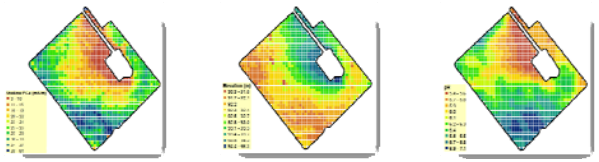
Low-Altitude Remote Sensing >>>

With its increasing popularity, low-altitude aerial imagery has become an essential component of fertility-related research. Periodic monitoring of crop physiology indicators allows for a better understanding of crop responses to different treatments and more accurate predictions of crop yield. The light-weight Hexacopter XL platform is a low-cost solution that allows completely autonomous operation from take-off to landing.

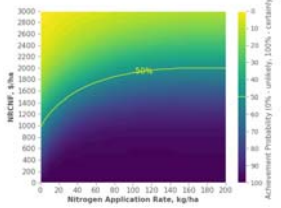
Geospatial Data Processing >>>

Remote sensing (RS) and proximal soil sensing (PSS) technologies provide high-density data revealing spatial heterogeneity of agricultural fields. These sensing technologies are used to infer thematic maps at a field scale. To receive the maximum benefits from high-density spatial coverage, a multi-dimensional spatial data clustering algorithm is being developed to better understand spatial structure and develop site-specific models revealing distribution of soil and plant attributes. The algorithm groups sensor measurements into a set of relatively homogeneous field areas by performing the neighborhood search analysis. The resultant map can be used to prescribe directed sampling locations and to optimize crop management.



NumericAg Decision Support System >>>

NumericAg (*www.numericag.com*) is a decision support system designed to help farmers and their consultants identify the least risky site-specific rate of key agricultural inputs, such as nitrogen fertilizer. This numeric simulation process integrates previous fertility trial records, information about local conditions and economic considerations to estimate probable net return over cost of fertilization.

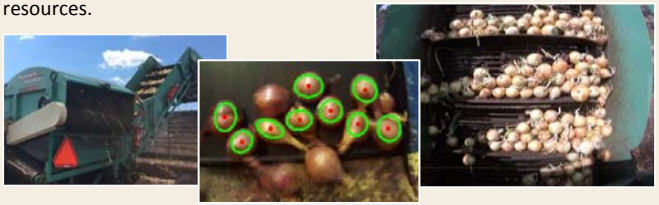


Water Quality Sensing >>>

Water quality monitoring is currently limited by expensive and labor-intensive data collection methods. Acoustic Sensory Telemetry (AST) is a new approach to monitoring that integrates telemetric fish tags attached to fish with sensors to identify a wide range of water quality constituents. AST is an alternative that can be used to detect the gradient of contaminants and measure their distribution in water, providing improved opportunities for understanding and visualizing their spatio-temporal dynamics. A robotic boat capable of automated navigation with wireless sensor communication has been developed to test both AST systems and water quality mapping technology.

Machine Vision Yield Monitor for Vegetable Crops >>>

A machine vision-based yield mapping system was developed to count vegetables (e.g., onions, carrots, lettuce, dry shallots and Chinese radish) according to their size during harvest. Coupled with a GPS receiver, this system outputs yield data as a geographical production map with multiple size distribution layers. It will help Quebec vegetable producers improve the logistics of their operations as well as optimize the use of their resources.



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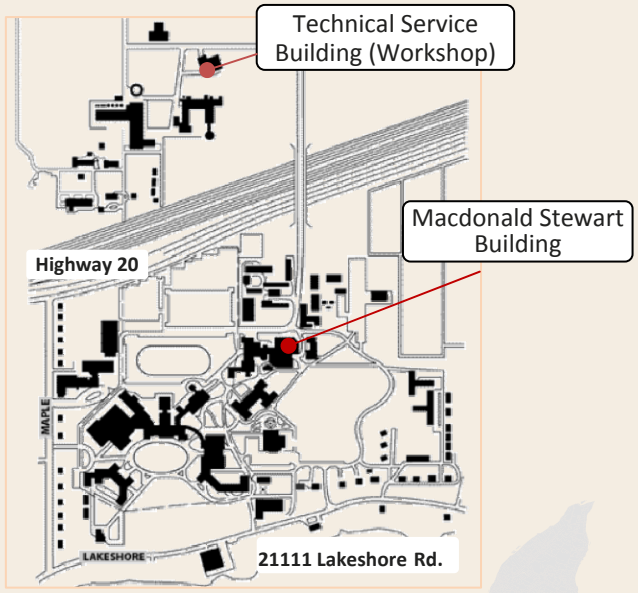
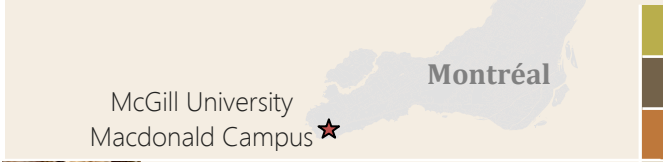


