Abstract
Robotics has the potential to transform the way operations in the Oil & Gas (O&G) industry are performed in the future. The launch of an international robotics competition called the ARGOS (Autonomous Robot for Gas and Oil Sites) challenge, based on a selective contest between world class robotics consortia is a bold way of pushing the emergence of technological solutions. In return the robotics community will become more aware of the specificities and safety requirements of the O&G industry. Having various teams competing allows different designs to be tested, fostering strong innovation and collaboration between individual consortiums.

Surface robotics presents two potential major impacts:

1. Health, Safety and Environment (HSE) (reduction of risk to personnel, environment and installation)
   - In emergency situations: be deployed much sooner than a human to interrogate sources of leak from remote locations, therefore reducing or eliminating human intervention
   - In high risk areas: faster detection of leaks leading to a minimization of exposure to operators.

2. Operational (cost reduction, efficiency increase and production)
   - In harsh and hostile environments: ability to perform tasks where operators have limited capacity to intervene
   - In difficult access locations: primary investigation without human presence could lead to gains in availability, time savings, and transport resources.

During a series of three competitions, teams will be evaluated through the capacity of their robot to move around a human engineered competition site, representative of a typical onshore/offshore production facility, performing reporting tasks in different scenarios (routine inspection and emergency) using different autonomy levels. The technical solutions will be adapted to O&G industry specific safety requirements on practical grounds: mobility on production sites and potentially explosive atmospheres.

Due to the nature of the O&G Industry and geographical locations, constraints are forced upon production installations such as tough atmospheric and stringent operating conditions. O&G operators have only recently begun researching surface robotics including the SENSABOT application, (NREC/CMU, 2012), a mobile inspection robot developed by Carnegie Mellon University. Building upon research already carried out and technology already developed, the ARGOS challenge aims to expand on this to create the next generation of autonomous robots for the O&G industry.
Introduction
The field of surface robotics is changing and developing fast with widespread use in manufacturing and service industries however O&G operators have only recently began researching this topic. The principal reason is that within the O&G industry there exists a higher number of technical challenges that must be satisfied before widespread implementation will transpire.

The presence of hydrocarbons and operating in potentially explosive atmospheres makes the O&G industry risk averse by its very nature. Robots must be designed to comply with equipment and protective systems intended for use in potentially explosive atmospheres (ATEX). With extremely stringent safety requirements, O&G operators demand robust and proven solutions. Surface robotic systems that can meet such standards are only in experimental and early demonstration/trial phases. The O&G industry requires convincing that robots can aid operations safely and not actually become a hazard itself.

Robotics already plays a part in the strategy of upstream exploration and production (E&P) O&G operators through remote operating vehicles (ROV) inspection subsea and intelligent pigging applications. Unmanned Aerial Vehicles (UAV) are becoming more and more common allowing structural inspection (flare, hull) without the need for human rope access team or helicopter intervention.

If surface robotic systems can be demonstrated and proven to the same degree, these systems will allow the reduction of human exposure to any risk for his/her safety whilst also ensuring high reliability and reactivity. Surface robotics may be used not only for Normally Unmanned Installations (NUI) but also to improve the efficiency of future green field sites working alongside humans and finally also to optimize today’s existing brown field sites where humans already operate.

This paper serves to describe the systematic process in which the ARGOS challenge aims to solve these issues in order for widespread acceptance of surface robotics by the O&G industry. The paper will explain the setup and launch of the challenge, the use cases that have been selected as the main business driver and also the technical requirements and expectations.

