Smart control of mechanical oil pressing using Deep Reinforcement Learning

AUTHORS

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I. INTRODUCTION

Reliable operation of solar-powered agro-processing equipment in off-grid settings remains a challenge for rural development. This work present a novel Deep Reinforcement Learning (DRL) controller for a standalone solar powered oil press. (Fig.1)

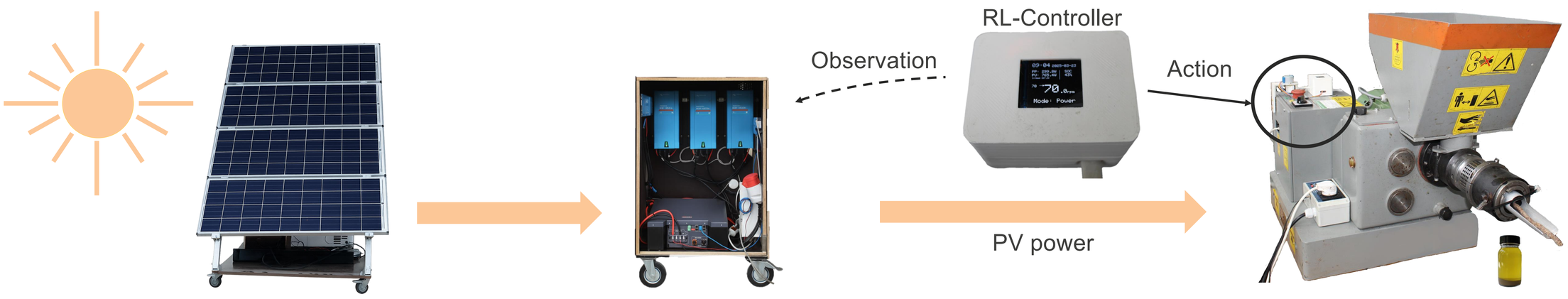

Fig. 1: Standalone PV-powered oil press with DRL controller

II. METHODS AND RESULTS

1. Model environment

A simulation model of the PV powered oil press was designed (Fig.2)

- DRL agent observed:
  - Hour (h) PV power (W) Battery SOC (%) Average irradiation (W/m^2)
  - Month Press power (W) Previous action (rpm)
- Action space:
  - Press rotational speeds (0–70 rpm)
- Reward: maximize oil yield, minimize battery cycling & interruptions.

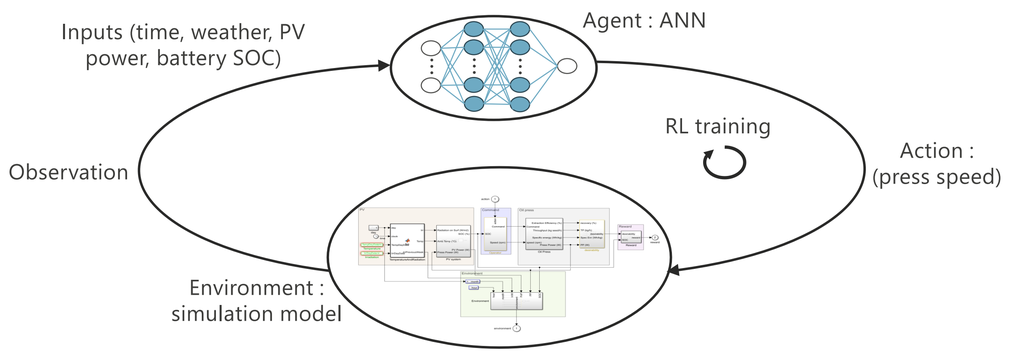

Fig. 2: Deep Reinforcement Learning agent trained in a PV-powered oil press simulation environment

2. RL training

- Training in simulated environment over 15 years of PVGIS-SARAH2 weather data.
- Added adversarial training focus on 5% least-sunny days to enforce robustness under low-irradiance.
- Outcomes : Stable reward evolution over episodes
  Daily throughput: → 96 ± 13.5 kg on sunny days
  → 90 ± 20.5 kg on cloudy days

