A Cognitive Architecture for Human-Robot Collaboration in Field Robotics

Beril Yalçinkaya
PhD Student

CMU PORTUGAL SUMMIT 2022
NEW FRONTIERS IN TECH

Introduction

Field robotics is a domain comprising single or multiple robots that are designed to achieve physically unendurable tasks in unstructured wild environments, such as forests. Due to the fact that these domains of application mostly requires a large amount of human labour, it is reasonable to think as to why not replace humans with robots, as we have witnessed in the other service robotics applications. The main reason for that falls on the life-long autonomy maintenance of the system under these challenging, unstructured and dynamic scenarios.. On the other hand, by having empathy, critical thinking, strategy and complex physical skills, humans are not removable from the loop, especially in such complex domains. Still, it is possible to combine the advantage of a robotic system, that is convenient for physically unendurable tasks, with human cognitive skills and assessment in these wild environments, fostering a symbiotic relationship between both agents, i.e, human-robot collaboration (HRC).

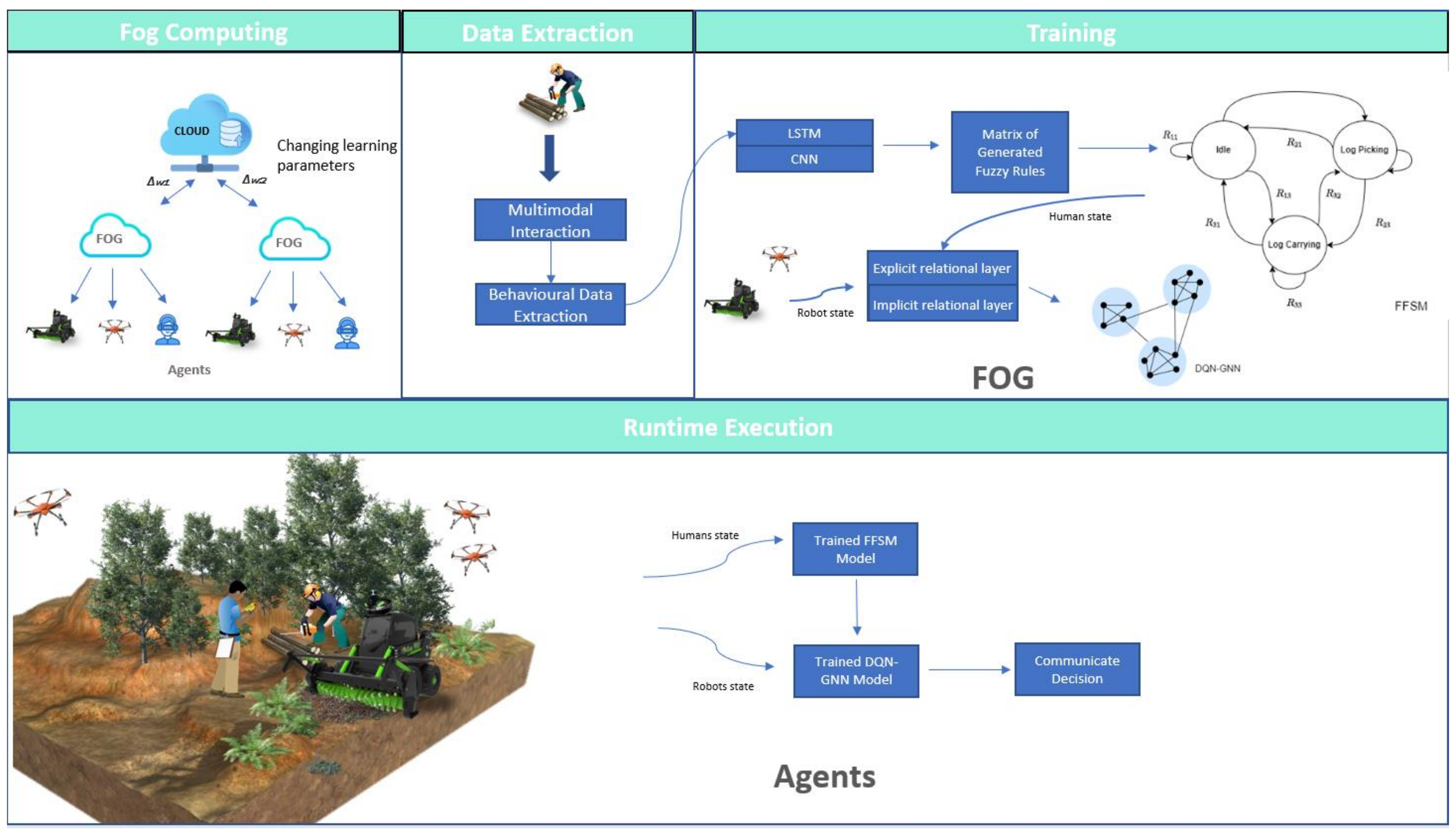
Methods

To achieve this, the proposed approach of the cognitive architecture for human-robot collaboration comprises a threefold complementary objectives:

