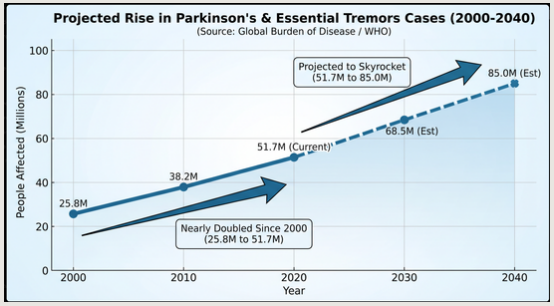
DEXTERA

Precision In Every Grip

The Problem

Hand tremors affect over **51.7 million** people globally, with Parkinson's cases **doubling since 2000**. This Dexterity Gap strips independence from patients and *forces professionals into early retirement*. Current solutions fail: passive aids are ineffective, while **active robotics cost over $6,000**. Consequently, millions lack affordable, data-driven tools, and doctors *lack objective diagnostic reports* to monitor disease progression remotely.



Our Aim

1. Democratizing Medical Technology (Affordability)
The primary aim is to *shatter the prohibitive $6,000+ price barrier* of current robotic assistive devices. By leveraging open-source microcontrollers (**ESP32**) and **modular 3D printing**, we aim to deliver a clinical-grade, active-stabilization wearable for under $100, making it accessible to low-income and marginalized communities.

2. Restoring Daily Independence (Quality of Life)
We aim to give patients their lives back. By utilizing active vector cancellation to dampen **4–12Hz** tremors, we aim to enable users to independently perform essential Activities of Daily Living (ADLs)—such as eating, drinking, and writing—while *extending the career longevity of high-precision professionals* who would **otherwise be forced** into early retirement.

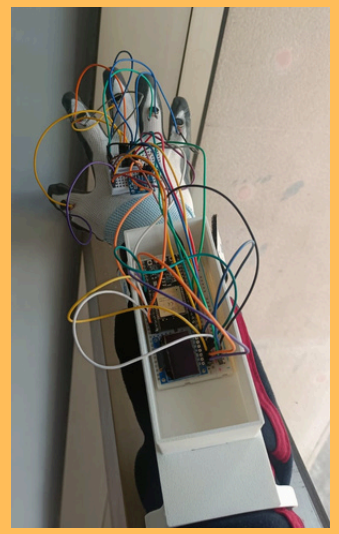
3. Enabling Data-Driven Healthcare (Diagnostic Utility)
We aim to transition tremor management from subjective observation to quantitative science. By bridging the **glove to a mobile app**, our goal is to **provide neurologists with real-time,** remote "Tremor Health Reports," allowing for accurate tracking of disease progression and medication efficacy without requiring the patient to visit a hospital.

SDG Goals Addressed

Our Solution

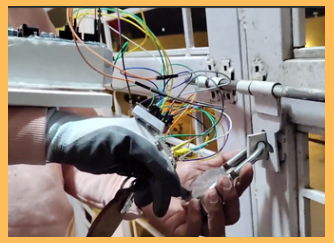
Project Dextera is an accessible, 3D-printed wearable that counteracts hand tremors for **under $100**. It operates on a continuous, closed-loop system:

- **SENSE**: An MPU6050 sensor tracks hand motion at **100Hz**, instantly distinguishing between *intentional movement and pathological tremors.*
- **STABILIZE**: An **ESP32 microprocessor** triggers **Linear Resonant Actuators (LRAs)** to emit precise "anti-phase" vibrations, actively absorbing and canceling tremors in real-time.
- **STREAM**: The device wirelessly transmits frequency data to a smartphone, generating objective "**Tremor Health Reports**" for remote neurological monitoring



Our Impact

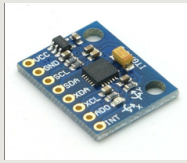
- **Empowering the next generation of STEM leaders through neuro-innovation**



- **Active stabilization enables essential activities of daily living (ADLs)**

- **Restoring mobility for those with advanced Parkinson's and Essential Tremors.**

Data-Driven Diagnostics



MPU 6050

ESP-32 Controller Board

To enhance tremor management, we created a **real-time diagnostic dashboard** that visualizes 100Hz telemetry from the ESP32 and MPU6050 sensor. It quantifies tremor severity using metrics like Tremor Twist, Motor Power, and Vertical Shake. The system differentiates between *pathological tremors and motor responses*, generating a detailed '**Tremor Health Report**' for remote sharing with neurologists, facilitating precise medication adjustments and long-term monitoring without hospital visits.

