

Project acronym: DustBot

Project full title: Networked and Cooperating Robots for Urban Hygiene

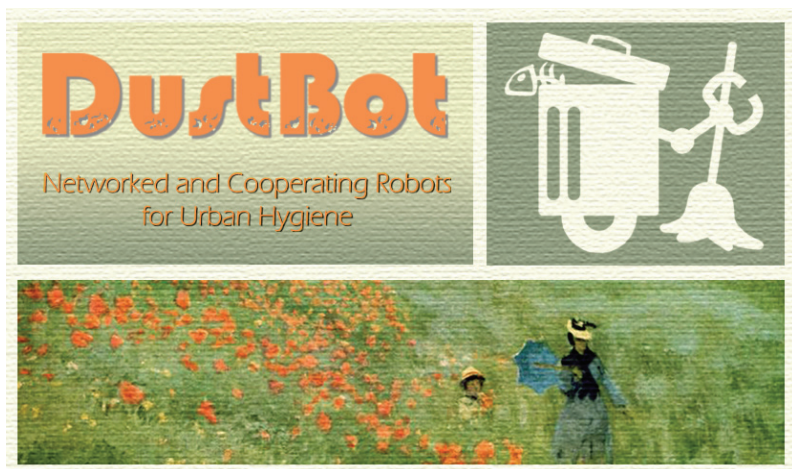
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Table of contents

1	Introduction	3
2	DustBot Dissemination and IPR	4
3	Dissemination through the project Web site	6
4	Scientific Publications	8
5	Intellectual Property Rights (IPR)	9
6	Press Releases	10
7	Presentations	11
8	Contacts to other EU projects	14
9	Plans for Exploitation	15
9.1	<i>Preliminary Analysis of DustClean Market Dimension</i>	<i>15</i>
9.2	<i>Regulatory constraints and rules.....</i>	<i>18</i>
9.3	<i>Opportunities for technology transfer and spin-out activities</i>	<i>20</i>

1 Introduction

This document is the deliverable D15 of the DustBot project, the "Report on Dissemination Plans". It reports planned and already performed activities for dissemination of the knowledge from the DustBot project.

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 infrastructure.

2 DustBot Dissemination and IPR

The dissemination activities aim at the transfer of knowledge coming from DustBot results. They will be performed in strict relation with all the technical activities, addressing the promotion of knowledge and awareness regarding Robotics, ICT and AmI solutions for the urban environment management. All partners contribute to the dissemination activities according to plans set-up within the project.

Dissemination of knowledge is and will be addressed both at scientific level and at public arenas. Public media and events are used to inform the open community. European policy makers, scientists, commercial users, public health services, are addressed with the information on global solutions for urban management applications, while industrial robotics and ICT players are addressed with the most relevant technical and viable outcomes. The most relevant scientific and technical results achieved within DustBot are published in international refereed Journals of the different fields addressed.

A detailed procedure was defined by the Intellectual Property Rights (IPR) Committee and this procedure has to be followed by the partners before submitting a paper to Scientific Journals and Conferences in order to raise awareness of Intellectual Property issues and to provide any relevant information to the partners in the case of Intellectual Property queries or concerns.

Specific activities for dissemination of DustBot knowledge are:

- SubTask 9.1.1: Participation in the most important conferences regarding the fields of DustBot interest, in order to promote and present the objectives and results achieved within the project (IEEE ICRA, IEEE IROS, IEEE/EMBS BIOROB, EUROSENSORS, IEEE SENSORS, etc.).



- Organisation of and participation in workshops and open days in order to meet DustBot technological partners and end users.
- SubTask 9.1.2: Organisation of a concertation meeting to enable exchange and discussion among the IST-Advanced Robotics funded projects. The focus of this meeting was on common technologies and challenges across projects, supporting creation of synergies, and avoiding duplication of work.
- SubTask 9.1.3: Preparation of scientific publications, press briefings and press releases.
- SubTask 9.1.4: Participation in working groups of the EU robotics networks and Technology Platforms (e.g. EURON, EUROP).
- SubTask 9.1.5: Dissemination through a public project Website and project brochures.
- SubTask 9.1.6: Preparation of a DustBot newsletter.
- SubTask 9.1.7: Dissemination of knowledge in industrial forums (Robotics, ICT, and Environmental Communities, etc.).

