Final Report Review

Title: Health prediction of individual animals in confined beef cattle operations through visual sensing and automated behavioral recognition

Lead Project Director:

Joshua Peschel, PhD, Assistant Professor, Dept. of Agricultural and Biosystems Engineering, Iowa State University, 2348 Elings Hall Ames, IA 50011. Email: peschel@iastate.edu Phone: 515-357-7448

Co-investigators:

Stephanie Hansen
Anna Johnson
Grant Dewell

Award Amount: $75,000

Nontechnical Summary

This project created a set of video-based precision livestock farming (PLF) tools to automatically monitor individual calf behavior. The motivation for this work was to move from in-person human observations to automated visual estimation of illness through the recognition of cattle behavior activity patterns. The project team of Drs. Joshua Peschel (Agricultural and Biosystems Engineering), Stephanie Hansen (Animal Nutrition) and Anna Johnson (Animal Welfare), along with two Iowa State students who were supported through this work: Katie VanValin (PhD Student) and Amalia Kolliopoulos (Undergraduate Student), designed and conducted a 96-animal study at the Iowa State University Beef Nutrition Research Unit to gather data for the visual PLF tool testing (Figure 1).

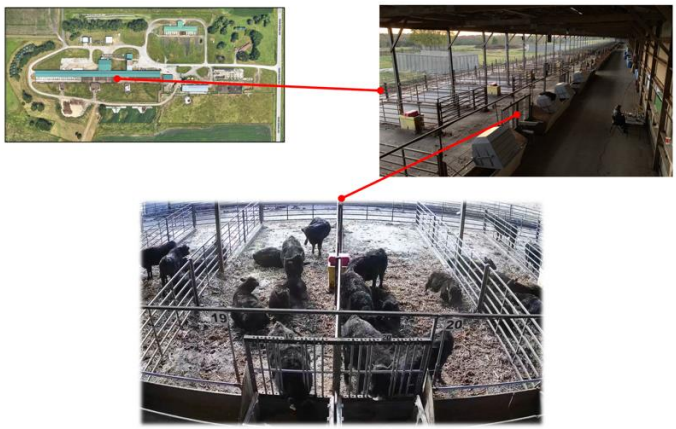

Figure 1. Experimental setup at the Iowa State Beef Nutrition Research Unit (BNRU). Color night vision recording equipment with 4k resolution was installed at BNRU which allowed for continuous recording on a per pen basis as shown. There were 96 steers involved in the study to determine if it was possible for a automated visual behavior recognition and tracking algorithm could be developed that was consistent with a human observer.

The research team created a machine learning approach to automatically recognize individual animals. An important part of this software was also keeping track of individual animals when they become visually blocked by another animal; therefore, a new lost calf algorithm was developed to find and re-track animals once they reappeared within the view of the camera (Figure 2).

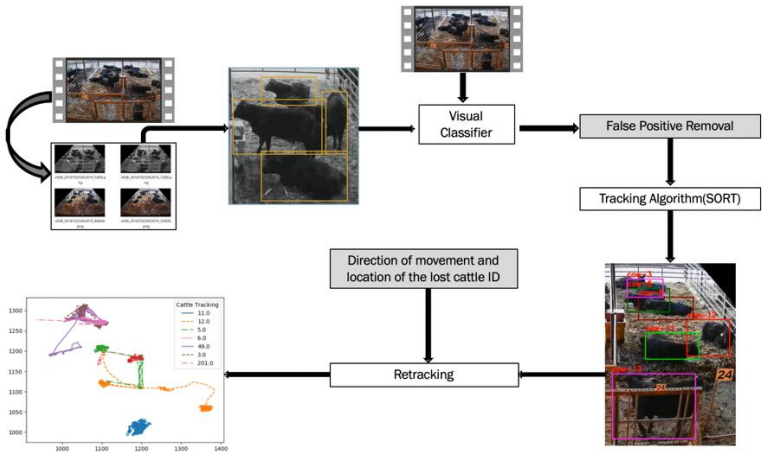

Figure 2. Overview of the visual precision livestock farming (PLF) recognition software. Video data are taken from cameras located over each pen. The individual animals are detected and given a unique digital number that is assigned to the animal throughout the entire automated observation. Subsequent parts of the software adapt to prevent false positives and to find animals when the view of them is blocked. Behavior including: standing, laying, eating, and drinking, is tracked.

The steers were divided into two groups for the experiment: i) for training and ii) for validation of the camera software (8 pens/group). The cattle were given a health challenge which caused the animals to appear sick for approximately 8-hours. There were 12-TB of video data recorded during the experiment which were later analyzed by the team. The results of the video data analyses showed that the visual PLF tools can recognize a set of standard behaviors (i.e., standing, lying, eating, drinking) at a mean average precision (mAP) of 96%, and that these data can be combined into individual animal behavior time series that were consistent with the human observations of the video, but also permitted automated continuous observation (Figure 3).

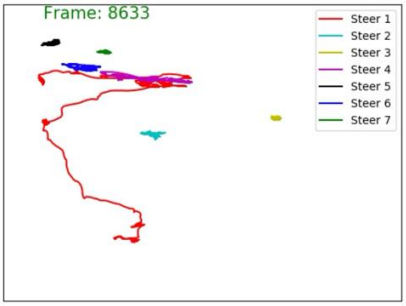

Figure 3. An example behavior time series that was automatically extracted from the video data for a 20-minute sequence of time. Here, Steer 1 was very mobile throughout the pen and visited both the feed bunk and water trough. Steers 2 – 7 were shown to exhibit sedentary behavior and did not visit the feed bunk or water. This behavior was consistent with human observation of the video during the time of the health challenge.

Impacts

- Continual monitoring of feedlot cattle with video cameras and visual precision livestock farming (PLF) recognition software may be used to identify behaviors associated with illness in individual animals.

Conclusions

- Use of video cameras and visual precision livestock farming (PLF) recognition software can recognize motion behaviors (standing, eating, lying, drinking) at a mean average precision of 96%
    - This precision is comparable to human observations of video recordings of animal behavior.

Technology transfer (Planned or Completed)

Scientific papers – 1
Extension/Outreach papers – 0
Scientific presentations – 4
Extension/Outreach presentations – 1

Students supported (Total or Partial)

Graduate students – 1
Undergraduate students – 1

Leveraged funding

$0