

Creating a New Educational Tool with Fabric Sensor Technology

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History of Manual Therapy and Joint Mobilization

- Earliest historical reference 400BC
- Manipulative therapy mainstay of osteopathic and chiropractic professions since latter part of 19th century
 - Response to perceived shortcomings in traditional allopathic medicine
- Specific techniques introduced into Physical Therapy curricula in the United States during 1980's for the management of patients with musculoskeletal disorders.

[J Man Manip Ther](#). 2007; 15(3): 165–174.

doi: [10.1179/106698107790819873](https://doi.org/10.1179/106698107790819873)

PMCID: [PMC2565620](https://pubmed.ncbi.nlm.nih.gov/PMC2565620/)

PMID: [19066664](https://pubmed.ncbi.nlm.nih.gov/19066664/)

A History of Manipulative Therapy

[Erland Pettman](#), PT, MCSP, MCPA, FCAMT, COMT



Traditional Schools of Thought for Benefit of Manual Therapy

1. Altering position of joint
2. Relieving pain
3. Normalizing joint mobility

Phys Ther. 2015 Apr;95(4):588-99. doi: 10.2522/ptj.20130541. Epub 2015 Jan 8.

Evidence-based practice implementation: case report of the evolution of a quality improvement program in a multicenter physical therapy organization.

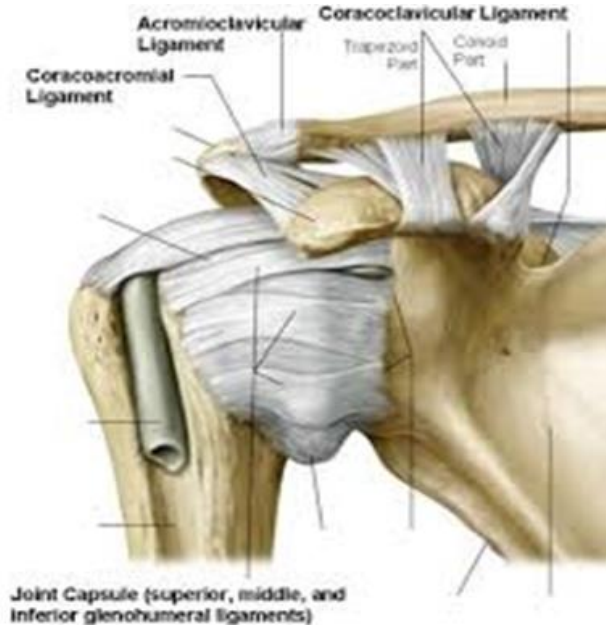
Stevens JM¹, Bise CG², McGee JC³, Miller DL⁴, Rockar P Jr⁵, Delitto A⁶.

