

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

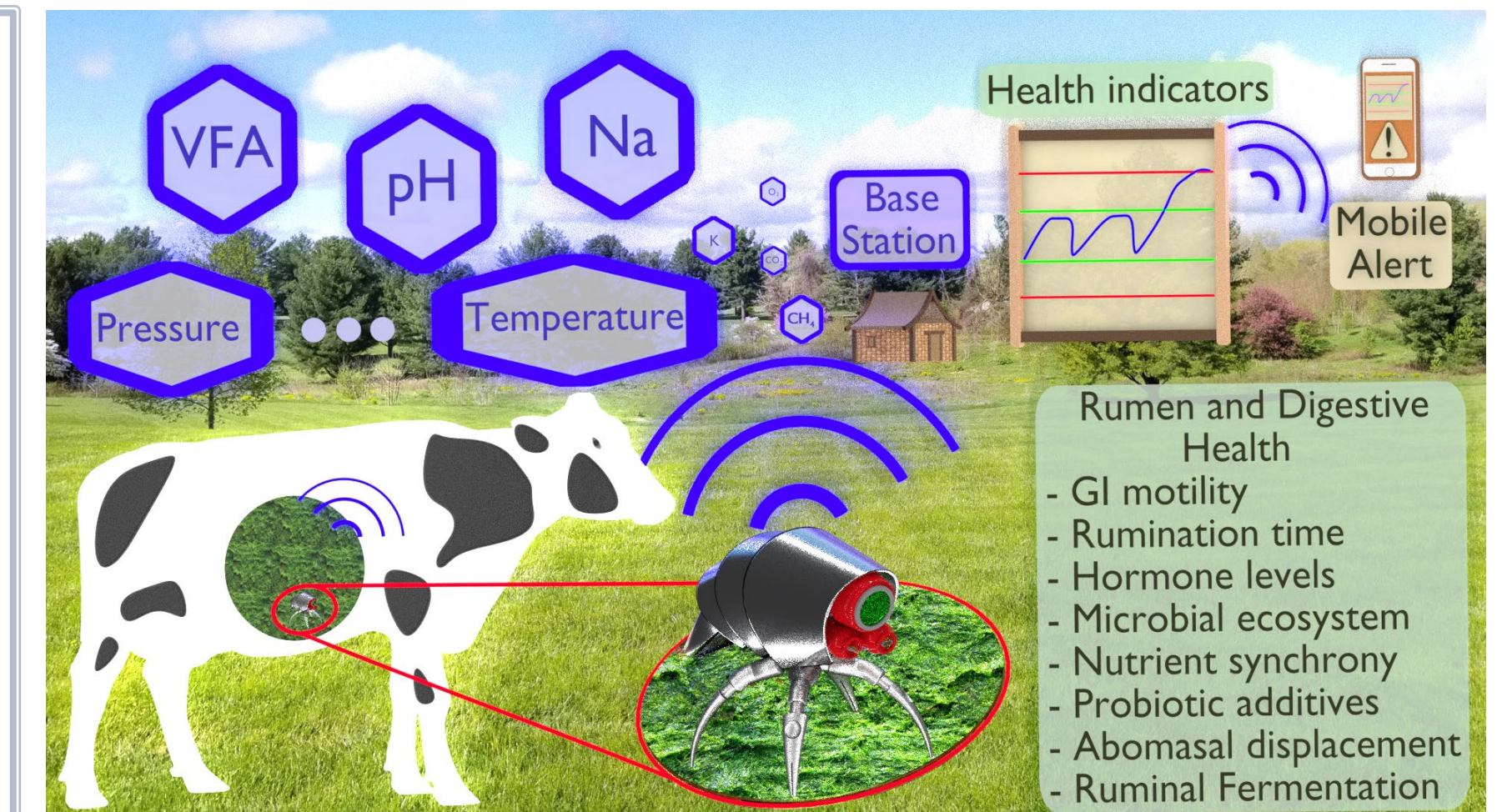
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Digestive functionality of ruminants is assessed by monitoring rumen environmental conditions.

The rumen pH, Volatile Fatty Acids (VFAs), motility and temperature are measured using a bolus.

The Gastro-Intestinal (GI) motility, microbial ecosystem, rumination time, and fermentation are the health indicators of ruminant's health.

