Smart Space-Based Lego® Mindstorms EV3 Robots Interaction

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***Abstract*—Nowadays cyber-physical environments are spreading wide all over the world. There are many systems such as "smart home", "smart car", "smart city", which are based on the real time interaction between physical world and cyber world. One of the examples of cyber-physical system is a "smart home" devices interaction for home cleaning. For example, there are two robotic vacuum cleaner in the house. Before the cleaning they creating a map of dirtying and split the house to the two parts based on the nearest dirty points. The other example is a situation when vacuum cleaner finds a hindrance, for example big toy or chair. It shares information about the situation through the smart space and manipulating robots should decide which of them would go to remove the hindrance.**

The demo provides interaction model of devices in smart space. These devices are robot cars based on the Lego® Mindstorms EV3 constructing kit with ultrasonic and gyroscope sensors (Fig. 1). Each car is driven by two independent large motors and controlled by control block with LeJOS installed on the SD-card. WiFi USB-adapter provides local area network connection. For the control block the LeJOS has been chosen because it is provide full functionality OS with JRE Environment. Robots shares information through the Smart-M3-based smart space via using the Java KPICore library.

After the start command receiving from the smart space, each car rotate at 360 degrees and fetch information about turn angle and distance from the gyroscopic and ultrasonic sensors correspondingly (action "1" on Fig.1). This information stores for the future processing to separate found objects. The separation algorithm discerns objects by analyzing difference between neighbor distances. All found objects are sorted by the average distance and shared through the smart space. Each robot has subscription to new objects that are appearing in the smart space. When the objects from the other robot appear, they are queried by listening robot and comparing with existing set of its objects. The values equality means that robots find each other and these values should be excluded from the set. If there are more than two equalities, robots should move toward one of the equal objects and repeat the area scanning. When robots find each other, they can detect the object and select the nearest robot. This robot turns to the angle the object is located in and moves to the object (action "2" on Fig.1).

Additionally the demo provides an Android-Based application for robot control through the smart space (Fig. 2). This application allows starting and ending robot moving, changing direction of moving (forward or backward) and turning around for object searching as well as showing the state of each robot. Robot shares each action throug the smart space. These actions are: moving forward or backward, turning to the right or to the left, scanning area, objects discerning, information sharing and making a decision. Two nearest objects are showing ih the corresponding fields.

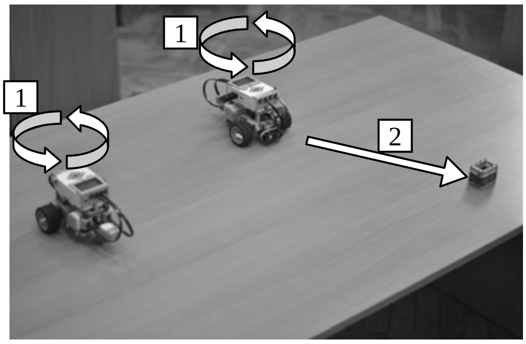

Fig. 1. Interaction model implementation

Fig. 2. Android application for robot control