Company Information

Company Name	*UNC Charlotte – ME Department*	Date Submitted	*12/05/2024*
Project Title	*Design of a portable low-cost measurement device for knee join muscle strength for adults with Sarcopenia (UNCC_ISODYNO)*	Planned Starting Semester	*Spring 2025*

Faculty Mentor

Faculty Mentor will be assigned to the project. If you have been previously working with a faculty mentor and want to continue that relationship, then enter their name here ________________. We cannot guarantee that faculty mentor will be available, but we will try to make that assignment if possible.

Technical Contact(s)*

Technical Contact	Name	Email	Phone
1	Dr. Nigel Zheng	nzheng@charlotte.edu	704-687-7301
2			
3			

*We would like to have more than one technical contact, so there is a back-up in case of travel, sickness, job re-assignment, etc. Also, these are the people that will have Event (Kick-off/Expo) invitations and name badges made for them, so please identify them to us so we can properly include them.

Financial Contact**

Name	Funding	Phone
Purchases through ME Dep.	Funding has been secured	

Billing Address	

** This is the person that understands that they will receive and process the invoice.

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.
Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills.

Discipline	**Number**	**Discipline**	**Number**
Mechanical	4-5	Electrical	0
Computer	0	Systems	0

<u>Company and Project Overview:</u>

UNC Charlotte ME Department – BioMed Concentration Project

Sarcopenia, characterized by loss of muscle mass and strength, impairs mobility and quality of life in older adults. Knee extension strength is a critical indicator of functional decline, and its accurate assessment is essential for early diagnosis and monitoring of sarcopenia. Current tools like isokinetic dynamometers are precise but expensive, bulky, and inaccessible in many settings. Some examples of such machines are shown in figure 1. There is a pressing need for a low-cost, user-friendly alternative.

Figure 1: Large scale isokinetic dynamometers currently in use

<u>Objective:</u>
1. Design a device that measures isometric knee joint muscle strength.
2. Ensure accessibility by minimizing costs while maintaining reliability.
3. Achieve portability to support use in various environments.
4. Develop a user-friendly interface for non-specialists, such as physical therapists or

caregivers.

Phase 1: Research and Design:
- Review existing muscle strength measurement methods.
- Design mechanical and electronic schematics.

Phase 2: Prototyping:
- Assemble the device using a strain gauge and microcontroller.
- Develop firmware for data collection and display.

Phase 3: Testing and Validation:
- Test the device on a small cohort of healthy adults.
- Compare results with a gold-standard isokinetic dynamometer.
- Optimize based on feedback.

Phase 4: Clinical Trials (if possible):
- Test on sarcopenic adults under clinical supervision.
- Refine design for usability and reliability.

Phase 5: Final Product (future work):
- Finalize the prototype for scalability and mass production.

Phase 1 corresponds to SD1 while Phases 2 through 3 correspond to SD2. A portable fully functioning testing rig with validated functionality are expected at the end of SD2.

Project Requirements:

The goal is to design and prototype a portable, low-cost device capable of accurately measuring knee joint muscle strength, specifically targeting older adults at risk of or diagnosed with sarcopenia. The device should provide reliable, standardized measurements and be suitable for use in clinical, home, or community settings. Following are some suggested elements of the proposed design:

1. **Measurement Methodology:**
    - Use a strain gauge-based force sensor to measure the maximum voluntary isometric contraction (MVIC) during knee extension and flexion.
    - The patient will sit in a standard chair, with the device secured to their leg and fixed to the chair frame.
2. **Key Components:**
    - Force Sensor: A strain gauge or load cell to capture force exerted by the quadriceps.
    - Microcontroller: Arduino or Raspberry Pi for processing data from the sensor.
    - Display Unit: LCD or mobile app interface to display results in real-time.
    - Adjustable Frame: Lightweight aluminum or ABS plastic frame for securing the device to various leg sizes.
    - Power Source: Rechargeable lithium-ion battery for portability.

3. **Data Output:**
    - The device will calculate and display maximum force (N) and store data for trend analysis.

Expected Deliverables/Results:

1.) A fully functioning prototype.
2.) Comparative validation data with isokinetic dynamometers (in lab at UNC Charlotte).
3.) User manual and training guide for operation.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- ME BioMed Concentration