Electronic LigaSure Handle

Daniel Cerna | Nicholas Gotlib | Yolande Idoine | Javier Ordaz | Grey Snyder | Olivia Ward

DESIGN CENTER COLORADO

Paul M. Rady Mechanical Engineering
UNIVERSITY OF COLORADO BOULDER

Background

- Medtronic is a leading medical device company specializing in the production of laparoscopic **medical devices** designed for **minimally invasive surgeries**.
- Medtronic's LigaSure™ XP Maryland instrument **cauterize**s and **precisely cuts blood vessels**, widely recognized as the gold standard for achieving hemostasis during surgical procedures.
- Current LigaSure™ device is **entirely disposable**, resulting in **unnecessary expenses** and **waste**.

Figure 1: LigaSure™ XP Maryland

Objective

- Develop a **sustainable**, **electronic** LigaSure™ handle using the existing, disposable, shaft assembly to **minimize waste** and eliminate the need for single-use sensors.
- Enhance the device's **durability**, offer comprehensive **user feedback**, **decrease customer expenses**, and **minimize medical waste** in landfills.

Requirements

- ✓ Device **fully compresses** spring in shaft assembly
- ✓ Jaw and blade fully deploy in **less than 1 second**
- ✓ The handle **translates position** to a digital signal
- ✓ Shaft swapping time is **less than 5 seconds**
- ✓ Shaft **rotates continuously** inside the device

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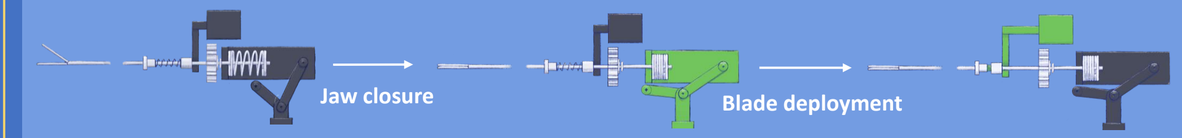
Device Functionality



Electronic Design

Push Button / Potentiometer

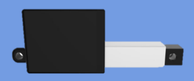
User Input to trigger mechanisms in device

Arduino Uno

Interfaces with LAC board to accurately read user inputs

Linear Actuator Control Board (LAC)

Controls accuracy, sensitivity, and stroke length of linear actuators



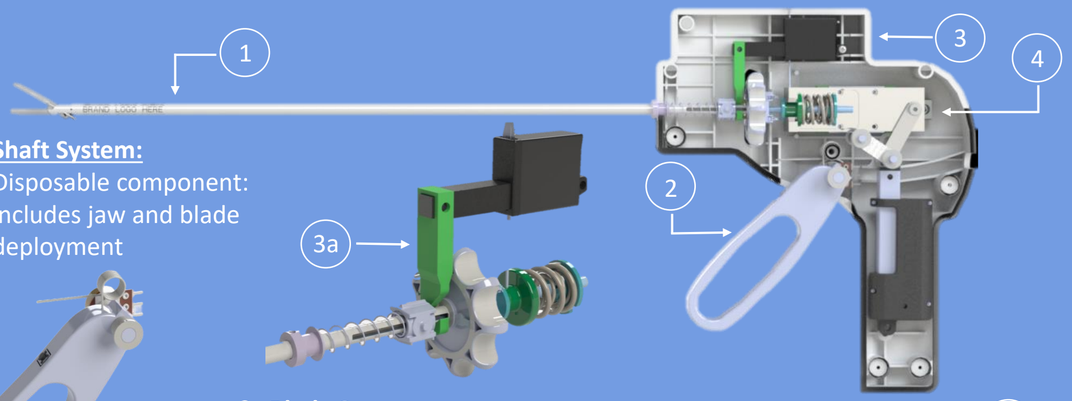
P-8P Micro Actuator

P-16P Actuator

Actuonix Linear Actuators

Receive digital signal to extend or retract based on user inputs

Hardware Design



1. **Shaft System:** Disposable component: includes jaw and blade deployment
2. **Handle System:** Translates handle position to actuator position and deploys blade
3. **Blade System:** Actuator deploys blade to bisect blood vessel
3a. **Blade Attachment:** Compresses blade spring stack
4. **C-Clip/Linkage System:** Translates force to the shaft assembly to close and tighten the jaw
4a. **Custom Links:** Machined links with built in spacers

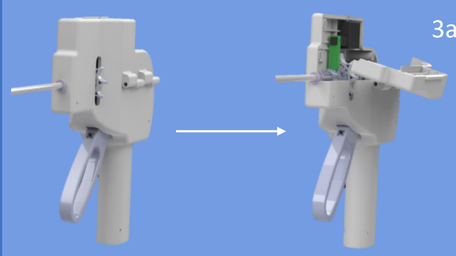


Fig 2: Clamshell Design

Analysis

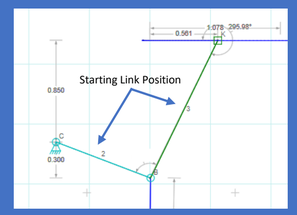
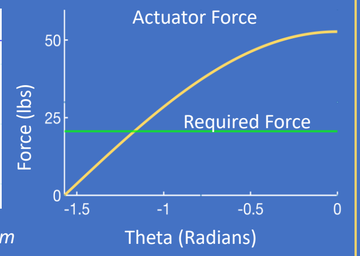


Fig 3: Linkage Simulation Diagram (Subsystem 4a.)



Testing Results

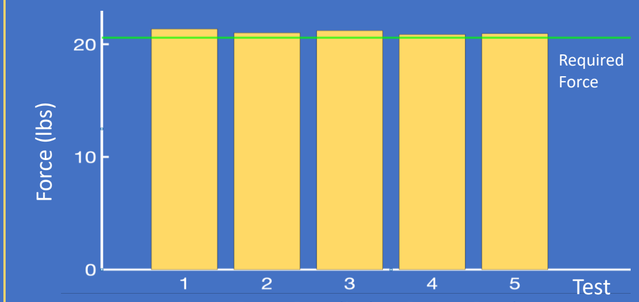


Fig 4: Force Supplied to Spring Stack

- Compression force to jaw = 21.082 ± 0.20 lbs
- Compression force to blade = 1.28 ± 0.16 lbs
- Time to swap shaft = 3.24 ± 0.91 s
- Time to fully close jaw = 0.39 ± 0.03 s
- Time to fully close blade = 0.62 ± 0.23 s

Conclusions

- Electronic LigaSure™ builds upon current Medtronic device and **satisfies all requirements**
- Device **fully compresses** both spring stacks
- Shaft is **user replaceable**

Future Steps

- Design for **biocompatibility**
- **Human factor** refinement
- Design for **compatibility** with other Medtronic devices
- Optimize **linkage** subsystem

Fig 5: Concept Sketch