**Design Requirements**

**Problem Statement**

Motorway gantries hold signs and signals on metal structures over motorways. They must be inspected to check their structural integrity, however their size and the fact they sit over motorways, which are busy and key infrastructure, makes in-depth inspection difficult. Motorway gantries have hollow elements, but these spaces are too small for a human to fit or UAVs to operate. The creation of a system to check the inside of the motorway gantry allows for more thorough inspection and can be done in a way that does not necessitate closing that section of the motorway or the erection of scaffolding/other inspection platforms.

**Mechatronic**

The system shall be able to move through a 300 mm by 300 mm space.

The system shall span at least 500 mm for climbing.

The system shall climb vertically, it should not slip down. If it slips it should know that this has happened.

The system shall not fall over.

The system shall be able to turn 90 degrees whilst the end effector stays within 2 300 mm by 300 mm windows as shown below:

A cross-section of a camera

Description automatically generated

**Sensing**

Sensing system is split into two parts:

1. Navigation/ Positioning:

The system is equipped with sensors to aid the navigation in the environment

The sensors system must be able to:

* Detect obstacles/flanges during climbing/turning
* Detect the orientation/position of the robot
* Detect if the robot is slipped

1. Non-Destructive Testing:

The system should be able to search for the following infrastructure faults:

* Surface damage
* Missing infrastructure sections
* Damaged coatings
* Signs of water: Running water, algae, etc.
* Brown staining
* Spawling of coating
* Remaining thickness of the wall
* Thickness of the wall coating

**Power**

The whole unit should be powered from a single power supply to simplify the power distribution, reduce risk for short circuits and prevent any current imbalance through the circuit

The unit should be tethered to just a single power line to avoid any tangles and kinks during locomotion and turning of the unit

The power distribution will be equipped with a fuse for overcurrent protection

**Control**

The system is mainly controlled by operator to ensure flexibility and real-time decision-making in navigating the gantry environment

The system shall have a UI that displays processed sensor data in real-time. This will enable the operator to monitor the system’s navigation and inspection process.

The system shall use a gamepad controller providing an intuitive interface for the operator.

**Budget**

The finished product shall cost no more than £1650

* The motors and actuators should correspond to 46% of the total – include costs for prototypes and testing
* The turning mechanism should use another 15% – raw materials for working unit and prototypes
* The sensors should use another 6.5% – cameras and positioning sensors
* The chassis should be allowed 7.5% of the total – raw materials for machining or fabrication a rigid case
* Controls should be 10% of the total – main processing unit, microcontroller, and drive boards
* Contingency costs will comprise of 7.5% of the budget – used for any unforeseen circumstances
* Other parts of the build will use another 7.5% of the budget – power systems, fasteners, and miscellaneous