Precisely Applied and Directed Movements

Shoulder Inferior Glide

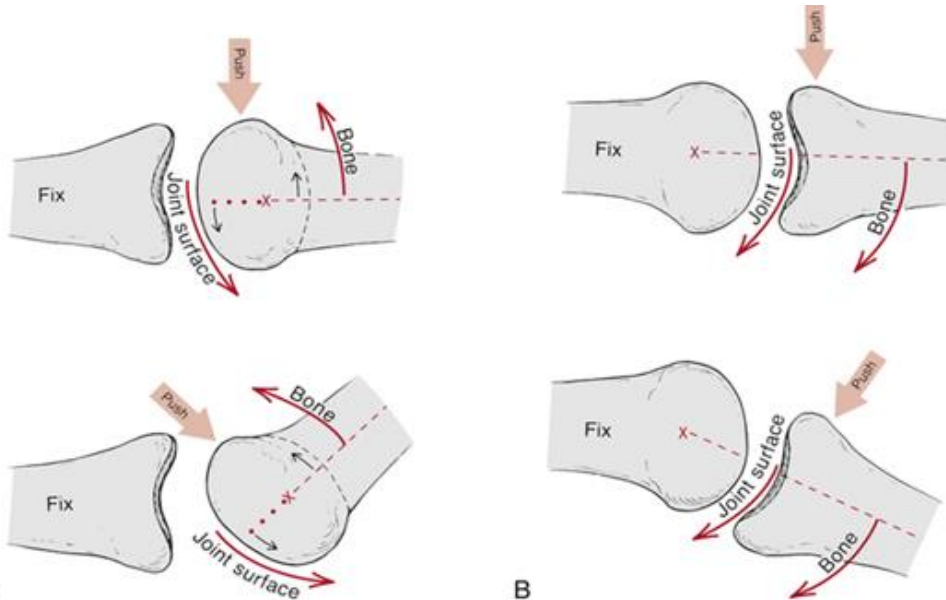


Shoulder Joint Capsule

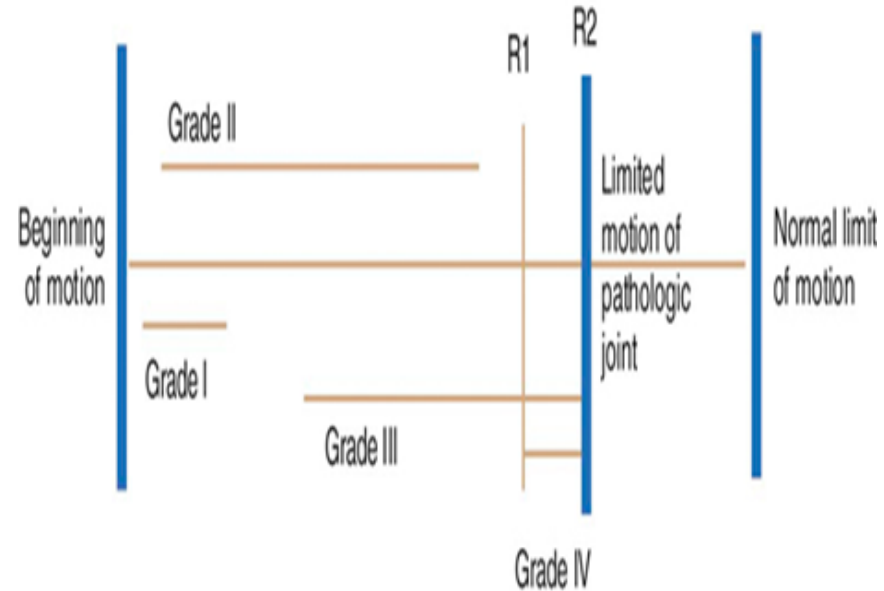


Skilled Intervention Required

Convex – Concave Rule



Mobilization Grading





Developed Skill Set





Educational Gap

- Student
 - Understanding relies primarily on observation and verbal feedback
- Instructor
 - Difficult to assess
- Materials do not exist that:
 - Provide sensor / visual biofeedback capabilities
 - Flexible enough to adapt & maintain signal over irregular body surfaces.



