Final report

Digital Livestock 4.0 2019/2020 Pilot Farmbot - Romani Pastoral Deployment Case Study

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Abstract

The purpose of this project is to provide digital solutions under MLA's Digital Livestock 4.0 2019/2020 pilot to Romani Pastoral Company. Farmbot was tasked with providing satellite communications enabled water tank and trough monitoring solutions. Multiple site visits were conducted for information gathering and installations of hardware. To fulfil the project objectives Farmbot developed a wireless trough sensor based on learnings from site visits. The project successfully demonstrated to producers that remote monitoring in areas where traditional connectivity is limited or non-existent is now commercially viable and most importantly reliable.

Executive summary

Background

The purpose of this project is to provide digital solutions under MLA's Digital Livestock 4.0 2019/2020 pilot to Romani Pastoral Company, specifically to provide water tank and trough monitoring using satellite connectivity. In doing so, Farmbot sought to demonstrate satellite solutions for monitoring tank and trough allows water monitoring solutions to be deployed across all areas of Australia.

The target audience is low to medium intensity producers in zero or limited cellular connectivity areas. Typically, these types of producers have large distances between their water points. Significant time, resources, and labour are required to maintain these sites. As a result, there are substantial benefits to providing an affordable and reliable solution.

Objectives

- Provide water tank and water trough monitoring solutions enabled by satellite connectivity.
- Develop the wireless trough sensor solution based on the learning from Romani.
- Demonstrate the commercial viability and reliably of these satellite solutions.

Methodology

- Satellite Monitor installation and trough inspections.
- Installation of prototype wireless trough sensor, and solution assessment.
- Installation of commercial wireless trough sensor, and solution assessment.

Results/key findings

- Satellite communications enabled monitoring is a reliable and commercially viable reality.
- The development of the wireless trough sensor was a success and resulted in a commercial product.
- The Farmbot wireless sensor ecosystem concept was validated.

Benefits to industry

The benefit of this project is the demonstration to producers that remote monitoring in areas where traditional connectivity is limited or non-existent is now commercially viable and, most importantly, reliable. The development of the wireless trough sensor provides producers with another option for trough monitoring solution, specifically targeting remote locations.

Future research and recommendations

Future research and development should be focused on expanding the wireless sensor ecosystem. In particular, water quality and animal tracking. Additional research in data analytics of the collected data, to explore water consumption and animal health, is also of significant interest.

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1. Background

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2. Objectives

The overall objective of the project was to provide Romani Pastoral - Windy Station with water tank and water trough monitoring solutions enabled by satellite connectivity. Specifically, Farmbot were to supply, install, and make operational the following digital components:

- one water tank sensor;
- three wireless water trough sensors; and
- one rain gauge.

This project required the development of a wireless trough sensor based on Farmbot's wireless communications technology. The design was to be guided by the learnings from the Romani site visit, but also designed to be as versatile as possible to account for the wide range of troughs used throughout Australia.

These objectives have been met. The satellite Monitor is measuring tank level with a connected rain gauge and as an established commercial product has performed as expected. The learnings from the multiple site visits have cumulated in the successful development of the wireless trough sensor with all three installed and using the satellite Monitor to provide the communications backhaul. The success of the Romani deployment has led to the wireless trough sensors now being a commercially available product in the Farmbot sensor ecosystem.

3. Methodology

The original project plan comprised:

1. Site Visit 1 - Monitor install and trough inspection
2. Development of the wireless trough sensor
3. Site Visit 2 - Wireless trough sensor version 1 installation

Learnings from the Site Visit 2 installation resulted in a change to the project plan. There was to a minor hardware upgrade to increase performance. A third site visit was undertaken to finalise the installation.

Due to the outbreak of Covid-19, there was a significant delay between Site Visit 2 and Site Visit 3. During this period there was continued development and, by the date of Site Visit 3, the commercial version of the wireless trough sensor was available to be deployed for the final installation.

Though there was a slight deviation of the original plan, the end result was a significantly better outcome as the final version of the wireless trough sensor could be demonstrated as a commercially viable product.

An overview of each of these stages are detailed in the following section.

4. Results

4.1. Site visits

4.1.1. Site visit 1 - 7/11/2019 - Monitor install and trough inspection

The purpose of the first site visit was to inspect each of the troughs, and to install the Farmbot Monitor which would provide tank level monitoring.

The installation of the Monitor is a simple process that can be completed in 10 minutes. The only tools required are a drill, hole saw, or step drill, and a socket drive bit.

