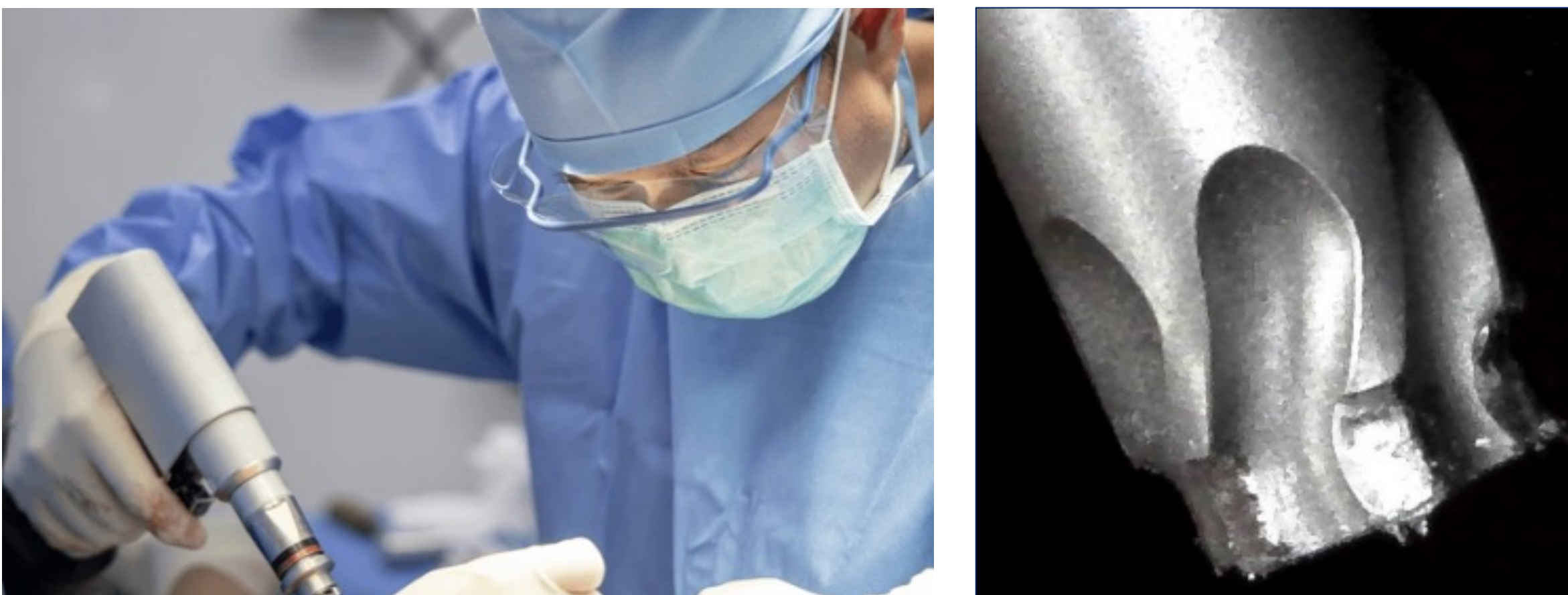


SMART25: Smart Driver for Orthopedic Screws

Aabhas Jain, Zuriel Erikson Joven, Jay Taylor, Dylan Zhu

Johns Hopkins University | Mechanical Engineering Senior Design 2025 | Sponsor: Shukla Medical

Introduction



- Awkward operative handling
- Sheared driver tip
- **Orthopedic surgeries often last 90–180+ minutes**, during which **awkward access**, **driver-bit fractures**, and **inefficient tool swaps** can prolong OR time, escalate fatigue, and risk incomplete procedures [1,2].
 - Targeting these **three key areas streamlines workflows** to help deliver **faster and safer orthopedic surgeries**.

Key Design Requirements

- Offer **faster screw extraction** than current manual extraction
- **Limit output torque** to prevent bit fracture
- Provide **improved surgical access** for surgeons
- Designed for **autoclave sterilization**

Solution

Our solution is a **Smart Orthopedic Driver** that:

- ✓ Offers **both manual and automatic modes** to eliminate tool changes
- ✓ Enables **variable torque limits** to prevent **driver bit breakage**
- ✓ **Pivots across 5 positions from 90° to 180°** for improved surgical access
- ✓ **Uses a medical-grade BLDC motor** and **aluminum handle** for autoclavability