Opportunity



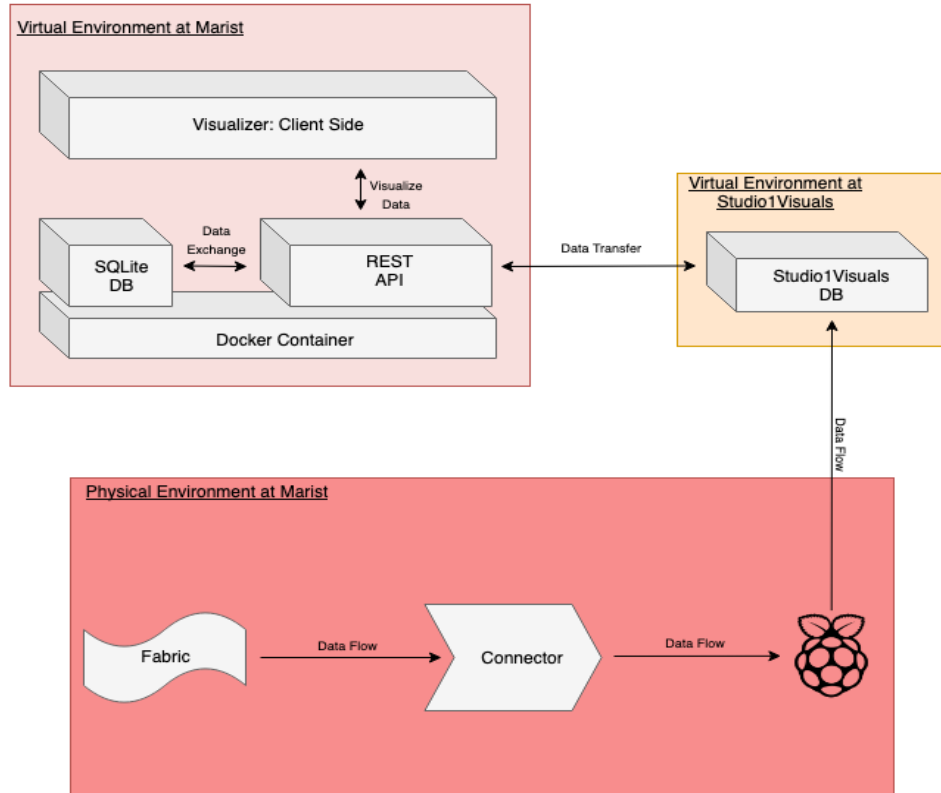
STUDIO 1 LABS



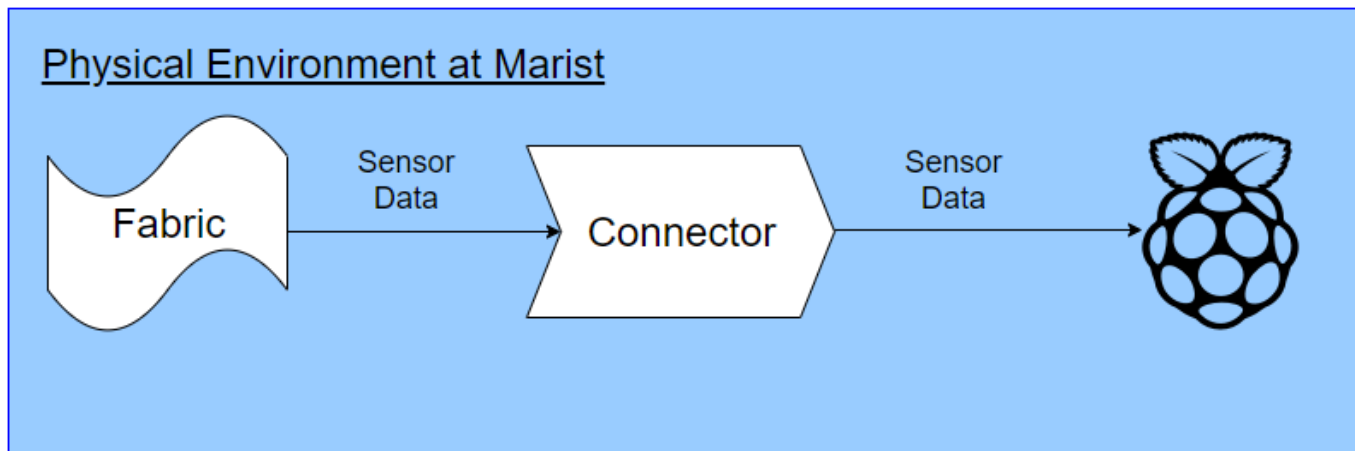
Student Motivation

- Honors By Contract
- Prior Coursework
- Excellent Mentors
- Strong Vision of the Project

Architecture Overview



Sensor Fabric System



The Sensor Fabric

- Developed by Studio 1 Labs
- 30 sensors are inside the fabric on a 5x6 grid
- Sensors output a voltage which increases with pressure applied
- Values are unaffected by the bending of the fabric





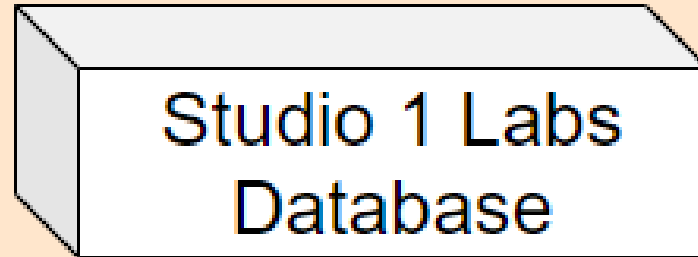
Connector and Raspberry Pi

- Connector connects fabric to Raspberry Pi
- Raspberry Pi runs a python script which transmits the data to the Studio 1 Labs Database