State of the Art
Surface robotics research and development (R&D) in the O&G industry has led to the design of two main design prototypes that exist today:

1. MIMROex
   Developed by the German research institute, Fraunhofer IPA (Pfeiffer et al., 2011), this robot system designed for maintenance and inspection, uses a human operator “teach and repeat” methodology to allow autonomous type behaviour where the operator essentially teaches the robot a sequence of motions and movements in required inspection positions. The robot can also be used in assisted teleoperation mode. The robot navigation is performed using Simultaneous Localisation And Mapping (SLAM) principles, communicating to the remote operator via a wireless Local Area Network (LAN). The robot manipulator has 6 degrees of freedom (DOF) complete with camera and mobile base containing fire and gas sensors. The robot is designed for ATEX zone 1. MIMROex was subject to a ten day offshore field test, carried out in difficult atmospheric conditions including high humidity and ambient temperatures. The results showed that the robot was unavailable 25% of this time due to communication and hardware failure with a further 10% of the time lost due to extreme weather conditions. This demonstrates the importance of having a robust communication protocol and the need for resilient design to achieve the required robustness and increase availability.

2. SENSABOT
Developed by the National Robotics Engineering Center (NREC), a spin off from the Carnegie Mellon University in America, the robot is designed for inspection purposes using an assisted teleoperation control mode via a wireless link and joystick human machine interface. The system uses a laser scanner for collision avoidance and benefits from a cog rail complementary structure designed to allow the robot to move between different levels on a multi floor production facility. The robot is designed to International Electrotechnical Commission System for Certification to Standards in Relating to Equipment for use in Explosive Atmospheres (IECEx). With a sensor payload containing inspection camera, thermal, vibration and toxic gas instrumentation, SENSABOT will be deployed in the Kashagan field for site testing in 2015.

Building upon research already carried out and technology already developed, the ARGOS challenge aims to expand on this to create the next generation of robots for the O&G industry.

**Challenge Instrument**

The robotics community are historically used to working in a collaborative environment in challenge/competition conditions. For instance, the French and American Defense Agencies and National Aeronautics and Space Administration (NASA) have launched challenges to encourage robotics research. The ARGOS challenge allows the identification of world class robotic actors and the building of competency relevant to the needs of the O&G industry. In return those different robotic actors will become more aware of those needs.

The competition and communication aspects of the challenge are already creating an internal and external dynamic on O&G robotics.

**Call for proposal**

In partnership with the French National Research Agency (ANR) an international call for proposals was launched in December 2013 to encourage external robotic actors from academic and industrial backgrounds to form teams and submit applications for the ARGOS challenge. The call was designed to promote innovation with a mechanism for teams to receive extra funding upon demonstration of scientific excellence in their submissions. The call allowed complete flexibility with teams free to propose the general architecture of their robot. A very successful return of thirty one teams answered the call from fifteen different countries, demonstrating interest on a global scale.

**Evaluation and selection**

A rigorous evaluation process meeting international standards ensued using an evaluation committee composed of external robotic experts and internal discipline specific specialists. Each technical submission was evaluated against the following criteria:

- Relevance to the call for proposal
- Scientific content
- Technical quality
- Industrial potential
- Methodology
- Team quality
- Adequacy of resources

A recommended shortlist was issued to a final management committee composed of different external robotic experts, ANR management and internal management figures including operations and HSE division. A final five international teams were selected in June 2014 taking into account the recommendations from the evaluation committee with a particular focus on the
industrial potential and also ATEX certifiability considerations. Each team was provided with initial funding. Table 1 shows the initial robot design and details of each of the five selected teams.