• Human-like decision-making modelling with enhanced fuzzy finite state machines

• Spatio-temporal decision-making with multi-agent deep reinforcement learning

• Knowledge transfer and distributed processing with fog-enabled federated learning

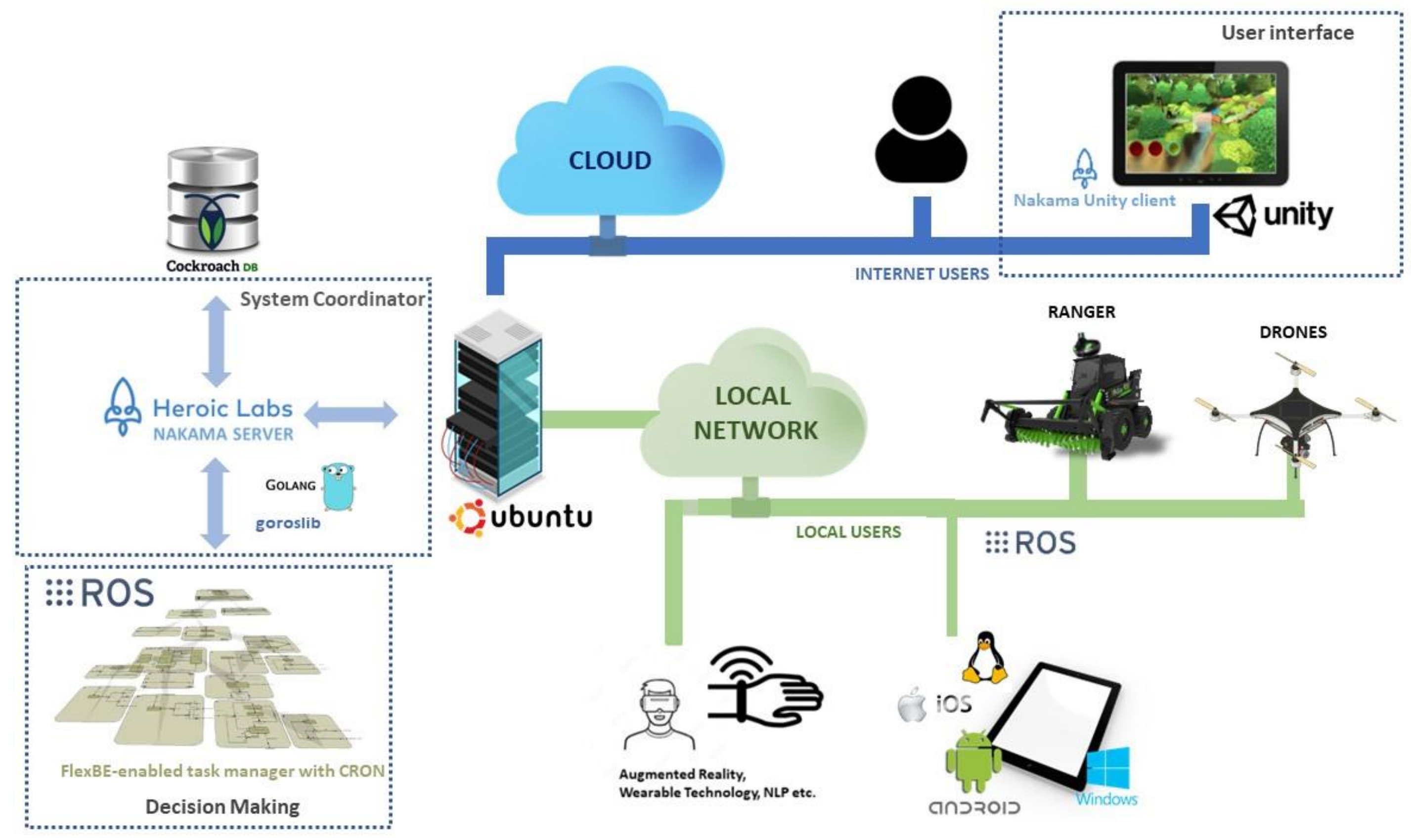


Conclusions

Based on the preliminary results, although at this stage, the proposed approach does not affect the tasks' performance individually, it certainly increases the level of consistent and stable system monitoring and interaction. As future work, our main goal is to go beyond the semi autonomous management system to proactive HRC. With this motivation our direction is to expand the presented architecture and include humans to the loop by achieving three proposed criterias.