Studio 1 Labs Database

Virtual Environment
at Studio 1 Labs





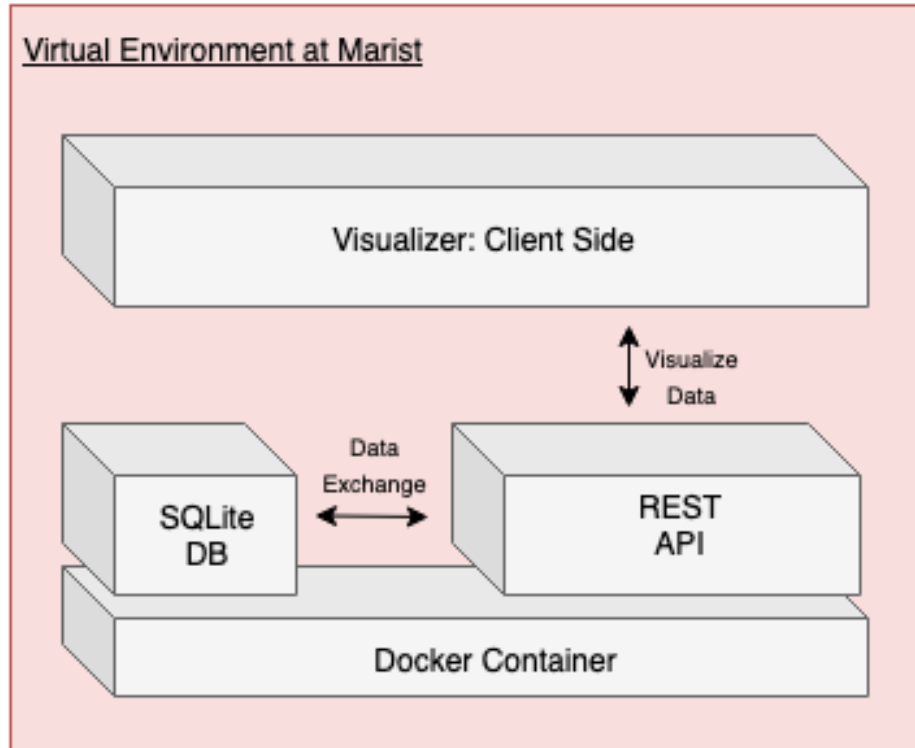
Studio 1 Labs Database

- InfluxDB is a type of time series database
- Data is stored with a timestamp
- SQL-like query language
- Each timestamp stores the voltage values for each sensor at that instance
- Our web application will query this database for the “actual” data





Visualizer Web Application





The Tools

- NPM Node.js
- Express.js
- Sequelize.js
- Passport.js
- Bootstrap
- Plotly.js
- Docker





Features on our Web Application

- Authorized account creation system
- Creating and viewing sessions
- Line graph visualization
- Heat map visualization
- Readings can be accessed instantly
- Visualizations can be shared



Development Highlights

- Successfully read data from the Fabric System
- Developed a REST API that aids in:
 - Account Creation
 - Database Querying
 - Route Protection / Authentication
- Developed a Sequelize Database for user accounts
- Modeled the pressure data using easy to read visualizations



Development Highlights Continued

- Containerized the system
 - By using docker images, we can seamlessly ship our application to users of different institutions
- Our Web Application is totally customizable and can be tailored/branded to any institutions likings



Landing Page

MARIST

About Documentation

Sign Up Login

Marist College Physical Therapy Pressure Visualizer

Calculate pressure readings in realtime using custom made fabric sensor sheets provided by [Studio1Labs](#). To begin interacting with your fabric sensor sheet, please Sign Up or Login to proceed to your dashboard.

Sign Up

Login

About The Project

This project is sponsored by Marist College and originated as an Honors By Contract project. The goal of the project is to display pressure readings calculated from technology provided by [Studio1Labs](#). This web application serves as a dashboard for visualizing these readings. The long term goal of this project is to eventually become a teaching aid for the [Doctor of Physical Therapy Program at Marist College](#).



Create Sessions

Line Graph

Line Graph: Details each sensor value is graphed with their average values over time, respectively. In addition, the overall average collected from all sensors is also graphed with respect to time.

