

## **Problem Statement**

**The client needs a lightweight, portable and cost-efficient 3 DOF end-effector for a pre-existing robot arm to scan, water blast and repaint rusted areas on the Halifax Class Frigate.**

## **Client Needs**

The client - Theodore Eastmond, the senior project engineer of Naval Materiel Technology Management of the National Defense of Canada.

-The Client requests an end effector for a pre-existing robot arm that will be used to carry out certain duties on the Halifax Class Frigate.

Requirements of end effector and control program for robot arm:

2 strong nozzles, one for paint and one for pressure washing along with a camera(with integrated lights)

The camera should be relatively good quality with integrated lighting system

End effector with 3 degrees of freedom arm

Should be able to broken down in 20lbs components

Should be able to be plugged into 120v outlets

Easily exchangeable heads

Can be operated by 1 non-technical person

Water resistant/proof

Suitable for small repairs every 3 months, large repairs every 8-12 months

A compressor for the water

Little or no technical experience by the user to be able to operate

Powered by Arduino or a Raspberry Pi

Programming language used should be C/C++ which is easily transferable to GCODE (Open source)

End effector should be 3D-printable and lightweight

End effectors need to scan and paint the area required.

Max weight at the end of the effector 750g

**PRIORITY REQUIREMENTS (in order of priority):**

- 1) Robot arm must be able to move using inverse kinematics
- 2) Cost-efficient End effector
- 3) Camera with surface scanning capability
- 4) Ability to fit into a 1m<sup>2</sup> spaces
- 5) Suggestions and Modification to Thor (pre-existing robot arm used by navy)
- 6) The ability to break down into 20lbs components
- 7) Nozzles can be swapped out
- 8) Easy to maintain
- 9) Relatively easy to use

**Potential Problems (determined from benchmarking)**

- Consistency of the clean (How will the robot take into account areas that are more/less rusted than others)
- Vibrations from the washer affecting the sensors
- 3D printed parts may be more prone to damage
- How to differentiate between rust and other contaminants
- Water and electrical lines pose tripping hazards in confined spaces
- GCODE challenge
- Must be able to maneuver in dark environments
- How to scan around potential obstacles