Enhancing Robotic Mission Analysis via Process Mining and Visual Analytics

Evaluation with Experts

INTRODUCTION

Please note that this interview will be recorded for evaluation purposes only

Background Concepts

Robotic Mission Analysis

A robotic mission consists of multiple activities executed over time. Mission analysis aims to understand: what actions were performed, in which order, and under which conditions. It supports debugging, performance assessment, and post-mortem mission understanding.

Process Mining

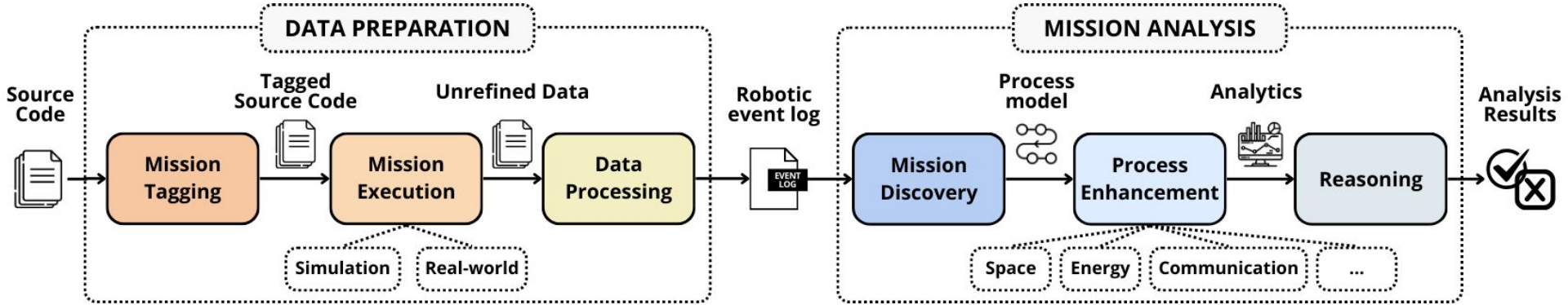
Process mining analyzes execution data recorded during system operation. It reconstructs a high-level representation of behavior from event logs.

Visual Analytics

Visual analytics combines automated analysis with interactive visualizations of complex data. Visualizations support human reasoning rather than replacing it

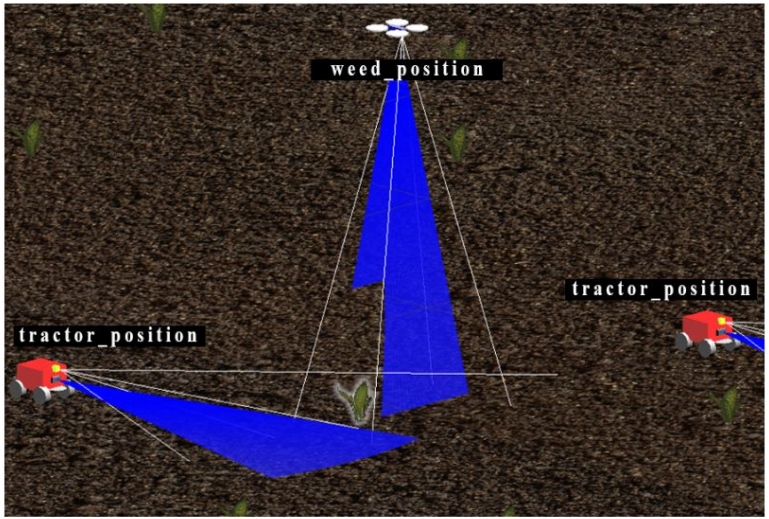
Methodology

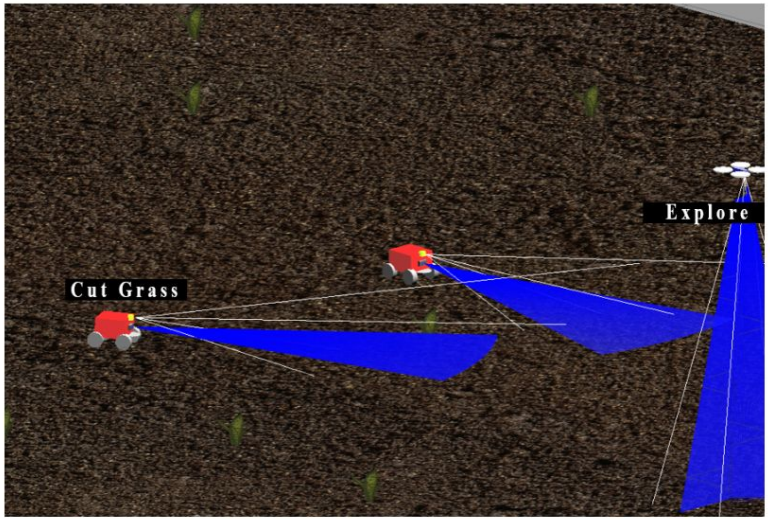
The methodology consists of a ***data preparation*** phase, composed of *mission tagging*, *mission execution*, and *data processing*, involving robotic event log preparation, and an ***mission analysis*** phase, composed of *mission discovery*, *process enhancement*, and *reasoning*, enabling robotic mission analysis via process mining and visual analytics



Case Study

Smart agriculture scenario where a drone cooperates with two tractors to identify and remove weed grass





