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Vertical Tank Inspection Device

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Introduction

The system currently being used by Newport News Shipbuilding (NNS) to perform tank inspections is time consuming and physically demanding. It also currently only allows the camera to be lowered into the tank in two foot intervals. The proposed design to improve this system will allow for a more precise inspection while cutting down on both the time and physical effort.

Design Criteria

- Camera and inspection device are placed in a soft-sided plastic box to reduce exposure to hazardous material.
- A motorized device system is created that doesn’t require changing out various pipe sizes.
- Camera is able to clear objects throughout the pipe (e.g. pipe, flanges, and walls) as it traverses through the tank.
- Assembly and disassembly of device for easy transportation.
- Each segment of disassembled device is not to exceed 50 lbs.
- User friendly device that requires little to no operation training.
- Device can support a camera up to 15 lbs.
- Camera can be lowered ~18 ft.
- Device moves at a speed of about one inch per second.

Design

Our design consists of four 5-foot long pieces of concentric PVC pipes of decreasing diameter, as seen in Figure 1 and Figure 2. The nominal diameter of the pipes are the following (in decreasing order): 3”, 2-½”, 1-½”, 1”, and ½”.

Figure 1: Solidworks drawing the proposed system.

Figure 2: Solidworks drawing of proposed design fully extended.

The torque required to be outputted by the stepper motor was calculated. The relationship between acceleration (in/s²), position from fully extended (inches) and the required moment about the spool center (in*oz) can be viewed in Figure 3.

Figure 3: Relationship between Acceleration (in/s²), position from fully extended (inches) and the required moment about the spool center (in*oz).

Figure 4: Flowchart of electrical sub-systems.

The Graphical User Interface (GUI) for our device was coded in Java. The GUI allows the arm to be controlled via a touch screen interface connected to a Raspberry Pi and Arduino which in turn control the stepper motor based off the user’s inputs. The GUI allows the users to raise and lower the arm in increments of feet and inches. The GUI can also show the camera’s current position relative to the access hole, or the “Current Depth,” in real time.

Figure 5: Graphical User Interface.

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