ROBINS
ROBotics technology for INspection of Ships

Practical implementation of robotic technologies for the inspection of ships

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PORT&SHIPPINGTECH MAIN CONFERENCE — PART OF genoa shipping week

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What is ROBINS?
- **EU co-funded collaborative R&D project (Horizon 2020)**
- **Partners from Shipping, Robotics and IT/CAD-CAE industry**
- **Aims at using robots and visual software tools for inspection of ships**
  ...Do we really need it?

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Specific challenges:
- **Overall examination:** providing means for the **selection of representative spaces**
- **Close-up survey:** **closely examine structural details** and to **identify any damage in association with wastage** over the allowable limits
- **Equivalence:** provide a **level of detail** of structural components **at least equivalent** to the level that could be obtained by **direct sensory experience of the Surveyor**
- **Critical factors:** **time** of operation, **completeness**, **accuracy** of data

Improved safety
- Working at height
- Inaccessible spaces
- Health threats
- Emergency situations

Economic benefit for:
- Robot and ICT industry
- Asset owners and operators
- Service suppliers
- Class societies

We think so!!!

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What kind of robots?

Aerial Drones
mainly for visual inspection

Crawlers
for TM and other close-up inspections

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What can robots do?

- **When**
  - ✓ Any time
  - ✓ Class surveys
  - ✓ Statutory surveys
  - ✓ Owner / Vetting
  - ✓ Repair assessment
  - ✓ …..
- **Where**
  - ✓ Plate surfaces
  - ✓ Stiffening members
  - ✓ Structural details
  - ✓ Welds
  - ✓ Partially or fully confined spaces

- **What**
  - ✓ Overall inspections
  - ✓ Spot visual inspection
  - ✓ Gaugings and NDT
  - ✓ Harsh, dirty, narrow and bumpy environment
- **Why**
  - ✓ Reduced survey duration
  - ✓ Simplified preparation
  - ✓ Enhanced safety
  - ✓ Asset condition monitoring and tracking

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Specific Challenges: Detection of onging wastage

Material wastage
- General corrosion
- Grooving
- Pitting
- Erosion

Fractures
Deformation
- Linear
- Planar

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Specific Challenges: Thickness measurement (TM)

- **Thickness measurements** are to be carried out at least in a **set of areas as described in the Rules**

30 mm

Procedure:
- Go to point
- Clean (hammering, grinding)
- Put couplant
- Multiple readings
- Averaging / filtering
- Recording (with position)

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Framework of (IACS) Rules

- **Rec. No. 42**
  - Used to **facilitate the required external and internal examinations**,
  - Including **close-up surveys** and **gauging**.
  - **Results normally obtained for/by the Surveyor**.
  - The results […] are to be **acceptable to the attending Surveyor**.
  - Inspections should be carried out **in the presence of the Surveyor**.

  No.42 Guidelines for Use of Remote Inspection Techniques for surveys

- **UR Z7 rev.26**
  - (1.2.3) **Remote Inspection Techniques as an alternative to Close-up Survey**
  - (1.2.15) […] **without the need for direct physical access of the surveyor / Inspector**

  Z7 Hull Classification Surveys

  Z17 Procedural Requirements for Service Suppliers

- **UR Z17 rev.13**
  - **Service suppliers for remote Inspection techniques**

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Improving robotic technology

The **actual needs and expectations of potential end users** are to be met and **improvements need to be done**:

- **Piloting vs. operating**

- **Advanced tooling**

- **Mobility (reaching points of interest)**

- **Advanced software tools**

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Piloting vs. Operating

- **Skills required today (piloting):**
  - **Operating beyond visual line of sight**
  - **Live video feedback only**
  - **Understanding position and orientation**

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- **Improving the ease of use (operating):**
  - *Ego-motion estimation*
  - *Progress in battery technology*
  - *(in)Sensitivity to environmental disturbance*

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Advanced Tooling

- **Preparation of the surface for TM**
  - Removing rust scales
  - Hammering
  - Grinding etc.

