ECHORD++

The European Coordination Hub for Open Robotics Development

5th Review Meeting – WP 5
PDTI (Public end-user Driven Technological Innovation)

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Barcelona, March 28, 2019

Bristol Robotics Laboratory
BLUE OCEAN ROBOTICS - for humans
RUROBOTS Cognitive Science at Work
SEVENTH FRAMEWORK PROGRAMME

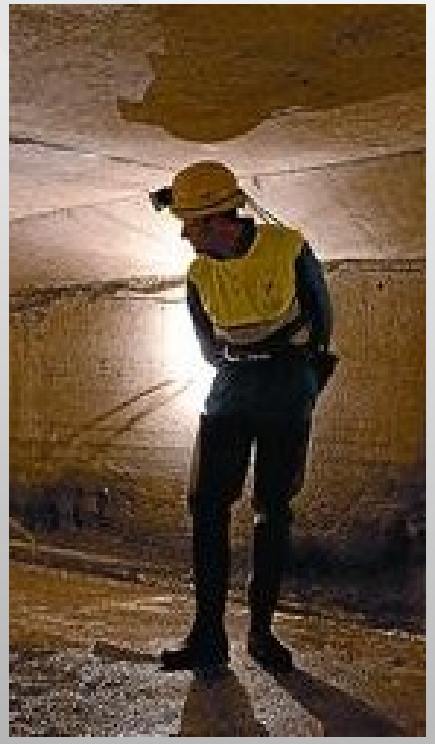
WP 5 – PDTI Urban. Main Achievements

- Urban robotics as a new area to solve Cities' Challenges
- The PDTI methodology has improved the PCP procedure
- Understanding robotics challenges for sewer inspection
- Two robotic inspection solutions has been designed and tested in real life environments in the Barcelona sewer network arriving to pre-commercial, TRL 7-8
- The operational inspection procedure and the inspection functionalities has been tested in five different locations of the Barcelona sewer network
- Large dissemination of the PDTI outcomes

WP 5 – PDTI Urban. Main Achievements

Urban robotics as a new area to solve Cities' Challenges

AREA	Location	Cities Challenges
INFRASTRUCTURES	HELSINKI	Traffic infrastructure inspection and maintenance.
INFRASTRUCTURES	BARCELONA	Automatic detection and road surface damage warnings.
INFRASTRUCTURES	CORNELLA	Improving waste management and street cleaning.
INFRASTRUCTURES	BARCELONA	Utilities infrastructures condition monitoring.
TIC AND TOURISM	GREENWICH	Improving tourist services at the city.
TIC AND PLANNING	SEVILLA	Improving the management, planning and urban city observations.
TIC AND MOBILITY	SEVILLA	Planning and information of urban accessible routes.
TIC AND ENVIRONMENT	MALAGA	Environmental monitoring and control.
TIC AND SURVEILLANCE	PADOVA	Providing safe and secure environments for citizens.
TIC AND MOBILITY	VALENCIA	Improving the management, planning and urban city observations.
PEDESTRIAN AREAS TECH	BARCELONA	Personalised mobility support for pedestrian areas.
PEDESTRIAN AREAS TECH	SITGES	Providing safe and secure environments for citizens.
PEDESTRIAN AREAS TECH	BARCELONA	Goods distribution technology to improve local retail.
PEDESTRIAN AREAS TECH	COIMBRA	Personalised mobility support for pedestrian areas.



WP 5 – PDTI Urban. Main Achievements

The PDTI methodology has improved the PCP procedure

PRODUCT INNOVATION LIFE CYCLE		
PDTI		
ACTIVITIES FOR UNDERSTANDING PUBLIC DEMAND	**ACTIVITIES FOR RESEARCH AND TECHNICAL DEVELOPMENT OF PRE-COMMERCIAL PRODUCTS**	PUBLIC PROCUREMENT FOR COMMERCIAL ROLL-OUT
PHASE 0	**PCP**	PPI

