

Uptime: Component Failure Prediction System for Agricultural Machinery



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1 BACKGROUND:

Grass Harvesting

Harvested grass is a nutritious feed source during winter.

- Requires state-of-the-art machinery.



Contractor Model

- Harvesting services: outsourced to third-party contractors.
- One contractor, many farmers (hundreds).

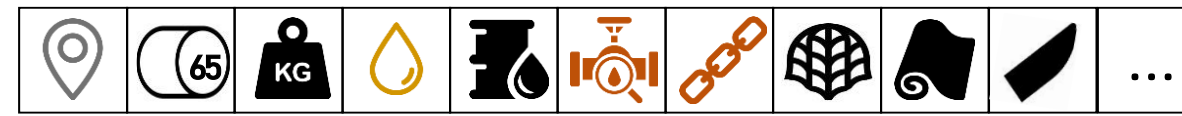
Pressure

- Implements experience significant loading.
- Breakdowns -> Delay -> Degrade crop value.
- Measuring load accurately involves bulky equipment at a significant cost.

Research Aims

- Approximate machine loading via a cost-effective data fusion approach.
- Test the system across a fleet of machinery using Telematic systems:
 - Benchmarking "in the wild".

2 DATA ACQUISITION:



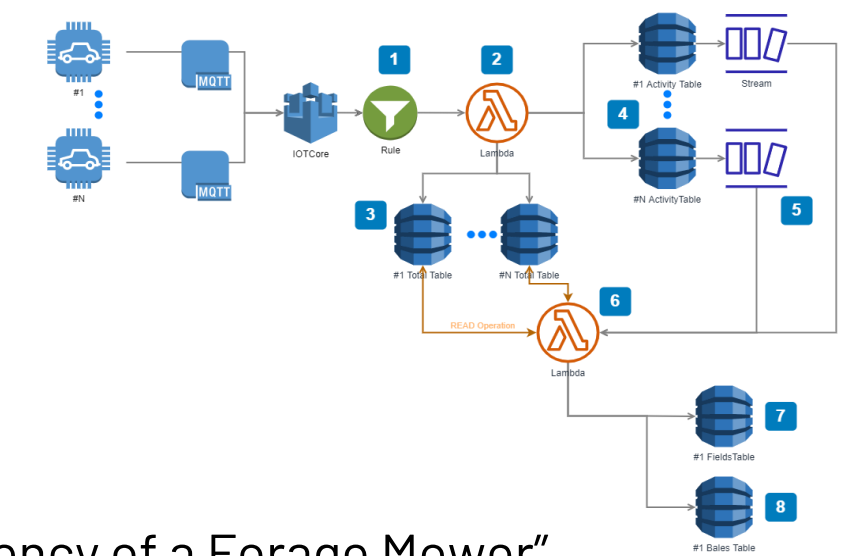
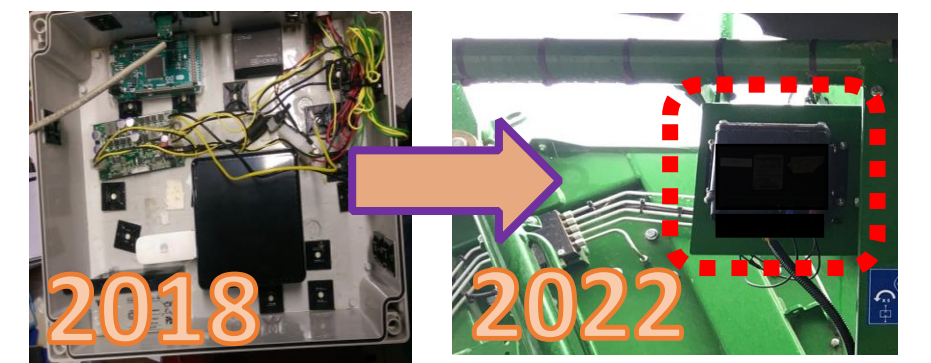
Machine Monitoring

Sensors attached to several McHale harvesting implements to monitor crop characteristics and machine loading.

Data Logging

2018: 3 machines (Lero Marie Curie).