<table>
<thead>
<tr>
<th>Robot Design</th>
<th>Team Name</th>
<th>Country of Origin</th>
<th>Consortium</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIR-K</td>
<td>(Autonomous gas leak</td>
<td>Japan</td>
<td>Best Technology (Coordinator)</td>
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<tr>
<td></td>
<td>Inspection Robot type K)</td>
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<td>Mobile Robot Research</td>
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<td>FUJISOFT</td>
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<td></td>
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<td>Tohoku University</td>
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<td></td>
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<td></td>
<td>Shibaura Institute of Technology</td>
</tr>
<tr>
<td>ARGONAUTS</td>
<td>(Autonomous ATEX certified</td>
<td>Austria, Germany</td>
<td>Taurob (Coordinator)</td>
</tr>
<tr>
<td></td>
<td>Robots for Gas &amp; Oil</td>
<td></td>
<td>Technical University of Vienna</td>
</tr>
<tr>
<td></td>
<td>industry)</td>
<td></td>
<td>Technical University of Darmstadt</td>
</tr>
<tr>
<td>FOXIRIS</td>
<td>(Flipper based O&amp;G ATEX</td>
<td>Spain, Portugal</td>
<td>GMV (Coordinator)</td>
</tr>
<tr>
<td></td>
<td>intelligent Robotic</td>
<td></td>
<td>IdMind</td>
</tr>
<tr>
<td></td>
<td>System)</td>
<td></td>
<td>UPM-CAR</td>
</tr>
<tr>
<td>LIO</td>
<td>(Legged robotic Inspection</td>
<td>Switzerland</td>
<td>ETH Zurich (Coordinator)</td>
</tr>
<tr>
<td></td>
<td>for O&amp;G industry)</td>
<td></td>
<td>Alstom Inspection Robotics</td>
</tr>
<tr>
<td>VIKINGS</td>
<td>(Robotic Vehicle using</td>
<td>France</td>
<td>IRSEEM (Coordinator)</td>
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<td></td>
<td>Kinematics &amp; Innovative</td>
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<td>SOMINEX</td>
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<td></td>
<td>Natural Guidance Systems)</td>
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</tbody>
</table>

Table 1: Selected Teams

Having various teams competing allows different designs to be tested and will foster strong innovation and collaboration between the individual consortiums and the O&G industry.

**Business Cases**

Internal interviews across a range of disciplines (operations, HSE, instrument/control, communications etc) were carried out with personnel to identify the technical operational requirements and organizational aspects of the challenge. The interviews identified different business cases which were built assessing two main impacts:
• **HSE impacts (reduction of risk to personnel, the environment and the installation)**
  These business cases were built based upon HSE statistics for E&P operational sites. It is envisaged that robotics will aid in faster detection of leaks leading to a minimization of exposure and risk to operators. During crisis/emergency operations, a robot could be deployed much sooner to interrogate sources of leak from a remote location and therefore reducing or eliminating human intervention.

• **Production impacts (cost reduction, efficiency increase and production)**
  These business cases were built based upon feedback from a range of existing operational production sites to ensure all of the different needs and challenges on each site were included. It is envisaged that robotic routine inspection can lead to time and costs savings in terms of operators, transport resources etc. In terms of spurious tripping causing emergency shutdowns (ESD), with the use of robotics it is envisaged that faster reset would be possible leading to a reduction in production losses.

  Based on these two impacts the following different business cases were identified:

  1. **Reduction of an offshore platform evacuated after a major hydrocarbon leak**
     It can take numerous days into a crisis after full evacuation before being able to send personnel back to the platform to safely assess the root cause of the leak. Deploying a robot on site could allow earlier root cause determination and significant reduction of crisis duration.

  2. **Reduction of human exposure to toxic gas**
     Kashagan Phase 1 contains five unmanned islands (four well pads plus one compression complex) with high H2S content (20%) and difficult access. The use of robotics would provide a safety benefit on Individual Risk (IR) by reduction of personnel exposure to toxic and flammable gas. The SENSABOT robot developed by NREC has been developed for this particular environment.

  3. **Reduction of human exposure to harsh environments**
     Arctic conditions lead to limitation of access due to weather severity and the extreme cold which prevents human work during parts of the year. Other harsh environments include:
     - Warm, dry / humid sites
     - Exposure to toxic fluids (sampling, pumps etc)
     - Radioactivity
     - Exposure to high radiation level (flare stacks)
     - Areas with difficult access (sea conditions, elevations etc where there is no access 50% of the time during four months per year)
     - Downgraded situations

  4. **Reduction of IR**
     Large onshore plants currently have a maximum IR figure of $10^{-3}$ per year as per current company individual risk acceptance criteria; however this figure will not be acceptable forever. Currently this equates to one fatality every ten years at site where the personnel on board (POB) is in excess of one hundred persons. On large installations such as Floating Platform Storage and Offloading (FPSO) with current technologies and high POB, IR figures are still above 3 to $4\times10^{-4}$ per year. Some National Companies now require for process risks an IR figure of $10^{-4}$ per year to sanction a project. To achieve IR figures of $10^{-4}$ per year, robots may be a solution, allowing the limitation of night shifts and reducing personnel exposure in risky areas.