PDTI									
ACTIVITIES FOR UNDERSTANDING PUBLIC DEMAND				**CALL FOR RTD PROPOSALS**	**ACTIVITIES FOR RESEARCH AND TECHNICAL DEVELOPMENT OF PRE-COMMERCIAL PRODUCTS**				
BRAINSTORMING	NARROWING DOWN	RANKING	CHALLENGE DESCRIPTION		**SOLUTION DESIGN**		**PROTOTYPING**		**SMALL TEST SERIES**

WP 5 – PDTI Urban. Main Achievements

Functionalities to be solved for sewer inspection by the robotic technology

FUNCTIONS			WEIGHT
Sewer serviceability inspection	Sewer performance (at least 1000 lineal meter/labour day)		Basic
	Images (Video)		Basic
	Geometric analysis (scanning)		Basic
	Monitoring	Air	Assessable
		Water	Assessable
Structural defect inspection			Assessable

Robotic challenges: Mobility, Autonomy, Communications

MOBILITY TEST

Description and conditions	Evaluation
Robot motion: 100 meters (autonomously) The word autonomously is not the appropriate one in this test, since the robot can be tele-operated, but it has to move without the help of the human operator in case of falling down, recover and continue moving. **Conditions:** • The robot has to include the equivalent weight of the sensors and electronic drivers • One trial in straight line and another one with a 90º curve. • The trial will be done in Barcelona • The trial will be done at different illumination conditions: with illumination and complete darkness.	1) **The maximum and minimum speed will be evaluated. 60 minutes is the maximum time to cover 100 meters. The minimum speed is specify by the precision to detect the defects, and has to be justified in the deliverable. This minimum speed has to be used in the trials.** 2) **Recovery test: The evaluators will place the robot in the ground of the sewer at different inclinations. The robot has to recover from these positions.**

COMMUNICATIONS TEST

Description and conditions	Evaluation
Send information (video and data) from one point to another at different distances (100m, 200m, 300m). The robot can be without movement to make the test. The robot should carry the same sensors used for mobility and autonomy tests. **Conditions:** Trials in straight line and curve specifying the maximum transmission speed (Baudrate). 100m straight line 200m straight line with one curve (90º). Radius 300m straight line with two curves (90º +90º). Radius	**1.- Communication bandwidth** **2.- Signal/Noise rate** **3.- Delay to send the information** **Note: The coordinators will provide to the Consortia the software that will be used for the evaluation.**

AUTONOMY TEST

Description and conditions	Evaluation
Demonstration that in 8 hours the robotic solution can arrive to 1 km away. The batteries can be charged or changed automatically or manually several times during the trial. Proposers have to specify the real autonomy and to indicate how the recharge will be done if it is the case. **Conditions:** • The results of the above test will be extrapolated considering the energy consumption in each case, and the performance in 8 hours will be forecasted. • The robot has to include the equivalent weight of the sensors and their electronic drivers • The trial will be done at different illumination conditions: with illumination and complete darkness.	**The platforms should cover a distance of 400m with the equivalent weight of the sensors and electronic drivers and the velocity should be the adequate to perform the required inspection functions. The energy consumption could be measure. And the batteries could be changed "in situ".**

WP 5 – PDTI Urban. Main Achievements

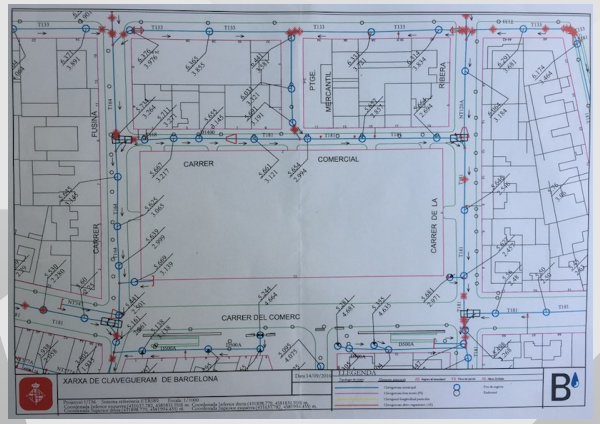
Two robotic inspection solutions has been designed and tested in real life environments in the Barcelona sewer network arriving to pre-commercial TRL 7-8

