COMMERCIAL APPLICATIONS OF SPACE-ENABLED ROBOTICS: ENERGY & UTILITIES USE-CASES

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Table of Contents

1. INTRODUCTION

This document lists the use cases to be used as part of the *Energy & Utilities* thematic area of the 'Commercial Applications of Space-Enabled Robotics' thematic call for proposals.

The use cases presented result from the cooperation between the European Space Agency (ESA) and key stakeholders in the energy and utilities sector. It aims to support the study and demonstration of services enabled by robotics and satellite technologies that are uniquely positioned to solve issues in the energy sector.

When writing the initial proposal (APQ/Outline proposal), the applicant will make clear what use case(s) their solution will address.

2. ENERGY & UTILITIES USE CASES

ESA and aforementioned key stakeholders have identified the below focus areas and use-cases within which space-enabled robotics may add value. Prospective bidders to this thematic call for proposals are invited to submit proposals addressing the below use-cases, or to submit alternative ideas based on their own research and knowledge.

2.1. Unnamed Multinational Energy Utility Company

2.1.1. Automation of Transportation of Wind Farm Components

In order to plan and carry out the transportation of large components required for the construction of wind power plants – such as large wind turbine blades (up to 100m in length), generators, and support structures – it is necessary to know the location and characteristics of the roads and infrastructure that may obstruct or complicate the transportation of the component to its target destination. Issues in transit can cause delays and threats to safety.

At present, a land survey (e.g. by car) is conducted in the months prior to delivery of the components to verify the optimal route based on factors including the state of the traffic and measurements of bridge passages, curvature radii, proximity to obstacles, trees and vegetation, power lines, buildings, and any further characteristics of the route that may pose difficulties. Following this verification, a detailed report is produced. The wind plant components subsequently arrive by ship to the port closest to the delivery field and are transported to this destination. The delivery vehicles used are trucks capable of independent movement of their axles by means of a special controller used by ground assistance, as needed to navigate the route.

Both processes – the modelling of the route and the transportation of the components via truck – can be supported with satellite technology and data, combined with robotics.

2.1.1.1. Preliminary Route Survey

High-resolution satellite imagery, complemented with further datasets as needed, could be utilised to create a 3D digital model on which to first simulate the transportation of the wind farm components, and subsequently be utilised for assisted navigation of the trucks themselves. The role of the model is to gauge the optimal path for transportation and understand the modifications required to the route or obstacles to enable safe and effective passage. The model should inform the need for obstructions to be removed (e.g. trees to be cut down) or more significant actions to be taken (e.g. changes needed to road elements, such as moving traffic signs etc.), and then allow further precise simulation to re-evaluate the viability of the path (having virtually removed the obstacle from the path) before acting in the real world. Alternative solutions to model creation can also be explored such as use of autonomous systems equipped with appropriate payloads to collect the model data before integration into a GIS (geographical information system).

2.1.1.2. Navigation and Operation of Semi-Autonomous Truck

The subsequent step would involve utilisation of the 3D model to navigate and operate the semi-autonomous truck according to the decided route from port to delivery field. This step would involve augmentation of the existing trucking system to enable semi-autonomous navigation and operations, accounting for the overall routing but also manoeuvres necessary to avoid obstacles. This step will require the use of high accuracy satellite positioning distributed along the length of the vehicles, and additional situational awareness data gathered in real-time to assist the transportation team throughout the entire route and alert of potential issues in-transit. Note that the 3D model would be actively referenced throughout the transit, thus it is not solely a precursory analysis tool but also actively used to guide the vehicle. Note that the *existing* truck system should be automated by interfacing with the actuators and motors already present in the vehicles for assisted navigation – entirely new robotic trucks are not sought. This integration will need to simplify the transportation itself, increasing the safety and confidence in completion of the transit.

The target outcome is faster, and more efficient means of activity planning, and a more safe, cost-effective, and precise process than the current manual method used.

Those interested to address this use-case could focus on one or both challenges, however, the 3D digital model will be required for the navigation of the semi-autonomous truck. Thus, 2.1.1.2. is dependent on 2.1.1.1.

2.2. Unnamed Multinational Energy Utility Company #2

2.2.1. Improved Automation of Drones for Repeatable Inspections of Hydropower Plants

Hydropower plants have many structures that require recurrent inspections. At present human labour, subsurface robotics, and drones are used to carry out such inspections. Much of the current inspection and monitoring process of non-submerged parts of the infrastructure relies on operation of drones by skilled pilots. The drones are equipped with imaging payloads to carry out visual checks of the infrastructure, and probes utilised to take ultrasonic thickness measurements at the surface of the infrastructure. There is interest in solutions to enhance the automation of such drone inspections for precise data collection, anomaly detection, and repeated inspections of the hydropower plant infrastructure over time. This use-case foresees the use of high-accuracy positioning, an increase in the accuracy of SLAM (Simultaneous Localisation and Mapping) and automated drone flight path planning to carry out such repeated inspections at the same *exact* coordinates on the infrastructure, with precision, on a recurrent basis.

2.2.2. Wind Turbine Blade Inspections and Repair

Wind turbine blades are constantly exposed to environmental loading from rain, hail, wind, moisture, dust, and beyond, which causes their gradual degradation and wear. Deployment of robotic solutions (drones and/or crawlers) for inspection and repair (composite or superficial repairs) of wind turbine blades could negate the need for humans to be working at height, and thus risking their own safety in completing inspection and maintenance work. Robotic solutions may also help negate the need to dismantle wind turbine blades and bring them to ground level to facilitate repairs for cases that require it, if such repairs can be completed at height. Robotics may be used to identify and precisely locate damages, quantify them, and repair them where needed. Solutions for accurate and automated wind turbine infrastructure inspection and repair are sought, both covering the external and internal facets of the infrastructure. Proposed solutions could involve a Launch and Recovery System deployed at height such that it is easily deployed to carry out inspection and repair activities. The robotic solution should have real-time imaging capability so that remote operators can guide/monitor the inspection and repair processes.

2.2.3. Solar Farm and Battery Energy Storage Inspection and Monitoring

At present, operators derive various data feeds directly from solar farms and battery energy storage, however, personnel are often deployed when issues are flagged. There is a need for automated visual checks when so prompted by the contents of the data feeds, as problems and hazards are indicated. A possible approach could be to carry out a visual check via satellite imagery to identify the source of the issue before confirming with an on-ground solution such as through robotics or drones. The latter will help determine whether a visit from personnel is necessary or not. This use-case foresees solar farm and battery energy storage inspection and monitoring facilitated by satellite data and a local, autonomous robotic system to provide higher accuracy information on relevant concerns identified by the satellite data. This is in order to monitor the state of the health of the assets.