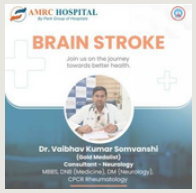
Dextera VS Rivals

Feature	Standard Passive Aids	High-End Robotics	Project Dextera
Cost	~$150	$6,000+	Under $100
Weight	~500g (Fatiguing)	~400g (Bulky)	<150g (Lightweight)
Data	None	Clinical Only	Real-time 100Hz Telemetry

Partnerships

We bridge the healthcare gap via a *Hub-and-Spoke model.*

- **Somvanshi Neuro Centre** acts as the urban diagnostic hub for distribution.



- Nath **Sanskriti Seva Sansthan** delivers Dextera "Lab Packs" directly to patients during rural medical camps, ensuring clinical-grade care reaches the most isolated communities

Nath Sanskrit Seva Sansthan
(Service to Humanity is Service to God.)

Expert's Comments-

"The idea of bringing active stabilization down to this price point is exactly what the field needs. I really like their approach to streaming the telemetry data. That said, a working prototype isn't a certified medical device yet. The algorithms might look great on paper, but human tremors are messy and unpredictable. The next hurdle for the team is rigorous clinical testing to prove the glove can adapt to different patients with different conditions over time. They've built a great foundation; now comes the hard part."

Dr. Vaibhav Sharma

Challenges Faced & Strategic Solutions

1. **The Signal-to-Noise Dilemma**: Our sensors ~~initially~~ couldn't distinguish between a user's intentional movements and the tremors we needed to cancel. Solution: We integrated a *Complementary Filter to isolate 4-12Hz tremor frequencies from normal motor activity*
2. **The Weight vs. Power Trade-off:** Effective stabilization typically requires heavy motors that cause muscle fatigue in elderly users. Solution: We utilized **Linear Resonant Actuators (LRAs) to deliver high-impact haptic pulses while keeping the device under 150g.**
3. **The Accessibility Barrier**: Traditional medical manufacturing is prohibitively expensive, often pushing final costs into the thousands. Solution: We leveraged modular 3D-printing and open-source hardware to produce a **durable**, clinical-grade wearable for **under $100**

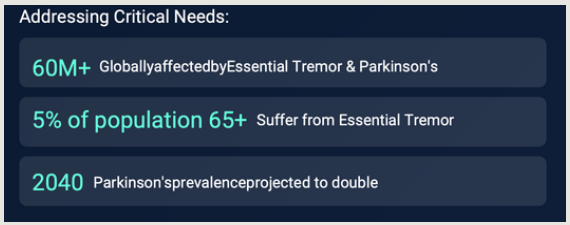
Outreach Strategy:

Key marketing strategies for Dextera include:

- **Clinical Advocacy**: Engaging medical professionals at neurology conferences to encourage them to prescribe Dextera as a reliable, cost-effective option.
- **Social Proof through Micro-Documentaries**: Launching a digital campaign that showcases real-life improvements with the Dextera Glove, featuring relatable patient success stories to share on social media.
- **Youth Ambassador Program**: Expanding mentorship to over 20 students to create a global community, enabling them to host neuro-engineering workshops and raise awareness about the "Dexterity Gap."

Our Learnings

To bridge the geographic healthcare gap, we utilize a Hub-and-Spoke model. Urban hospitals distribute sub-$100 gloves to rural clinics, where patients transmit telemetry via low-bandwidth networks. We *ensure sustainability* through solar-ready architecture—using low-power ESP32 chips compatible with portable solar-charging kits—and **localized manufacturing via regional 3D-printing hubs for on-site repair**



Our Team

Akshaj Nigam
Outreach & Operations Director

Gul Goyal
Hardware Engineer & Team Lead

Scaling the Impact: Future Horizons

Technical Evolution: From Logic to Learning
Edge AI Integration: Transitioning to Machine Learning for personalized tremor stabilization by training models on telemetry data.
Haptic Refinement: Upgrading the LRA array to a multi-point haptic mesh for improved stabilization in precise tasks.

Clinical Expansion: "**Lab Pack" Initiative**
Data Democratization: Providing Dextera Lab Packs to universities and neurology clinics to build an open-source dataset of tremor frequencies, improving diagnostic accuracy for neurological conditions.
Remote Monitoring Ecosystem: Enhancing the smartphone dashboard into a telehealth portal, enabling doctors to adjust device settings and prescribe remote "digital therapy" sessions.

Global Accessibility & Certification
ISO & Regulatory Pathways: Researching ISO 13485 certification to evolve Dextera from a student prototype to a clinically-validated device.
Local Manufacturing Hubs: Partnering with local 3D-printing hubs in developing regions to produce hardware on-site, keeping costs under $100 and reducing carbon footprints.