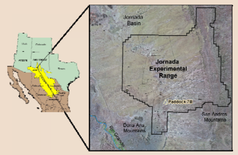

Gathering Cows Using Virtual Fencing Methodologies

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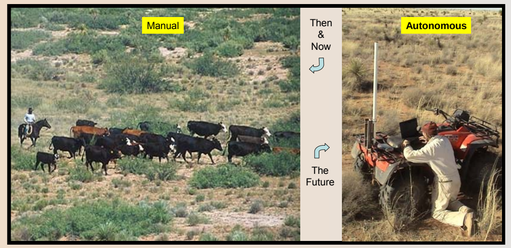
Abstract

Free-ranging livestock are classically controlled by herders. Holding, moving, or gathering free-ranging cattle requires flexible husbandry practices for efficient and effective low-stress animal management. Behavioral theory and practical experience indicates cattle can be taught to respond to auditory cues. Preliminary research has demonstrated that cows can be gathered autonomously using recorded audio cues associated with manual gathering. However, efficient gathering requires movement in the proper direction. Therefore, we believe using audio cues administered from directional virtual fencing (DVF™) equipment can facilitate proper animal orientation and facilitate the gathering of animals with minimal human intervention. Results from applying directional audio cues to free-ranging cows using hardware and software developed by the Massachusetts Institute of Technology (MIT) will be discussed in light of how many animals in a herd potentially need to be instrumented in order to successfully gather the entire group.

Objective

- Is it possible to autonomously gather free-ranging cattle using preprogrammed audio cues to which the animals have been previously habituated?

Gathering



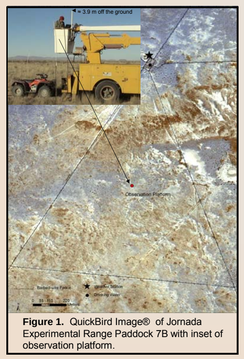


Figure 1. QuickBird Image® of Jornada Experimental Range Paddock 7B with inset of observation platform.

Materials and Methods

Rangeland, cattle, weather, training

The study was conducted near Las Cruces, New Mexico, on the U.S. Department of Agriculture – Agricultural Research Service's Jornada Experimental Range in a 217 ha triangular shaped area (Paddock 7B, Figure 1). This relatively brush-free Chihuahuan Semidesert Grassland was stocked with cow-calf pairs between 27 January and 5 February 2009. The single Hereford, and two of the four crossbred Hereford x Brangus cow-calf pairs, had previously been controlled using DVF™ methodology while the two youngest crossbred cows were naïve to electronic control. No precipitation was recorded throughout the trial and ambient air temperatures and wind speeds were typical of the long-term means. The cows had previously been gentled to accept wearing electronic equipment packages by feeding cottonseed cubes to each cow individually as they were instrumented. Each cow was given 862 g or less of cottonseed when cows were handled to change batteries or download data while in the Four Corners Corral.

Electronic hardware, software and equipment platform

No electrical stimulation cues were used and only the cows (not calves) were instrumented. A global positioning system (GPS) ET-312 receiver manufactured by GlobalSat® Technology Corporation (Taipei Hsien, Taiwan) was programmed to collect 1 Hz cow location data while AeroComm AC4790 radios (Lenexa, KS) in each of the five electronics boxes (Schwager et al. 2008) provided wireless communication between the free-ranging cows and a base station located on an observation platform approximately 3.9 m off the ground (Figure 1). From this position the entire paddock perimeter could be observed with field glasses. Although the solar powered electronics package designed by MIT was programmable as to type, direction, intensity and duration of the audio cues to be applied, in this trial it was the senior author's voice that was played simultaneously from both speakers for either 30 or 60 sec at a 100% intensity during cuing. Under laboratory conditions this "song" of a manual gathering using an ATV had been recorded on a voice activated recorder in 2007 and exited the ten speaker housings with a mean intensity of 110 ± 1 dB. The equipment platform worn by each cow consisted of a neck saddle and stretch halter (Figure 2), termed an ear-a-round (EAR™). It was developed by the Jornada and placed the speaker housing, when the EAR™ was worn by a cow, between 2 and 15 cm below it's ear. Once observers reached the observation platform cows were not disturbed for at least 30 min prior to beginning the audio cuing. The "song" was played from both the left and right speakers without regard to directionality in this trial. Furthermore, the time when cuing was initiated and the number of times each cow was cued and choice of cuing interval for 30 or 60 sec was determined based on the judgment of the senior author's observation of the group.

