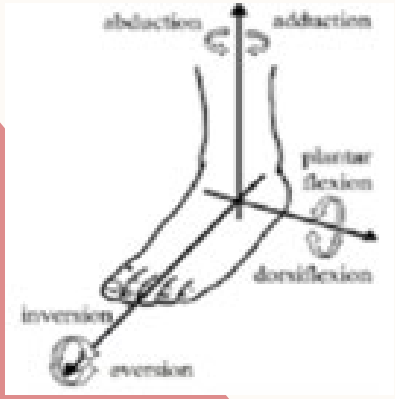
3-DOF ADAPTIVE ANKLE REHABILITATION DEVICE

MOTIVATION & GOAL

- One of the most prevalent injuries
- Personal experience
- Better customized and convenient domestic access, incorporating multiple functions



MECHANICAL DESIGN

Initial Design

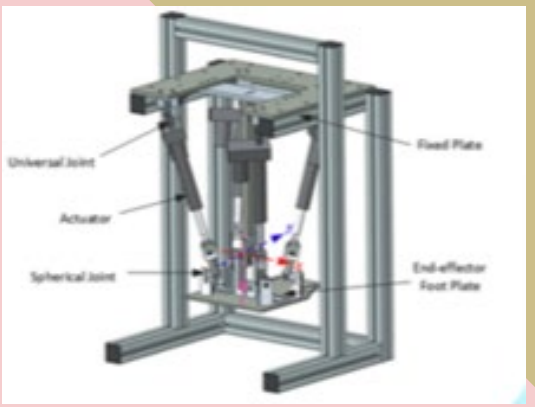
Four actuators in parallel, independently moving to control a platform.

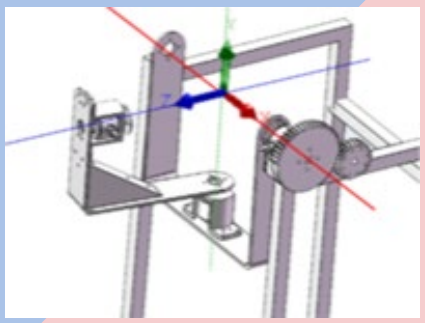
- More stable
- Cannot complete movements abduction and adduction
- No means for acquiring torque
- Complex calculations

Final Design

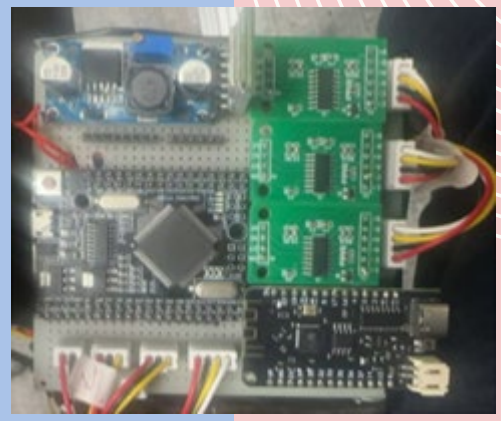
Three platforms in series, moving together to accomplish spherical action.