3 Dissemination through the project Web site

The DustBot Web site has been set up and published on 20 December 2006 at www.dustbot.org. On June 20, approx. 18 months after it was established, the DustBot Web site had 12800 hits.

The home page of the official project Web site contains the following information of public interest (see Figure 1):

- The project information.
- A description of the main objectives of the project.
- A brief description of the partnership.
- The presentation of news related to the project.
- A brochure of the project and some copies of press releases, available under the section Dissemination.
- A section dedicated to the Users' Club.



Fig. 1 – The home page of the DustBot project

Recent updates of the Website mainly include updates of the dissemination section with:

- “Report on the state of the art analysis on navigation and obstacle avoidance methodologies”
- “Report on Dissemination Plans”
- New press releases
- New publications in the section results

4 Scientific Publications

This section reports the dissemination activities performed by the consortium in terms of works sent to International Conferences and Scientific Journals focused on the DustBot objectives and activities in the period December 2007 – May 2008. In particular, Table 1 reports a list of publications drawn up by the DustBot partners and sent to Conferences and Journals.

Title	Authors and Affiliations	Conferences and Journals
<i>Better Than Nothing Mobile IPv4 Fast Handovers</i>	<i>A. Doswald and S. Robert (HEIG-VD)</i>	<i>To be presented at the 72nd IETF Meeting in Dublin – 27th July 2008 to 1st August 2008</i>
<i>Towards Environmental Monitoring with Mobile Robots.</i>	<i>Marco Trincavelli, Matteo Reggente, Silvia Coradeschi, Hiroshi Ishida, Amy Loutfi and Achim J. Lilienthal</i>	<i>Proc. of IROS 2008, to appear</i>
<i>Gas Distribution Modeling Using Sparse Gaussian Process Mixture Models</i>	<i>Cyril Stachnis, Christian Plagemann, Achim J. Lilienthal and Wolfram Burgard</i>	<i>Proceedings of Robotics: Science and Systems (RSS), 2008, to appear</i>
<i>Gas Distribution Mapping of Multiple Odour Sources using a Mobile Robot</i>	<i>Amy Loutfi, Silvia Coradeschi, Achim J. Lilienthal and Javier Gonzalez</i>	<i>Robotica, to appear</i>

Table 1 – DustBot papers

5 Intellectual Property Rights (IPR)

A detailed procedure on Intellectual Property Rights (IPR) was been defined by the Project Coordinator and by the IPR responsible (Synopsis). This procedure declares the steps to be followed by the partners before submission of a paper to a scientific journals or a conference or in case of a patents' release, in order to raise awareness of Intellectual Property issues and to provide any relevant information to the partners in the case of Intellectual Property queries or concerns.

Together with the submission of a conference paper, the paper has to be uploaded by the author into the IPR folder on the internal pages of the DustBot Web site. This triggers an e-mail that is sent to the responsible persons which then can raise IPR issues. In case of a conflict, the authors have to withdraw the paper.

In the case of a journal paper, the paper draft has to be uploaded by the author into the IPR folder 15 days prior to the submission. Again, the DustBot partners are automatically informed about the submission by e-mail. They can then raise IPR issues during this period and if there are IPR issues, the authors have to withdraw the paper. The same procedure is applied in the case of patents.

A description of the procedure is downloadable from the Folder IPR, included in the DustBot members' area.

6 Press Releases

Articles published on newspapers and bulletin during the reporting period are listed below in descending chronological order:

- Neue Luzerner Zeitung “Erfunden: Roboter und Ameisen-Zebra” (09/04/2008)
- Focus/rifiuti “Robot made in Pisa per la raccolta dei rifiuti” (February 2008)
- L'Espresso “Addio Spazzino, arriva il robot” (28/02/2008)
- Il Tirreno (Pontedera) “La spazzatura viene a prenderla sotto casa il robot del Sant'Anna” (30/01/2008)
- La Nazione (Pontedera) “Prima passeggiata del robot spazzino” (30/01/2008)
- L'Unità Firenze “Già in strada il robot spazzino” (30/01/2008)
- Il Sole 24 Ore “In azione a Pontedera il robot spazzino” (30/01/2008)

7 Presentations

Dissemination presentations and lectures at scientific and educational organizations will be held throughout the project lifetime. The following presentations are planned for the near future.

