Step Revive: 3-DOF Serial Multi-Modal Adaptive Ankle Rehabilitation Device

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Engineering Goal: Create an ankle rehabilitation device that can enhance domestic accessibility for patients and be used conveniently through mobile phone and PC interfaces

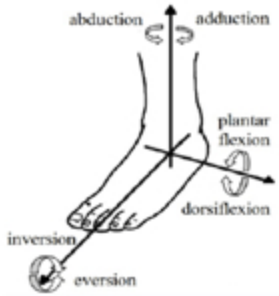
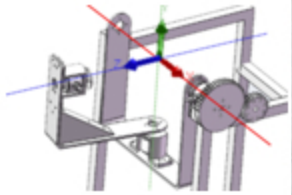


Image from https://www.researchgate.net/figure/Normal-ankle-movements_fig1_282655858

Current Limitations:

- Restrained customization ability
- Incapability to rotate in some directions

Different Parts of Design



Screenshot from SolidWorks by student

Pictures taken by student

Mechanical Structure

- Ankle center overlaps with device platforms' axes intersection
- Real-time torque feedback

System Control Design

- 2 control boards with inter-serial communication
- Bluetooth connection with software
- Passive/active movements

Screenshot from diagram drawn by student

Experiment Results

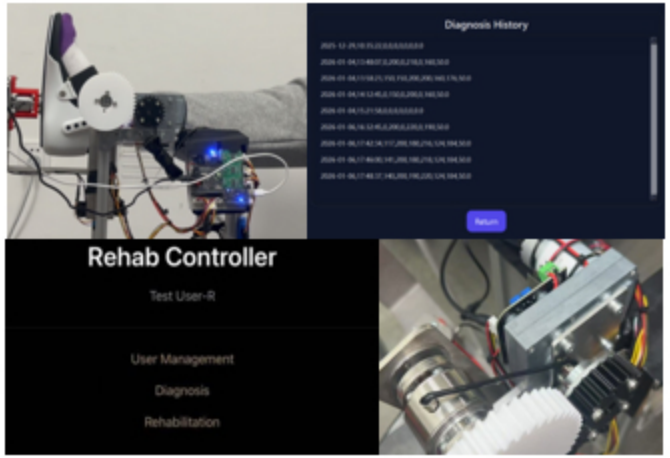
Forward Backward				Inward-Outward	Left-Right
Less than 140	140-160	160-190	More than 190	All angles	All angles
90	50	30	30	50	20
-20	-50	-90	-100	-50	-20

Human Ankle Range		Forward Backward	Inward-Outward	Left-Right
Trial 1	Minimum Angle	117	180	124
	Maximum Angle	200	216	184
Trial 2	Minimum Angle	141	180	124
	Maximum Angle	200	218	184
Trial 3	Minimum Angle	140	190	124
	Maximum Angle	200	220	184

The device enables adaptive and safe usage through reacting to patient's force exertion and limit of rotation range within human abilities.

Conclusions

The device was able to....

- Enable spherical rotation of ankle joint
- Quantify and visualize recovery data through angle and torque
- Enhance availability with low cost

2 screenshots from PC interface, 2 photos taken by student