Open-source Natural Language Processing on the PAL Robotics ARI Social Robot

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ABSTRACT

We demonstrate how state-of-art open-source tools for automatic speech recognition (`vosk`) and dialogue management (`rasa`) can be integrated on a social robotic platform (PAL Robotics' ARI robot) to provide rich verbal interactions.

Our open-source, ROS-based pipeline implements the *ROS4HRI* standard, and the demonstration specifically presents the details of the integration, in a way that will enable attendees to replicate it on their robots.

The demonstration takes place in the context of assistive robotics and robots for elderly care, two application domains with unique interaction challenges, for which, the ARI robot has been designed and extensively tested in real-world settings.

CCS CONCEPTS

• **Computer systems organization** → **Robotics**; • **Computing methodologies** → **Cognitive robotics**; **Natural language generation**; **Speech recognition**.

KEYWORDS

social robotics, speech recognition, natural language processing

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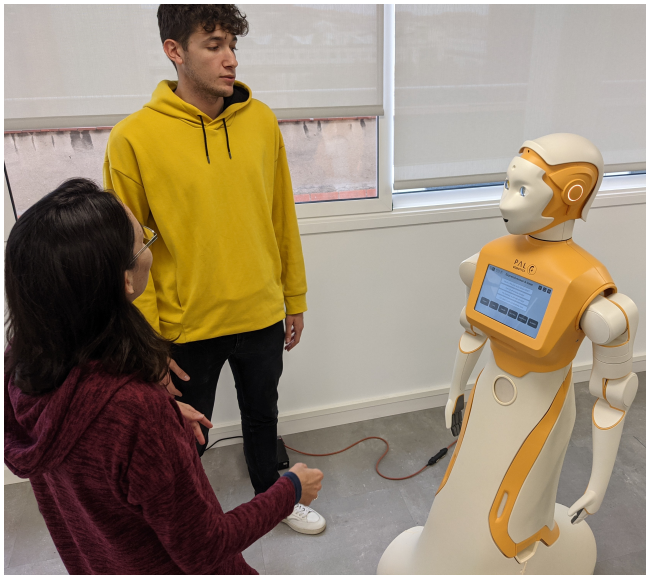

Figure 1: The ARI robot, interacting with two persons

1 INTRODUCTION: NOVELTY AND IMPORTANCE

ARI [1] is a social robotic platform, developed by PAL Robotics. It is designed as an anthropomorphic robot, with a focus on social interaction (Fig. 1). First launched in 2019, it has been deployed since in numerous research projects linked to social human-robot interaction, with a particular focus on elderly care and assistive robotics (projects H2020 SHAPES, H2020 SPRING, H2020 TALBOT, H2020 PRO-CARED).

While the robot was originally relying on cloud-based solutions for automatic speech recognition (ASR) and dialogue management (namely, Google Speech and Google DialogFlow), several issues were raised, including privacy issues (especially relevant within the European Union due to the strict data protection regulations), and the practical requirement of a working, good quality Internet connection.

In addition, the emergence of a new open-source standard for social signal processing and representation (*ROS4HRI*, [4]) created an opportunity for developing a novel open-source pipeline for natural language processing (NLP), focused on the integration with social robots.

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As a consequence, we decided to redesign our NLP pipeline, combining state-of-the-art off-the-shelf open-source software components with a new ROS-level *intent* system to ultimately offer standard-based multi-modal interaction capabilities on the robot.

The resulting system is a complete NLP pipeline for social robots, ROS-based, ROS4HRI-compliant and open-source. It is novel and highly relevant to any research group doing verbal human-robot interaction.

The demonstration will present this work on an actual ARI robot that will be brought to the conference, also presenting the unique challenges of assistive robotics and elderly care for NLP.

2 TECHNICAL OVERVIEW OF THE DEMONSTRATION

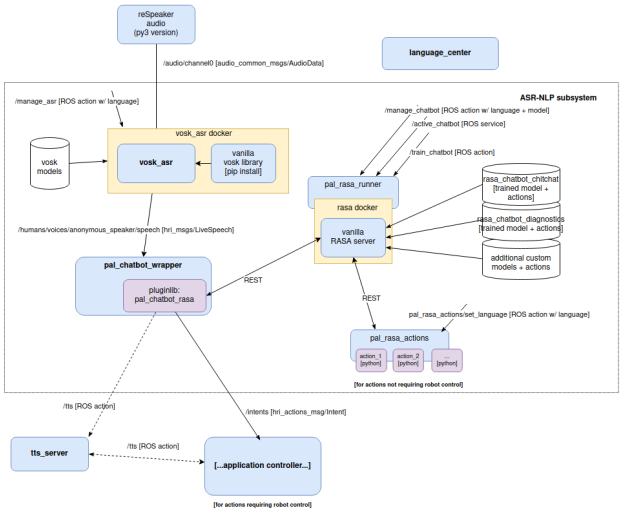

Figure 2: Overview of the NLP pipeline

Fig. 2 provides an overview of the NLP pipeline that we will demonstrate. It builds on the `vosk`[1] package for multi-lingual ASR, and on `rasa`[2] for dialogue management.

In addition to these two off-the-shelf system, our NLP pipeline includes (1) full compatibility for ROS (including the ROS4HRI [4] standard); (2) explicit management of internationalisation via a dedicated *language center* that manages both textual translations, and model swapping for ASR/TTS/dialogue management; (3) it introduces the concept of *user intents* (that are independent from the *chatbot intents* found in eg `rasa`): *user intents* embody user-initiated commands or desires, and allow decoupling the user intentions recognition nodes from the robot's application controller. This, in turn, opens up new opportunities for code sharing and reusability of robot controllers across platforms. Finally, we also integrate our NLP pipeline with our Knowledge Base & Reasoning framework, to allow reasoning on facts gathered through different modalities, such as vision. As such, the dialogue management can be easily enhanced with sensed events occurring around the robot in real-time.

[1]https://alphacephei.com
[2]https://rasa.com/

Figure 3: Deployement of the ARI robot in a daycare centre for older adults. The robot supports the work of the carer during exercising sessions.

During the demonstration, we will explain on the ARI robot how the speech pipeline processes raw audio into user intents, and how these intents are then used by the robot controller to generate social behaviours.

3 APPLICATION DOMAIN

While the demonstration itself will be focused on the technical implementation of the NLP pipeline, our research and final design has been strongly influenced by the requirements gathered from deploying the ARI platform in hospital and care centres (eg. Fig. 3 [2, 3]). We will also present during the demonstration a selection of videos created over the past year, showing real world deployments of the ARI robot in assistive scenarios, and how our verbal interaction pipeline addresses some of the needs of such applications.

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