- SSD logging.
- 2022: 7 machines (Lero).
- Customised telematic systems.
- Prototype serverless backend.
- 2023: 40 machines+ (Lero).
- Telematics with full aws backend for filtering (3) and pre-processing (for (4)).

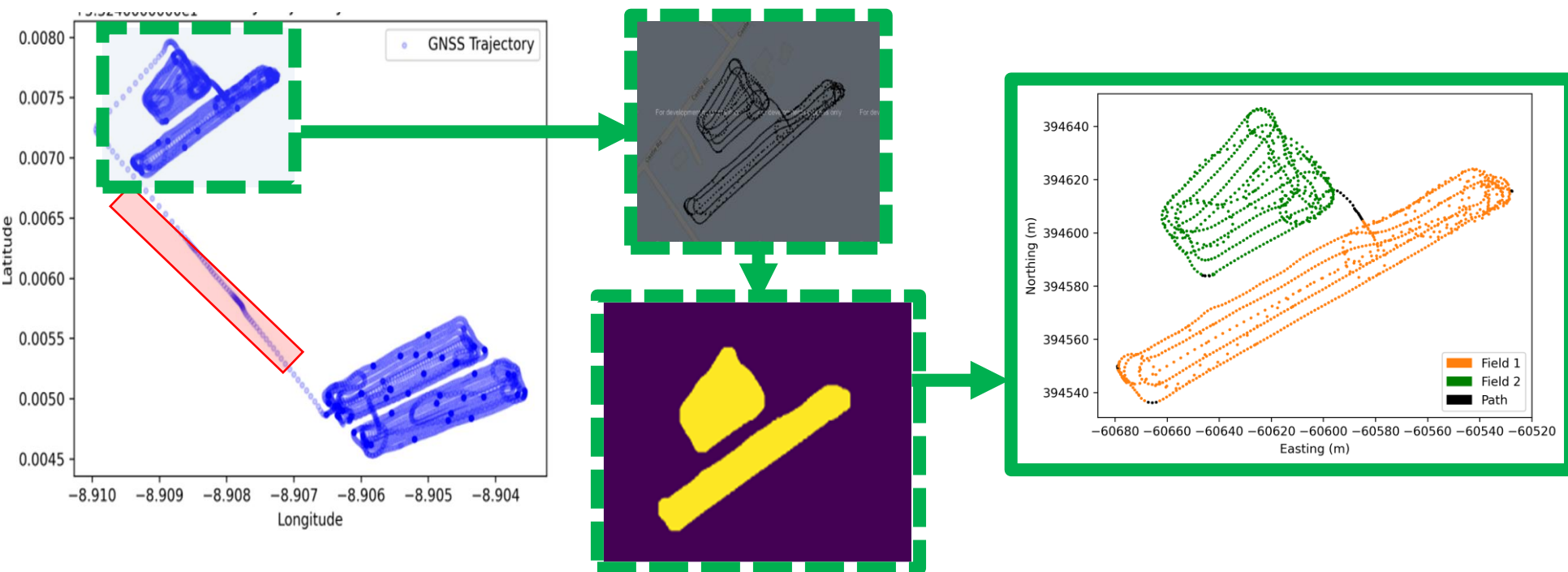


Outputs:

- T. Crotty *et al.* "A Season in Data: Efficiency of a Forage Mower", LAND. TECHNIK 2020, Düsseldorf, 2020, vol. 2374.
- T. Crotty *et al.* "The Efficiency of Grass Silage Mowing", In preparation.