- Invited guest lecture on "Airborne Chemical Sensing with Mobile Robots" by the University of Malaga, (Spring 2008; Speaker: Achim Lilienthal, ORU).
- Invited lecture on "Gas Distribution Modeling with Autonomous Sensor Networks" at Delft University of Technology within the symposium "Safety First: Dealing with Disasters" (Delft, Netherlands, March 13, 2008; Speaker: Achim Lilienthal, ORU).

A preliminary list of future events and conferences expected in 2008 and interesting for the DustBot Consortium are reported in the following table.

Future interesting events
The Seventh International Conference on Machine Learning and Applications (ICMLA 2008), December 11-13, 2008 – San Diego, CA, USA which has a special session "From Biological Intelligence to Machine Intelligence: Abstraction, Evaluation, and Validation of Algorithm for Olfactory-Based Navigation"
See: http://www.icmla-conference.org/icmla08/CFP_SpecialSession1.html
IEEE/RSJ 2008 International Conference on Intelligent Robots and Systems. September, 22-26, 2008, Nice, France

Table 2 – List of events and conferences interesting for DustBot

The project objectives and preliminary results obtained have been presented in the events listed in descending chronological order below. Speaker, time and place of the presentation are indicated in brackets.



- Presentation of the paper “Gas Distribution Modeling Using Sparse Gaussian Process Mixture Models” at the Robotics: Science and Systems conference in Zürich, 27 June 2008 by Cyril Stachnis (the paper was joint work of Achim J. Lilienthal together with Wolfram Burgard, Christian Plagemann und Cyril Stachnis).
- Demonstration/presentation of DustBot and of the DustCart functionalities in Rovereto (TN), Italy, during a technological forum, called “the Discovery on Film VIII MOSTRA DEL FILM SCIENTIFICO E TECNOLOGICO Museo Civico di Rovereto e Sperimentarea”, May 29-30, 2008.
- Presentation of the DustBot Project and DustCart during the registration of the television program “SuperQuark”, May 16, 2008. The program will be transmitted on the National television “RaiUno” on July 10.
- Presentation of the AASS Learning Systems Lab by Achim J. Lilienthal with special focus on the DustBot project, Malaga, 22 April 2008.
- Presentation of the AASS Learning Systems Lab by Achim J. Lilienthal with special focus on the DustBot project, Malaga, 22 April 2008.
- Presentation of the DustBot project to the “Sino-German-Italian HI-tech Forum on Environmental Monitoring Microsystems” by Prof. Dario in Chongqing (China), 19 April 2008.
- Invited lecture on “Gas distribution modelling with autonomous sensor” by Achim J. Lilienthal at the symposium “Safety First: Dealing with Disasters”, Delft University, 13 March 2008.
- Presentation of the paper “A System Architecture Supporting Mobile Applications in Disconnected Sensor Networks” by D. Tacconi at the IEEE Globecom conference in Washington DC, USA, 26 November 2007.



The DustBot project was further presented to companies such as Toyota Europe, STMicroelectronics, Electronics Telecommunications Research Institute (ETRI) and SK Telecom from Korea, Karcher GmbH from Germany, etc.

Finally, the DustBot objectives and the obtained results of the project have been presented and discussed with academic Institutions (e.g. Chemnitz University of Technology from Germany, Ministry of Science and Technology (MOST) and University of Chongqing from China, etc.).



8 Contacts to other EU projects

HWC is going to establish contacts and a possible collaboration/exchange of information, with another project ("Message") that has objectives similar to those developed in the WP5. In particular, the project will develop and demonstrate the potential of diverse, low cost sensors to provide data for the planning, management and control of the environmental impacts of transport activity at urban, regional and national level. This includes their implementation on vehicles and people to act as mobile, real-time environmental probes, sensing transport and non-transport related pollutants and hazards.