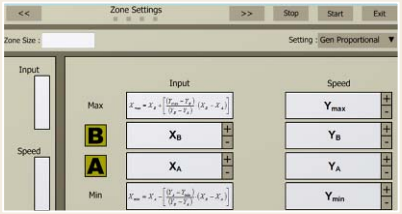


2017-2018

McGill

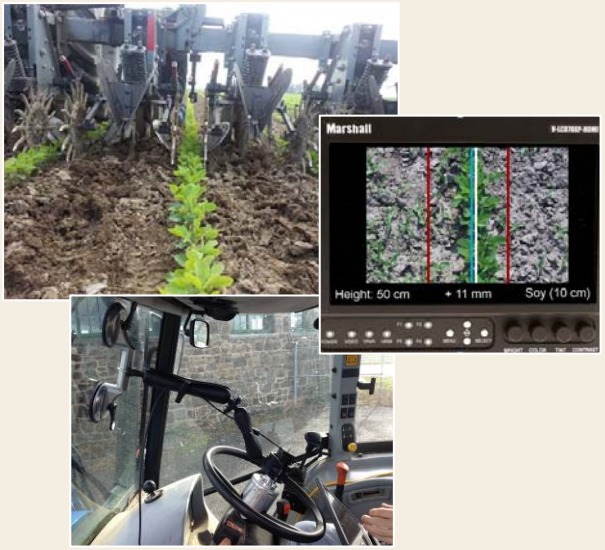
Smart Tractor >>>

Tractor-based variable rate technology was developed and tested on the Macdonald Campus farm. To demonstrate this technology, the following applications were implemented: 1) variable rate liquid cattle manure management based on field elevation, 2) variable rate spraying based on the status of vegetation, 3) variable depth planting of corn based on soil water content, 4) variable speed during forage harvesting based on the crop biomass, and 5) prescription map-based tractor automation.



Machine Vision Guidance >>>

A computer vision guidance system was developed to assist organic farmers during inter-row cultivation in the early stages of seedling growth. By taking a continuous video feed of the crops passing beneath the cultivator, the lateral offset of the crop row is determined by segmenting the plants from the soil using a dynamic band-pass HSV filter. The location of the row is then estimated based on the statistical distribution of plants in the direction of travel. An output signal is generated to control the electro-hydraulic steering system. Furthermore, the same machine vision system has been adopted to guide the tractor. An adaptive PID controller was developed to control the new quick-attach stepper motor tractor steering mechanism.



On-the-Go Soil Sensing >>>

Mapping the apparent soil electrical conductivity (ECa) in agriculture production using electromagnetic inductance (EMI) and galvanic contact resistivity (GCR), paired with global navigation satellite system (GNSS) technology, provides relatively high spatial data resolution. Mapping soil ECa, along with field elevation, has become a standard practice in mapping field heterogeneity. Soil ECa is important in relation to soil salinity, texture, moisture and fertility levels. A set of tests was conducted to verify the sensor performance over time as well as the operational effect on soil ECa measurements. An automated prototype galvanic contact resistivity scanner system has been developed as well. It uses two pairs of rolling electrodes configured in an equatorial dipole-dipole to obtain continuous scans of soil electrical resistance. In addition, a new capacitance-based sensor allows on-the-go measurement of near-surface soil water content during any field operation. This sensor was used to map soil moisture across large areas to facilitate the follow-up decision making process and/or to control the parameters of a specific field operation, such as planting depth, in real time.

Integrated Crop Sensing >>>

Since the plant itself is the best “sensor” for it responds to changing soil environments, it is crucial to monitor crop parameters during the growing season. This integrated crop status mapping system allows for the simultaneous assessment of chlorophyll content, biomass, canopy size and temperature in real time. Our goal is to detect early crop stress and to distinguish between “hungry” and “thirsty” crops. The use of ultrasonic and laser proximity sensors as well as infrared thermal sensors is beneficial for a number of potential applications, such as green vegetable harvesting logistics.

Integrated On-the-Spot Soil Analyzer >>>

As an alternative to on-the-go technologies, on-the-spot measurements can be collected where spatially sporadic data are needed or field surface coverage does not allow for the continuous engagement of soil and parts of the sensor system (e.g., pastures). Recently, ruggedized instruments taking Vis-NIR spectroscopy to the field for on-the-spot determination of soil properties have been developed (Veris P400, Veris Technologies Inc., Salina, Kansas USA). The advantage of this system is its ability to collect multi-sensor measurements on-the-spot. Vis-NIR soil spectra, soil penetrating forces and soil electrical conductivity (EC) are three measurements that can be performed in soil profiles up to 100 cm depths. A newly developed on-the-spot analyzer (OSA) is capable of simultaneously deploying several sensors to measure soil properties at a predefined depth. The OSA uses an array of potentiometric sensors and can simultaneously determine ions such as H^+, K^+ and NO_3^-. This technology is expected to extend the suite of deployable sensors and allow the integration of data acquisition practices. For example, a portable mid-infrared spectrometer was evaluated to predict soil particle distribution in moist soil conditions. The instrument uses diffuse reflectance variable filter array (DRVFA) technology. Digital microscopy and an in-situ glucose-induced CO_2 emission gas analyzer are other examples of sensing systems under development that could be deployed using OSA.

Temporal Soil Monitoring >>>

To make production-related decisions in real time, it is important to monitor soil and crop characteristics remotely. Temporal monitoring also helps with the assessment of dynamic processes, such as the emission of greenhouse gases (GHG). A handheld instrument for on-the-spot CO_2 determination and a network of wireless stations were used to obtain relevant data. Implementation of temporal monitoring of GHG fluxes has helped to assess the environmental impact of different cropping practices.