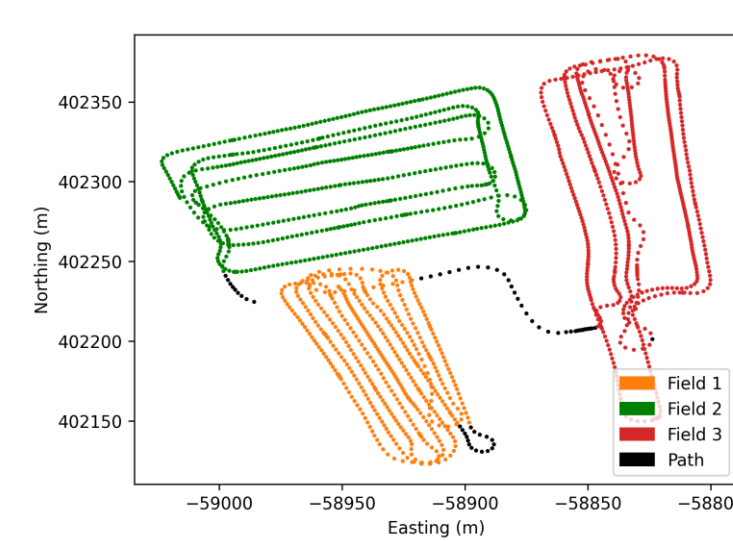
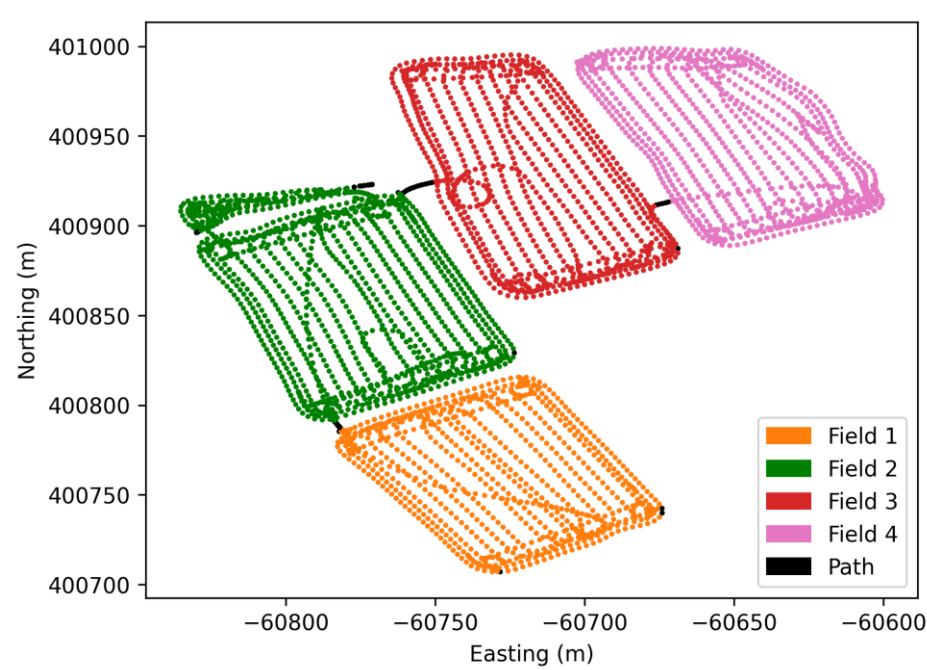
3 OUTPUT: GEOMETRIC FIELD DELINEATION (FILTERING):

Aim: Delineate fields based on a PTO activation and coordinates.



Challenge: PTO remains active between adjacent fields. Algorithm must automatically determine a) the number of sites and; b) the boundaries of the sites, if multiples present.

Methods: Coordinate-based segmentation using morphological image operations.



Fields Present		
>1	31	1
1	1	294

Results: Accuracy: >99%.