Figure 1. Monitor installation by Pascal Hendricks - Windy Station

The trough inspections involved viewing the terrain between the Monitor and each of the troughs. It further involved measuring the dimensions of the trough structure, float valve cover, and removable lid. This inspection also yielded the method of mounting the wireless trough sensor to the removable lid of the trough.

4.1.2. Site visit 2 - 12/3/2020 - Wireless trough sensor version 1 installation

The purpose of the second site visit was to install three wireless trough sensors. They were each installed in approximately 10 minutes. The installation was also shown to require only hand tools. This validated the simple mounting method of the product.

During the installation, Farmbot tested the strength of the wireless coverage from the Monitor. While there was reasonable reception at all three troughs, there was concern about the reliability of transmission due to the heavy vegetation surrounding the troughs. In one case, the vegetation was above the height of the wireless trough sensor antenna (Fig. 2). In the event that there would be moisture on the vegetation due to dew or rainfall, this might attenuate the signal sufficiently to cause packet loss.

Farmbot determined that this was an unacceptable risk. As a result, the decision was made to leave only one wireless trough sensor in the field, to validate the overall functioning of the device. Farmbot would then return with upgraded sensors with a higher gain antenna to significantly boost the communications link to the Monitor.

Another learning from the install was the need to locate the wireless trough sensor on a map. This indicated that an onboard GPS would have many benefits. These include, automatically and accurately placing the trough on the map as well as enabling the wireless trough sensor to be moved to other troughs when a paddock was not in use.

Figure 2. Wireless trough sensor v1 surrounded by vegetation - Windy Station

4.1.3. Site visit 3 - 23/7/20 - Wireless trough sensor v2 installation

The purpose of the third site visit was assess the condition of the existing sensor, remove it, and install three version 2 wireless trough sensors. The outbreak of COVID-19 resulted in travel restrictions and Romani Pastoral restricting all person to person contact with non-company personnel. The consequence of this measure was the significant delay in the installation date.

Field programmer test

Farmbot Monitors require a firmware update to communicate with newly developed wired and wireless sensors. Since the satellite version of the Monitor does not have two-way communications, it cannot be remotely updated in the field. To ensure backwards compatibility, the Monitor can be physically updated with a handheld device called a Field Programmer. The process involves connecting the programming cable into the Monitor and pressing a button to run. This was an opportunity to test the Field Programmer. The solution worked perfectly, with the entire process taking about 3 minutes.

Assessing the wireless trough sensor version 1

The deployed wireless trough sensor version 1 ran for 7 months with uninterrupted transmissions and functioning as expected. This validated the effectiveness of the overall Farmbot wireless sensor technology even without the improved antenna.

A discovery of the process was the accumulation of filth over the surface of the product housing. Over time, this could potentially reduce the output of the solar panel which in turn could have deep drained the battery, causing it to be prematurely fail. This validated the change to solely using a long-life replaceable battery. Overall, it was deemed to be a successfully deployment.

Figure 3. Wireless trough sensor v1 after 7 months in the field - Windy Station

Wireless trough sensor v2 installation

Testing the reception strength of the sensors at each location showed a significant improvement on the previous version. Installation was able to be installed in 8 minutes, and with only hand tools. This was an improvement on the previous method of installation.

Fig. 4 Shows one of the installed wireless trough sensors. In this particular mounting configuration, the sensor is bolted to the removable concrete lid of the trough with the water level probe passing through the lifting hole in the lid. Handles on the sensor allow it and the attached lid to be lifted for easy maintenance of the float valve.

A detailed overview of the wireless trough sensors can we found in the following section.

Figure 4. Wireless trough sensor v2 - Windy Station

4.2. Provided solutions

4.2.1. Monitor overview

The Farmbot Monitor is an out of the box, ready to use, solar powered device that supports a wide range of plug and play sensors both wired and wireless.

It has two communication variants-satellite and cellular. The Romani pilot Monitor is a satellite variant that uses the Globalstar satellite constellation. The constellation enables it to have global connectivity, excluding the polar regions.

To meet the requirements of the project a water level sensor was connected which automatically configures the Monitor to provide real-time reporting of the tank level. The Monitor also acts as a base station for the three wireless trough sensors in the area, providing the communications backhaul of the trough data. This is achieved by using a LoRa radio for its long range and low power but also using a proprietary communication protocol. Unlike LoRaWAN solutions which require large, expensive base stations and the correct frequency, the Farmbot LoRa protocol communicates only with Farmbot Monitors and sensors and is not held by LoRaWAN protocol packet restrictions and local gateways.

The Farmbot Monitor is an established commercial product with over three thousand deployed across Australia.

