Project Deliverable B

Needs Identification and Problem Statement

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Abstract

On Halifax-class frigates, the Department of National Defence has a need for a robotic arm that uses inverse kinematics to paint surfaces. The robot must also scan and clean areas to identify and remove defects. To design the robot, a design process with several steps will be followed. Thus far, raw data about the product has been gathered from one of the users. At this stage in the design process, the data from the user needs to be interpreted to identify user needs and to formulate a problem statement. This report categorises data from the user, interprets and prioritises the user needs, and establishes a problem statement.

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1.0 Introduction

The Department of National Defence expressed the need for a robotic arm with three degrees of freedom to paint areas on Halifax-class frigates. Raw data was collected from the client and analysed to identify the needs of the user. The client stated a necessity for the use of inverse kinematics and discouraged the use of G-code. Using these requirements and others collected during the client interview, the problem statement was created.

2.0 Needs Identification

In this section, user needs that were interpreted from raw data from a user are categorised into subsections and explained. The subsections of needs are followed by a discussion of the relative importance of the needs based on what the client said.

2.1 Safety

This robot will be transported and operated by a single person. This means that the arm cannot be too heavy or awkward. The arm itself needs to be able to support a maximum of 1 kg and a pressure of 8 bar from the sand/water blast. To avoid injuries and further damage the robot must be able to scan an area for people and objects.

2.2 Technical

Since the product will be operating on a ship and possibly in confined spaces, it should fit through a space a maximum of 1 m^2 and should not exceed a weight of 20 lbs. If the robot is heavier than 20 lbs, it should be able to separate into components that can be removed easily. The robot end effector should be detachable and switchable.

From a technical aspect, the product should be user friendly and designed to be used by a single user with little to no technical experience. This includes the operation, the assembly, and the disassembly. It should also operate using inverse kinematics with exactly three degrees of freedom using an open source programming language, such as python or C++.

2.3 Miscellaneous

At some point, the robot will break or need maintenance. To ensure that the product can continue to be used, the product should be reproducible using 3D printing and easily maintained by one individual.

When in motion, the robot arm will be able to extend within a one metre radius. This movement means that the centre of gravity will change dynamically. The robot should not tip over because it would lose functionality and if safety procedures are not followed, it could possibly fall from an elevated platform and hurt someone.

2.4 Hierarchy of Needs

When analysing the needs of the user and client, the safety requirements of the product are the most important because the user's safety is always the top priority. The second most important part of this project are the technical and dimensional requirements. The product needs to be easily transportable around the ship and do its job effectively. Finally, miscellaneous needs were identified which are important, but less so than the former subsections.

3.0 Problem Statement

After compiling the user needs, the problem statement for this project was formulated: "On Halifax-class frigates, the Department of National Defense has a need for a safe, light, and durable robotic arm that uses inverse kinematics with three degrees of freedom to scan for defective areas to paint. The robot must be easy to use and maintain by a single user."

4.0 Conclusion

The Department of National Defence has a need for a robotic arm that uses inverse kinematics to paint surfaces. In this deliverable, data collected from the client was interpreted into requirements for the product and ranked in order of importance. A problem statement was generated from these requirements. Moving forward with the project, more thorough benchmarking is required to formulate a list of design criteria.