- SIAR prototype is very close to commercialization
- ARSI's software can be already sell as a stand alone solution
- Diverse components of both prototypes can be already commercialized

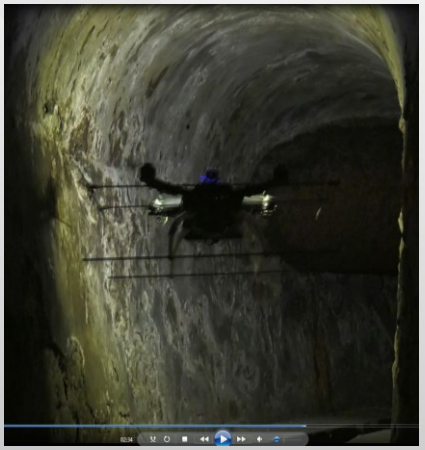
WP 5 – PDTI Urban. Main Achievements

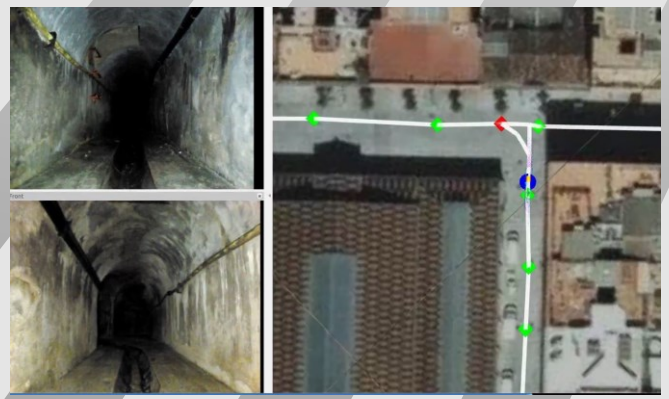
The operational inspection procedure and the inspection functionalities has been tested in five different locations of the Barcelona sewer network : Paseo Sant Joan / Mercat del Born / Plaza Virrey Amat / Avenida Pearson / Zona Forum

Mercat del Born



ARSI





SIAR

WP 5 – PDTI Urban. Dissemination

Continuous dissemination of the PDTI procedure

PDTI												
ACTIVITIES FOR UNDERSTANDING PUBLIC DEMAND								CALL FOR RTD PROPOSALS	ACTIVITIES FOR RESEARCH AND TECHNICAL DEVELOPMENT OF PRE-COMMERCIAL PRODUCTS			
BRAINSTORMING		NARROWING DOWN		RANKING		CHALLENGE DESCRIPTION			SOLUTION DESIGN		PROTOTYPING	SMALL TEST SERIES

WP 5 – PDTI Urban. Main Objectives Phase III

Main Objectives

- **Test series to verify and improve the development of robotics in sewer inspection**
- **Improvement of the prototypes developed in Phase II to achieve TRL7-8 level (focus on autonomy, mobility and communications)**
- **Improvements in the inspection of serviceability, monitoring and the structural inspection of the sewer network.**
- **Improvements in operational procedure required during the inspection.**
- **Market research to identify scalability and transferability of the solution.**

WP 5 – PDTI Urban. Main activities

PDTI Urban. 5th REPORTING PERIOD. December 15th, 2017 to December 14th, 2018
MAIN ACTIVITIES:

- **Kick off Telco Phase III**: December 19th, 2017
  Explanation of the monitoring process, evaluation criteria and deliverables required, the dissemination and communication activities offered by Echord++ and the actions proposed to improve marketability.

- **1st Monitoring Period**: 15/12/2017-14/03/2018.
  09/03/2018. TELCO and report of the deliverables D26/28-9. Changes and Improvements based in phase II final evaluation.

- **2nd Monitoring Period**: 15/03/2017- 14/06/2018.
  19/04/2018. MARKETING WORKSHOP. External experts' evaluation and discussion of the marketing proposals.
  19/06/2018. TEST of serviceability inspection at the sewer network. Complete operational procedure.

