Networked and Cooperating Robots for Urban Hygiene:

the EU funded DustBot Project

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Abstract - The DustBot project is aimed at designing, developing, testing and demonstrating a system for improving the management of urban hygiene based on a network of autonomous and cooperating robots, embedded in an Ambient Intelligence (AmI) infrastructure. In the final scenario, the robots will be able to operate in partially unstructured environments (such as squares, streets, parks, etc.) and to sweep them from rubbish and dirt. They will be able to transport small quantities of home garbage, collected on demand from citizens, at their doors. By using preloaded information on the environment (e.g. area maps) and inputs from on-board and external sensory systems, and by taking advantage of the benefits provided by the Ambient Intelligence platform, the robots will move with a proper (and selectable) level of autonomy to carry out their tasks. Two kinds of robots have been designed and they are under development: the cleaning robot (DustClean) and the citizen-friendly robot for garbage collection (DustCart). The cleaning robot is equipped with cleaning tools and with multiple sensors for monitoring atmospheric pollutants, giving information on the environmental quality in real time. The DustCart robot is equipped with the cart for bin-liner transport and discharge and with the user interface aimed at providing selected information about air quality and waste management to different users.

Keywords - Service robotics, ambient intelligence, streets cleaning, door-to-door garbage collection.

1. Introduction

The use of robots in complex real environments creates demands for Ambient Intelligence (AmI) infrastructure including distributed (Wireless) Sensor Networks (WSN) supporting the deployment of in-field robots, providing information and guiding actions. In effect, the integration of autonomous robots with distributed sensor and actuator networks can improve the system making possible the achievement of new functionalities, extending the capability of the robots in term of environment perception and interaction; this vision has being denominated ''Network Robot Systems'' (NRS) [1].

A good example of this kind of integration is provided by the DustBot system. The DustBot project [2] is aimed at designing, developing, testing and demonstrating a system for improving the management of urban hygiene based on a network of autonomous and cooperating robots, embedded in an Ambient Intelligence infrastructure. The system under development consists of a number of autonomous robots working in a real urban environment, providing services for the urban hygiene (cleaning and removing rubbish from the ground), monitoring some dangerous urban pollutants (e.g. CO, NO_X, SO_2, O_3, Particulate Matter -PM-10, etc.), and offering a friendly interaction with people present in the operative area. In particular, two kinds of robots have been designed and they are under development: the cleaning robot (DustClean), equipped with cleaning tools and with multiple sensors for monitoring atmospheric pollutants, and the citizen-friendly robot for garbage collection (DustCart), equipped with the cart for bin-liner transport and discharge and with the user interface aimed at providing selected information about air quality and waste management to different users.

The urban environment is "structured" by using numerous wireless network nodes, which have the double functionality of collecting information on the environment and, as a beacon, of providing a framework for the orientation of robots in the environment.

This paper intends to provide an overview of the DustBot system, including the motivation, the applicative scenario and the state of development.

1.1 Motivations

Municipal solid waste management has become a critical issue in urban cities of developed countries. As pointed out by [3] a rising quality of life and high rates of resource consumption patterns have had a unintended and negative impact on the urban environment - generation of wastes far beyond the handling capacities of urban governments and agencies.

In order to tackle the waste problem, the European Union has set up a framework (i.e. the 6th EAP) for environmental policy-making [4].

The European Union's approach to waste management is based on three principles:

1. Waste prevention, which consists of reducing the production of waste by improving manufacturing methods and influencing consumers behavior.

2. Recycling and reuse of waste material such as packaging, batteries, and electrical and electronic waste.

3. And lastly, improving final disposal and monitoring, which means using incineration and landfill only as a last