CAAIN Project Stories

2021-22 Open Competition

Project Name:	**Feasibility of an Autonomous Solution for Optimized Application of Livestock Manure**
Summary:	Liquid manure. To most people it's something you hope not to step in. But to many farmers, it's a necessary source of crop nutrients. Unfortunately, its application depends on unskilled labour that tends to deliver inconsistent and poorly measured results. Enter Haggerty AgRobotics with their project team of farmers, industry professionals, and university researchers who will design, test, and document a potential commercial autonomous farming system to apply liquid livestock manure both in bare fields and on standing field crops. They will employ an autonomous power platform and proprietary technology to eliminate the use of unskilled labour and more precisely determine and respond to crop needs. In addition to requiring only highly skilled workers, this technology will provide significant economic and environmental benefits by delivering a marketable made-in-Canada solution capable of assessing impact on crop yield and reducing greenhouse gas emissions generated by improperly timed applications of manure. The resulting reduction of nutrient losses will save producers time and money while positively impacting the ecological footprint of modern North American livestock operations.
CAAIN Contribution:	$ 508,415
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Project Name:	**ANT: An Innovative Approach to a Fully Autonomous Greenhouse Mobility Platform**
Summary:	Project ANT aims to provide an innovative autonomous mobile platform to the controlled environment agriculture (CEA) industry. It breaks from the traditional approach of the single-purpose greenhouse robot, and will demonstrate the feasibility of a flexible platform capable of carrying various payloads and addressing many of the challenges inherent in CEA automation. ANT is a system of autonomously navigating robots serving as a universal mobile platform for nearly any greenhouse automation task. It uses multiple classes of robots that cooperate to delegate tasks efficiently and lower total system costs. The initiative will accelerate the development and adoption of new automation by

solving the complex technical challenges associated with effectively and efficiently relocating tools around a greenhouse. For example, the developers of an automatic tomato harvesting machine can focus on the intricate operations required to remove fruit safely without being concerned about how to move from plant to plant. ANT is an enabling technology that will improve automation in indoor agricultural operations, reduce associated labour requirements, and enhance Canada's reputation as a global leader in agri-food innovation.

CAAIN Contribution: $ 627,898

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Project Name: **Autonomous Tractor Kit for Enabling Autonomous Farm Implement Operation**

Summary: Using autonomous farm equipment is widely viewed as a partial solution to the labour shortages plaguing the agri-food sector. However, one of the barriers to the adoption of such technology is its tendency to rely solely on GPS-driven navigation controllers, which are adequate to the task only in environments without unplanned obstacles. In effect, this means an autonomous tractor is not truly independent, as it requires the constant presence and vigilance of a trained human operator, defeating the purpose of the so-called autonomy.

Edmonton-based Mojow's EYEBOX™ technology is a small, rugged, economical sensor suite outfitted with multiple cameras, a GPS, and a powerful computer to process data in real time. The system functions by collecting images automatically and passing them through a variety of algorithms that classifies each pixel to create (or update) a digital representation of the entire farming entity (field boundaries, roads, field entrances, or anything else of interest). This electronic "twin" of a farm's physical attributes serves as the foundation (or primary input) of the autonomous navigation controller—the "brain," if you will, that makes EYEBOX-guided machinery truly autonomous. The continuous intake of real time image data from the peripherals of the tractor assures a high level of relative position accuracy between the vehicle and any physical object encountered within its working environment.

As part of this project, the team intends to develop the following autonomous technology key enablers:

- Real-time detection of, and response to, all relevant external and internal field boundaries, requiring the development of deep-learning models and software algorithms.
- Real-time detection of, and response to, all types of field entrance, specifically
    - Small-width entrances,
    - Larger-width entrances, and
    - Single-field segment to segment.

This will permit a tractor, without any human interaction, to identify, predict, and choose an appropriate route from roadway to field, field to roadway, or from one segment to another within a single field. The EYEBOX will save time by appropriately planning and executing the most efficient entrance and exit locations.