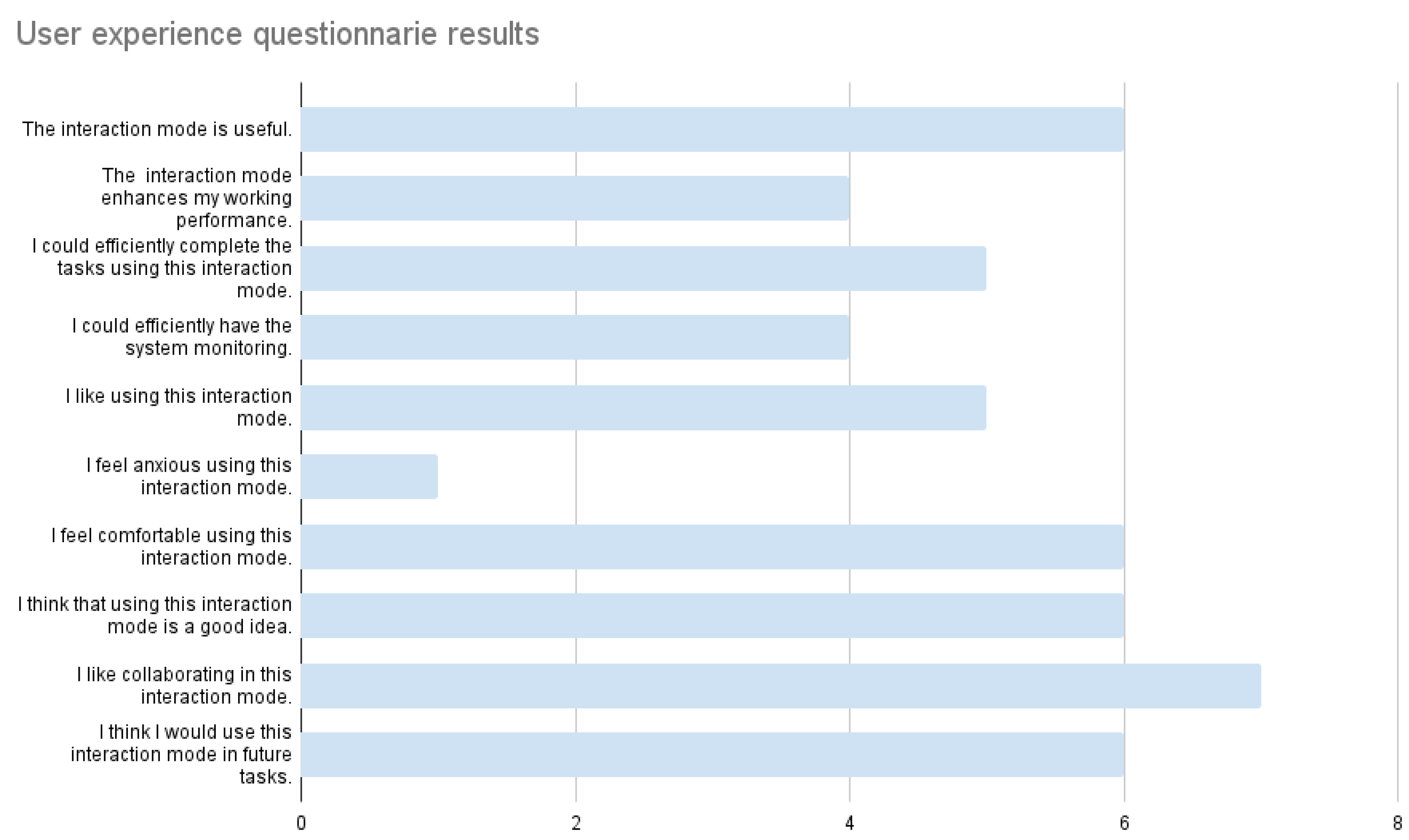
Current Architecture

As preliminary work, a game based gui was built to enable hri that comprises explicit commands from human to MRS and system monitoring, tested with the robots of Ingeniarius in solar panel maintenance use case. Besides, this work is an initial step to integrate the fog architecture into the system.



Results

The usability of the system has been evaluated by adopting an experimental setup in which the client from the manufacturing company of the robots who has the required knowledge and awareness of the solar panel installation, was asked to perform cleaning of solar panels via UI, enabling robots to perform all behavioural operations.



Acknowledgements

This work was partially funded by Fundação para a Ciência e a Tecnologia under the scope of the CMU Portugal and SAFEFOREST Project (CENTRO-01-0247-FEDER-045931)

Carnegie Mellon Portugal

fct Fundação para a Ciência e a Tecnologia

SAFEFOREST

INGENIARIUS