9 Plans for Exploitation

Exploitation activities aim at defining the plans for the exploitation of the results of the DustBot project and in particular the plans for the industrialization and commercialization of DustCart and DustClean robots.

This activity is pursued by carrying out a market analysis, expected at month 22, as activity of task *Task 9.2.1 - Market and Cost-Benefit Analysis* and by establishing agreements with potential exploitation partners as part of the activity of Task 9.2.2 - *Identification of opportunities for technology transfer and spin-out activities*.

A preliminary analysis has been presented in Deliverable D11 "Plan for Using and Disseminating Knowledge". Additional details are reported below.

9.1 Preliminary Analysis of DustClean Market Dimension

A preliminary analysis on the dimension of the European market of DustClean has been made.

In this analysis an estimate of the market for the Tuscany region has been made and the numbers estimated have been extended to Europe according to demographical data.

For what concerns the analysis in Tuscany, only cities with a population of at least 10.000 inhabitants were considered. In Tuscany the cities with more than 10.000 inhabitants are 63.

Tuscany: Major cities (>10.000 inhabitants)= 63

Cities have been divided into three segments according to number of inhabitants as reported in the following table.



Segment	Populations	Number
Segment A	Chief towns	10
Segment B	>20.000	27
Segment C	10.000-20.000	26

Table 3 - Segmentation of cities according to population in Tuscany

An estimate of the pedestrian areas has been made on the bases of data reported on a document released by Legambiente in 2007, which estimate the average extension of pedestrian area in relation to inhabitants:

Pedestrian area average extension: 0.3 m² per inhabitant

This data allow to estimate the dimension of pedestrian areas of the cities as reported in the following table:

Segment	Populations	Pedestrian area
Segment A	Chief towns	30.000 m ²
Segment B	>20.000	6.500 m ²
Segment C	10.000-20.000	3.000 m ²

Table 4 - Estimation of the dimension of pedestrian area in Tuscany

According to DustClean specifications the system is designed to clean an area of 3.000 m² area, thus the number of robots that could be installed in a city according to its population are reported in the following table.

Segment	Populations	Number of Robot
Segment A	Chief towns	10 units
Segment B	>20.000	2 units
Segment C	10.000-20.000	1 unit

Table 5 - Estimation of the number of robots for city

By considering the number of cities in Tuscany reported in Table 3 and the number of robot for city reported in Table 5 we can estimate the number of robots for Tuscany, as reported in Table 6. The total number is:

Segment	Populations	Number of Robot
Segment A	Chief towns	100 units
Segment B	>20.000	54 units
Segment C	10.000-20.000	26 units

Table 6 - Estimation of the number of robots for Tuscany

These data have been extended to Europe considering that

Tuscany inhabitants are 6% of Italy inhabitants

Italy inhabitants are 12% of EU inhabitants

Thus we can estimate the number of robot for Europe as reported in Table 7.

Segment	Populations	Number of Robot
Segment A	Chief towns	13000 units
Segment B	>20.000	7500 units
Segment C	10.000-20.000	3600 units

Table 7 - Estimation of the number of robots for Europe

For a total of 24.100 robot in Europe.



9.2 Regulatory constraints and rules

A crucial point for a successful exploitation of the DustBot project results and for an effective deployment of DustBot robots in the urban environment are the regulation and rules for the safety and use of the systems. These regulations include both the following aspects:

- EU Directive concerning health and safety requirements for designing and using machine;
- rules for the deployment of robots in urban environment, i.e. regulations for robots that make use of public roads and share roads with other road users.

The former point has been deeply considered in the past and actually two main EU Directives concerning health and safety requirements for designing and using machines exist:

- Machinery Directive 98/37/EC
- Low Voltage Directive (LVD) 2006/95/EC or 73/23/EEC

Machinery Directive 98/37/EC

The Machine Directive 98/37/EC applies to machinery and provides the essential health and safety requirements in a general way for the design and use of industrial machines including robotics systems.

For the purposes of this Directive, "machinery" means an assembly of linked parts or components, at least one of which moves, with the appropriate actuators, control and power circuits, etc., joined together for a specific application, in particular for the processing, treatment, moving or packaging of a material.

