AI-MAS Group

Computer Science & Engineering Department

Adding context-awareness capabilities to assistive robots in Ambient Intelligence Scenarios

Coordinators **Nr. Students**

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1. Introduction

The domains of Ambient Intelligence (AmI) and Active and Assisted Living (AAL[1]) are seeing increasing interest and practical development at levels of both research and innovation.

In both domains, one of the central aspects is the interaction with the user and understanding of the situation in which the user is in (e.g. the location, the activity the user performs). All of this in the attempt to adapt different application behaviors according to user preferences and current *context*.

One of the newest, more interesting and researched modes of interacting with the user is through social assistive robots[2], especially in countries with a tradition in robot manufacturing[3].

The AI-MAS laboratory has been active in recent years in projects which seek to develop a platform for assistive robotics (SPARC[4]) and one for context information management in AmI and AAL applications (CONSERT[5]).

In a new project proposal, the main objective is to endow both assistive robots, as well as platforms for driving assistance (ADAS) with the ability to manage and reason about context information (e.g. the location of a user in the home, whether the user is alone or with company, whether the user is tired).
The complex-event processing[6] based reasoning engine developed in CONSERT takes a knowledge-driven approach (i.e. inference is crafted by human experts with a lot of domain knowledge, in a rule-based manner) to infer information about the current user context.
This leads to quick, easily understandable and *explainable* inferences which are critical in the robotics and driving assistance domains.

1AAL: http://aal-europe.eu
2 AAI Robotics: https://www.activeadvice.eu/news/concept-projects/potenziaal-insights-in-the-potential-of-robotics-in-the-aal-sector-a-study-of-ofai-railtec/
3 Robots for elderly care in Japan: https://www.reuters.com/article/us-japan-ageing-robots-widerimage/aging-japan-robots-may-have-role-in-future-of-elder-care-idUSKBN1H33AB
4 SPARC project: https://aimas.cs.pub.ro/sparc/
5 CONSERT project: https://aimas.cs.pub.ro/consert/
6 https://en.wikipedia.org/wiki/Complex_event_processing

However, the deployment method of the CONSERT platform is currently a web-based one, whereas in the robotics and automated driving domains, almost all of the available (open-source) applications run over a framework called ROS[7].

This work proposal aims to develop a new deployment type for the CONSERT platform which allows it to run over ROS, thus enabling context-aware application processing to various robots and driving automation systems (e.g. AutoWare[8], Apollo[9]).

2. Objective

The main objective of this work proposal is to develop a novel, ROS-based deployment means for the architecture and reasoning cycle of the CONSERT platform, in order to greatly facilitate context-aware processing of information in assistive robotics applications.
The work will be coupled with efforts from another AI-MAS lab proposal, seeking to enable management of health and home monitoring information of an elderly-care platform (CAMI[10]) by the Pepper robot.

Specifically, tasks in the proposal consider the following:

- **Milestone 1**
  - Understanding of the CONSERT information flow and deployment units
  - Design of a ROS-based architecture that accommodates the CONSERT Middleware processing units
  - Design and implementation of ROS message formats that encode both sensor content (e.g. presence detect, temperature of 24°C), as well as meta-information (e.g. temporal validity, certainty of measurement, provenance)
- **Milestone 2**
  - Implementation of ROS sensing nodes for home monitoring sensors such as: motion sensors, door-window switch sensors, temperature and luminosity sensors, etc
  - Implementation of ROS nodes that implement the coordination protocol existing between CONSERT sensing, inference and query units. Special care must be given to edge cases where inferred information violates integrity constraints (e.g. uniqueness properties such as the same person cannot be in two places at the same time) and means for conflict resolution
- **Milestone 3**
  - Integration and testing of the developed platform on the Pepper robot, using sensors and application scenarios from the CAMI project
  - Testing of the platform by development of knowledge-based inference rules for various recorded AmI scenario datasets

7 http://www.ros.org
8 https://autoware.ai
9 https://apollo.auto
10 CAMI project: http://camiproject.eu

3. Required and Learned Skills

Requirements:

- Good programming experience in Java, Python and/or C++
- Minimum 12h per week availability
- Love for software architecture design is a plus :-)
- Familiarity with rule-based systems is a plus
- Familiarity with ROS is a plus :-)

Skills learned:

- Experience working with sensor data streams
- Experience working with robotics frameworks
- Experience developing and testing knowledge driven inference mechanisms for recognizing Activities of Daily Living (ADL)
- Experience in software architecture design for complex and asynchronous data flow applications