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Context-based perception and understanding of human intentions

João Quintas
Instituto Pedro Nunes
Coimbra, Portugal
jquintas@ipn.pt

Paulo Menezes
University of Coimbra
Coimbra, Portugal
pm@deec.uc.pt

Jorge Dias
University of Coimbra
Coimbra, Portugal
Khalifa University
Abu Dhabi, UAE
jorge@deec.uc.pt

***Abstract*— This work focus in the importance of context awareness and intention understanding capabilities in modern robots when faced with different situations.**

The objective is to be capable of providing new features for robots, which enable new real-world applications, and extend their autonomy, in terms of self-management and cooperation with humans or other systems.

Gaze estimation and gesture interpretation are modalities, closely related with context-dependent human intention understanding, that are addressed in this work.

I. INTRODUCTION

Humans perception is heavily influenced by top-down predictions, making it more difficult to detect out-of-context objects than familiar ones [1]. Pevtzow and Goldstone [2] suggested that the categories a person has learned affects what features of an object he or she perceives. Context also impacts decision-making and action. Mellers and Cooke [3] reported preference measurements are also context-sensitive. Learning is affected by context, as studies as far back as those of Pavlov have demonstrated. Ferstl [4] studied context extensively in language use, usually with ”context” meaning the history of prior utterances, but also including other kinds of context. Holtgraves (1994) [5] has found that the status of the speaker relative to the hearer affects whether the literal meaning of an indirect request is activated.

In the last two decades several authors have proposed definitions for context and context-awareness systems for computing applications. Bill Shilit, et.al., in [6] presented context as the information about location, identity and environment. Turner in [7], presented a context-mediated behaviour framework for submarine autonomous robots. He related context to environment, mission-related and agent-related features, which influence agent's behaviour. Dey, et. al., [8] extended previous definitions to a more general concept, trying to overcome the subjectivity inherent to the use of examples.

Context is understood as the set of relevant information that can be used to characterize the situation of an entity, which is relevant to the behaviour to be performed. A context-awareness system is known to be a system that uses context to provide information and/or services according to what is expected, where relevance depends on the user's task.

The abstract architecture of context-aware systems in figure 1 presents a four layers framework [9]. At the bottom, the network layer involves the physical structure of the system, including communications support and the sensors for collecting low-level of context information. The middleware layer manages processes and store context information. The application layer provides users with appropriate service. Finally, the user infrastructure layer offer a suitable interface to users and other applications.

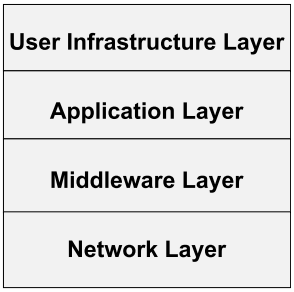

Fig. 1. Abstract layer architecture for Context-Awareness Systems

II. WORK IN PROGRESS

In human interaction, the contextual information can influence the understanding of personal intention. We can infer human intention by analysing specific types of features in a person's pose and combining them with the context to understand the whole situation [10].

Several perception modalities are often used in robotic systems in order to attain human-robot interaction, in particular in scenarios where understanding human intention is required. We are currently extending our previous work [10], which explores a context-based approach to influence the adaptation of the perception capabilities of the robot to its specific situation in order to improve its interaction features.

In the scope of this work, two components for human-robot interaction were implemented.

Gaze orientation is used to infer the person's visual attention. From the robot's point of view, knowing the user's gaze, can be used as an attention gauge. Gesture identification is used for detecting deictic and periodic gestures used in human-robot interaction, allowing the user to point directions, places, or objects (see figure 2).

The information provided by these two modules in inherently influenced by the location where the agents are, the environment surround them, their internal characteristics that

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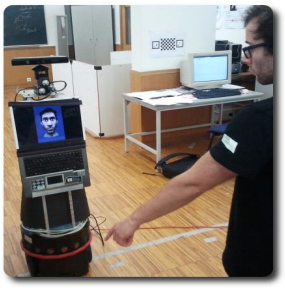
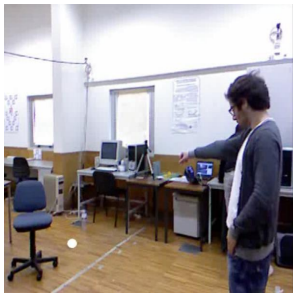


(a) Interacting with the Hilario robot



(b) Result of pointing gesture. The white point is the location where the gesture is directed.

Fig. 2. Context-based understanding of intention experiments: context-sensitive for periodic and deictic gestures and attention based on user gaze

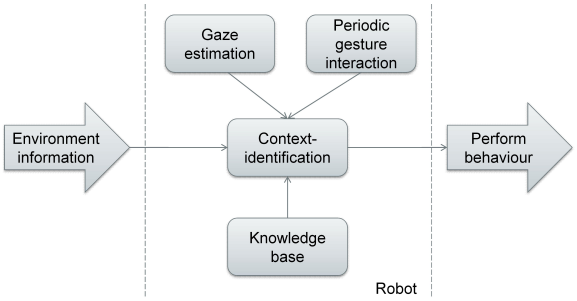


Fig. 3. Different components involved in context-aware intention understanding

are relevant for the situation, and the behaviour that both are trying to achieve.

Therefore, the gaze tracking and gesture identification are now being integrated with the context-aware module, which will be responsible to infer additional information about the user intention and contribute to adapt the robots behaviour accordingly to each situation.

In figure 3 they are depicted the current components and how they relate with the robot's perception and behaviour.

Gaze and gesture information are processed by the context-identification module, which maps inputs perceived with acquired knowledge in the knowledge base. A working example could be if a vague gaze occurs in a context that requires full attention from the user, the robot can adapt to this, changing it's operating mode to a more efficient strategy. The set of behaviours to be performed by the robot as gaze changes must be delimited by the context, thus acting as a filter to all the possible behaviours the robot could execute. For example, given the context of "attending to the door", if the user directs his gaze to the door the robot should behave as a butler, however if the context is "ask for help", pointing to the door should trigger an emergency procedure of calling for a first-responder

In the scope of this work an ontological representation for context is being formulated, which takes into consideration information regarding environment, mission and self-characteristics.

It is expected that this approach allow a flexible and

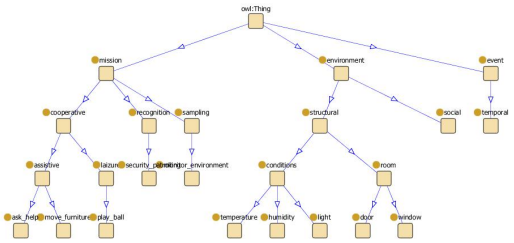


Fig. 4. Example of a possible context descriptor using an ontological representation

scalable knowledge base. These requirements are important in problems, which include complex and incomplete domains of information, that may need to change information classification and relationships at any point in time.

III. CONCLUSION AND FUTURE WORK

The paper considered the importance of addressing contextual information for intention understanding for modern robots. We proposed a possible methodology to address the problem of understanding the user intention, by means of context identification based not only on gaze tracking, but also on gesture analysis. We believe that these two mechanisms can provide important information for achieving the construction of a robot that can infer about user intention. This will be possible through a context-dependent interpretation of these two interaction cues.

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