Local virtual enclosures to enforce managed grazing

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DAIRY INNOVATION HUB

Background

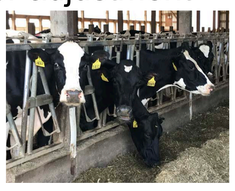
- 500 head of dairy cattle grazing on 200 acres in rural Cuba City WI;
- Using <u>rotational grazing</u>:
  - Pasture broken into 2-3 acre paddocks;
  - Paddock advanced as grazed
    - 2X/day in Spring; less in summer
  - Land is 3-4X more productive; est. $100/head/year benefit
- Cattle move on their own from **barn**, down **path**, into **paddock** (cattle are not tracked or led)

Desire for Improvement

- Fencing moved manually, est. <u>1 hr/day</u>
  - "Quality control" also an issue
  - "Tumblewheel" system in use
- <u>No data</u> on which cows are grazing, and for how long.
- Existing GPS systems are costly
  - *Designed for beef, large ranges*
  - *$40/head/year = overkill*

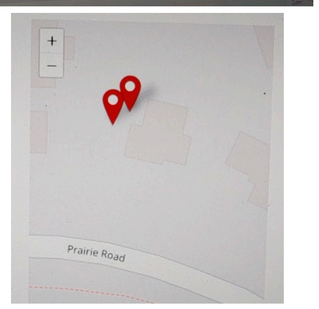
Goal: Automated Rotational Grazing

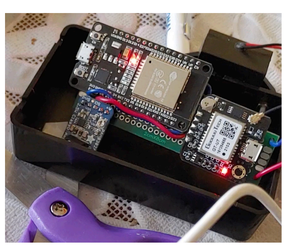
- Target: nominal $10/head/year cost
- Use <u>local</u> tracking (vs. satellite) to lower cost
- Challenging! Pursuing **<u>two tracks</u>**:
  1. <u>Virtual fencing</u>: cow collars with "invisible fence"
  2. <u>Physical fencing</u>: automated barrier adjustment



Track 1: Virtual Fencing

- Advantages: Flexibility, data, ease of use
  - *Potential disadvantages: complexity, cost, herd acceptance*
- **Professor with student researchers** used for development
- Smart Collars
  - Solar panel with battery
  - GPS tracker
  - Speaker (audio signal for boundary)
  - Electrical shock module under investigation
- Web-based interface
  - Marking boundaries
  - Tracking collars





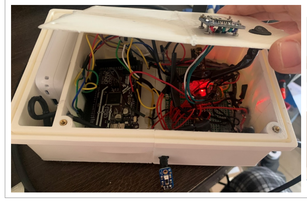
Track 2: Physical Fencing

- Advantages: Cost, data, compatibility (with both herd and staff)
  - *Potential disadvantages: flexibility, mechanical reliability*
- **<u>Engineering Senior Design</u>** used for development

A. <u>Fall 2020: ATV-pulled, electrified cart with winch</u>
   A. Simple, effective, low-cost solution
   B. Compatible with existing workflow
   C. No large-scale installations needed
   D. Cart doubles as a mobile sensor platform
      A. Pasture data
      B. RFID tracking of herd entry/exit

B. <u>Spring 2021: Automated cart (Team #1)</u>
   A. Powered by electric wheelchair motors
   B. Improved wheels
   C. Controlled via smartphone app
   D. Raspberry Pi and motor controllers

C. <u>Spring 2021: Sensor Platform (Team #2)</u>
   A. Temperature, pressure, humidity
   B. GPS
   C. Real-time clock
   D. SD-card data storage
   E. Cable tension
   F. Communications between two carts
   G. Weatherized



Future/Continuing Work

- **Physical Fencing (Fall 2021)**
  - <u>Sensor node (Student researcher)</u>
    - Smaller, weatherized, expandable
    - Add RFID reader
    - Upgrade GPS (to ±2 cm)
    - Communication needed: field-wide WiFi? LoRa?
  - <u>Automated Cart (Senior Design)</u>
    - Automated connection to electric fencing
    - Automated winch operation
  - Two-cart test: build second cart!
- **Virtual Fencing (ongoing)**
  - Add electrical shock generator smart collar
  - Over-the-air updates
  - Light sensor for "indoor sleep mode"
  - Energy/battery check; power conservation