Wireless data transfer to a base station for health assessment and corrective actions.

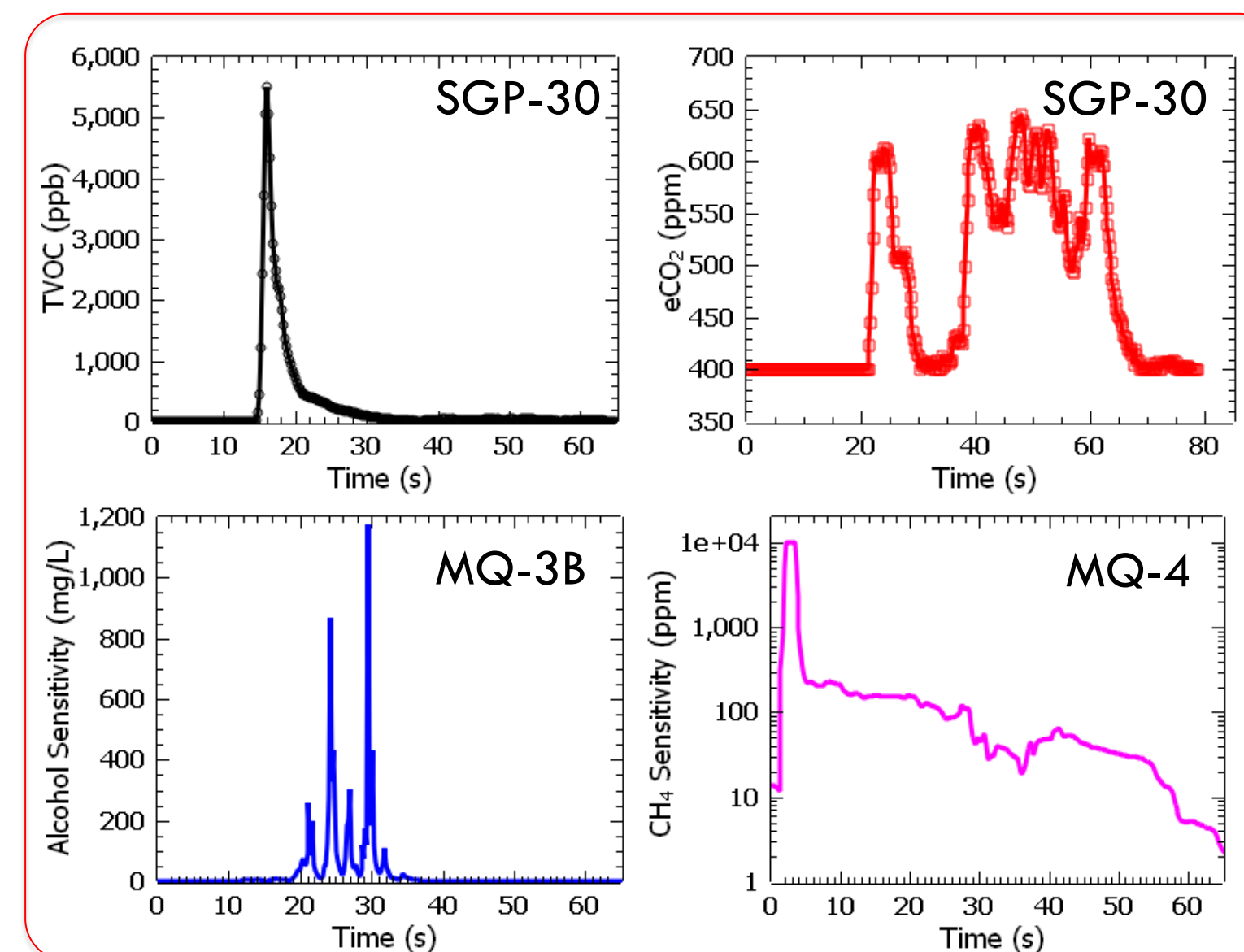
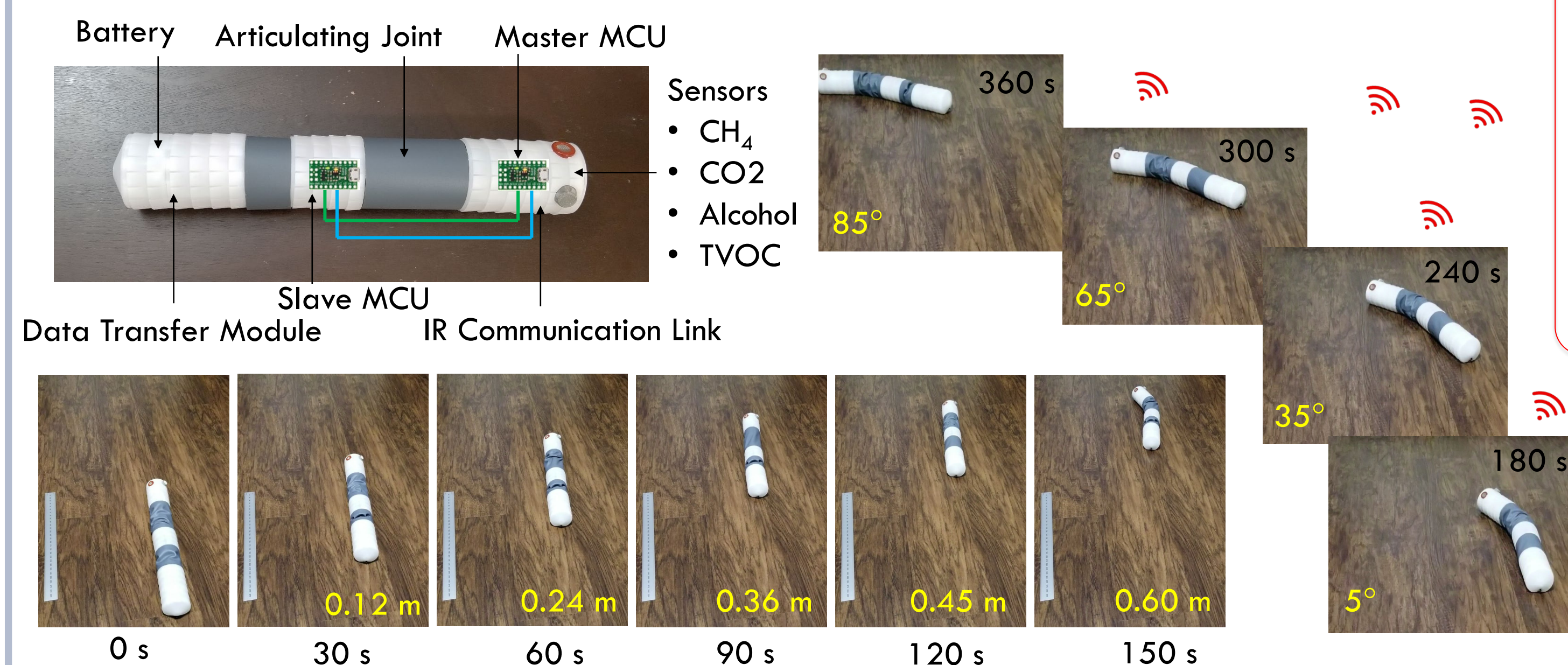