Design

Push-To-Connect

- Standard Hudson Connection



Medical-Grade BLDC Motor

- Autoclavable

Proportional Trigger

- Variable Speed

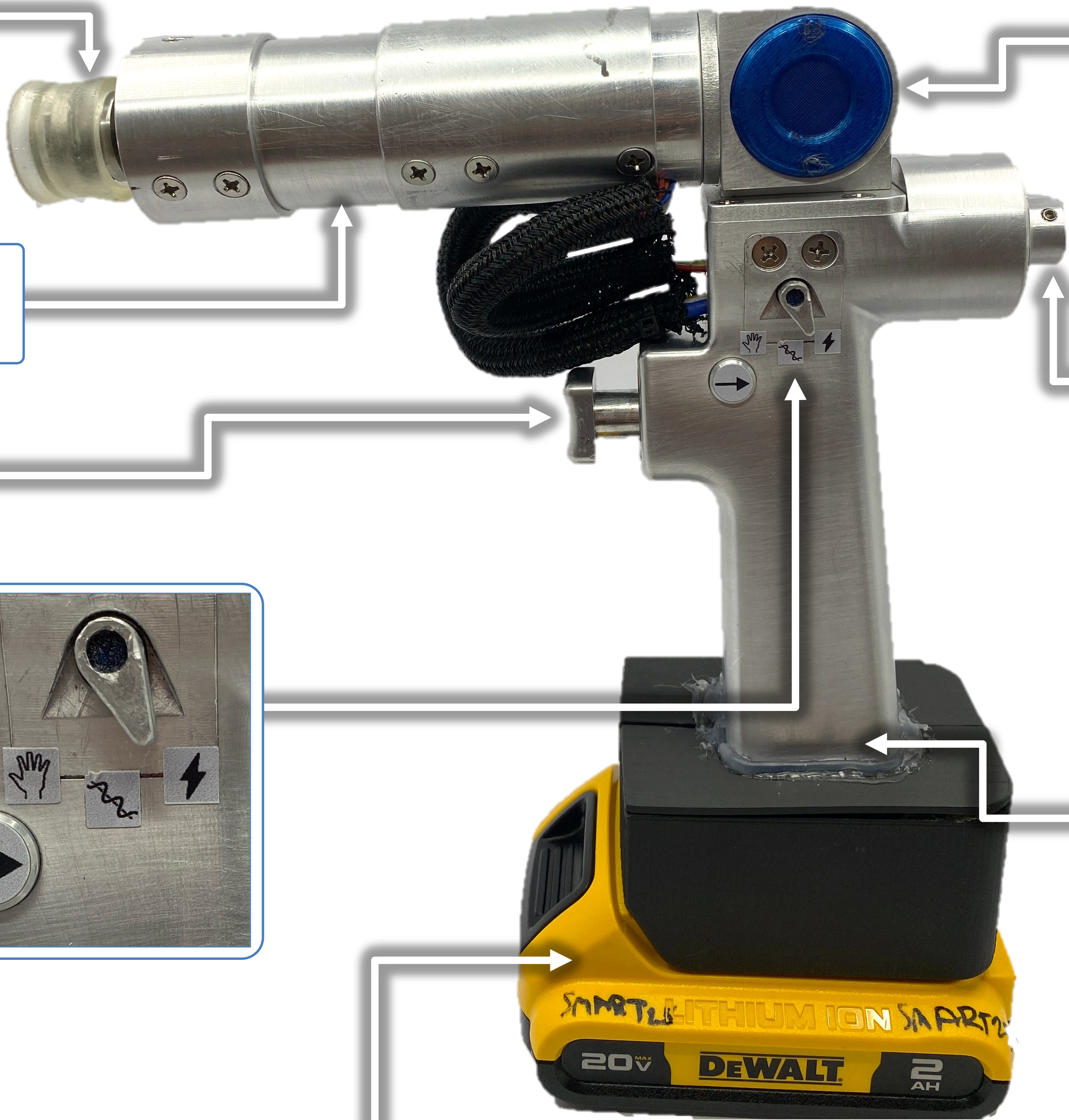
Direction + Mode Switches

- Forward/Reverse
- Manual/Automatic/Oscillation



Power Management

- 20V Power
- Enables Peak Motor Current Draw (63A)



