ISOBlue is an open source bridge from ISOBUS to Android smartphones and tablets. ISOBlue enables the transfer of data from agricultural machinery to Android, where it can then be forwarded on to the cloud.

ISOBlue is open source and uses the open platforms BeagleBone Black and Android. This allows for an extensive community of developers to utilize and improve ISOBlue. All of the related code is on Github at https://github.com/ISOBlue.

ISOBlue Data Flow

What is ISOBUS?
ISOBUS is a networking standard used in much of today's agricultural machinery. It consists of two busses over which messages are sent. Each message contains a Parameter Group Number (PGN) which identifies the message data and its proper interpretation. Some PGNs are defined in the ISOBUS standard, but many of them are proprietary.

Why ISOBlue?
The data used by the monitor to generate yield maps is transmitted over ISOBUS. ISOBlue was made for retrieving these data. The data can then be processed and analyzed, for example to create better yield maps. Some of the ISOBUS data of interest are:

- GNSS Position
- Grain flow rate
- Moisture
- Header height
- Ground Speed

One of the challenges with ISOBlue is that much of the data does not use standardized PGNs. Of the data of interest, the following are contained in proprietary messages:

- Grain flow rate
- Moisture
- Header height
- Ground Speed

This makes retrieving those pieces of data more difficult.

Using ISOBlue
ISOBlue has been successfully used to log ISOBUS data from combines during harvest. During the data collection, two experiments were conducted to help identify and decode the grain flow rate measurement within the ISOBUS data.

The ISOBUS is the district to the diagnostic point of a combine. Using a custom Android application written as part of the project's scope, the combine's ISOBUS data were received and logged on an Android tablet.

Data Logging

Experiment 1 steps:
1. Data logging was started in a new file on an Android tablet just prior to connecting the sensor
2. The sensor was disconnected
3. After some time, data logging was stopped
4. Data logging was restarted in a new file shortly before the sensor was reconnected
5. The sensor was reconnected
6. After some time, data logging was stopped

To the right are two plots showing a point for each observation of a message, one from the first file logged and one from the second file logged. The y-axis is PGN and the x-axis is elapsed time in seconds.

From these plots it was seen that there is a PGN which disappears/appears based on the flow sensor.

Decoding the Flow Sensor Message
A second experiment was run which was meant to create a set of ISOBUS data which corresponded to a known yield.

Experiment 2 steps:
1. Started with the combine not harvesting
2. The total bushels recorded by the monitor was noted
3. Data logging was started in a new file on Android tablet
4. The combine began harvesting
5. After some time the combine stopped harvesting
6. The change in total bushels logged by the monitor was recorded
7. The data logging was stopped and the file was marked with the change in total bushels

Looking at the data field of the PGN found in experiment 1, a portion of the data payload seemed to correspond to the flow rate (because it was observed to be changing). That portion, interpreted as unsigned integers, is plotted above. A least squares fit was performed with the following form:

$$\alpha = \alpha_1 + \alpha_2 x$$

where $$x$$ is a vector where the i-th element is the sum of the aforementioned data payload from the i-th file, y is a vector where the i-th element is the recorded change in bushels for the i-th file, and alpha is the scaling factor to go from a flow measurement (in unknown units) to a measurement in bushels per second. The figure to the right shows the fit.

Yield Maps

A yield map was generated using the flow rate and GNSS information from the recorded ISOBUS data. It was compared to the map exported from the combine's monitor. Below is a plot of the locations of the map points, yellow is from the monitor and blue is from ISOBlue.

What We Learned
When comparing the ISOBlue generated yield map to the exported one, various differences were identified. As seen to the left in a zoomed section of the above map (yellow replaced with black), the positions of the two maps have a relative offset. Additionally the ISOBlue map has more points. These points appear to be from when the combine is not actually harvesting, and could likely be eliminated once more information is retrieved from the ISOBUS (e.g. header position).

There were also slight differences between the generated corn flows and those in the map exported from the monitor.

It is evident that the monitor is doing things differently than what was done to generate the ISOBUS map.

Future Goals
The next step is to perform detailed statistical analyses on the yield maps. One example is how best to resample the data for display and image processing.

Another goal is to implement "aggregate by finger" where one can select an arbitrary portion of a map and get information as to the characteristics of that portion and how it differs from the rest of the map.

Yield Maps

Future Goals

Data Logging