ECHORD++

The European Coordination Hub for Open Robotics Development

4rth Review Meeting – WP5

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ARSI Team at EURECAT

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PDTI Urban Robotics: Sewer inspection

Public end-user Driven Technological Innovation

Sewer inspections require many humans to work in risky and unhealthy conditions.

The current need of **the City of Barcelona** is:

• reducing the labour risks,

• improving the precision of sewer inspections

• and optimizing sewer cleaning expenses

Introducing a **robotics solution** in this process aims at addressing all them.

Sewer inspection: Current procedures

The sewer network of Barcelona is 1532 km long
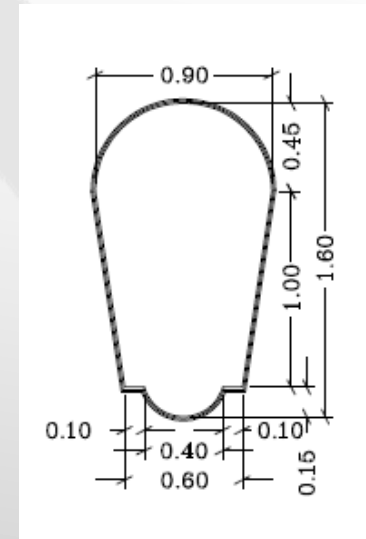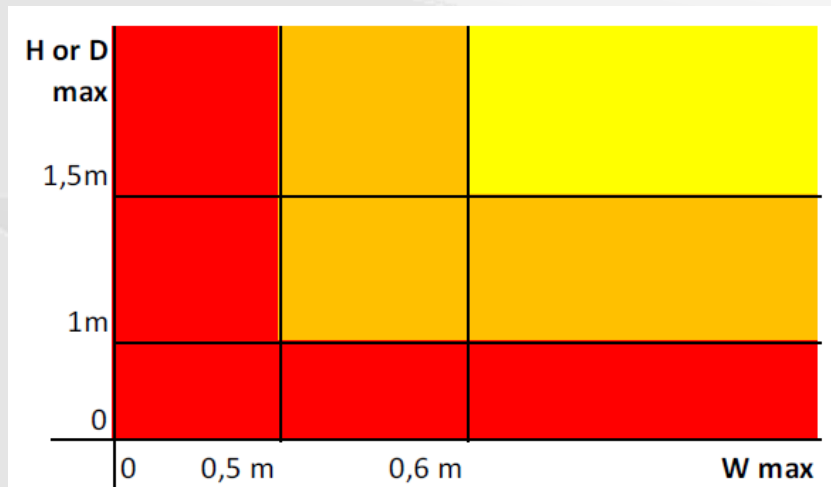
Approximately 50% is accessible to workers

Workers walk all along the pipe and perform visual inspections and decide interventions

Special health and safety measures are required + other risks like slippery sections, obstacles or biological risks from the potential contact with wastewater

Currently: about 1.5 km of sewer every 6 hours

Sewer accessibility

Three categories:

TYPE OF SEWER	LENGTH (m)	PERCENTAGE
Non visitable sewers	541.000	35%
Semi visitable sewers	148.000	10%
Visitable sewers	843.000	55%
TOTAL	**1.532.000**	**100%**

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State of the art in Inspection Vehicles

There exists some inspection vehicles, usually tethered and teleoperated, equipped with several type of sensors, capable to illuminate and perceive the environment and generate models of the sewer.

Courtesy: IBAK

Echord ++ seeks advances in:

Robot autonomy
Real-Time Decision Making

Mobility
Possibility to Focus on Defects

Functional Requirements

FUNCTIONS			WEIGHT	
Sewer serviceability inspection	Sewer performance (at least 1000 lineal meter/labour day)		10%	80%
	Images (Video)		40%	
	Geometric analysis (scanning)		20%	
	Monitoring	Air	9%	
		Water	1%	
Structural defect inspection				15%
Sampling				5%

Operational Requirements

perception

robustness

Integration in the environment

dependability

scalability

adaptability

endurance

intuitiveness

decisional autonomy

communication

cognitive ability

configurability

flexibility

motion capability

ARSI Value Proposition

ARSI Consortium

The ARSI Consortium is composed by:

R&D → **MARKET**

The consortium covers the entire value chain including:

• FCC is a world reference company in environmental urban services company,

• a worldwide leader in sewer inspection robots manufacturing

• a research center with experience in both aerial robots for harsh environment and perception

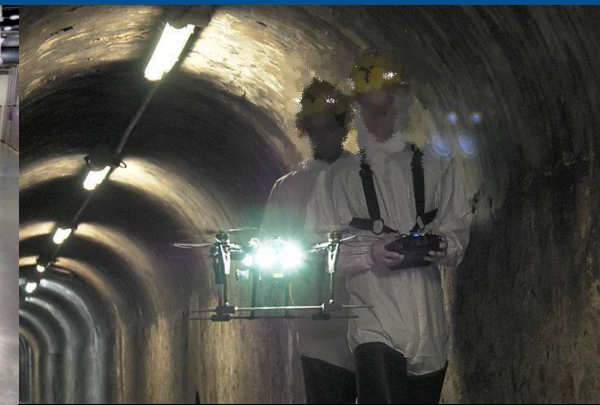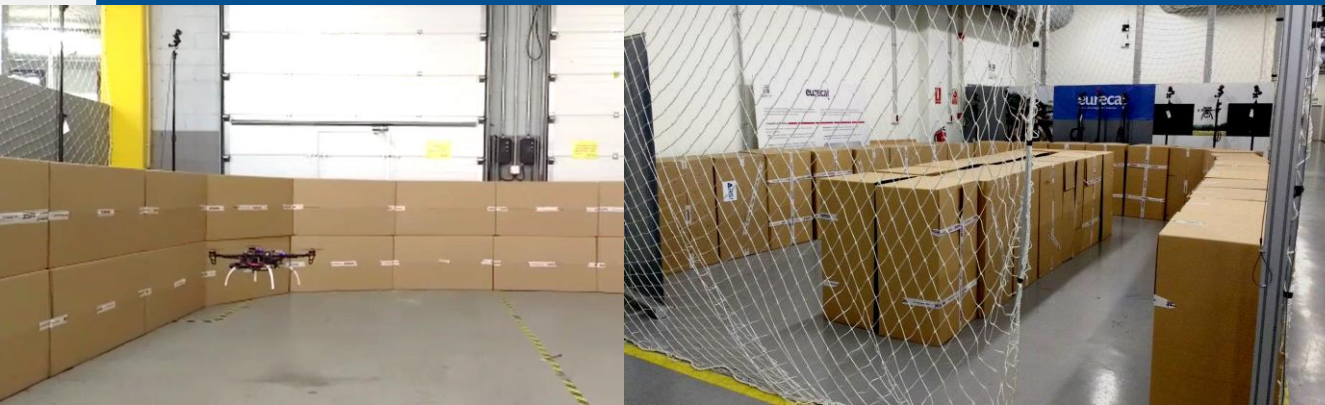• a company specialized in aerial robots operation, manufacturing, simulation and training.

