MODELING AND SIMULATION FOR FARMING DRONE BATTERY RECHARGING

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Objective

IoT devices have several applications and they need energy to keep their continuous work.
This work aims to propose a **coordination recharging process** to improve this device **autonomy**.

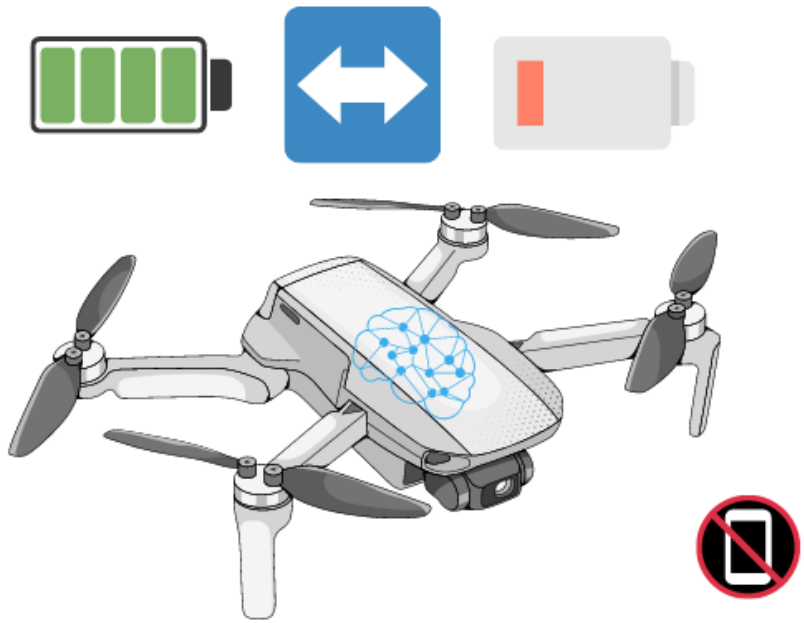

Figure 1: Model main idea

Source: Authors' adapted from Canva

Drones and Agriculture

The farming sector has a significant economic impact on Brazil's gross domestic product (GDP). [FAO 2022]
Drones, can perform farming activities as [Radoglou-Grammatikis et al. 2020] & [Hager 2023]:

- herds and crop monitoring;
- image capturing;
- seeding;
- fruit harvesting;
- spraying.

Figure 2: Drone spraying
Source: https://tinyurl.com/mwnrdm6h

Our Proposal:

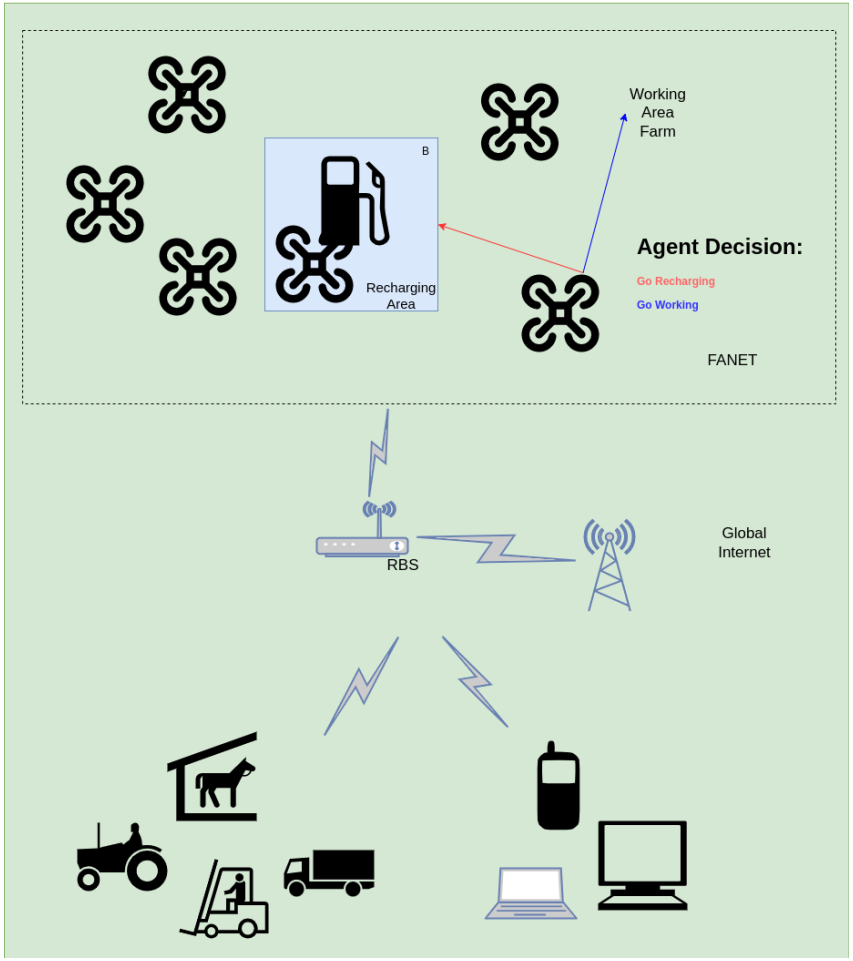

Figure 3: Connected Farm Concept.

Source: Authors

Model Description

- The model was implemented in Agent-Based Simulation Software NetLogo [Wilensky 1999]
- The agent uses internal policies based at the El Farol Bar Problem. [Arthur 1994] & [Rand and Wilensky 2007]:

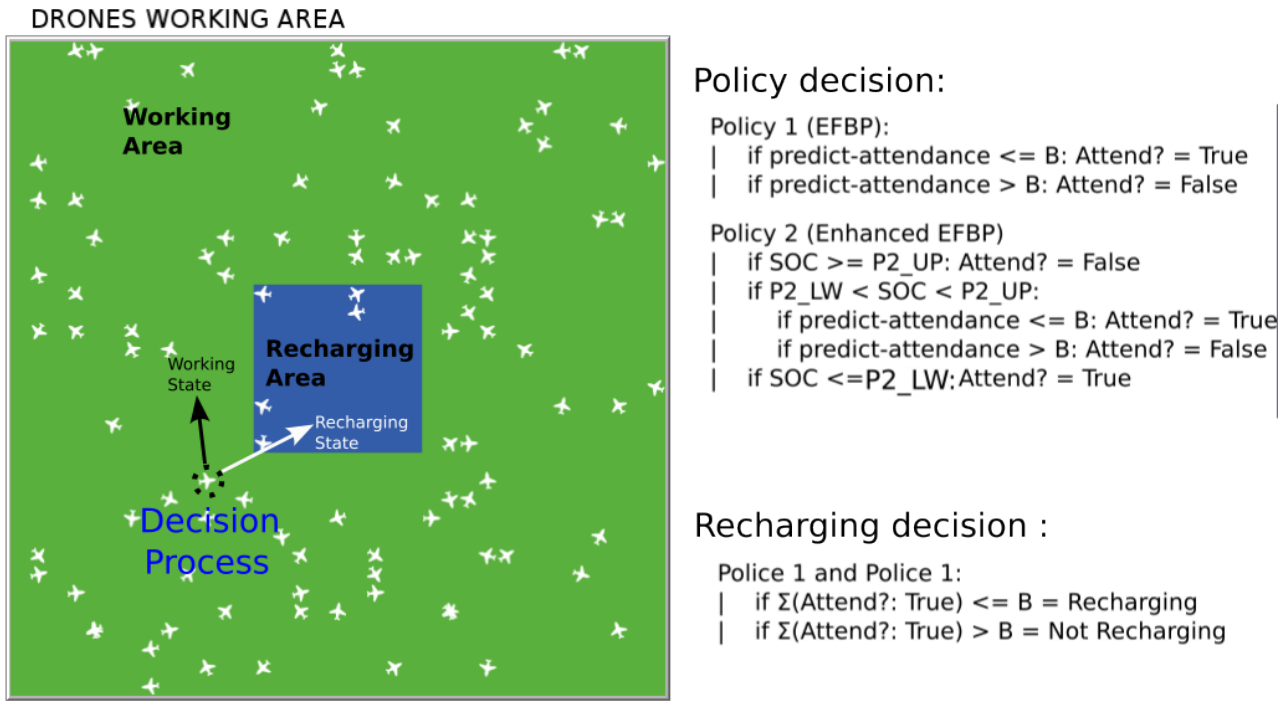

Figure 4: Model representation
Source: Authors

Simulations Description

- 2^5 Scenarios * 100 replication = 3200 simulations runs.
- 1000 ticks or any residual drone.

