Whispering Knowledge with Shapes: Robotic Tutoring for Path-Finding in Building Environments.

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Abstract—In this work, we introduce the concept of a robot-based interface, in which each robot (swarm robots) realizes a single reconfigurable physical pixel. The general idea is to use the physical pixels as a means to display information directly in place and in the context of the user, who is exploring the environment, by giving the right information at the right time. Each robot is a semi-autonomous mobile self-reconfigurable interface, augmented with a small screen of colored smart material that changes color according to the position and the role of the single robot. The swarm represents the information itself, displaying the desired shape such as an arrow.

I. INTRODUCTION

Nowadays buildings are complicated mazes. Finding an office, a specific place or a person is a non trivial problem. Giving the user appropriate personalized information is a critical task. The information should be immediate, easy to read, personalized for the user and localized in the belonging ambient. Different solutions have been given, such as a mobile guide for a museum, localized interactive monitors or embedded blinking leds, which mimic the movement toward a direction to change the users’ behavior[1]. However, none of these solutions personalize the information and adapt the information to the place and the context, forcing the user to carry radio-frequency identification tags or other uncomfortable technology (such as marking hats). By using the Kinect and by placing robots on site we can assure that the user can interact transparently with the system.

II. THE SYSTEM

The system is designed as a transparent interface, the user identifies himself at a checkpoint, e.g., the helpdesk of the main hall, just by declaring his own intention, e.g., “I need to reach Mr. Minuto’s office”. The helpdesk indicates the general direction and the user moves toward the specified direction. At the first crossing, the user is attracted by the swarm robots that assume the configuration of an arrow, which moves toward the correct location according to the user’s request, as shown in Fig.1. After that, the robots reconfigure in idle position to wait for the next user. To build the interface two main components are required: the tracking system and the swarm robots display.

A. The Tracking System

The tracking system tracks the identities and feeds the necessary information into the physical display, such as the target user (and relative shape and direction to assume) and the obstacles that can appear on the path (e.g., other users).

A Kinect-based tracking system is being developed to be able to address and track all the users in its sight. The idea is to have a system that is able to track identities from a classical blob tracker. When a user is addressed in one of the checkpoints, an identification number is attached to the blob and tracked during the journey. When the user is lost, there are three possibilities:

- the user is out of sight, i.e., lost.
- the blob has merged with someone else’s blob. We aggregate the information in “AND” until the system is able to address the blobs again.
- the blob has split in two or more parts. The information of the old blob are inherited in a doubt condition, i.e. an “OR” mode, on the generated blob.

The system has some limitations and can be used only in a controlled environment. Moreover, the system is modular so that it will be further developed with other features tracked.

B. The Physical Display (swarm robots display)

The swarm of robots is augmented with a smart material screen on the top (thermochromic or photochromic color, allowing the material to carry the information as explained in[2]) waiting to be activated when the user can see it. The swarm acts to maintain the formation in front of or near the user (following the system coordinates) and, in the case of obstacle detection, it reconfigures when the obstacle is removed. The color display helps the user to understand the information directly and the programmable colors allow the creation of animations to attract and address the user better, by keeping the user looking and feeling the physical device.

REFERENCES