  5. **Manned facilities – automation of repetitive tasks**
     Most of the everyday work of human operators is used on the following repetitive tasks (figure estimated at approximately five hours and thirty minutes per shift), most of which
could be performed by a robot, significantly reducing operating costs and personal exposure:

- Visual routine inspection
- Monitoring of process parameters
- Gauge reading
- Fluids sampling

6. **Normally Unmanned Installations (NUI) – incident prevention and recovery**

For NUI, potential robotic applications include:

- Regular survey
- Reduction of closed circuit television (CCTV) number and associated costs
- Leak detection before potential escalation
- Incident investigation without exposing personnel to hazardous situations
- Earlier re-start after spurious shutdown (reduction of production shortfalls)
- Inspection of platform prior to sending personnel

**Technical Requirements**

**Scenarios**

The internal interviews provided different potential applications for robotics which were each assessed on a “robotization” score versus profit score matrix. The “robotization” score evaluates the possibility of the task being able to be performed by a robot as opposed to a human, taking into account the following criteria:

- Design adequacy (relevance of the design for the task, relevance of intelligence, motion and application device)
- Constraint compliance (close use to O&G, ATEX certifiability)
- Technology readiness
- Amount of providers
- Available design diversity

The profit scoring methodology is based on the following types of expected gains:

- Safety (potential gain)
- Efficiency (potential gain)
- Time savings (potential gain)
- Introduction of work evolution (potential gain)
- Potential risk of robot introduction (potential loss)
The applications were further classified into two different categories; the first, all of those applications deemed as an industrial product and the second, those applications more suited to an advanced research project. The matrix, shown in figure 1, identified the following two scenario applications which fell into the research project category and were selected for the challenge due to their matrix scores and the fact that both applications have the potential to be performed using a single robotic platform:

1. **Emergency Operations – Recovery Scenario**
   An autonomous or assisted teleoperated robot for reporting and specific operations including leak detection and localization in degraded and potentially hazardous situations.

2. **Routine Inspection – Task Automation Scenario**
   An autonomous or assisted teleoperated robot for surveillance and routine visual inspection operations in normal situations on production sites within difficult environments.

For both scenarios the focus is for the robot to safely move over the entire onshore or offshore production site in a potentially hazardous explosive environment, reporting on the situation in complete or supervised autonomy during day or night operations.

**Tasks**
In order to meet the demands of the business cases described previously, the robot must be able to perform two main tasks:

1. **Mobility in a human engineered environment**
   Wireless mobility on a representative competition site (concrete, steel floors and gratings, light slopes, steps and staircases, obstacles etc) in autonomous or assisted teleoperation control mode. The competition site that will be used during the challenge is shown in figure 2, a decommissioned former gas dehydration skid that is today used for firefighter and human operator training.
Main task characteristics:
The robot must demonstrate its capability on a competition field representing a typical onshore or offshore production facility:

- The robot has to move on different surfaces; concrete ground, steel floors and gratings; light slopes and steps up to several centimetres in height.
- The tasks are planned to be carried out in a multi floor setting: the robot must be able to ascend and descend stairs to move between the levels using its own power. The competition site is approximately 15 x 15 meters, has various floors and is composed of pipes, drums, columns, valves, pumps and associated instrumentation. To provide maximum mobility, a wireless solution is compulsory. The robot will be battery powered with an associated minimum autonomy.