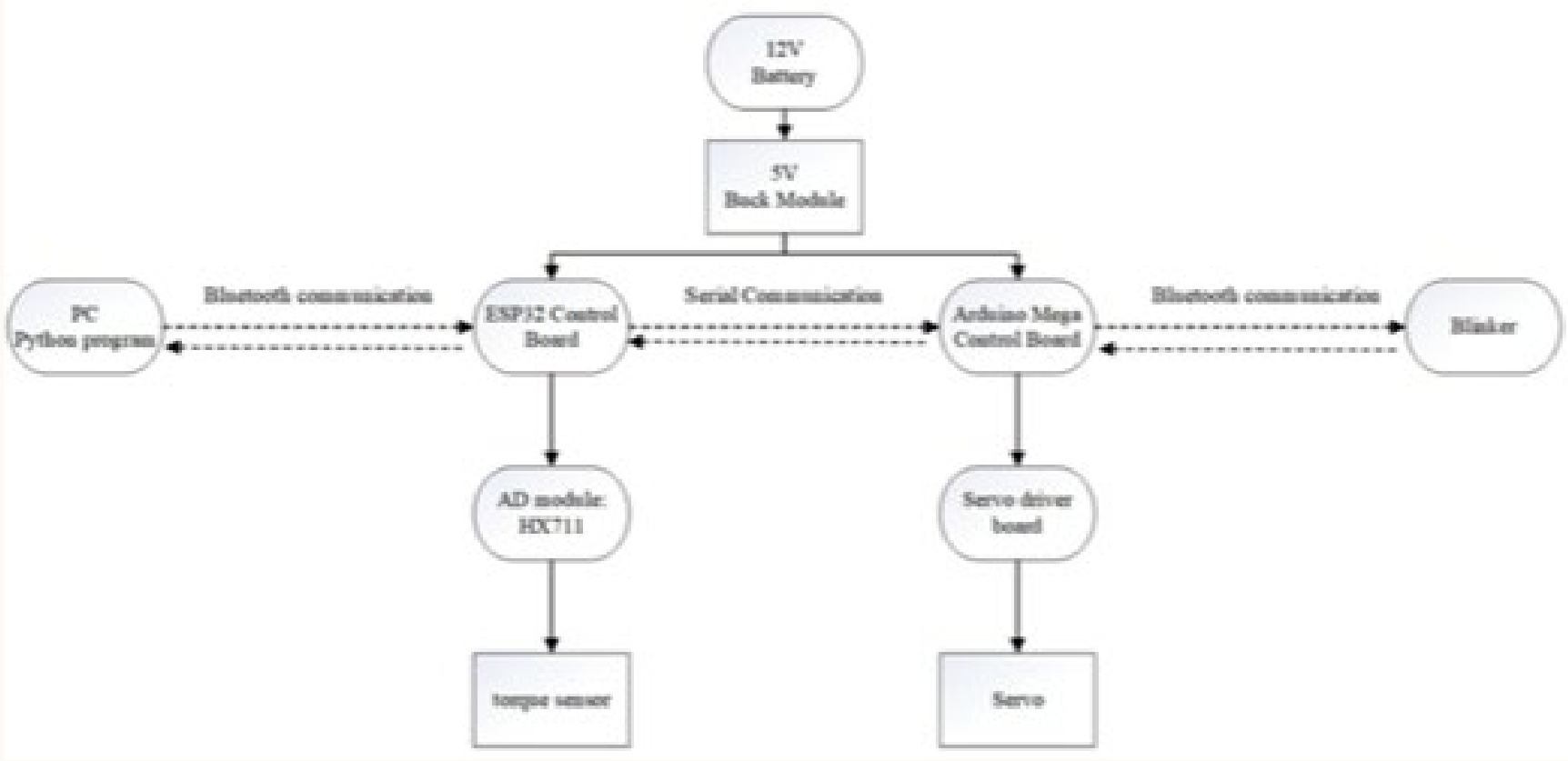
- Each corresponds to one axis, intersection and ankle center overlap
- One servo motor and one torque sensor on each platform
- More straightforward control





