
	CABLE SHARK ASSEMBLY OPERATING PROCEDURE						
	WC:	219	APPROVAL INITIALS:				
	REV:	2	LEAN	AS	SAFE		ND
	DATE:	5/6/24	PROD	CB	ENGR		DF
SPECIAL SAFETY INSTRUCTIONS:							
➤ Keep hands away from moving machinery.							
➤ Preventative Maintenance must be done before starting production							
➤ PPE Required: Safety Glasses, Cut Resistant Gloves, Earplugs/Muffs, Steel-Toed Boots/Shoes							
➤ PPH GOAL: 400							

Objectives

This SOP aims to guide the assembly of the Cable Shark product using a human-robot collaborative framework enhanced by Large Language Models (LLMs) for efficient and safe operations.

Introduction

This procedure outlines the steps for assembling the Cable Shark product using a collaborative approach between human operators and robotic systems. The framework utilizes LLMs to facilitate natural language communication for task management.

Component Specifications / Dimensions

1. Housing

- Dimensions
 - Length: X mm
 - Width: X mm
 - Height: X mm
 - Wall Thickness: X mm
- Features: Two screw holes (diameter: 4 mm) on each side for securing the housing. Internal grooves for accommodating the wedge and spring.



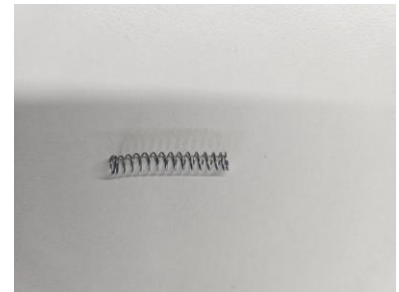
2. Wedge

- Dimensions
 - Length: X mm
 - Width: X mm
 - Height: X mm
- Features: Teeth facing inward with a pitch of xx mm. One side tapered to fit securely into the housing.



3. Spring

- Dimensions
 - Outer Diameter: X mm
 - Inner Diameter: X mm
 - Free Length: X mm
 - Wire Diameter: X mm
- Features: Compression spring



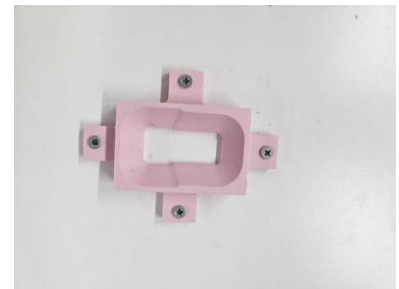
4. End Cap

- Dimensions
 - Diameter: X mm
 - Height: X mm
 - Inner Diameter (groove): X mm
- Features: Groove to fit securely over the spring end. Smooth surface finish for a tight fit.

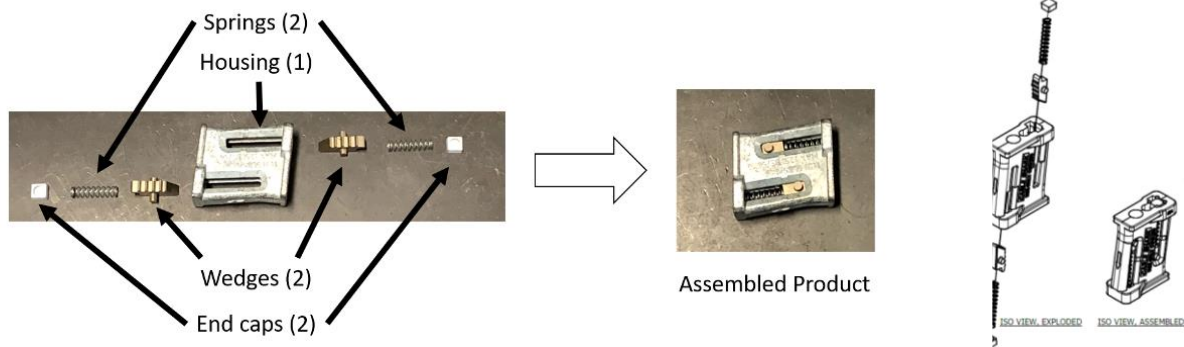


5. Assembly Holder

- Dimensions
 - Length: X mm
 - Width: X mm
 - Height: X mm
 - Groove Width: X mm
 - Groove Depth: X mm
- Features: Grooves and notches to hold the housing, wedge, spring, and end cap in place during assembly. Non-slip base to prevent movement during assembly.



Component Assembly Instructions



1. Housing: Position the housing on the assembly holder with the internal grooves facing upward.
2. Wedge: Insert the wedge into the housing with the teeth facing inward and the tapered side fitting snugly into the internal grooves of the housing.
3. Spring: Place the spring into the housing, ensuring it sits well and compresses slightly to fit securely.
4. End Cap: Insert the end cap over the spring, pressing it firmly into the housing to secure the spring in place.
5. Assembly Holder: Use the assembly holder to stabilize each component during the assembly process, ensuring precise placement and secure fitting.

Human-Robot Collaboration

- The assembly process can be divided between human operators and robots to optimize efficiency and leverage the strengths of both. For example, **human operators can manually insert the wedge into the housing**, a task that requires precision and adaptability, especially in dynamic or intricate situations.
- After the human operator has inserted the wedge, they can command the robot to take over the remaining assembly tasks. This includes inserting the spring, end cap, and ensuring all components are securely fitted.
- Voice commands can be used to instruct the robot to continue with specific tasks. For instance, once the wedge is placed, the human operator can say, "Continue assembly," and the robot will proceed with inserting the spring and end cap.

Error Notification and Resolution

- The robotic system is equipped with sensors and an LLM module to monitor and manage the assembly process. If the robot encounters any errors, such as misaligned parts or missing components, it will immediately notify the human operator.
- Notifications will be delivered in clear, natural language messages generated by the LLM module, ensuring that human operators can quickly understand and address the issue. For example, if a spring is missing, the robot might say, "Spring component missing. Please place the spring in the housing."
- After the human operator resolves the error, they can instruct the robot to resume the assembly process from where it was interrupted. This ensures a continuous and efficient workflow, minimizing downtime and maintaining high productivity.

Example Commands for Human Operators

- To start assembly: "Start the assembly."
- To address a missing component error: "A component is missing. Please place the springs correctly."
- To resume after error resolution: "I've fixed the error. Resume assembly."

Safety

- During the assembly process, it is crucial for human operators to maintain a safe distance from the robot to prevent any accidents or injuries. The assembly area should be clearly marked, and operators should stay outside this zone when the robot is in operation.
- The robotic system is equipped with sensors to detect the presence of human hands or any other body parts within its operational range. **If the robot detects a human hand or any part entering its workspace, it will immediately notify the human operator** about the potential danger.
- Before starting the assembly process, human operators should perform regular safety checks to ensure all safety protocols are in place. This includes checking the functionality of the sensors and ensuring the emergency stop button is easily accessible.
- In case of any immediate danger, the emergency stop button should be pressed to halt all robotic operations instantly. The light in the e-stop button will turn off when released, and operations can only resume after the issue is resolved and the button is reset.