bwc1792154 Barewalls ©

- **Improvements**
  - *Modular and possibly standards-based design*
  - *Available payload*
  - *Progress in battery technology*

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Mobility (reaching points of interest)

- **Mission:**
  - **Reach specific structural components**
  - **Observe details** from any desired point of view
  - **Make measurements** on such components

- **Dedicated crawlers** nowadays are able to overcome 90° corners, climb vertical walls, walk upside-down, and other remarkable abilities.
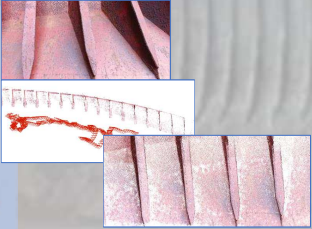- Nevertheless, **many types of obstacles cannot be overcome yet**.

IACS Rec. 87

- **Significant advances are needed** in order to carry on thickness measurements **in all desired places and in reasonable time**.

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Dedicated Software Tools

- **End user application**
  - **Customized application** for users of the marine industry
- **3D model reconstruction**
  - **State-of-the-art** reconstruction tools (photogrammetry, SLAM)
- **Virtual tours**
  - **Annotated virtual model** of a cargo space
- **Advanced image processing for defect detection**
  - **Machine learning approach** with convolutional neural networks (CNN)
- **Efficient scan of large spaces**
  - **Process very big point clouds**

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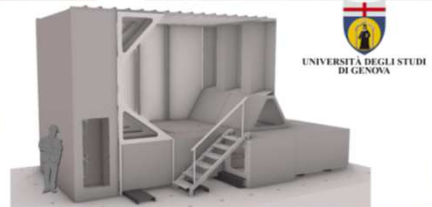# What is the Testing Facility?
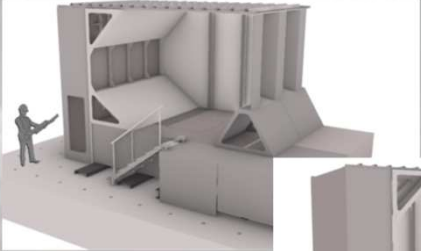
- A **test bed** expected to provide an **easy and economical** way for **assessing and developing** robotic platforms

- The **location where** shipping, robotics and IT/CAD-CAE stakeholders **meet** to discuss, design, develop and test new marine inspection technologies and **set rule** requirements

- **Training/competence center** about **in-service management** of ship and offshore, welded structures

Slide 3

Testing facility main module (section A)

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Each area simulate different structural conditions and ship ages

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Controlled environment... real defects

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Testing protocols to assess specific capabilities of RAS (section B)

The RAS is required to perform one of its typical actions in different working conditions. E.g. a drone should take a picture of a target while flying inside a harsh space or a crawler should take a thickness measurement while climbing on an inclined surface. Examples are:

✓ Stay in place test (SIP test) in the flight robustness part of the TF
✓ Surface transition (ST test) in the adhesion test module of the TF
✓ Obstacle crossing (OC test) in way of the adhesion test module of the TF
✓ Vibrating structure test (VS test), not yet available

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Testing protocols and trials arrangements

➔ Target: at least human surveyor performances

✓ Definition of testing protocols according to current rule requirements

✓ Typical trials working group: +1 test leader + 1 class surveyor + 1 superintendent, as usual in practice

a. Trials instructions delivered, then group leader tasked to supervise trials taking own notes as well as comments from end-users, i.e. class surveyors or shipowner superintendents

b. In tests where end-users somehow instruct RAS pilot, this will be regarded as an assessment of the team working, i.e. it is part of the trials as well (human factor)

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Worked out examples, photos

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Worked out examples: video

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3D reconstruction video

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How to stay in touch?

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GE Inspection Robotics AG	CH
Open Cascade SA	FR
Universitat de les Illes Balears	ES
Università di Genova	IT
Fayard A/S	DK
Ships Surveys and Services s.r.l.	IT
Glafcos Marine Ltd.	GR

Stakeholders' visits to the TF are more than welcome (by appointment only)

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Thank you for your kind attention!

...just launched