The following are excluded from the scope of the Directive:

- machinery whose only power source is directly applied manual effort;
- machinery for medical use used in direct contact with patients;



- means of transport, i.e. vehicles and their trailers intended solely for transporting passengers by air or on road, rail or water networks;
- agricultural and forestry tractors;
- machines specially designed and constructed for military or police purposes.

The Machine Directive 98/37/EC is mainly defined for and applied to industrial robots, and thus it is outside of the scope of DustBot. Nevertheless, it is the only existing Directive that could be applied to the design and use of the DustBot robots.

Low Voltage Directive (LVD) 2006/95/EC or 73/23/EEC

The Low Voltage Directive (LVD) 2006/95/EC or 73/23/EEC applies mainly to electrical equipment and provides the essential health and safety requirements in a general way for these devices.

This Directive covers electrical equipment designed for use with a voltage rating of between 50 and 1000 V for alternating current and between 75 and 1500 V for direct current.

Broadly, the Directive covers consumer and capital goods designed to operate within those voltage limits, including in particular electrical appliances, lighting equipment including ballasts, switch gear and control gear, electric motors and alternators, electrical wiring, appliance couplers and cord sets, electrical installation equipment, etc.

The Directive covers all risks arising from the use of electrical equipment, including not just electrical ones but also mechanical, chemical (such as, in particular, emission of aggressive substances) and all other risks. The Directive also covers health aspects of noise and vibrations, and ergonomic aspects as far as ergonomic requirements are necessary to protect against hazards in the sense of the Directive.

Even if it is mainly defined for and apply to home electrical appliances, the Low Voltage Directive (LVD) 2006/95/EC or 73/23/EEC will be applied for the design and use of the DustBot robots.

Rules and regulations for the deployment of robots in urban environment

A major remark concerning the industrialisation of the DustBot products and hampering the possible exploitation of the project results by industries relies on the lack of rules and regulations at worldwide level for the deployment of robots in urban environment.

At present, the Road Traffic Law does not take into account situations in which machines other than cars and motorcycles would use roads: rules and regulation for robots that make use of public roads and share roads with other road users in urban environment do not exist.

The reason of this lack mainly relies on the fact that until now robotic technologies were not mature enough to be employed in this context and few products exist. Some attempts have been made in Japan where a special zone for robot test and development has been set up in Fukuoka in November 2005. In the special zone administrative measures such as the change of Traffic Law have been established to allow robots to use roads during the experiments.

This matter goes beyond costs and efficiency issues and needs to be fully addressed at a higher level than the project consortium.

9.3 Opportunities for technology transfer and spin-out activities

These activities are pursued during the project life by:

- registration of patents and brands;



- creation of new businesses (spin-offs) for the commercialisation of DustBot products and services by companies created to this end;
- internal exploitation of new technologies that will be commercialised by partners already in the consortium;
- external exploitation by transferring technologies to other companies or by establishing agreement with other companies.

Recently, a strong declaration of interest from the big Italian-French company ST Microelectronics, one of the world's largest semiconductor companies, has been devised to the DustBot project. ST Microelectronics envisages a good potential for the DustBot robots to become products in a few years time with an interesting market, and propose to supply (for free) the electronic components for the prototypes.

An agreement between ST microelectronics Scuola Superiore Sant'Anna and RoboTech is under evaluation to provide the microcontroller boards for the following robot components:

- DustCart low level system controller (STEVAL-IFN002V1);
- DustClean low level motors controller (to be defined);
- DustBot localization system (STEVAL-IFN002V1);

Another agreement has been established between RoboTech and the local distributor in Lucca of Karcher, world leader in road sweeping machine. The local distributor will provide support for the supply of components for the realization of DustClean, such as brushes and tools.

A contact has been also established between RoboTech and Scuola Superiore Sant'Anna with the central R&D department of Karcher, Winnenden, Germany. The R&D department demonstrates interest in the DustBot project and a visit to Polo Sant'Anna Valdera in Pontedera and RoboTech in Peccioli has been programmed for the 8th of July 2008. Objective of the visit is a presentation of the activities of the DustBot project and the discussion of the possible role of Karcher in the exploitation of the results of the DustBot project.