- Real-time detection of, and response to, all roadway types, specifically dirt and gravel roads and double track trails. Successfully programming autonomous field-to-field transition is a necessary system capability if EYEBOX is to achieve its goal of freeing farmers from their tractors.

EYEBOX is designed to operate ISO 11783-certified farm implements such as air seeders, planters, sprayers, and fertilizer spreaders. However, Mojow intends to start with land rolling and heavy harrowing, thereby proving its concept before adding tools that apply product.

Designed for flexibility, this technology will be able both to convert conventional tractors into autonomous vehicles and be integrated into OEM machinery to enhance functionality.

When fully operational, the EYEBOX platform will lower a farm's production costs while increasing output and reducing reliance on manual labour.

CAAIN Contribution: $631,981

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Project Name: SoilOptix®: Advancing Processes to Predicting Soil Organic Carbon

Summary: Quantification of soil organic carbon (SOC) remains a limiting factor for agricultural producers seeking to balance the value of implementing regenerative agriculture against a carbon market looking to offset related emissions. SoilOptix® is a global leader in providing high-resolution soil fertility and texture information at field scale, offering 335 data points per acre. The accuracy and precision of the information generated—i.e., predicting percentage and ton-per-hectare of organic carbon—offers users tools to develop management decisions for agricultural practices, coupled with the ability to access the carbon offset market. In other words, the SoilOptix® platform will allow producers to assess their farm's potential to sequester carbon as an integral part of their operation.

Quantifying SOC is a multi-step process based on existing regional soil models that are then scaled to predict SOC levels across larger geographic areas, delivering a marketable product. The project team will employ gamma spectrometry sensors to map the soil, applying a standard operating procedure to collect the field data. Physical samples will be extracted at a ratio of one sample per three hectares. These will be tested at a Canadian soil laboratory. Results from the lab and survey will be processed by SoilOptix®, resulting in high-resolution layers of SOC.

This project will advance the SoilOptix® team's ability to apply artificial intelligence and machine learning to scale the application of its technology as a leading predictor

of soil organic carbon. The end result will be to reduce the need for, and cost associated with, testing soil samples without sacrificing the predictive accuracy required for carbon markets.

CAAIN Contribution: $67,533

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Project Name: **GeoAI Platform for Automating Manual Observation Associated with Wheat Production (Phase 2)**

Summary: Canada's grain sector is a key economic driver, contributing over $20 billion in wheat export sales annually. Product quality is a critical component of the grain value chain, impacting everyone from producer to consumer. Evaluation is the responsibility of grain inspectors, who must manually identify, separate, and analyze degrading kernels to determine a sample's quality and grade. These subjective results can be unreliable and inaccurate, and may result in conflict between the buyer and seller, damaging important commercial relationships. For many years, the industry has sought an affordable solution capable of delivering a quick and accurate end-use quality assessment based on representative samples.

In the first of the project's three phases, the team of agri-food companies and academic institutions employed diverse technologies to develop a novel geospatial artificial intelligence (GeoAI) platform proof-of-concept that automates manual wheat-production observations. The GeoAI team leveraged geospatial, deep learning, machine vision, and high-performance computing technology to evaluate three representative primary objective characteristics and one subjective characteristic in Canada Western Red Spring Wheat (CWRS) kernels.

Phase 2 will launch commercial applications for wheat producers and grain buyers, with more robust datasets and higher accuracy for five primary objectives (Ergot, Fusarium Damaged Kernels, Hard Vitreous Kernels, Sprout, and Sawfly) and two subjective grading factors (frost/heat stress damage and Green) in CWRS kernels. Phase 3 will include a licence agreement with the Canadian Grain Commission to digitize annual grain grading guides and launch commercial grading machines for legal trade.

The project team's goal is to create and market a scaled-up, all-in-one GeoAI-driven cloud platform that automates numerous agricultural tasks, with a focus on grain grading. This will reduce manual observation requirements, increasing productivity, profitability, sustainability, and competitiveness for Canadian producers, which aligns with CAAIN's mandate to advance the agri-food sector by supporting advances in automation & robotics, data-driven decision-making, and smart farm platforms.

CAAIN Contribution: $711,586

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