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The ORCA Hub: Explainable Offshore Robotics through Intelligent Interfaces

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ABSTRACT
We present the UK Robotics and Artificial Intelligence Hub for Offshore Robotics for Certification of Assets (ORCA Hub), a 3.5 year EPSRC funded, multi-site project. The ORCA Hub vision is to use teams of robots and autonomous intelligent systems (AIS) to work on offshore energy platforms to enable cheaper, safer and more efficient working practices. The ORCA Hub will research, integrate, validate and deploy remote AIS solutions that can operate with existing and future offshore energy assets and sensors, interacting safely in autonomous or semi-autonomous modes in complex and cluttered environments, co-operating with remote operators. The goal is that through the use of such robotic systems offshore, the need for personnel will decrease. To enable this to happen, the remote operator will need a high level of situation awareness and key to this is the transparency of what the autonomous systems are doing and why. This increased transparency will facilitate a trusting relationship, which is particularly key in high-stakes, hazardous situations.

CCS CONCEPTS
• Human-centered computing → User interface management systems;

KEYWORDS
Autonomous systems, intelligent systems, transparency, trust, situation awareness, explaining robot actions, cognitive load

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1 INTRODUCTION
The international offshore energy industry currently faces three major challenges of an oil price expected to remain less than $50 a barrel, significant expensive decommissioning commitments of old infrastructure (especially North Sea) and small margins on the traded commodity price per KWh of offshore renewable energy. Further, the offshore workforce is aging as new generations of suitable graduates prefer not to work in hazardous places offshore. Operators, therefore, seek more cost effective, safe methods for inspection, repair and maintenance of their topside and marine offshore infrastructure. Part of this solution is deploying robots and autonomous systems in the air, on the rig and on the water surface and subsea. This will mean fewer staff offshore, reduced cost and increased safety. The long-term industry vision is thus for a completely autonomous offshore energy field, operated, inspected and maintained from the shore.

The hub will investigate key areas in robotic autonomy, mobility, manipulation, sensor processing, autonomous mapping, navigation, multimodal interfaces and human-machine collaboration. It is the latter two that we focus on here. Key to adoption of robotics and AIS is the ability for users to feel confident and trust them enough to deploy them in remote high stakes, hazardous environments. Our solution will be to provide effective communication of their world view, which includes explanations of actions and plan failures to develop trust, avoid unnecessary aborts and increase adoption. Core to our approach is the interpretation and explanation of autonomy models, which include both black-box (e.g. deep neural network) and grey-box models (e.g. Bayesian networks) of the learning algorithms for planning and interacting with the environment. This increased transparency will facilitate collaborative activities such as re-planning with multitasking, and aid decision making. Specifically, we will develop interaction techniques to increase robotics transparency in the following ways:

1) “Why did you do that?”: Explain the robot’s behaviour models with various scrutability levels (from black-box to rule-based systems).
2) “What are you doing”: Explaining activity, reporting what the system is actually doing (not what it thinks it’s doing).
3) “What do you see/sense?”: Explain the environment.
4) “What if you do this instead?”: Explain possible outcomes of alternative plans, thus aiding decision making.

2 OUR APPROACH
In order to facilitate representation of explanations in context, we will create an adaptive, situated multimodal interface that is in tune with the user’s cognitive load. We will adopt a user-centred design approach, capturing from users in-situ operational goals and context, user mental models, terminology, preferred modality (e.g. speech, gesture, augmented reality) and visual conventions. This
which the ORCA hub would interface; background: MIRIAM

will inform iterative development of both the user interfaces and models from observational data of robots and the environment. We is part of the DARPA XAI COGLE project, to induce programmatic from robot behaviours and controllers in order to produce queri-

load low.

unconscious visual) processing, in order to keep operator cognitive

hierarchical cognitive chunking and human perceptual (particularly

explanations will be presented in a structure and form that exploits

Bayesian network) reasoning, and the resulting visual and textual

be applied to both black-box (e.g. CNN/RNN) and grey box (e.g.

the autonomous system in a meaningful way. This approach will

of the plan that is being carried out, so that users can interact with

mation presentation and explanations with the user’s actual needs

hear what the interface can tell them for certain. Balancing infor-

tion and may depend on the user with some users preferring to

receive all information and hypotheses and some just wanting to

hear what the interface can tell them for certain. Balancing infor-

mation presentation and explanations with the user’s actual needs

and cognitive load in a dynamic, fast moving environment, will

be essential to the successful deployment of robotics and AIS in

offshore robotics and elsewhere.

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