Main actions required:
The robot is expected to move on the competition site using different control modes:

- Assisted teleoperation control by a human operator.
- Autonomously (the operator only indicates the intended destination to the robot) in a known area.
- The Human Machine Interface (HMI) design must be user friendly so that it can be used by a non robot expert operator.

2. Smart reporting and analysis of the environment

The robot must collect information (and transmit to the control room) via various sensors including image/video, sound and temperature. Different inspection rounds and missions will be tested including pre-programmed actions with autonomous detection, identification and localization of anomalies.

Main task characteristics:
The robot must report on the situation in an area (collection of information and transmission to the control room). All commands and data must be able to be communicated to and from the robot by a wireless link using Wi-Fi protocol.

Main actions required:
The robot has to read sensor dials, tank levels and valve positions, according to a pre-defined programme, and send a report of the inspection round. Furthermore,
the robot must autonomously detect and identify anomalies.

Technical constraints
To perform such tasks in environments described in each of the business cases, the robot must exhibit stringent technical capabilities. The following technical constraints are imposed on the robot design:

ATEX certifiability
The main constraint for the robot design is that the robot must be ATEX certifiable. The required level of certifiability for the robot is: ATEX Zone 1.

Within the framework of the challenge, it is not necessary to go through full ATEX certification. However, this certification being mandatory for equipment intended for use on operational production sites containing hydrocarbons in potentially explosive atmospheres, teams must demonstrate that their solution is compliant with ATEX regulations. By the end of the challenge, the robot must be fully ATEX certifiable. This compliance will be assessed by an independent third party verification ATEX expert.

Atmospheric and visibility conditions
To withstand the difficult environments described in the business cases robot design must include for atmospheric conditions expected to be encountered in real conditions. The robot must be able to fulfill the required tasks under daylight and night-time conditions. In normal conditions the robot shall be able to operate without human intervention for several weeks.

General constraints
The robot must be safe for its environment and cohabit with humans, sharing the same surroundings. It must not collide with any of the fragile equipment and structures. It must also avoid possible mobile obstacles.

The robot must be able to collect information with the same distance range and position as a typical human. The robot must be able to collect information in difficult to reach areas typical of a dense industrial environment behind structures and materials.

Competition Series
During the challenge, three separate competitions will be held, each of five day duration. The teams will be evaluated by a competition jury composed of external robotic experts and internal discipline specialists including operations, HSE, instrument and control. The competitions will become increasingly more difficult with the competition rules document being rewritten and updated depending on the success of the previous competition. The first competition in June 2015 shall focus on an autonomous routine inspection mission on the ground floor of the competition site. Instrumentation anomalies will be introduced; the detection of a general platform alarm and detection of unknown obstacles will be tested.

The second competition in March 2016 will introduce the multi floor environment and test the ability of the robot ascending and descending platform staircases. Autonomous reactions to further hazards such as the simulation of leaks will be tested as well as the autonomous negotiation of obstacles. Conditional programming will be introduced upon anomaly detection. The robots ability to adapt to changes to its environment will also be performed. Wireless communication will be deliberately injected with faults and interruptions to observe behaviour in downgraded situations.

The third & final competition in December 2016 will test the full autonomous functionalities of
the robot with respect to both routine and emergency response mission scenarios and the robot's ability to detect and localize all simulated hazards.

**Post Challenge**
The challenge has the aim of producing a design prototype that meets a Technology Readiness Level (TRL) of five. The technical requirements tested during the competition series should allow the teams to achieve this and ultimately produce a solution that can be industrialised for practical use. The overall ARGOS challenge winner will be announced late 2016/early 2017. The winner will be awarded a bonus for industrialization of the winning design prototype which will be used to meet enhanced post challenge design objectives.

The design must be such that it is suitable to withstand extreme environmental conditions such as desert and arctic climates and highly salty atmospheres. Additional features may be included such as a manipulation arm to perform tasks such as sampling fluid, valve operation and resets with more complex artificial intelligence algorithms. Full ATEX certification must be achieved (if not already received), and the successful completion of a stringent factory acceptance test must be carried out before ultimately performing an industrial pilot on an actual operational production facility in difficult atmospheric conditions.