For this project, Farmbot provided one Satellite Monitor with a level sensor which has as run continuously since installation.

4.2.2. Wireless trough sensor overview

Farmbot Wireless Trough Sensors ensure that graziers always have an up to date picture of the available water supply, right up to the point of consumption to ensure the wellbeing of their stock.

It is designed to be simply and quickly installed by farm labour on most modern troughs. To achieve this the base plate of the sensor has a set of generic mounting holes that can be used with a range of fasteners for each situation. A hardened plastic dome ensures that it can't be easily damaged or dislodged by the wayward cattle.

The sensor communicates with any Farmbot Monitor in a range of 2-5km depending on terrain. The use of a very low power electronics and radio allows it to run on replaceable battery power for a minimum of 2 years.

Water level is measured using a submersible hydrostatic pressure sensor. This allows for easy installation and does not require calibration like ultrasonic-based level sensors.

4.2.3. Data, alerts and integrations

The tank and trough data are transmitted from the Monitor via satellite to the web platform. Through the users' dashboard, a list of all the monitored assets is accessed. The data for each asset is available to view as a graph or in table form. All the historical data is permanently stored and can be downloaded in csv form on request.

Tank level data

Fig. 5 shows an example of tank level data. Multiple data points are sent in each transmission which allow the graph to have a high level of resolution - This detail can provide insights into the inflow and outflow of the tank.

Multiple alert triggers can be set up indicating minimum or maximum levels in the tank. Additionally, each transmission includes the trend of the tank level. In the rare event that there is a lost data transmission an alert can be generate if this trend line breaches an alert level providing an added level of protection.

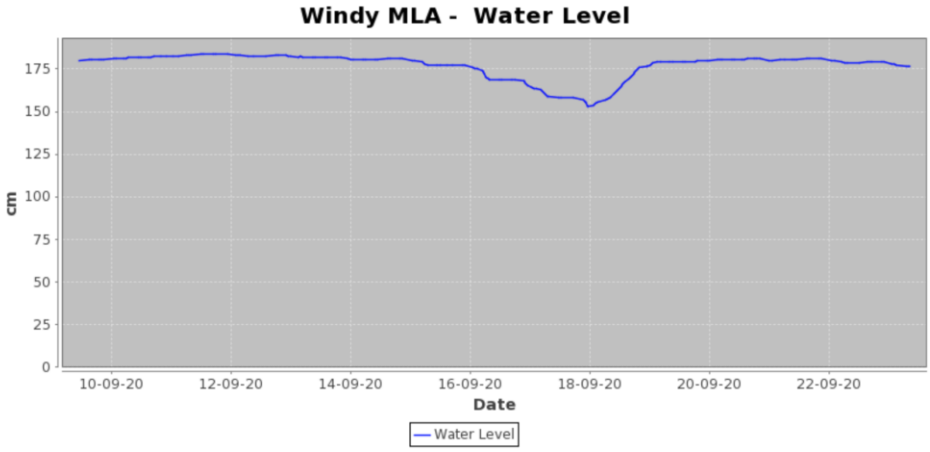


Figure 5. Water Tank Level Graph

Trough level data

The wireless trough sensor provides the average and minimum water level in the trough for each transmission period of the Monitor. The reason for this is to make the transmission of multiple wireless sensors affordable over satellite communications. At the same time, it will still provide the relevant information to give insights into water consumption and forewarn of pending problems with the supply infrastructure and the float valve.

Fig. 6 shows an example of this. The average trough level provides the main trend information and gives a clear view of whether the overall supply system is coping.

The minimum level will highlight where there are periods when the trough is in demand. When the average and minimum level are aligned, the graph shows there is no movement in the level.