WP 5 – PDTI Urban. Main activities

PDTI Urban. 5th REPORTING PERIOD. December 15th, 2017 to December 14th, 2018

MAIN ACTIVITIES:

- **3rd Monitoring Period:** 15/06/2018-14/09/2018.
  19/09/2018. TEST of structural inspection of the sewer network.
  Complete operational procedure.
  Deliverables D26/28-13. Tests and tests results.

- **4th Monitoring Period**: 15/09/2018- 14/12/2018.
  13/12/2018 FINAL TESTS and EXPERT PANEL
  14/01/2019 MARKETING PANEL

WP 5 – PDTI Urban. Main activities

PDTI Urban. 5th REPORTING PERIOD. December 15th, 2017 to December 14th, 2018

STAKEHOLDERS INVOLVED:

END USERS-PUBLIC ENTITY

BCASA TEAM J. Varela, MJ Chesa, L. Martinez and Brigades

TECHNOLOGICAL AND ROBOTICS CONSORTIA

ARSI AND SIAR CONSORTIA

EXTERNAL EXPERTS. Robotics and Market

Tjibbe Bouma, Ivan Olivella

COORDINATOR. Robotics, informatics and social

UPC TEAM A. Sanfeliu, A. Puig-Pey, A. Grau, Y. Bolea, J. Casanovas, H. Martinez

SUPPORT TEAM M. Neitz, F. Pepponi (TUM). Geoff Pegman, Franziska Kirstein and BOR Team

WP 5 – PDTI Urban. ARSI Main Conclusions

- The aerial team has developed a solution with a high commercialization potential
- Technical outcomes:
  - The final platform design flies in the sewer doing inspection, but it not yet suitable to be transferred to market at the present stage
  - The technical innovations have been in the platform, perception systems and inspection software.
  - ARSI's software can be taken as a stand-alone solution and commercialized for service providers.
- New steps:
  - Look for hardware solutions oriented to specific types of inspection areas and inspection tasks

WP 5 – PDTI Urban. SIAR Main Conclusions

- The SIAR team has developed a solution very close to commercialization that can be applied to sewer, tunnels, and other type of inspections
- The final cost is lower than expected and can reach 0,2€/m (BCASA cost is 0,5€/m)
- Technical outcomes:
  - The final platform design it is very mature, robust and reliable. It works very well in most of the sewers trials.
  - The technical innovations have been in the platform, autonomy, communications, perception systems and inspection software.
  - SIAR's software it is very good from the technical point of view, but it needs further refinements for the service providers
- Next steps:
  - Continue doing trials with the customers

WP 5 – PDTI Urban. SIAR & ARSI Main Conclusions

SIAR & ARSI

- **Technology of both consortia that can be already commercialized:**
  - software service provider,
  - wireless communications,
  - sensor developments,
  - data handling and analysis,
  - robotic platforms.

Lessons learned in PDTI

- **Phase 0 is a very important part of the PDTI process**, it requires to have clear ideas to help the public bodies to look for proposals that can be solved with robotic technologies
- **To succeed in the robotic solution**, the research and technological team has to guide in the different development phases
- **The challenges have to be broken down in achievable goals**, because to try to solve the complete challenges can drive a unsuccessful PDTI project
- **If the challenge is enough narrowed then a TRL9 can be achieved**, otherwise it will require additional funding to achieve the final product
- **How to commercialize a PDTI product may require to look for different market solutions** that are difficult to understand when a PDTI starts

Use of expertise gained in the future

- **The PDTI expertise have been already transferred in new European projects**
- **The knowledge acquired in the PDTI process can be used in diverse areas:**
  - The PDTI methodology in the new PCPs
  - The technical knowledge of the challenges can be transferred to new projects and areas
- **The great human relationship will always be maintained**

Thank you for your attention!

The ECHORD Plus Plus Consortium acknowledges support by the European Commission under FP7 contract 601116.