Current Challenges: Limited locomotion capability, uncontrolled measurements at desired locations, short duration deployment, and lack of wireless transmission.

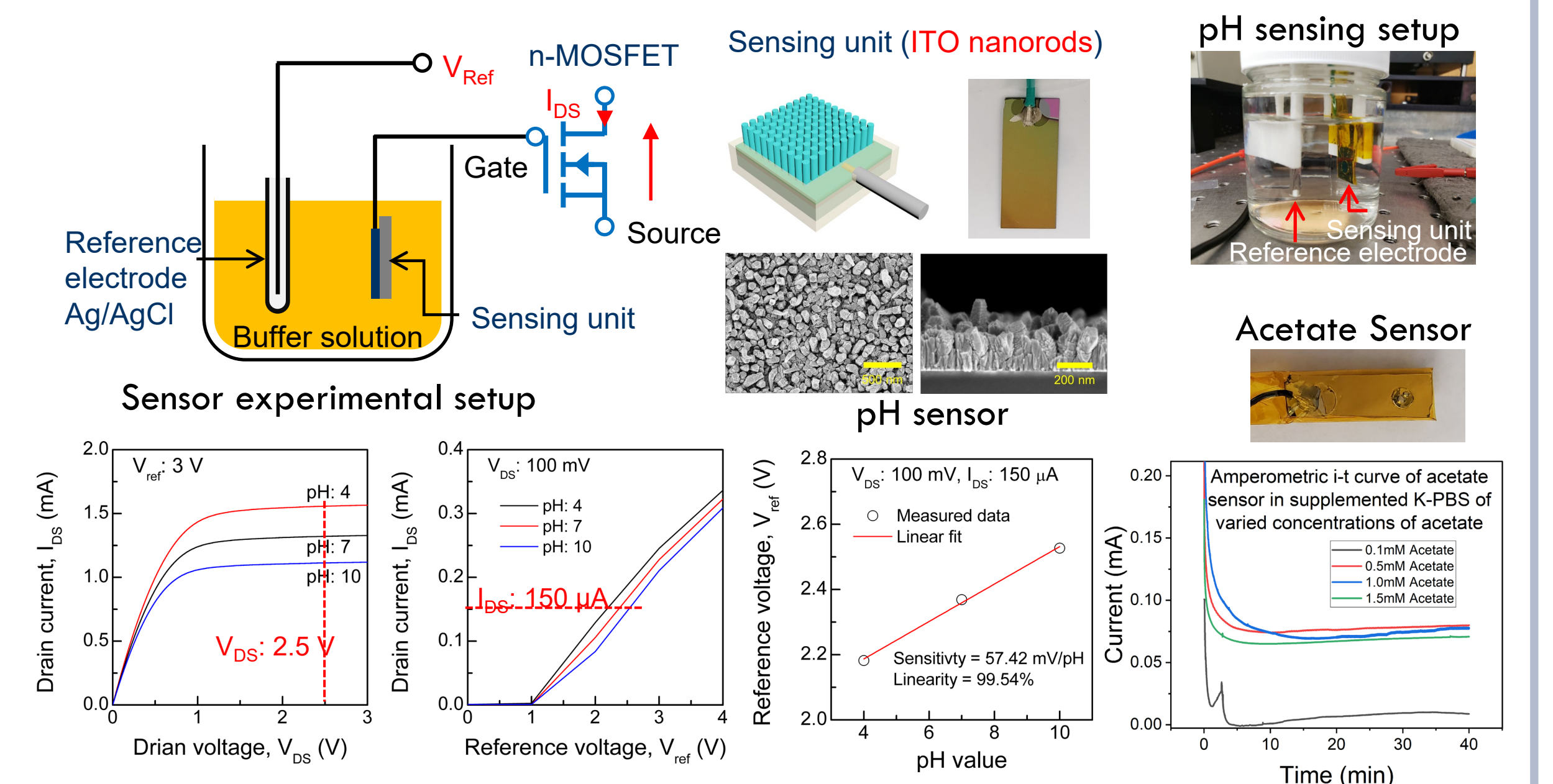
Scientific Impacts: Animal welfare, food production, energy generation, fermentation, predictive health monitoring, machine learning, and data analytics.

Research Approach:

- Bio-inspired remotely operated vehicle is realized with onboard sensors.
- An average speed of 4 mm/s is achieved mimicking a caterpillar gait.
- Sequential segment actuation and articulating joint are implemented.



- The peristaltic locomotion and steering capabilities are verified.
- Data from four onboard sensors are transferred wirelessly over time.
- The robot will be miniaturized and consist of the developed sensors.



- The pH sensor based upon extended-gate field-effect transistor is developed for rumen monitoring.
- A sensitivity of 57.42 mV/pH with 99.54% linearity is achieved.
- Tri-enzymatic acetate sensor demonstrating sensitivity in varied acetate concentrations is in development for use in rumen fluid.

Societal Impact: Collaboration with farmers on improving food production efficiency, safety and quality. Advancing the biomedical, wireless data and energy transfer fields of research.

Education and outreach: Organize summer camps and lab tours for high-school students to engage them in STEM activities. Student / postdoc / research faculty training.

Potential impact: Improved understanding of rumen. Develop interdisciplinary courses on emerging technologies covering biomedical robotics, bio-inspired locomotion and mechatronics.