Methodology at Work

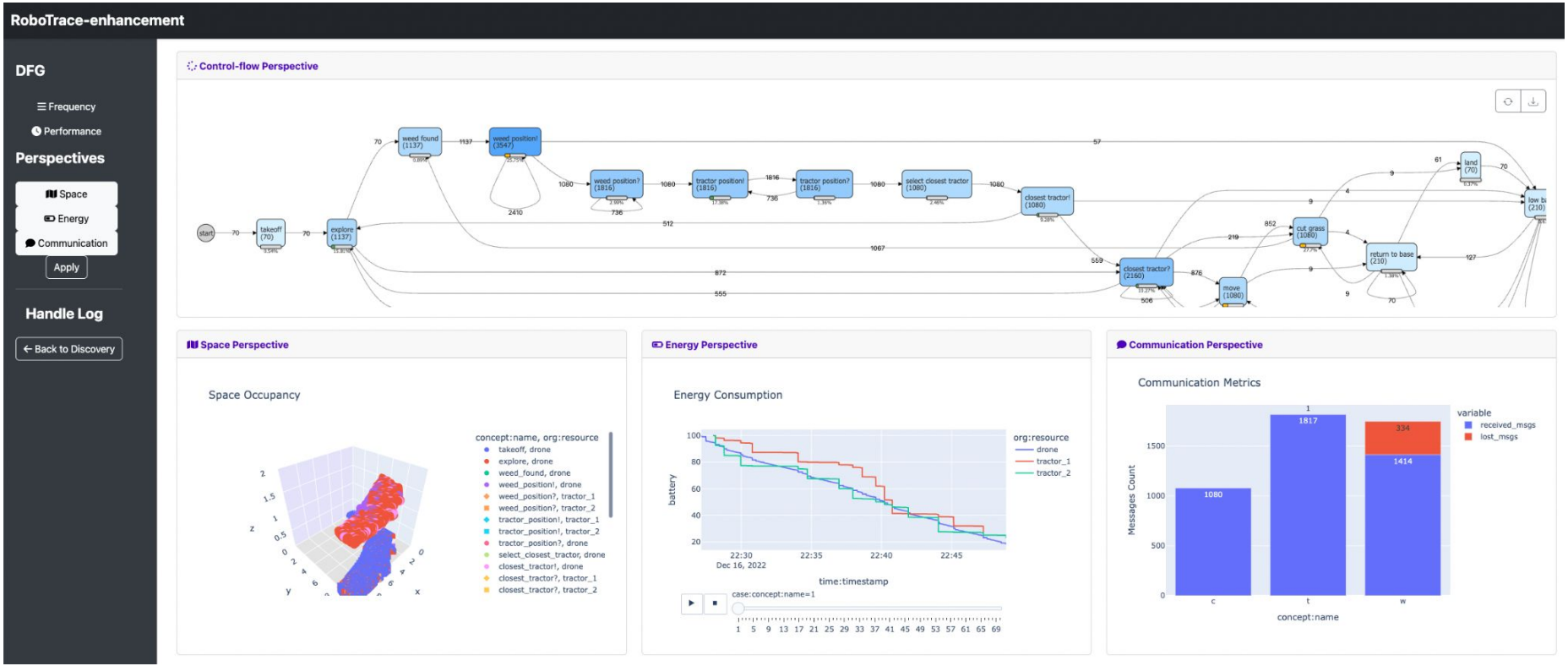
```
tag = TagTopic()
tag.activity = "cut_grass"
tag.lifecycle = "start"
ros_publisher.publish(tag)
CutGrass(ros_node)
tag.lifecycle = "complete"
ros_publisher.publish(tag)
```

Tag integration

Case	Time	Activity	Transition	State	Attributes					
					x	y	z	Resource	Msg	Battery
...	...	...	...	...	...	...	...	...	...	...
38	10:08:53.12	explore	null	inprogress	0.59	3.33	1.48	drone	null	97
38	10:08:55.01	explore	null	inprogress	0.99	4.01	1.48	drone	null	97
38	10:08:56.55	explore	null	inprogress	1.12	4.52	1.48	drone	null	96
38	10:08:57.61	explore	complete	null	1.66	5.03	1.48	drone	null	96
38	10:08:57.88	weed_found	start	null	1.66	5.03	1.48	drone	null	96
...	...	...	...	...	...	...	...	...	...	
38	10:08:58.00	weed_postition!	complete	null	1.66	5.03	1.48	drone	m52	94
38	10:08:58.30	weed_postition?	start	null	0.25	1.12	0.0	tractor_1	m52	85
38	10:08:58.30	weed_postition?	complete	null	0.25	1.12	0.25	tractor_1	m52	85
38	10:08:58.30	tractor_position!	start	null	0.25	1.12	0.0	tractor_1	m53	84
38	10:08:58.32	tractor_position!	complete	null	0.25	1.12	0.0	tractor_1	m53	84
38	10:08:58.34	weed_postition?	start	null	0.17	1.12	0.0	tractor_2	m52	71

Event log

Methodology at Work



https://github.com/SaraPettinari/robotrace

DISCUSSION

Q1. How would you assess the effort required to define and integrate activity tags into robotic mission?

In which scenarios do you think tagging would be feasible, and in which might it become impractical?

Q2. Based on the process model, can you describe what happened during the mission?

Q3. Did the additional perspectives influence or refine your understanding of the mission? How did the combination of the process view and these visualizations affect your reasoning about the mission behavior?

Q4. How would you normally analyze a robotic mission like this using the tools, data, or practices you currently rely on?

Evaluate the Utility wrt Baseline approaches

Q5. Do you think you could have reached similar insights or conclusions using your usual tools or approaches?

Anything to add?

THANKS!