EXTENDED-ABSTRACT

Designing Interaction for Multi-agent Cooperative System in an Office Environment

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Designing Interaction for Multi-agent Cooperative System in an Office Environment

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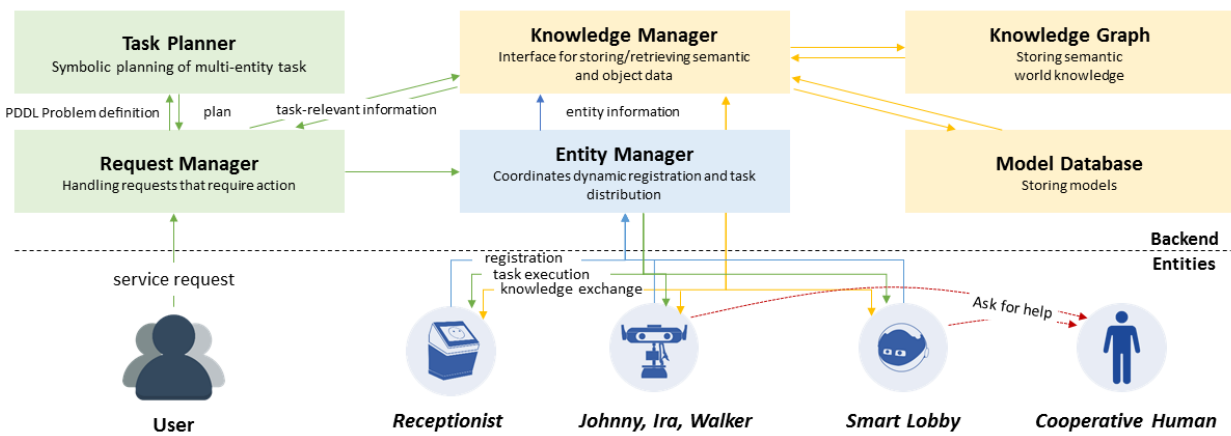

Figure 1 The system overview shows the backend parts and the entities. The green, yellow, and blue parts relate to planning, to storing and accessing the knowledge of the system, and to the registration of entities and the task distribution of created plans.

ABSTRACT

Future intelligent system will involve various artificial agents, including mobile robots, smart home infrastructure or personal devices, which share data and collaborate with each other to serve users. Designing efficient interactions which can support users to express needs to such intelligent environments, supervise the collaboration of different entities and evaluate the outcomes, will be challengeable. This paper presents the design and implementation of the human-machine interface of Intelligent Cyber-Physical system (ICPS), which is a multi-entity coordination system of robots and other smart agents in a workplace (Honda Research Institute). ICPS gathers sensory data from entities and receives users' inputs, then optimizes plans to utilize the capability of different entities to serve people.

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CCS CONCEPTS

•Human-centered computing~Interaction design~Empirical studies in interaction design

KEYWORDS

Robot; human-robot interaction; cooperative intelligence; multi-robot system

1 Introduction

Multi-robots concept was introduced in the early 2000s to improve the system's robustness and capabilities [1]. After 20 years of development, the current multi-robot system becomes more complex and consists of multiple artificial agents. Those agents can be very different in their form and functionality, such as mobile robots, static smart home infrastructure, or smartphones. One of the challenges for an intelligent system can be seamless interactions between artificial agents and human, which requires the system share concepts about existing objects and ongoing events in their environment [2][3]. Our work presents a human-machine interface with which is aimed at tackling the mentioned challenge. The interface design is based on a multi-robotic system called ICPS (Intelligent Cyber-Physical system), which is implemented in a typical office workspace. It consists of three kinds of entities: SmartLobby, which is a lobby equipped with cameras and other sensors, and touch screen tables; Johnny, Ira and Walker, three mobile robots that are able to move inside the office; and Receptionist, a stationary booth at the reception of the office, which is equipped with camera, microphone and a touch screen. These entities are coordinated by ICPS to perform certain tasks, such as fetching objects, searching for persons or guiding guests to specific locations. Through Multi-model interaction methods, e.g. graphical interfaces, speech interaction, gestures and facial expressions, ICPS is able to receive requests from users, provide feedback about the progress and execute the task efficiently.

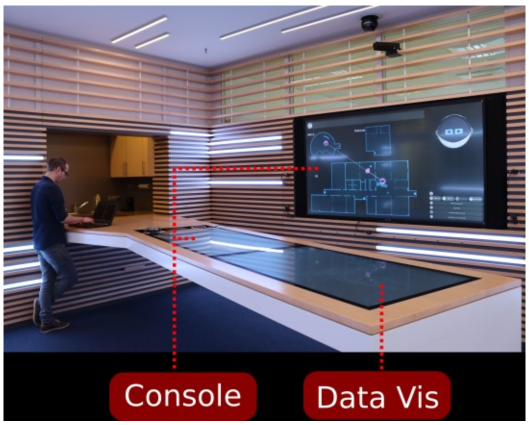

Figure 2 SmartLobby entity. The console interface and data visualization are displayed on the three screens.

2 System Design of ICPS

Figure 1 provides an overview of the components of the presented system. It is implemented as a centralized architecture including a backend and the entities that it controls. The term entity in this context is not restricted to robots, but also includes smart infrastructure, such as the depicted SmartLobby. Entities themselves do not communicate among each other, but only with two backend components. Firstly, the Entity Manager, which allows entities to register at the system and for the backend to assume control of them. Secondly, the Knowledge Manager, which coordinates the storage of sensory information received from the entities and allows other components to query this information via a common interface. The subsequent section provides more details on the interface design of different entities.

3 Entities and Interfaces

3.1 SmartLobby

SmartLobby is a lobby space equipped with various sensors, e.g. Kinect cameras and microphone array, which can detect faces and locations of people in the room (Figure 2). Smartlobby has the capabilities of receiving command and informing people about the progress of the current task.

3.2 Receptionist

The ICPS includes a stationary computer showing a virtual receptionist (similar to the 3D virtual avatar as in the SmartLobby). The stationary computer is equipped with touchscreen, camera, microphones and it is used for registering new visitors to the system (Figure 3 left). After the registration process, visitor's information (name, face recognition model …) are stored in the ICPS backend knowledge representation.

Figure 3 Left: Receptionist entity used a virtual avatar robot to interact with humans. Right: Mobile Robot Johnny.

3.3 Mobile Robots

We are using mobile robots which equipped with Kinect cameras mounted on a pan-tilt-unit for moving the head (Figure 3 right). The cameras are encased in a 3D-printed robot head. Laser scanners in the front and rear allow the robots to localize themselves in the room and Kinova JACO2 arms enable the robots to transport objects. These robots have the capabilities of "moving to a specific location", "fetching an object" and "informing person" etc. They are equipped with sensors measuring their own pose and recognizing persons in 3 meters.

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