Table 1: Experimental Parameters Levels

Parameters	-	+
Policy	1	2
Quantity of drones (Qty)	100	200
Mean Battery consumption (BC) % per cycle	5	10
Mean Battery consumption normal Std Dev. (BC_SD)	0,1	0,5
Battery Gain in an effective recharging (BG)	70	100

Source: Authors' elaboration

Results

Two results types :

- Reliability measure — The survival ratio of the remains drones at the end of the simulation ;
- Effectiveness measure – The average time the agents were not attending the recharging place (working).

A higher value is better.

Reliability Measure

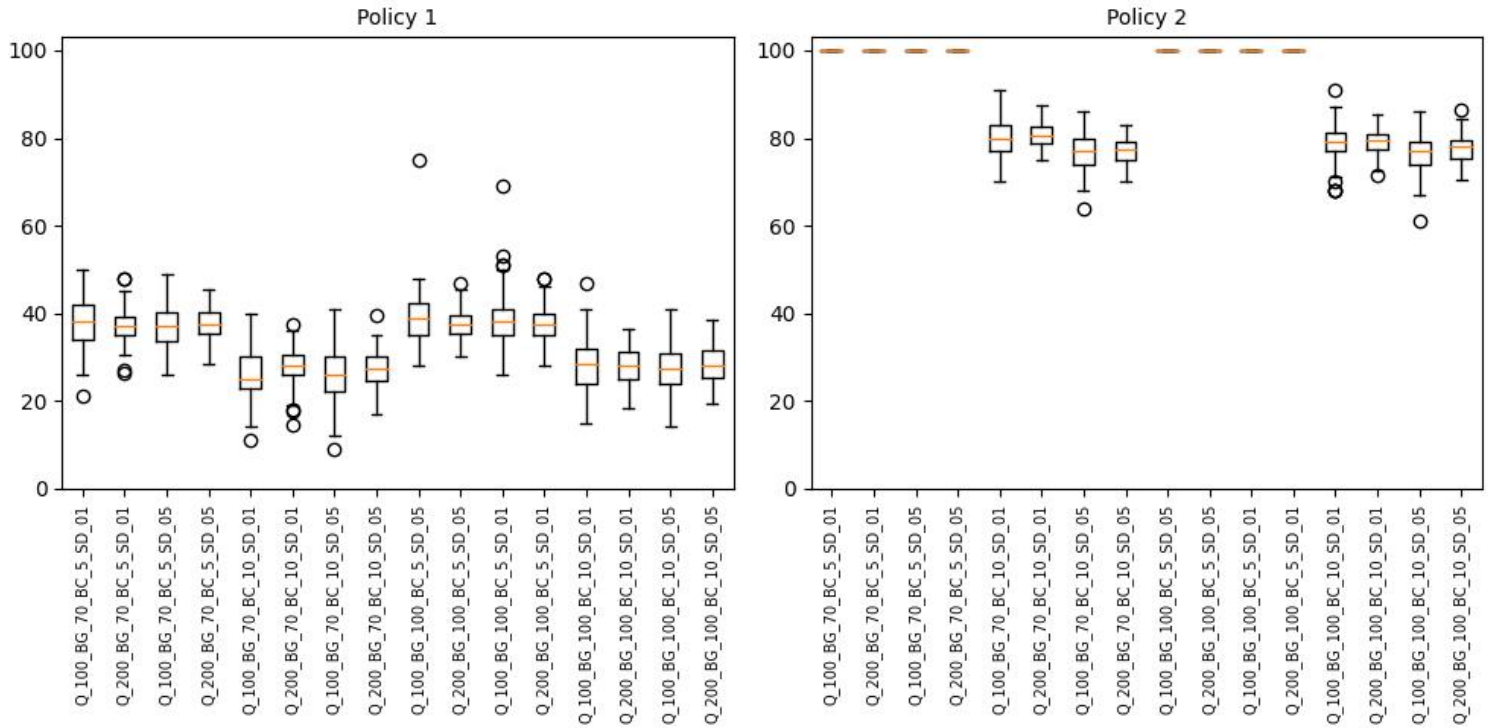

Figure 5: Reliability results

Policy 2 agents' results (89.21%) were better than Policy 1 (32.53%) survival rate.

