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

May 2018

Project Reference Number

NIA_NGTO006

Project Registration

Project Title

Mobile robot for automated identification of failures in HV substations

Project Reference Number

NIA_NGTO006

Project Licensee(s)

National Grid Electricity Transmission

Project Start

October 2016

Project Duration

4 years and 10 months

Nominated Project Contact(s)

Oliver Cwikowski

Project Budget

£550,000.00

Summary

This project aims to use machine-learning methods to improve thermal substation inspections, with a view to automate data collection andinspection in the future. By taking environmental data and load data with thermal imaging inspections, contextual information can beobtained.

Nominated Contact Email Address(es)

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Problem Being Solved

National Grid undertakes periodic inspections of substation assets. These inspections are currently carried out using, amongst other items, infrared/thermal imaging (theromgraphic) cameras and radio frequency (RF) based discharge measurements. These inspections provide early indications of failure within the substation assets. These inspections also provide an opportunity to understand asset condition but are ‘spot’ measurements highlighting potential issues only visible at the time of the inspection. The benefit of these inspections are currently limited as:

- certain types of faults can be intermittent and therefore may not be detected by periodic monitoring
- measurements may require systems to be under load, and loads are variable as a function of time of day / day in the year weather conditions may significantly influence measurements.

This project seeks to identify a solution that can take regular measurements supporting the condition assessment of substation assets without relying on people entering the substation, and to also reduce the number of false reading surveys that are undertaken. Due to the intermittent nature of the faults we are looking to measure, false reading surveys (where a fault is only partially identified, or not identified at all at the time of the survey being conducted, due to the time limiting factor of an actual operators presence within the substation) are time consuming to correct and may lead to repeated surveys being undertaken.

Method(s)

The project will seek to develop an autonomous device that can take regular thermographic / RF measurements of substation assets (including within risk management zones) and use the information collected by these measurements to identify patterns of unusual behavior in the substation asset.

Scope

The scope of the work will be as follows:

Task 1. Data collation: The first part of classifying normal behaviour is to collate data from multiple sources on the high risk assets. Data from previous tests will be made available for use and a fixed monitoring system (with appropriate sensors) will be installed at a substation. This fixed monitoring system will allow the measurement of data in a range of weather conditions and under a range of load conditions. It will therefore provide specific data that can be used in the data analytics task. New data will be also be collected as required in experiments in the high voltage (HV) lab at the University of Manchester.

Task 2. Data processing: Different statistical analysis tools will be applied to interpret the data collated in task 1 in order to create metrics. From this analysis, models of normal asset behaviour will be produced. This task will investigate methods for predicting if the measurements are within the normal range. If not in range, it is assumed that the asset is at a higher risk of failure / investigations should take place.

Task 3. Comparison of available localisation systems: A number of systems exist to accurately provide location data for mobile robotic platforms. The standard method of differential global positioning system (GPS) and magnetometers may not work correctly in HV substations, due to the metalwork reflections and the noisy RF environment. Trials of different localisation systems will be carried out to understand the likelihood of receiving accurate location data. The trial will also include buying a robotic platform, attaching measuring devices and operating the platform in a high voltage substation.

Task 4. Providing information to the operator: This task will evaluate ways to present intuitive information to the operator of the measurement system [the human – machine interface (HMI)]. This will ensure the location of the potential failure is identified along with relevant measurement information.

Objective(s)

The overall objective of this project is to develop an autonomous device capable of continuously monitoring assets in order to reduce the number of false reading surveys.

The objectives of the project are as follows:
- To collect data that supports the value proposition associated with continuous monitoring of substation assets
- To develop algorithms that successfully identify assets with higher probabilities of failure
- To develop a prototype mobile robot, including the attachment of measuring devices which is capable of operating in a high voltage substation
- To evaluate the ability to locate an autonomous system accurately and therefore allow it to move around a substation without human interaction
- To develop techniques that provide information to operators allowing them to rapidly identify potential failures

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be deemed successful if we are able to develop an autonomous device to collect, and the algorithms to analyse, asset condition data; and highlight to an operator components at risk of failure / requiring maintenance.

Project Partners and External Funding

External Funding – EPSRC iCase funding (through the University of Manchester) £81,430

Potential for New Learning

The learning from this project would provide benefit to all network licensees within the UK given the common substation infrastructure that exists. There may be differences in the scale of deployment between transmission and distribution sites with a lower requirement for autonomous systems at the smaller scales.

Scale of Project

The project will be based around a desktop literature review and a range of laboratory based experimental measurements to develop and build a prototype. Once developed the prototype will be trialed within a substation environment in close proximity to the University of Manchester, using the algorithms developed based on the data received from installing a fixed monitoring system within the substation.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

This project will be based within the University of Manchester for the development of the algorithms and the mobile platform, with site trials of the prototype taking place within a suitable high voltage substation.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£470,000 of NGET NIA expenditure

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)

The estimated net present value benefit for this project is £2.2m. This is based on phased reduction on the number of hours required to correct false reading surveys.

Please provide a calculation of the expected benefits the Solution

Based on one of the areas in which this device could be utilised, and taking into account further development costs, it is anticipated that this robot would save; 50%, in the first five years of deployment and; 90% in the following five years, of the time needed to correct false reading surveys.

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

If successful, this method would be replicable across all GB Network Licensees high voltage or low voltage substations.

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

The estimated cost of each robot is in the region of £25,000 (excluding any re-development costs).

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

The data analytics that are developed and the autonomous platform / techniques to capture data could be used by all network licensees as part of their overall asset management practices.

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

This project fits within the following value area of the Electricity Innovation Strategy:
Managing Assets - Managing assets throughout their lifecycle

☑ 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.

There are no similar projects registered on the ENA Smarter Networks portal.

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

There is no current automated solution to take regular measurements of substation assets and data analytics is increasingly becoming an area of focus for NGTO in the field of asset management.

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

This project carries an element of risk (primarily technical and operational) because research and development of a robotic solution to continuously monitor assets with the purpose of reducing the number of false readings has not been done before. NIA funding offers the most appropriate route for NGTO to evaluate and assess such a solution.

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

This project contains a number of risks (as summarised above) and NGTO would only be able to consider funding the project at the point when the technical and operational functionality had been demonstrated. The learning from this project would also provide benefit to all Network Licensees given the common substation infrastructure that exists. For this reason, NGTO believe this project is appropriately funded through NIA.

This project has been approved by a senior member of staff

☑ Yes