Pivot

- 5 Distinct Driver Positions



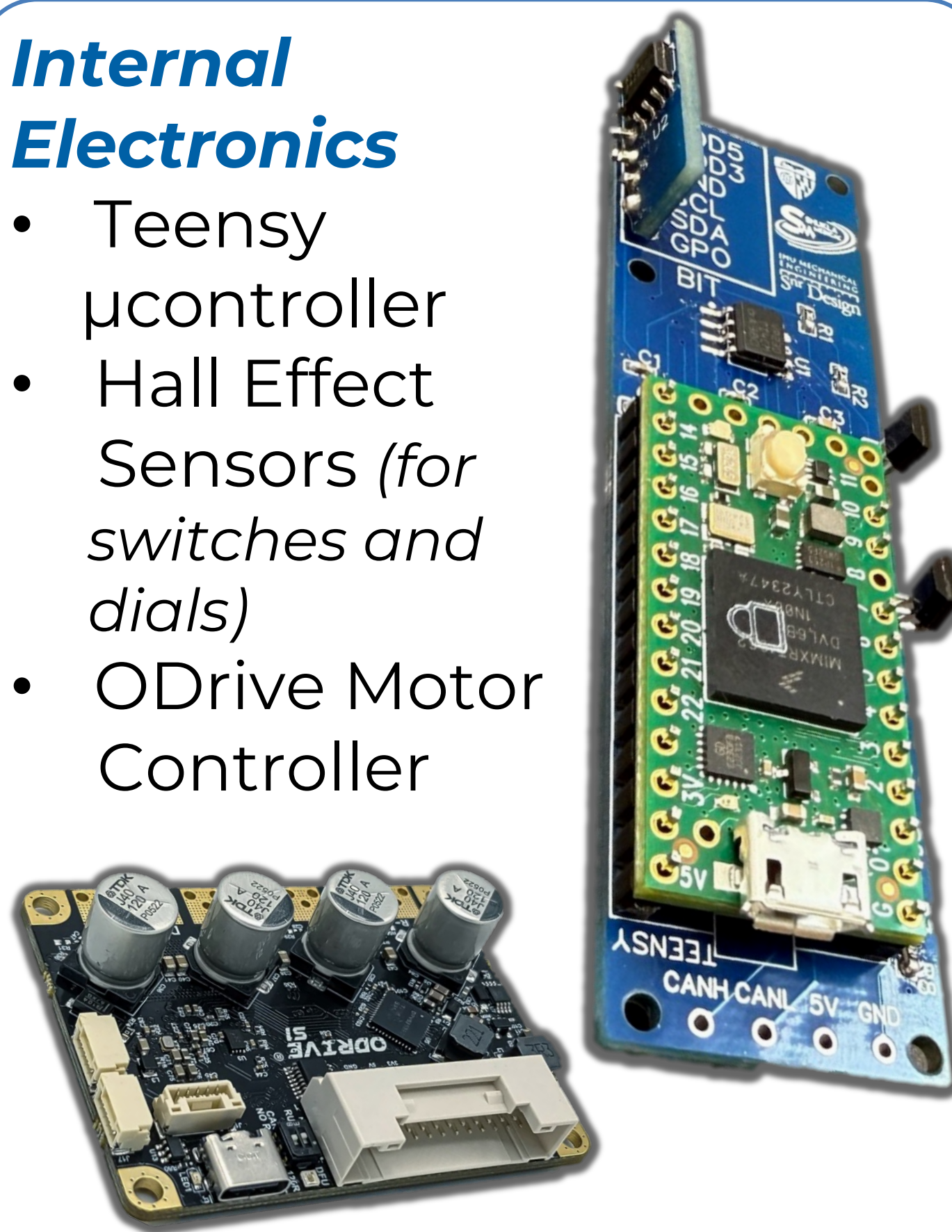
Bit Selection Dial

- Set Driver Tip & Torque Limit



Internal Electronics

- Teensy μ controller
- Hall Effect Sensors (for switches and dials)
- ODrive Motor Controller



Shukla Smart Driver

Results & Clinician Feedback

Torque limitation at $n_{safety\ factor} = 1.3$ results in under 0.01% chance of bit fracture

Clinicians offered **enthusiastic, positive feedback** regarding our solution:

Manual mode offers “breaking the bond ourselves” like traditional screwdrivers

- Sandesh S. Rao, Attending Surgeon

Pivot is a “good principle”

- Savya Thakkar, Associate Professor of JHU Orthopedics



Surgeon using Smart Driver in manual mode

Future Goals

Translation into production stage requires:

- **Hermetically sealed electronics** (e.g., manufactured by Composite Motors)
- **Sterility Assurance Level** testing to verify effective autoclave sterilization
- Securement of **loose external wires**
- Enabling **cannulation through motor housing**

Acknowledgements

Senior Design: Professor Belkoff, Rich Bauernschub, Daren, Stipe, Rich, Mark & the JHU Machine Shop

JHU Bayview Campus: Demetries Boston, Dr. Lynne Jones, & the Alpha Center

JHMI Orthopedic Surgery Residents & Clinicians

Composite Motors: Russ Lucia

Shukla Medical: Adam Gosik-Wolfe, Austin Stroh

(N.d.). Retrieved from <https://www.shutterstock.com/search/orthopedic-surgeon>

[1] Definitive Healthcare. (n.d.). What are the most common orthopedic surgeries? Retrieved from <https://www.definitivehc.com/resources/healthcare-insights/most-common-orthopedic-surgeries>

[2] Vasireddi, N., Vasireddi, N., Shah, A. K., Moyal, A. J., Gausden, E. B., McIlwhorn, A. S., ... Calcei, J. G. (2024). High Prevalence of Work-related Musculoskeletal Disorders and Limited Evidence-based Ergonomics in Orthopaedic Surgery: A Systematic Review. Retrieved from <https://pmc.ncbi.nlm.nih.gov/articles/PMC10936985/>