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Remote and Proximal Sensing

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Agronomy Agent's Corner #16

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Remote and Proximal Sensing

Collecting imagery of field conditions has been a popular concept with mixed results for at least ten years. The use of satellites to collect the imagery is called remote sensing. The use of sensors closer to your field that are mounted on planes, helicopters, or drones is called proximal sensing. The selection of which sensor to use depends on how often, how detailed, and which bands you are interested in collecting imagery. Passive sensors collect imagery only from what is reflected from sunlight or energy released from the object being studied. Active sensors will add their own energy to an object being studied.

Taxpayer Funded Satellites

NASA provides free access to much of the data collected by the Landsat series of satellites. Landsat 8 is currently the newest satellite in this series. It collects images over any given area on the surface of earth once every sixteen days. The data has limited geographic precision by providing reflectance data on pixels ranging from 15 to 100 m depending on the band. The bands used to calculate normalized difference vegetation index (NDVI) are all provided on a 30 m pixel. The primary use of this satellite is to make county wide or larger estimates of production. Waiting sixteen days to acquire data is too long to address pest problems and adjust irrigation plans. Thirty m pixels are too large to make well informed management zone decisions for things like spray boom section control. If cloud cover is heavy when an image is taken, the next opportunity is a long wait.

Private Satellites

Private satellites can provide images up to every twelve hours and on a detail as small as two m. This level of detail overcomes many of the limitations of Landsat satellites. While acquisition cost of images per acre can be low, the catch is individual images (tiles) cover several sections (frequently 400). To justify acquisition of these images, several neighbors, a coop, or a large acreage operation would need to contribute to the cost of acquisition. Observing a drop in NDVI within a day's time is fast enough to take preventative action by scouting for the issue. Watching for trends over time in NDVI or NDWI overlayed with yield monitor data contributes to the development of management zones.

Manned Aircraft

Collection of imagery from manned aircraft can cover a better customized area than private satellites. This allows for a producer to collect imagery from discontinuous fields. Cost is still incurred by flying from field to field, but this can be minimized by a good flight plan and including neighbors in the data collection plan. The detail of these images can be as great as from drones. The area covered in a day is far superior to drones. Scheduling is more flexible than satellites as well.

Drones

When I attended the 2014 International Conference on Precision Agriculture, there was a multitude of drone vendors. After two years of learning about the cost of operating drones the excitement faded. The operational costs include:

1) Labor
    a. Battery recharge
    b. Data collection and processing
    c. Drone field setup time and travel
2) Maintenance
    a. Crashes are expected
    b. Batteries have a limited number of recharges
3) Recurring software license fees

The largest area I have been able to cover in a single drone flight is about 130 acres. When arriving at a field it takes thirty-five to forty minutes to setup, launch, fly 130 acres, and return to the take off site. The next step is to check that image collection occurred properly. After that you can move on to the next imagery collection site. Unless 5G or Wi-Fi exist in your field you will need to upload the data at the end of the day. Another limitation is the time required to charge batteries. After a flight down to twenty percent of the battery life, it takes about two hours to bring a battery up to full charge. To achieve a 130-acre flight, with a hexacopter requires two batteries to be on board. The battery charger I had that holds four batteries is sequential. Even though it held four batteries, it would only charge one at a time. Acquisition of multiple battery chargers is an additional expense to keeping your drone in the air. After the daily flight work is complete and data uploaded, there are still several steps required to make the data meaningful. All the time required to collect and process the data adds up to labor costs.

Equipment cost is not fixed. When a drone vendor came to sell their product at my office, they said there was a "crash guarantee. If you put a piece of plastic in the air enough times, it will eventually crash." In three years of flying drones, I experienced several crashes. The damage ranged from none to breaking an arm, motor, and sensor mount off a Matrice 100. The most common crash in my early flights was bending a propeller on the headland weeds. As I gained more experience and confidence with taking over for manual landings, this became less of an issue. The most damaging crash was a battery that quit when 10% life was showing. I also witnessed a vendor lose a drone when the motor suddenly quit at 200 ft above ground level. That drone was never found. Looking for a drone with less than one square foot of surface area on any given edge in a heavily lodged 36-acre field is close to hopeless.

Overcoming the limitations requires regulatory changes and advances in science. From a regulatory perspective, drones are currently limited to four hundred feet above ground level (AGL) and within visual range with limited excursions beyond visual range. Battery life also limits drones to visual range when flown at four hundred feet. To safely remove these two regulations, flight transponders are necessary to communicate drone's location to low flying aircraft. Batteries will need to be replaced with hydrogen fuel cells. The advances needed in science are to create more scouting tools. The tools will be a mix of new indices and machine learning to find specific issues.

On a more optimistic level for drones, they are versatile on the type of image data they can collect. Changing the sensor mounted on your drone can collect any wavelength you are interested in reviewing. A basic sensor is a visual range camera. The bands they collect are labeled red, green, and blue. Depending on the manufacturer, the range of wavelengths collected by each band may extend beyond the actual color label. These sensors are essentially just for a visual scan of the field. The next level up will include near infrared. These sensors are useful to create NDVI and NDWI readings. Sensors beyond four bands are much less commonly used on drones. Mid wave infrared can be used to collect leaf temperature data. Sensors with up to thirty bands are referred to as multispectral. These sensors can be used to develop new indices to measure field conditions. If a researcher is interested in a comprehensive review of electromagnetic reflectance, hyperspectral sensors are available. These sensors will let you choose which wavelengths are useful when designing a multispectral camera. If you choose to use a hyperspectral camera, be aware the data volume will be in the order of terabytes. Storage and processing demand will be large when analyzing the data. Geiger counters can be used as drone mounted sensors as well. The potential agriculture application of a drone mounted Geiger counter is measurement of potassium fertility. Potassium is about 0.012% potassium 40. If Geiger counter numbers decrease after harvest, the reduced radioactivity is a result of potassium removed by the crop.