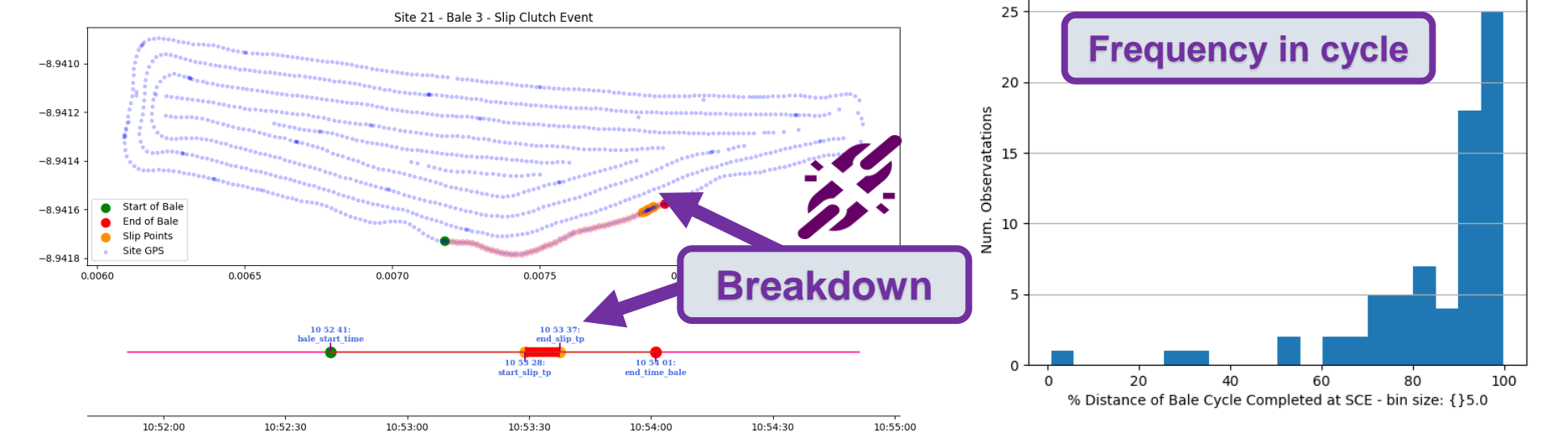
- 172 baler fields and 155 mower sites.

Outputs:

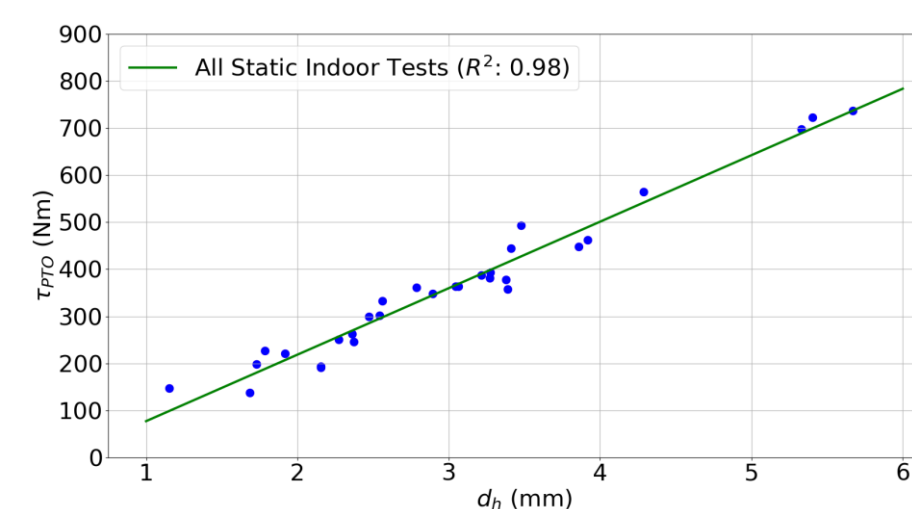
- S. Harkin *et al.* "Automated Geometrical Field Boundary Delineation Algorithm for Adjacent Job Sites" presented at ICPA Minesota, USA, July 2022.
- S. Harkin *et al.* "Field-to-Field Coordinate-based Segmentation Algorithm for Adjacent Job Sites on Agricultural Harvest Implements" In preparation.

4 OUTPUT: COST-EFFECTIVE MACHINE LOADING APPROXIMATION:

Aim: Approximate harvest implement loading to counter machine breakdown.



Challenge: State-of-the-art load measurement systems are neither cost-effective (€5000+) or robust enough for long-term implement deployment.



3500 bales Load Estimation Error		
	Nm	%
Mean	86	7
Median	71	6
Std. Dev	69	6

Results:

- Workshop tests: $R^2 = 0.98$ between ground truth and approximation.
- In-field tests: $R^2 = 0.96$.
- Season-long testing: Prediction mean error is approximately 7%.

Outputs:

- T. Crotty *et al.* "A Novel Cost Effective Method for Round Baler Load Estimation" In preparation.

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