**Conclusion**
The challenge intends to build competency and create a dynamic on robotics within the O&G industry to help prepare for the future and generate ideas on additional smart field applications. The systematic approach using staged competitions of increasing difficulty will allow many realistic scenarios and missions to be tested using typical hazards encountered in real-life situations. The involvement of key internal personnel (operations and HSE) throughout the challenge setup, launch, evaluation process, team selection and mission definition ensures that the results are very much end user driven.

The challenge, a first for the O&G industry, is a flagship R&D project for operators with the opportunity to promote collaborative innovation on next generation robots, especially in the area of safety for its personnel with potential valuable extension to other petrochemical facilities and public domains (fire fighters etc). Risk is mitigated by the strong evaluation and selection process ensuring the highest quality teams were selected to participate. Results will be communicated regularly not only internally but to a wider external audience in order to raise awareness of robotics to and receive general acceptance from the O&G industry as a whole.

**Acknowledgements**
The authors would like to thank ANR for their support during the launch of the call for proposal process and subsequent evaluation.

**Nomenclature**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ANR</td>
<td>French National Research Agency</td>
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<tr>
<td>ARGOS</td>
<td>Autonomous Robot for Gas and Oil Sites</td>
</tr>
<tr>
<td>ATEX</td>
<td>equipment and protective systems intended for use in potentially explosive atmospheres</td>
</tr>
<tr>
<td>CCTV</td>
<td>Closed Circuit Television</td>
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<tr>
<td>DOF</td>
<td>Degree of Freedom</td>
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<tr>
<td>E&amp;P</td>
<td>Exploration and Production</td>
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<tr>
<td>HMI</td>
<td>Human Machine Interface</td>
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<tr>
<td>HSE</td>
<td>Health Safety and Environment</td>
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<tr>
<td>IECEX</td>
<td>International Electrotechnical Commission System for Certification to Standards in Relating to Equipment for use in Explosive Atmospheres</td>
</tr>
</tbody>
</table>
IR        Incident Rate
LAN       Local Area Network
NASA      National Aeronautics and Space Administration
NREC      National Robotics Engineering Center
NUI       Normally Unmanned Installation
O&G       Oil and Gas
POB       Personnel on Board
R&D       Research and Development
ROV       Remote Operating Vehicle
SLAM      Simultaneous Localization and Mapping
TRL       Technology Readiness Level
UAV       Unmanned Aerial Vehicle

References
SPE-175471-MS
AUTONOMOUS ROBOT FOR GAS AND OIL SITES

Kris Kydd, Total E&P
Serge Macrez, Total E&P
Pascal Pourcel, Total E&P
ROBOTICS IN OIL AND GAS

- Already exist in E&P activities
- **UAV** Unmanned Aerial Vehicle
- **ROV** Remote Operating Vehicle
- **AUV** Autonomous Underwater Vehicle
SURFACE ROBOTICS

• O&G Industry beginning to look into...

• Two major impacts

1. HSE  Reduction of risk to personnel, environment & installation

2. Operational  Cost reduction, efficiency increase & production
POTENTIAL INDUSTRIAL APPLICATIONS

• Reduction of human exposure
  • toxic gas
  • harsh environments

• Recovery of a platform evacuated after major HC leak

• Operations on large onshore fields

• Reduction of IR on complex facilities with large POB

• Normally Unmanned Installations
ROBOTIZATION MATRIX

Best design is an industrial product (that still needs adaptation for Oil & Gas though)

Best design is a research project

SPE 175471-MS • Autonomous Robot For Gas And Oil Sites• Kris Kydd
OBJECTIVES

Emergency operations

Recovery scenario

Routine inspection

Task automation scenario

Autonomous or assisted teleoperated robot for reporting and specific operations including leak detection and localization in degraded and potentially hazardous situations.