The Challenges
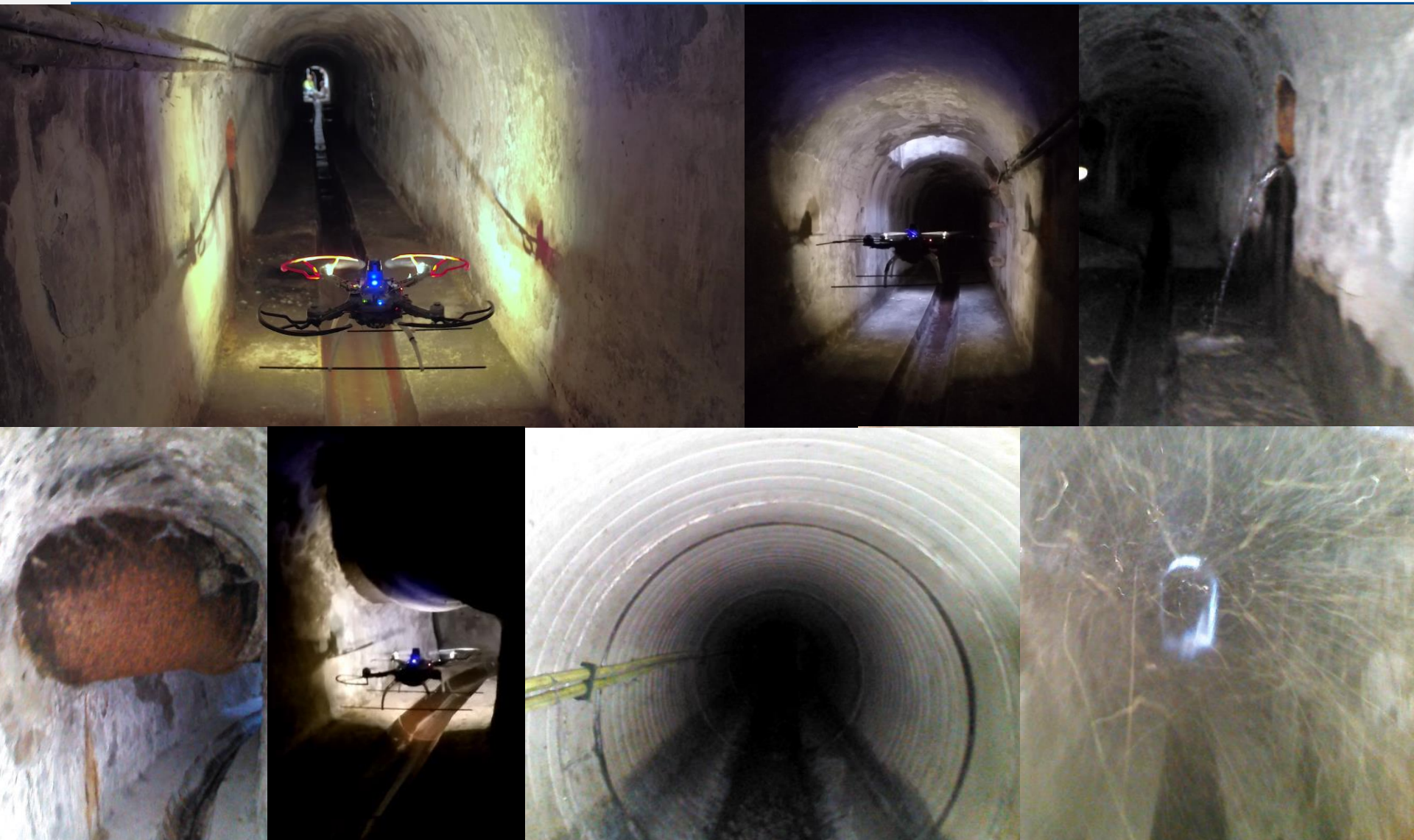
The *REAL* Challenges
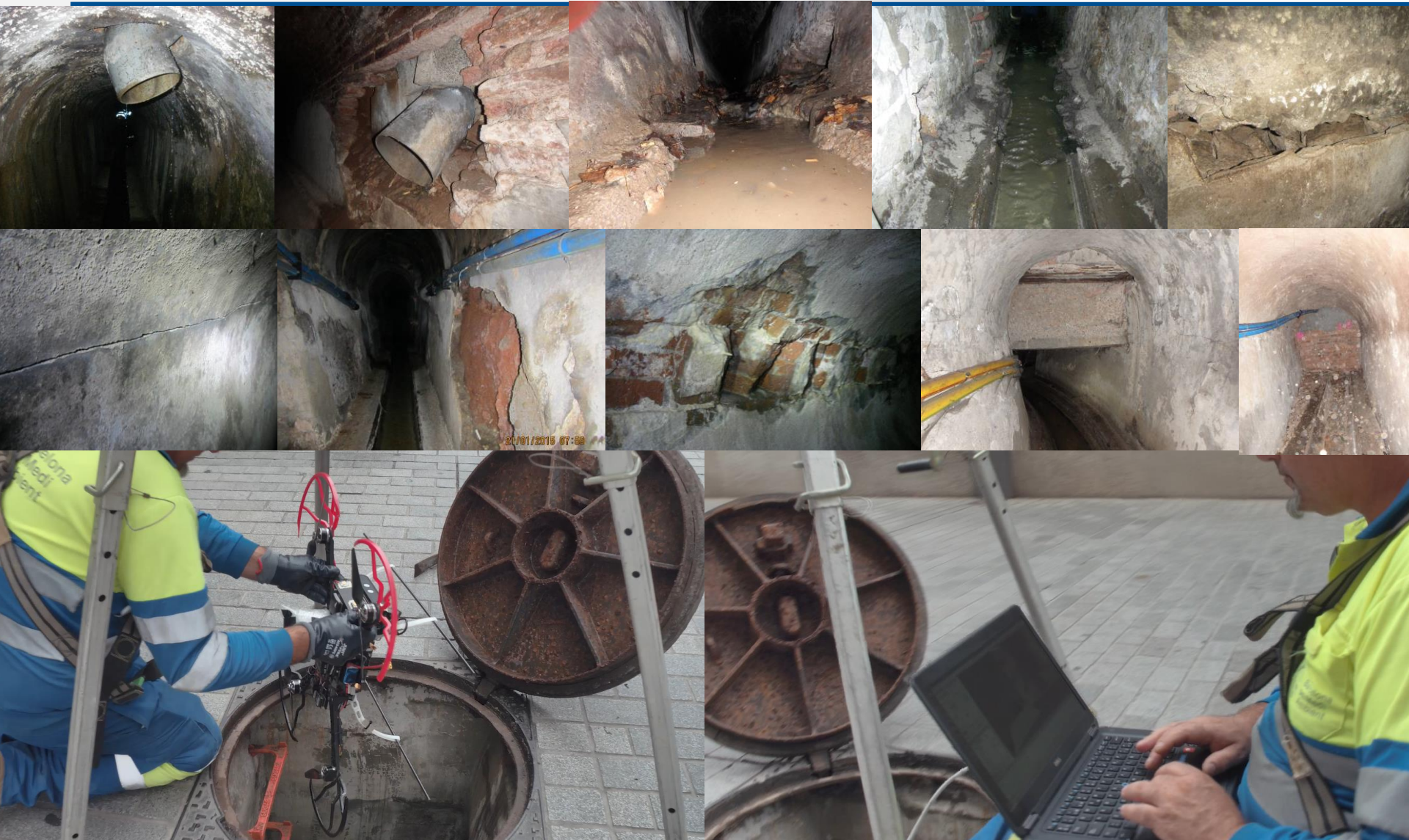
The process towards TRL7

