Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

NIA Project Registration and PEA Document

Date of Submission

Nov 2016

Project Reference Number

NIA_SGN0104

Project Registration

Project Title

Robotic Roadworks System (RRS) - Stage 2

Project Reference Number

NIA_SGN0104

Project Licensee(s)

SGN

Project Start

November 2016

Project Duration

0 years and 6 months

Nominated Project Contact(s)

Ollie Machan, Innovation Project Manager

Project Budget

£305,303.00

Summary

Following on from the Stage 1 feasibility study, the scope of this research and development project is to continue maturing the RRS technology whereby SGN and ULC can gain confidence in the project's success in its entirety. The project will facilitate the development of the systems and includes additional conceptual design to refine the Robotic Roadworks System along with additional analysis, and hands on evaluation of high potential technologies such as utility locating technologies. Further evaluation of the preliminary tools and sensors will enable final selection of critical system components. This evaluation will facilitate system design and integration efforts for the mobile platform, robotic arm, and automation component of the RRS

Nominated Contact Email Address(es)

sgn.innovation@sgn.co.uk

Problem Being Solved

Operations and maintenance costs represent a major portion of any GDNs budget. Gas main excavations as currently performed are very labour-intensive and disruptive, but necessary to repair aging infrastructure and install new asset. Various operational teams are required to perform asset location and mark up, excavation, sheeting and shoring, repair or replace and reinstatement. A single excavation represents a major investment of time, money, personnel, and equipment. The costs of these excavations are ultimately incurred by the gas customer. The cost of labour, the cost to operate and maintain the vehicles and equipment, and the cost of lane rental and permitting will only continue to increase.

In addition, the underground networks of major cities can be very crowded, with gas, sewer, water, electrical, telecommunications, and other utilities running in close proximity to one another. These underground networks are often inadequately mapped and the locations of different utility infrastructure installed below street level are almost never integrated on the same map. This lack of integration can lead to accidental impacts with unknown buried infrastructure during excavation; potentially causing service disruptions, serious damage, and even loss of life and property.

Keyhole excavation has become a standard method used to access buried utility infrastructure. Keyholes drastically decrease the size

of the excavation - making them minimally disruptive to customers and the public. Although repairs and maintenance performed via keyhole is a substantial improvement over standard excavation techniques, improvements to the full end to end process would yield dramatic benefits to end users and to the GDNs.

SGN are now looking to assess the possibility of introducing a more advanced innovative robotic roadworks solution to improve the operational processes, specifically around excavations and the works required in them.

Method(s)

Task 1: Shortlist Robotic Operations

- Under Stage 1 of the project, a list of potential operations was collaboratively developed by ULC and SGN and formed the basis for the preliminary feasibility assessment.

Task 2: Identify and Test Locating and Mark-Out Solutions

- During Stage 1, an investigation into locating technology and techniques was performed. While some existing locating technology may hold great promise for locating underground utilities, there is potential to develop and refine locating and mark-out tools and techniques for a mobile platform. As a next step, during Stage 2, ULC will perform comprehensive research, review state-of-the-art locating and mark-out solutions, and identify the latest research that has commercialization potential.

Task 3: System Architecture and Conceptual Design

- ULC will develop the initial system architecture and continue with the conceptual design of the system. System architecture development includes the following tasks:
- Identification of system functions and components based on operations selected under Task 1. These system functions will be documented in the report.
- Identification of key interfaces and potential technologies for these interfaces. This includes developing the preliminary requirements for these interfaces.
- Development of preliminary electronics and software architecture. This includes the determination of the types of electronic and software components e.g. circuit boards, control panels, user interface etc. that will be required for the RRS and the interfaces between these components. The architecture will be documented in the form of block diagrams.

Task 4: Preliminary Investigation and Development of Excavating Method

- Under this task, ULC will review the current excavation tools including minimally invasive tools and determining the adequacy of the tools in performing excavations while minimizing the risk of accidental infrastructure damage. Following this review, ULC proposes to build a new tool or method for use with the RRS system.

