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A Digital Twin for Human-Robot Interaction

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Abstract—To avoid putting humans at risk, there is an imminent need to pursue autonomous robotised facilities with maintenance capabilities in the energy industry. This paper presents a video of the ORCA Hub simulator, a framework which unifies three types of autonomous systems (Husky, ANYmal and UAVs) on an offshore platform for training and testing human-robot collaboration scenarios such as inspection and emergency response.

Index Terms—human-robot interaction, cooperative robotics

I. INTRODUCTION

The long-term industry vision for the energy sector is for a completely autonomous offshore energy field, operated, inspected and maintained from the shore. This will mean fewer staff offshore, reduced cost and increased personnel safety. Keeping the human-in-the loop will be key for operation success in terms of maintaining situation awareness and understanding what the robotic systems are doing and why. The EPSRC funded ORCA Hub Programme [1] is investigating, developing and testing robotic systems and artificial intelligence to transform the energy sector into an industry of remote solutions. An essential step towards this long-term vision is the ability to train, test, evaluate and visualise robotic activity that would happen remotely. In this paper, we present a novel simulated digital twin for such a remote platform and discuss its uses and applications, focusing on human-robot interaction.

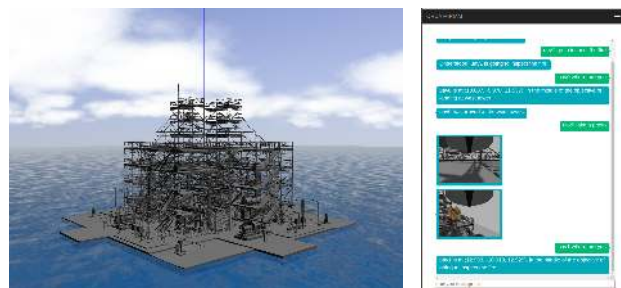
II. SIMULATOR OVERVIEW

The ORCA Hub simulator is a ROS-enabled oil rig environment (see Fig. 1(a)) composed of four Autonomous Robot for Gas and Oil Sites (ARGOS) rescue scenario towers [2]. The simulator provides a semantic description of the oil rig structure, i.e. a map from 3D coordinates to high-level labels, which bridges the human-robot communication gap. Moreover, to ease some of the inherent robotic challenges, the simulator provides a semantic road map for autonomous point-to-point navigation and collision-free planning. The simulator supports HRI (see Fig. 1(b)), including interacting with the robotic platform through natural language commands and receiving vehicle and mission status through natural language such as “inspect the fire on the top floor of the east tower”, building on previous work [3].

The video will show multiple instances of robotic platforms simultaneously deployed in the simulator (see Fig. 1(c)). Specifically, the following robots: (i) ANYmal, an agile quadruped ideal for uneven terrains, (ii) Husky, a medium-size robot with large payload capabilities, capable e.g. of

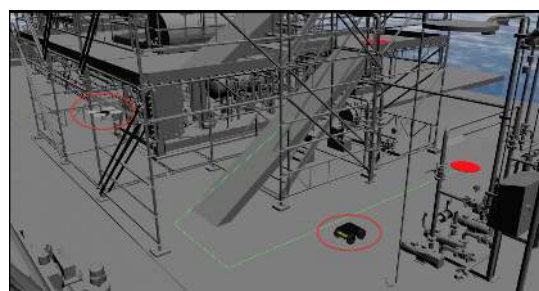
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(a) Simulated oil rig

(b) Natural language interaction interface



(c) Multiple robots on site: Husky and UAV

Fig. 1. Overview of the ORCA Hub simulator.

extinguishing a fire, and (iii) Unmanned Air Vehicles (UAV), ideal for aerial inspections. The video will exemplify the use of such a diverse set of robotic platforms for enabling a wide range of capabilities, for cooperative inspection of large areas and emergency response and natural language interaction.

III. IMPACT

This digital twin will have high impact in terms of developing HRI techniques for example facilitating human-robot trust in high stakes scenarios such as emergency response. It will also allow testing of task planning algorithms for cooperative inspection and long-term autonomy, and human-guided supervision and control of the robotic assets from remotely located control stations. Being able to exhaustively test these applications ensures the coherence and efficiency of the execution plans, thus increasing likelihood of adoption of robotics and autonomous systems for high-risk environments.

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