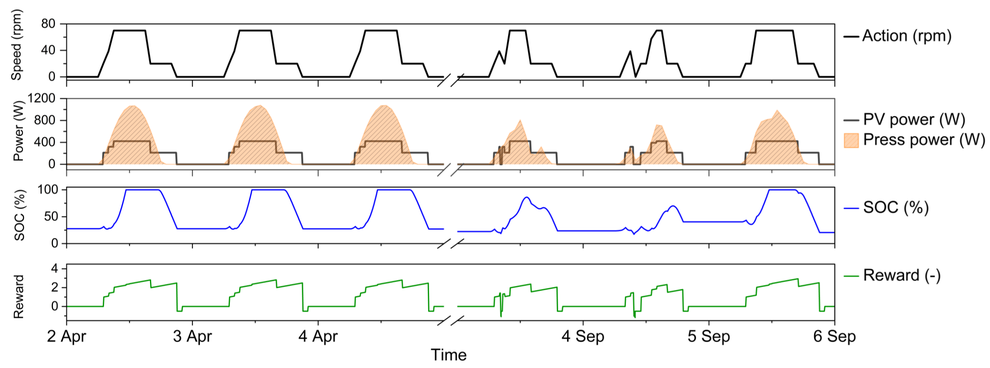

Fig. 3: In silico performance of trained agent during sunny (left) and cloudy (right) days

3. Deployment on ESP32

- Policy deployed on ESP32 controller and tested on KK20 oil press (Fig.4)
- Operation during sunny day
  - Operation time : 10 h → 14 h
  - Seeds processed : 129 kg → 126 kg
  - Oil produced : 40.4 kg → 40.4 kg
  - Energy utilization : +13%
- Operation during cloudy day
  - Outages : multiple → 1 shutdown (Fig. 5)
  - Operation time : 5.6 h → 8.3 h
  - Seeds processed : 62 kg → 35 kg
  - Oil produced : 21.6 kg → 12.3 kg
  - Energy utilization : +61%

Fig. 4: Deployed agent on a microcontroller

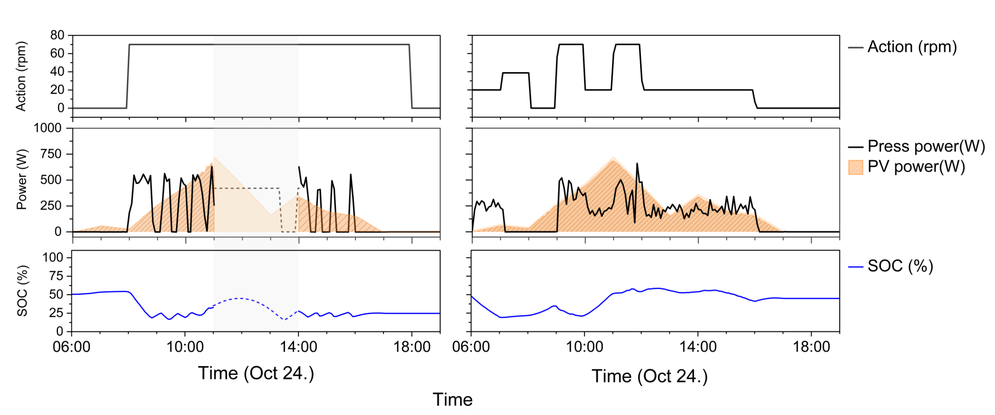

Fig. 5: Experimentation of the control unit on a solar power oil press without controller (left) and with (right) controller

III. CONCLUSION

The controller improves production time, efficiency, and robustness of off-grid oil pressing. It displays solar and pressing parameters, and automatically adjusts press speed based on weather conditions. Future work will address seasonal reward shaping and crop-specific optimization.

Scan for more details

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