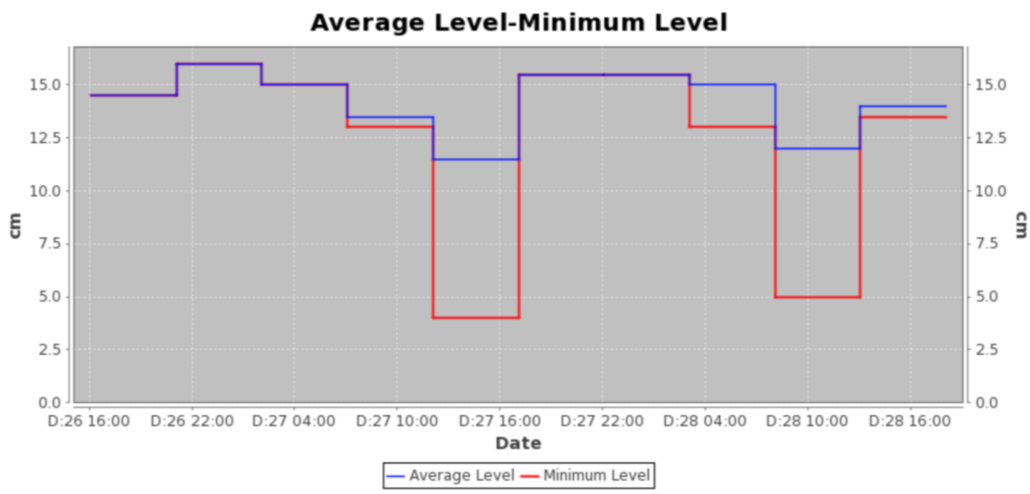
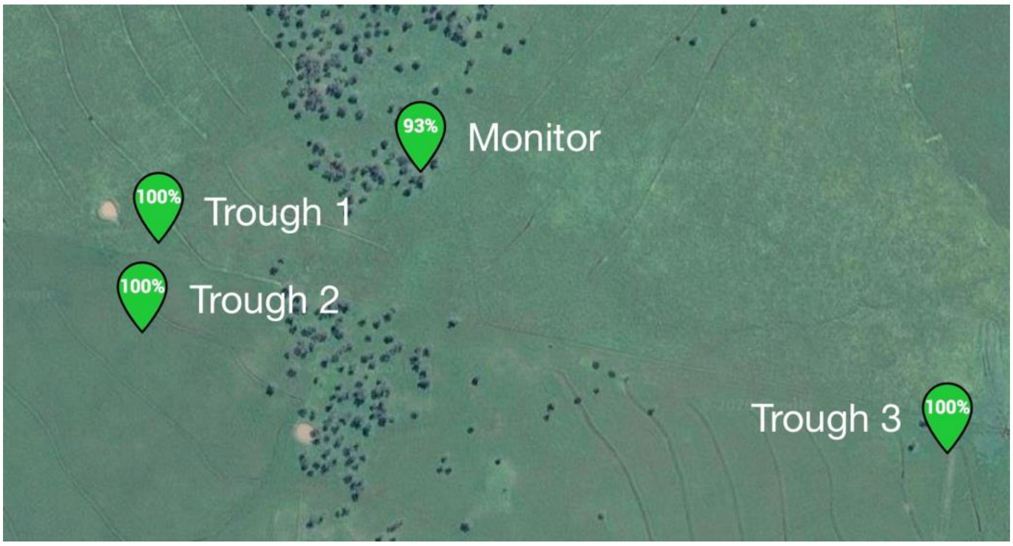


Figure 6. Trough Level Graph

Map view

The Map view is shown in Fig. 7 giving a satellite view each of the assets and their percentage



full.

Figure 7. Map view of monitored assets

Integrations

The Farmbot web platform is able to integrate to third parties via a push API. For Romani Farmbot integrated with Agriwebb to send Tank and Rainfall data to their dashboard.

5. Key findings

Satellite communications enabled monitoring is a reliable and commercially viable reality. The Monitor ran uninterrupted and has been fully functional since the beginning of its installation. There were no periods of monitoring downtime or missing data and, by extension, this communications reliability was applied to the wireless sensor data backhaul (troughs).

The wireless trough sensor is a successful solution for trough monitoring. The development of the wireless trough sensor resulted in a robust and reliable design based on the learnings from the Romani site visits. Importantly, there was also continued learning on the deployment of wireless technology in agricultural environments.

The end result of the success of the wireless trough sensor is the validation of the Farmbot wireless sensor ecosystem.

6. Conclusion and recommendations

Water is critical to the Australian red meat industry and Farmbot's offering allows water monitoring solutions to be deployed across all areas of Australia. This project is a successful demonstration of Farmbot's water tank and trough monitoring satellite solutions. The benefit of this is the demonstration to producers that remote monitoring in areas where traditional connectivity is limited or non-existent is now commercially viable and most importantly reliable. An additional benefit of this project is it highlights Farmbot's ability to rapidly develop new solutions to meet the growing demand for innovative technology for digital agriculture.

The success of the wireless trough sensor is the first step in the development of the Farmbot wireless sensor ecosystem. With the Monitor acting as a wireless base station, a range of sensors can be deployed off a single satellite communications backhaul. This creates additional value by reducing the upfront and communications costs for each wireless sensor.

Future research and development should be focused on expanding the wireless sensor ecosystem. In particular, water quality and animal tracking. Additional research in data analytics of the collected data to explore water consumption and animal health is also of significant interest.