Effectiveness Measure

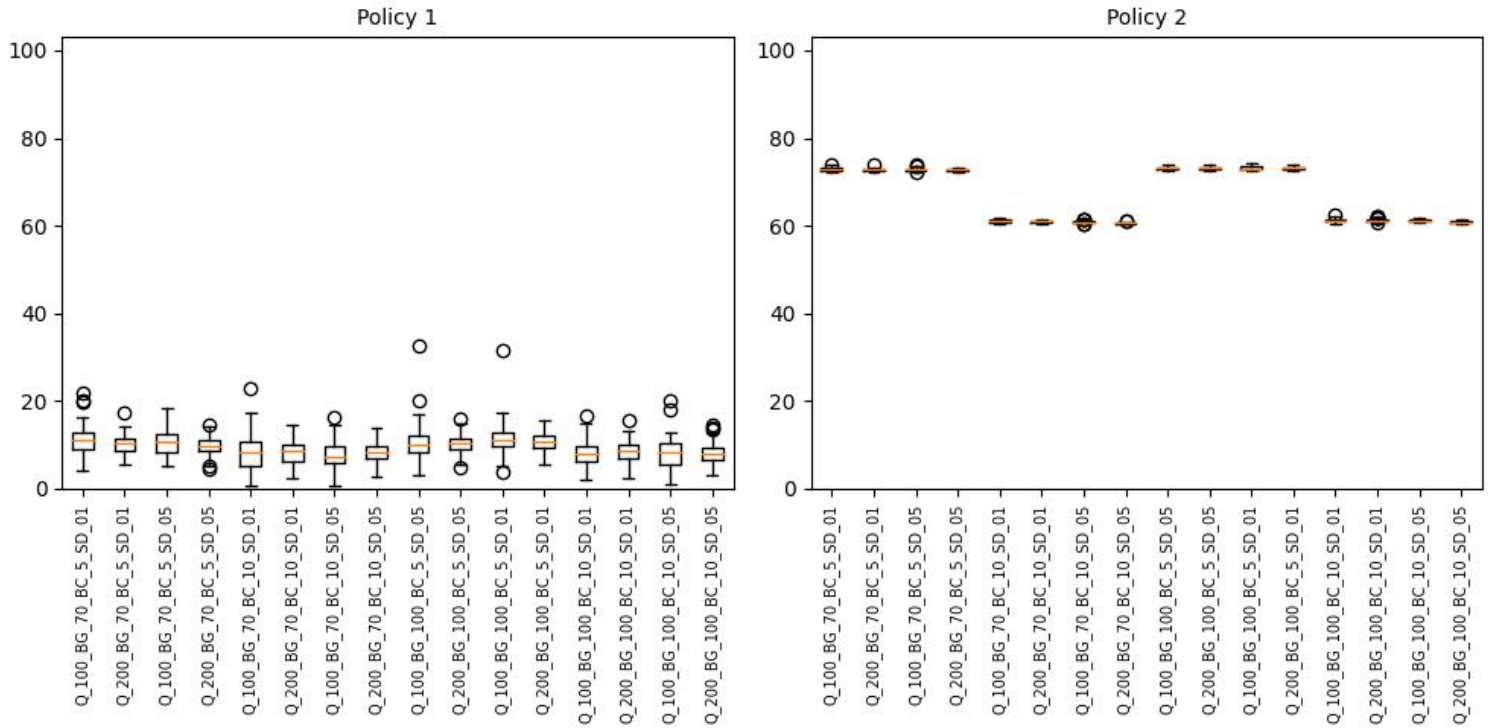

Figure 6: Effectiveness results

Policy 2 has better effectiveness average performance (66.9% versus 9.35%) than Policy 1.

Final Remarks

Conclusions:

- This ongoing work proposes an energy supply process in farming solutions drone swarms.
- Experiments show that Policy 2 presents better performance results than Policy 1.
- This finding is an opportunity for new policy decision usage.

Future works:

- Different UAV internal policies, e.g: Fuzzy Logic, Deep Learning, Kalman Filters, etc.,
- Environment, drones, and simulation improvements.

ACKNOWLEDGMENTS

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Thank you!

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Questions??