens (GroupHouseNet)

STSM start and end date: 01/05/2019 to 31/05/2019

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PURPOSE OF THE STSM:

Tail biting out-break is considered as a welfare-reducing problem with economic consequences for pig production. Physical damage caused to the tail can lead to death by blood loss and secondary infection can spread throughout the body. The reasons of tail biting are multifactorial, including external factors such as nutrition, sex ratio, and environment (floor type, stocking density, ventilation, lack of enrichment) and internal factors such as genetics, sex and health states. The complexity leads to tail biting is usually detected only when there is already blood visible in the pen and an outbreak already occurred. An early indication that an outbreak is likely to occur might help farmers to intervene before major damage happens. Former studies have proved indicators like the frequency of performed tail bites, oral manipulation, tail posture, amount of posture changes, and activity could be reliable predictors for an outbreak, which give gives the possibility to implement early warning systems of tail biting using Precision Livestock Farming (PLF) technologies that offer an advantage of continuous, objective monitoring of animals.

The aim for this STSM is combining the tail-biting behaviour knowledge from animal science (Institute of Animal Welfare Science, Austria) with PLF technology (M3-Biores, KU Leuven, Belgium) in order to develop algorithms based on computer vision in 2D video that allow automatic prediction and/or detection of tail biting behaviour in fatten pigs. The Insitute of Animal Welfare Science provides pig facilities and expertise in creating datasets as well as training the student pig behaviour knowledge, while M3-Biores group provides video analysis, modelling and algorithm development. A technical route was proposed, and the feasibility verification was carried out during this STSM, that is, the deep learning based action recognition system that takes videos as input to the model. The basic idea of this route is to detect and count the frequency of performed tail bites as the indicator to predict the risk of the tail-biting outbreak.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

1. Experimental materials and setup

The data were collected in Medau research farm with the IP camera (GV-BX 1300-KV, Geovision). Top-video videos of 24 undocked pigs in two pens were captured continuously with clinical signs of tail biting behavior. A total of 300 tail-biting events were labeled out by an expert. Each tail-biting event lasts from 1s to 10s.

2. Methodology

From the perspective of computer vision, the tail-biting behavior includes temporal features in addition to the spatial features present in the 2D image. Compared with other social behaviors (e.g. aggressive behavior etc.), the tail-biting event has a relatively smaller range of motion. In most cases, only the movement of biter's head and victim's tail can be observed. In very rare cases, this biter follows the victim with slow movement. Therefore, the more commonly used features, like activity index used to measure the activity intensity can not be directly applied. Two approaches were proposed and tested:

1). Convolutional neural network + Long short-term memory (CNN+LSTM)

This network architecture was used in action recognition of human, which has already achieved satisfying results on human behavior dataset. The CNN has the ability to extract spatial feature, while LSTM is in charge of extracting temporal features. The first trial was to verify the feasibility of applying this model to the pig behavior. Original raw videos (tail-biting events happened within group) without any processing were taken as the model input, and the behavior categories (biting/non-biting) were taken as the output. However, the results show only 52.3% accuracy in the validation dataset, which closed to random guess meaning the model learned nothing. This probably because the input is the raw video with a group of pigs visible by the model, in which the tail-biting events can happen in any place. The model is not "smart" enough to locate the region of interest automatically. Therefore, the second trial is to extract the interaction pair firstly, then throw the interactive behavior between two pigs into the model.

2). Interaction behavior extraction by object detection and tracking

When trying to extract the interaction behavior of two pigs among the group and remove the unrelated individual, locating and identifying each pig in every single frame is necessary. The transfer learning based object detection has been used in PLF of pigs, like eating behavior, lying posture etc., which has already shown outstanding results compared with tradition image processing. We employed Single Shot Detector (SSD) for this task. A pre-trained SSD model was fine-tuned by over 3000 pig instances from one pen which labeled by bounding boxes using software named Labellmg. Then, a tracking algorithm was developed by the assumption that the same pigs won't move a lot between two adjacent frames. The tracking results as showed in the following figure which give ID with different color of bounding box.



Based on the tracking trajectory of each pig, all pig-to-pig interactions can be cropped. Same model as in approach 1). with new interactive behavior make the accuracy as high as 92%.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

The main results during this STSM include:

- 1). A well-annotated tail-biting dataset was obtained, which can be used for understanding tail-biting behavior, developing algorithm and being a benchmark for the future;
- 2). A pig behavior recognition method based on deep learning framework was proposed. The idea of simplifying behavior detection in group lever into interactive behavior was highlighted, which have the potential of detecting other different types of social behavior among pigs, like aggressive behavior;
- 3). The contribution from two research groups benefitted from each other with a deeper understanding of this topic from a different scientific perspective;
- 4). Personally speaking, new ideas get inspired by this STSM. For example, the model can be improved by optimize object detection method, tracking method and action recognition method. Each of them could be a very interesting topic.

FUTURE COLLABORATIONS (if applicable)

From a practical point of view, we want the system to warn tail-biting outbreak as early as possible, which require animal scientist reveal if the tail-biting have an early behavioral clinical signal. Also, for researchers in PLF aspect need to explore corresponding image features. This makes the two sides have a very broad space for cooperation.

From this cooperation, one common doubt need to be explained in the future, that is, even if our model works well in a pig pen, can we get the same result in another type of pig pen? To answer this, more cooperation will be necessary.