Instrumented Cow

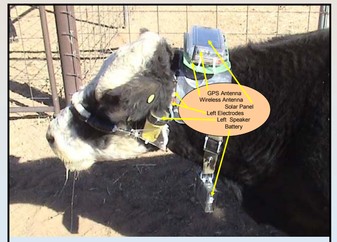


Figure 2. Cow 4127 with an equipment platform consisting of a neck saddle and stretch halter (ear-a-round, EAR™) for carrying a solar powered electronics box that can be wirelessly controlled to deliver directional virtual fencing (DVF™) audio and electrical stimulation cues.

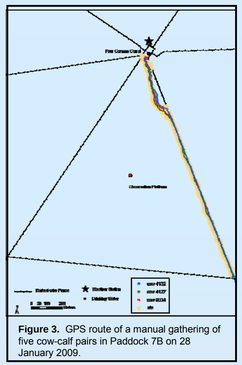


Figure 3. GPS route of a manual gathering of five cow-calf pairs in Paddock 7B on 28 January 2009.

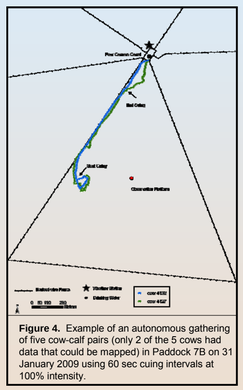
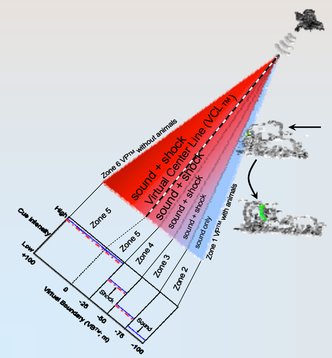


Figure 4. Example of an autonomous gathering of five cow-calf pairs (only 2 of the 5 cows had data that could be mapped) in Paddock 7B on 31 January 2009 using 60 sec cuing intervals at 100% intensity.



Directional Virtual Fencing (DVF™) is:

- A **methodology** for controlling the location and direction of movement of free-ranging animals without conventional fencing.
- A combination of **global positioning system (GPS)** technology and **animal conditioning** using sound and electrical stimulation when necessary.
- A way to produce directional movement of animals on a landscape using **bilateral cues** ramped from least to most irritating. Cues applied to the animal's left side move the animal to the right and vice versa.

Literature Cited

- Albright, J. L., W. P. Gordon, W. C., Black, J. P., Dietrich, and W. W. Snyder. 1966. Behavioral responses of cows to auditory training. *Journal of Dairy Science*. 49:104-106.
- Anderson, D. M. 2007. Virtual fencing – past, present and future. *The Rangeland Journal*. 29:65-78.
- Schwager, M., C. Detweiler, I. Vasilescu, D. M. Anderson, and D. Rus. 2008. Data-driven identification of group dynamics for motion prediction and control. *Journal of Field Robotics*. 25(6-7):305-324.

Results and Discussion

These data represent a preliminary evaluation of MIT electronic hardware and software and an equipment harness (EAR™) for autonomously gathering free-ranging cows. Although all five cows were instrumented throughout the trial, only two or three cows consistently gave data that could be mapped. Overall, the trial proved successful with only a preliminary evaluation of the potential 4,000,000 rows of data.

- It was possible to autonomously gather free-ranging cows using only audio cues.
- The cow training protocol to optimize autonomous gathering has yet to be fully developed, however, a food reward at the location where cows are instrumented and de-instrumented appears positive.
- Manual gathering of five cow-calf pairs (Figure 3; 0.85 m/sec) took longer than autonomous gathering (Figure 4; 1.37 m/sec).
- Even though all five devices did not consistently record data that could be mapped, all five cow-calf pairs followed the same route when autonomous gathering was observed to be operating properly.
- The wireless radio link between the base station (observation platform) and the five cows was unpredictable and relatively short (≤ 900 m) and was responsible for the majority of the equipment failures.
- Except for the wireless radio antennas that consistently became dislodged from pointing skyward and three broken external connections; the electronics box and the electronics proved to be quite robust.
- The EAR™ caused no physical or noticeable psychological harm to the five cows during this nine day trial.

Conclusions

- Free-ranging cows can be gathered autonomously using only audio cues administered from DVF™ devices.
- Incorporating paddock information such as the location of trails, drinking water and corrals and replacing manual sequencing with algorithms that can administer sounds directionality through software will improve the efficiency of autonomous gathering.

Disclaimer

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Acknowledgements

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