ELECTRONIC COMPONENTS & SYSTEM STRUCTURE

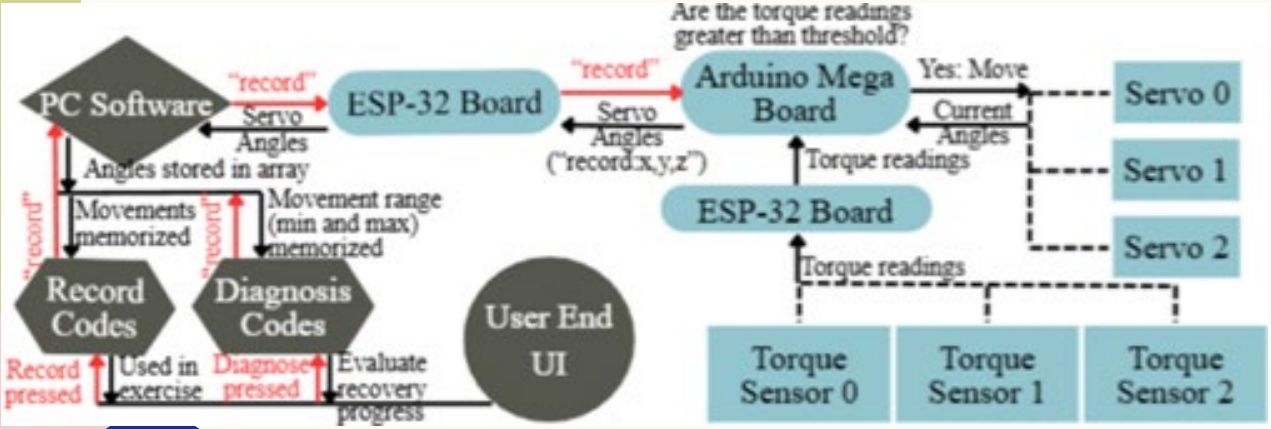




SOFTWARE FUNCTIONS

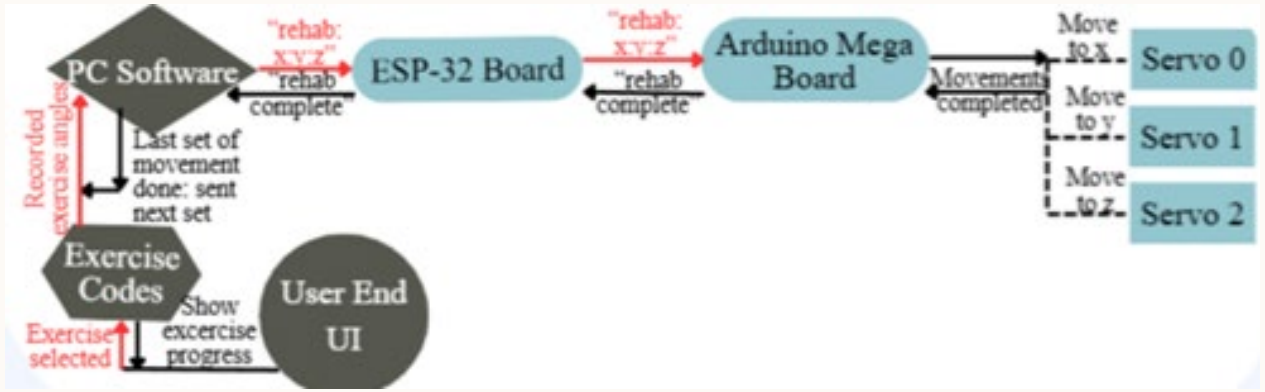
Passive Movement (Record, Diagnosis)

Device follows patient's movement to collect trajectory/data.



Active Movement (Exercise)

Device brings patient's foot to move and complete exercises.



EXPERIMENT 1: TORQUE THRESHOLDS

Torque Thresholds	Forward Backward				Inward-Outward	Left-Right
Angle Range	Less than 140	140-160	160-190	More than 190	All angles	All angles
Positive	90	50	30	30	50	20
Negative	-20	-50	-90	-100	-50	-20

- Achieving the passive movement mode
- Safety: too much force exerted in opposite direction of current movement leads to emergency stop

- Values read from the programmed diagnosis function

- Forward-Backward divided into 4 ranges due to gravitational pull on the platform when it is raised into the air

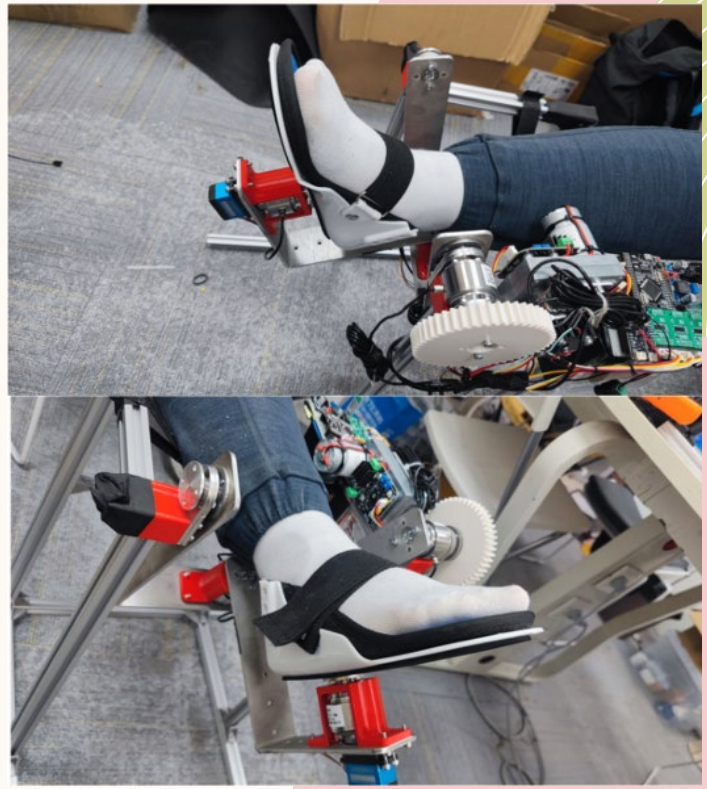
EXPERIMENT 2: HEALTHY ANKLE ROTATION RANGE

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

- Only tested on student, with three independent trials
- Ensure that the device can fulfill patient's needs
- Set mechanical stop to ensure rotation does not exceed normal ankle abilities

CONCLUSIONS

- Enabled all six ankle movements
- Responsive in data collection, acknowledged quantification and visualization needs
- Safe and accessible assistance



FUTURE OUTLOOKS

- Change power source from battery pack to plugs suitable for home usage
- Append more sensors for more accurate evaluation of recovery state
- Add a greater user group both for experiments and overall data collection
- Connect the control boards and interfaces through Wi-Fi to enable online upload
- Develop an AI model on the software side for further customization abilities