A few notes on Bluetooth and Wi-Fi with LeJOS and EV3

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This short note gives an overview of how we use these networking technologies in the course. For more details and examples, refer to the moodle pages.

1 Introduction

The EV3 and LeJOS supports both Bluetooth and Wi-Fi; the first one is built-in and the second one needs a Wi-Fi dongle, that you can get from your teachers of you want to work with it. We have used Wi-Fi already for uploading programs to the EV3 and have them executed. What is perhaps more interesting is that we can access these technologies from programs running on EV3 and other devices to establish communications between different devices.

Everyone has some idea of what these two technologies are and what they are used for. For historical background and technical overview, we refer to two quite good Wikipedia articles:

- `https://en.wikipedia.org/wiki/Bluetooth`

- `https://en.wikipedia.org/wiki/Wi-Fi`

2 How to ...

To use Bluetooth, we need to establish a PAN, Personal Area Network, between the involved devices, and for Wi-Fi, we need to connect each device to a WLAN, Wireless Local Area Network. For Wi-Fi, this requires an additional device, namely a router which is can be a separate device or a suitable smartphone.

Chapters 12–14 in Bagnall's book "Maximum ..." gives an overview of how we can use the two technologies with EV3 and LeJOS. Lucklily, when the relevant network connections have been established, they look more or less the same seen from the programmer's point of view.

However, you should be aware that getting anything to work, may require a lot of trial-and-error experiments, reading of LeJOS' and Java's APIs, and searching for example code on the Internet.

3 Applications

3.1 EV3 ↔ Computer

This can be used for, e.g.,

- The computer controls the robot, which means that the computer is running a program that decides the steps that the robot should and sends this as commands to the robot. The robot's program is then an interpreter for these command. This may be combined with the robot taking care of elementary behaviours such as keeping the balance or avoiding minor obstacles, which means that the computer can take care of overall strategic decisions.

  Depending on the "level" of control, the robot may send raw sensor data back to the computer or overall summaries of its investigation. (E.g., a Mars rover: "Hey Earth, I found ample resources fresh water!!")

- The computer controls several robots, combining the different reports from the robots and in tirn coordinates their efforts in an overall plan.

- The EV3 may use the larger computer for various external resources that do not fit into the EV3, e.g., large databases.

- Using external systems for navigation and localization. Qualisys Motion Capture System is an excellent system for this, and RUC has a small lab with a set-up of such equipment. It uses a set of infrared light sources and infrared cameras, and when you attach some special reflectors (typically three) to you robot, the system can give you a very precise measurement of the robot's pose (i.e., position plus direction). The system can handle several robots at a time – just mount the reflectors in sligtly different patterns on each robot, so the system cab see a difference.

  To use this together with your EV3 robot, you may have software running on the computer and allow the robot to send a request any time "where am I?"

Most demonstrations of indoor flying drones flying in formations have been made using Qualisys Motion Capture System. *A good idea for the mini project – although only recommended for students who have lots of programming experience.*

3.2 EV3 ↔ EV3

- Two or more EV3's may coordinate their effort exchanging messages about what the sense and which subtasks they believe to have accomplished.

- Two or more EV3's may be part of the same physical robot. This can be a way of using more motors and sensors than what is possible with a single EV3, which has only 4+4 ports. It may also be used to obtain more computational power in the robot.

3.3 EV3 ↔ Arduino

- Another way of getting more sensors and actuators, especially such that are not supported by LeJOS and-or can be hand tailored with Arduino.