Autonomous robots for surveillance, routine visual inspection operations in normal situations on production sites with difficult environments.

Build and test robot prototypes ATEX certifiable (TRL5)
AUTONOMOUS ROBOT FOR GAS AND OIL SITES

• Challenge Instrument

  • Trigger collaboration within robotic community for Oil & Gas issues

  • Robotics community are used to working in a collaborative manner (e.g DARPA)

  • Create internal dynamic

  • Tests different robot designs in a selective competition series
CHALLENGE LAUNCH

- Call for Proposal in key figures

- 31 projects received from consortiums and assessed by
- 15 countries represented from around the world
- 5 research teams selected in June 2014
Example: Initial test under controlled conditions. Limited obstacles. Ground floor only.

Example: Increase difficulties in terms of obstacles. Introduce multiple floors. Autonomy to detect leak.

Example: Final test – autonomous routine rounds disrupted by unexpected events and having to respond and report to “base”.

SPE 175471-MS • Autonomous Robot For Gas And Oil Sites• Kris Kydd
Name: AIR-K (Autonomous gas-leak Inspection Robot type K)

Country of Origin: Japan
Consortium: BestTechnology, Mobile Robot Research, FUJISOFT, Tohoku University, Shibaura Institute of Technology
Name: **ARGONAUTS** (Autonomous ATEX Certified Robots for Oil & Gas Industry)

Country of Origin: **Austria**
Consortium: **Taurob GmbH, TU Wien, TU Darmstadt**
Name: **FOXIRIS** (Flipper-based Oil & Gas ATEX Intelligent Robotics System)

Country of Origin: **Spain & Portugal**

Consortium: **GMV, IdMind & UPM-CAR**
Name: **LIO** (Legged robotic Inspection for Oil & Gas industry)

Country of Origin: **Switzerland**
Consortium: **ETH Zurich & Alstom Inspection Robotics**
Name: **VIKINGS** (Robotic Vehicle using Intuitive Kinematics and Innovative Natural Guidance Systems)

Country of Origin: **France**
Consortium: **IRSEEM, SOMINEX**
## TECHNICAL REQUIREMENTS

### 1. Mobility

<table>
<thead>
<tr>
<th>Task Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robot must demonstrate its capability of movement</td>
</tr>
<tr>
<td>- Range of surfaces, slopes and steps</td>
</tr>
<tr>
<td>- Multi floor setting</td>
</tr>
<tr>
<td>- Competition site is 15 x 15 meters, composed of pipes, drums, columns, valves, pumps, compressors, ...</td>
</tr>
<tr>
<td>- To provide maximum mobility, a wireless solution is compulsory.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Actions required</th>
</tr>
</thead>
<tbody>
<tr>
<td>- <strong>Autonomous operation mode</strong> – no direct intervention by human operator except in the case of an anomaly</td>
</tr>
<tr>
<td>- <strong>Semi autonomous operation mode</strong> – interaction between robot system and human operator through high level commands</td>
</tr>
<tr>
<td>- <strong>Assisted teleoperation mode</strong> – remotely controlled by human operator</td>
</tr>
</tbody>
</table>
TECHNICAL REQUIREMENTS

2 Reporting

Task Characteristics

Robot must report on the situation using various sensors:
- Image/Video
- Sound
- Temperature

All commands and data must be communicated to and from robot by wireless link.

Actions required

Robot has to read instrumentation and valve positions, according to pre-defined programs and send inspection reports.

Robot must autonomously detect and identify anomalies.
CONCLUSION

• Overall challenge winner will be announced late 2016 / early 2017

• Awarded bonus for industrialisation of winning design prototype

• Post Challenge
  • Full ATEX certification
  • FAT completion
  • Industrial pilot carried out on actual operational facility

• A first for the O&G industry, robotic challenge is a flagship R&D project for operators, promoting collaborative innovation on next generation robotics
Acknowledgements / Thank You / Questions

Total E&P