Instructions: Simply click on "Start Session" to begin recording sensor data, then click on "Stop Session" to conclude recording sensor data for that session. Once the session has concluded, you must add a description that details the session performed. Finally, click "save" and your results will be populated under the profile section of the dashboard.

Heat Map

Heat Map: Provides a visual describing where the forces were applied to the sensor fabric sheet by providing a 5 x 6 matrix of sensors. Each sensor is represented by a square and the location is precisely mapped to the region on the fabric sheet. Average sensor values are collected and displayed in its square respectively, to view the average simply hover over the region (square) of interest.

Instructions: Simply click on "Start Session" to begin recording sensor data, then click on "Stop Session" to conclude recording sensor data for that session. Once the session has concluded, you must add a description that details the session performed. Finally, click "save" and your results will be populated under the profile section of the dashboard.

Begin Recording

Session Description:

Start Session

Save Session

Begin Recording

Session Description:

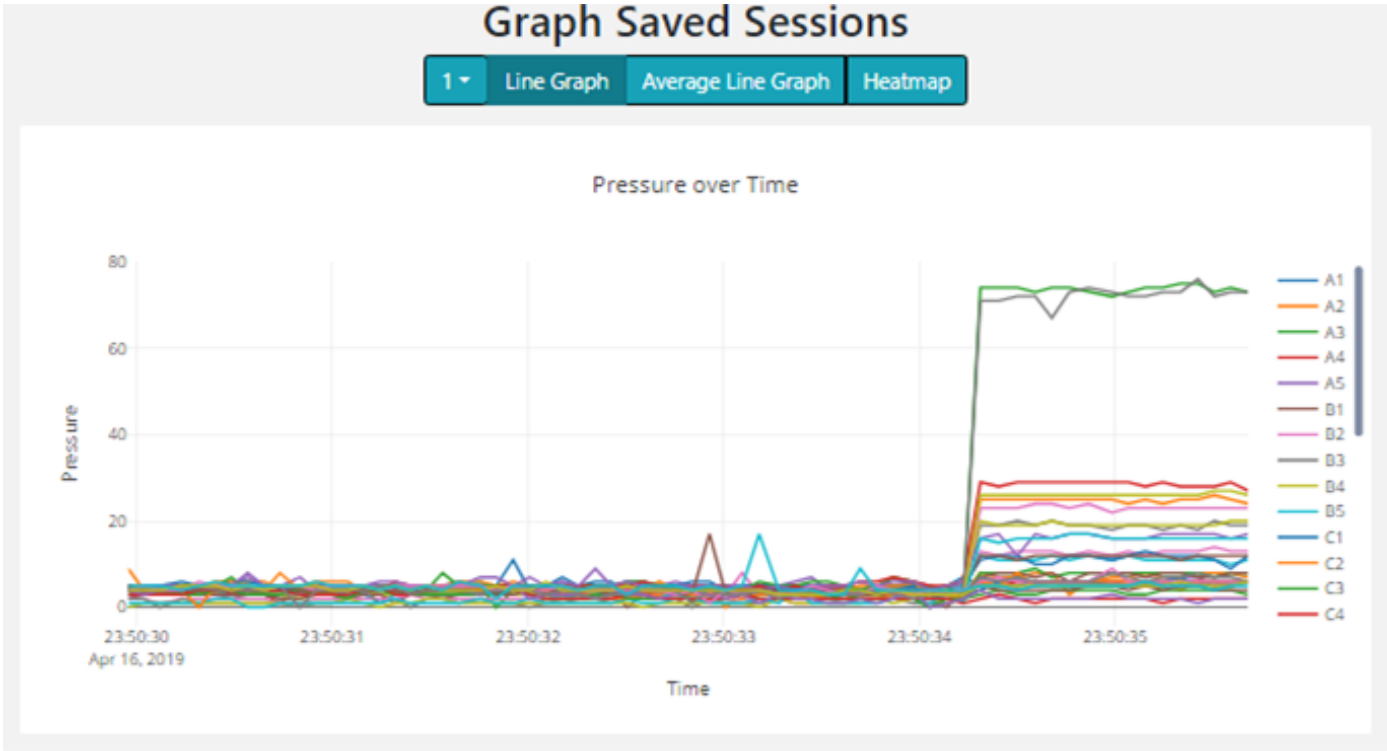
Start Session

Save Session



View Sessions

Session #	Description
1	1 plate
2	2 plates
3	3 plates
4	3 plates (retake)

