Rumen Understanding through Millipede-Engineered Navigation and Sensing (RUMENS)

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https://portal.nifa.usda.gov/web/crisprojectpages/1018631-nri-int-collab-rumen-understanding-through-millipede-engineered-navigation-and-sensing-rumens.html

The development of precision livestock farming enables end-users, i.e., farmers, to make real-time adjustments to parameters, such as feed composition, sunlight exposure, and earlier treatment/intervention of ailments that arise. A wirelessly controlled robot equipped with sensors to monitor temperature, pressure, and volatile fatty acid concentrations can be utilized to make these adjustments and improve productivity and animal welfare while decreasing greenhouse gas emissions.

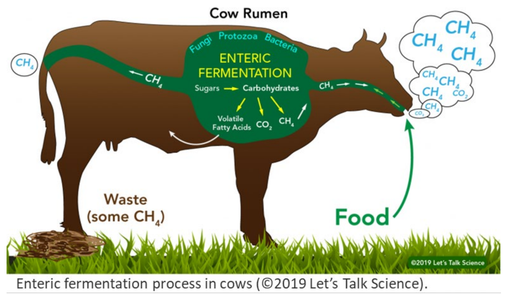
Challenges: Heading disturbance rejection and path tracking capabilities of the swimming robot, 3-D swimming, coordinated quantification of biomarkers, baseline drift, sensor sensitivity, selectivity, and lifetime

Scientific Impact: Livestock production, precision livestock health monitoring and animal welfare, reduction of greenhouse gas (GHG) emissions, machine learning, data analytics

Research Approach:

Fish-inspired swimming robot:

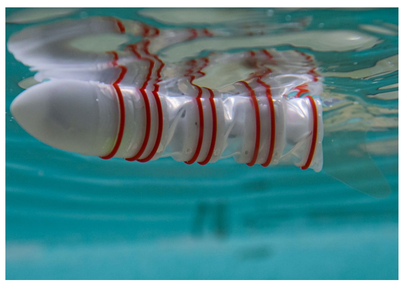
- Bluetooth Low Energy (BLE) wireless communication was used to transmit data between the robot and external computers.
- Feedback control algorithm was implemented to control the robot's heading.
- Line-of-Sight (LOS) method was implemented to achieve the path tracking capability of the robot.
- Pectoral fins with shape memory alloy (SMA) are being added on the robot to achieve 3D swimming.

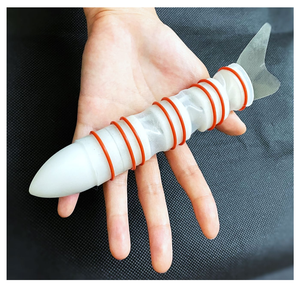


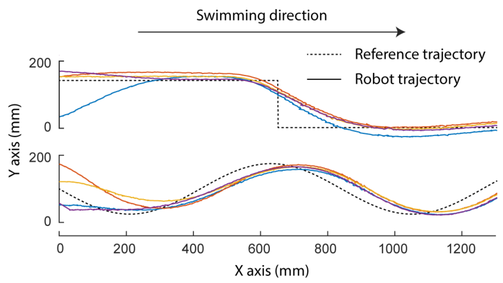
Enteric fermentation process in cows (©2019 Let's Talk Science).

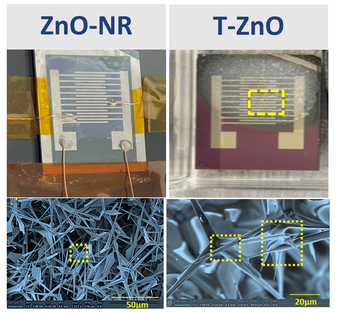
Sensor Development:

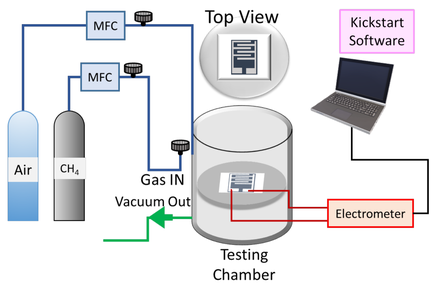
- Volume of GHG eructated from ruminants can be correlated to volatile fatty acid concentrations in rumen
- Zinc oxide nanorod and tetrapod-morphologies were fabricated as external methane (CH_4) sensors and tested with UV, and metallic nanoparticle catalysts to determine optimal response and decrease operating temperature
- Eructated gas sensors to be used in conjunction with sensors deployed on robot to improve production and animal health and well-being

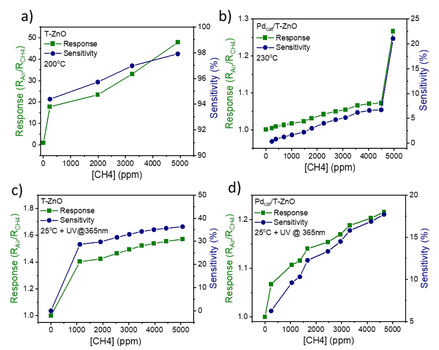












Societal Impact: Integration of a robot in the rumen will allow farmers to obtain real-time, accurate health data of their livestock. By utilizing precision livestock farming, food production and quality of life of the animals can be vastly improved.

Education and Outreach: Organize annual GO-FEST summer camps and interactive programming for high school students to become involved in STEM and spark potential interest in future careers in STEM.

Potential Impact: The combination of external and internal sensors will provide the necessary health data for farmers to take appropriate measures to decrease GHG emissions without sacrificing production or animal well-being.

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