1. *Localization using external Motion Capture system*
2. *Control tuning using Motion Capture system*
3. *Localization using onboard sensors (Visual Odometry)*
4. *Autonomous flight along a cardboard wall (wall following)*
5. *Autonomous tunnel following in cardboard tunnels*
6. *Cardboard tunnels of increasing complexity (narrow, turns, intersections, obstacles)*
7. *Control tuning in real sewers*
8. *Autonomous path following in real sewers*

Where we are now?

Click to see the video

What is coming in Phase III?

1) Develop new platform

- Higher payload capacity (goal=1kg vs 700g in phase II)
- Longer flight autonomy (goal=15mins vs 7mins in phase II)
- Optimized sensor payload (new RGBD cameras, 360deg laser)
- Better protection against impacts, humidity
- Improved onboard software, new functionalities

2) Implement tools and algorithms for planning & analysis

- Mission planning interface
- Data review & analysis software
- 3D reconstruction algorithms
- Defect detection algorithms
- Data storage, meta-data indexing

Impact of being part of PDTI in ECHORD++

Positive aspects	Potential improvement areas
• Contact with final client and end user. • Acceleration of development. • Access to market. • Creative environment. • Structural support for Dissemination and Exploitation	• Administrative aspects. • Definition of phases and expectations. • Criteria for evaluation and KPIs. • Representation of targeted market.