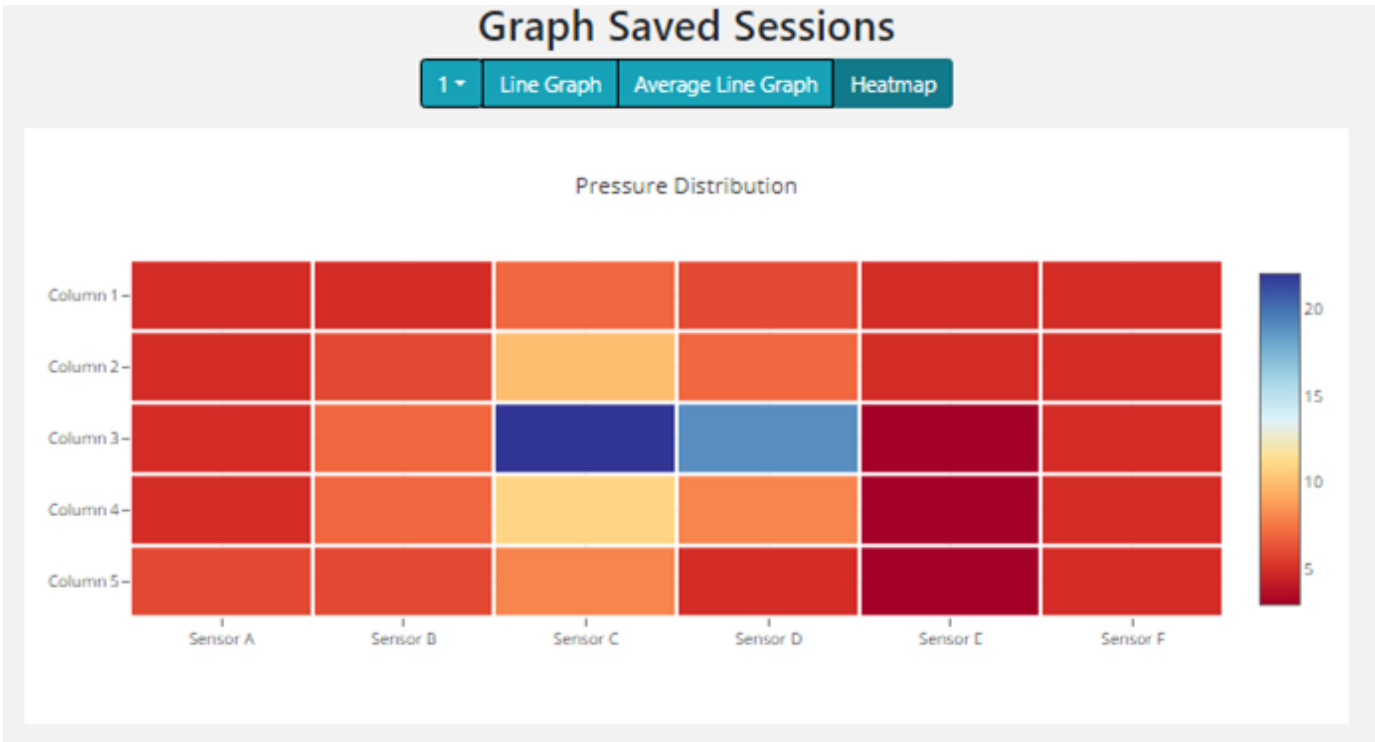




View Sessions

Saved Sessions

Session #	Description
1	1 plate
2	2 plates
3	3 plates
4	3 plates (retake)





Challenges Faced

- Time constraints
- Connector issues
- Passport.js - Authentication
- Docker - Containerization



Takeaways

- Collaborative development
- Experience working in a team
- Communicating between different parties
- Learning different technologies
- Research techniques



Future Work

- Kothapalli Brothers / iSpace Research Fellowship
- Prototype fabric from Studio 1 Labs
- Conduct intra/inter-rater reliability tests
- Introduce new features to the website
- Integrate IBM Watson IoT Platform features

Thank you!

Are there any questions?

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https://www.youtube.com/watch?v=dfJa_CS0ZiU