Task 5: Review and Update Phase 1 Considerations

- Under Stage 2, ULC will review the operational considerations and excavation processes outlined in Stage 1 and may update them based on new information derived during shortlisting the operations in Task 1, determining the locating and mark-out technology in Task 2, developing the RRS architecture and conceptual design in Task 3, and developing excavation methods in Task 4.

Scope

Following on from the Stage 1 feasibility study, the scope of this research and development project is to continue maturing the RRS technology whereby SGN and ULC can gain confidence in the project's success in its entirety. The project will facilitate the development of the systems and includes additional conceptual design to refine the Robotic Roadworks System along with additional analysis, and hands on evaluation of high potential technologies such as utility locating technologies. Further evaluation of the preliminary tools and sensors will enable final selection of critical system components. This evaluation will facilitate system design and integration efforts for the mobile platform, robotic arm, and automation component of the RRS

Objective(s)

The objective of this project is to:

- Carry out a hands on investigation into performing current operational repair and maintenance activities using a new innovative robotic system.
- Finalise a list of core hole and compact excavation repair/maintenance operations and rural excavations that may be used in the system development. Additionally, focus will be applied to selecting operations, not currently performed in core holes, which may be performed in a core hole when using this new system.
- Finalise a robust cost benefit analysis (CBA) which may be used to support an ongoing Stage 3.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The success criteria for the project are:

- Finalisation of priority operations that form the baseline for the design and development of the RRS
- Summary of research of conventional and state-of-the-art Locating and Mark-out technologies. This will include test results from hands-on testing performed under this stage of work
- Description of the maturation of the RRS conceptual design including potential sensors and tools and the preliminary layout of these tools, sensors and equipment in the truck and on the mobile platform
- Results of preliminary development of system architecture with a focus on key components and interfaces
- A list of preliminary system requirements to aid in further system development under the next stage of work
- Results of research into a 'soft touch' excavation tool solution for eliminating damage during excavation
- Updates to the Stage 1 outputs generated during Stage 2 for the robotic arm selection, operational considerations for deploying the RRS, procedural steps for performing keyhole operations with operator intervention points and learning outcomes, will be provided in this final report.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

This project has been designed to be the second stage of a larger project developing a Robotic Roadworks System. Adopting a stepwise approach allows the costs and risks to be managed whilst at the same time gauging the engineering viability for the following stage.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

The research and development study will be undertaken at the ULC offices in New York state. No field trials are anticipated during this stage.

Revenue Allowed for the RIIO Settlement

There are no direct saving benefits anticipated.

Indicative Total NIA Project Expenditure

The total project expenditure is £305,303, 90% of which is allowable NIA expenditure (£274,773).

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

n/a

How the Project has potential to benefit consumer in vulnerable situations:

n/a

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

It is difficult to accurately quantify the actual financial benefit at this stage; as indicated by the low start TRL shows the Method is at an early stage of development and cost estimates will be refined as it is further developed. However, It is envisaged that deployment of this technology may lead to financial benefits in the following areas:

- Reduction in manual excavations in the public carriageway
- Less excavated material send to landfill
- More efficient and cost effective operations methods
- More efficient and costs effective reinstatement methods
- Reduction in the import of virgin or recycled backfill material
- Less disruption to customers and members of the general public

Please provide a calculation of the expected benefits the Solution

N/A

Please provide an estimate of how replicable the Method is across GB

This method could be applied across the whole of GB and applies to all network licensees.

Please provide an outline of the costs of rolling out the Method across GB.

This is not currently known.

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

☑ A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).

☐ A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)

☐ A specific novel operational practice directly related to the operation of the Network Licensees system

☐ A specific novel commercial arrangement

RIIO-2 Projects

☐ A specific piece of new equipment (including monitoring, control and communications systems and software)

☐ A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven

☐ A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)

☐ A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology

☐ A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution

☐ A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

By undertaking this development work the gas industry as a whole can share the overall cost, knowledge, risk and subsequent benefit from development and testing.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

N/A

☑ Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

Is the default IPR position being applied?

☑ Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

n/a

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

n/a

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

n/a

Relevant Foreground IPR

n/a

Data Access Details

n/a

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

n/a

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

n/a

This project has been approved by a senior member of staff

- [x] Yes