Stroke Rehabilitation Soft Robotics

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INTRODUCTION:

Stroke rehabilitation is a treatment process that helps patients regain independence and quality of life after a stroke. This project is focused on rehabilitation treatments that target spasticity in stroke patients. Spasticity is abnormal muscle tightness due to prolonged muscle contraction and can be very painful. Post-stroke spasticity is a common complication that contributes to limitations and difficulty for patients to use their affected arm in everyday life. It can occur from 19 to 92% of patients. Prevalence can vary widely based on the severity and chronicity of a stroke as well as the definition of spasticity. dependent

Treatment now consists of medications, botulinum injections, muscle stretching, and a range of motion exercises. Often muscle stretching is extremely painful and requires patients to go see their occupational therapist multiple times a month. This form of treatment becomes very costly and time-consuming. Portable devices allow patients to increase the frequency of therapy on personal time in order to optimize the limb for rehabilitation therapy with a clinician.

MISSION STATEMENT:

To develop an at home wearable device designed to manage upper limb spasticity in patients affected by brain injuries, strokes, spinal cord injuries and other similar conditions. By providing effective passive therapy during rest, the device aims to alleviate spasticity, enabling better functional use of the limb to support progress in the rehabilitation therapy process.

CUSTOMER REQUIREMENTS:

1	Manage Effects of Spasticity
2	Minimal Pain
3	Durability
4	Customizable
5	Cost-efficient

Other Customer Requirements: Works with rehabilitation therapy, long battery life, adjustable, intuitive controls, skin integrity, reusable/cleanable, user friendly controls/interface, data collection, quiet, minimal interference, portable, lightweight design

FUNCTIONAL REQUIREMENTS:

1	Safe Force Application
2	EMG Sensors
3	Pressure Sensors
4	Lightweight Material
5	Quick Charge Battery

Other Functional Requirements: Temperature sensors, reduced humidity, hypoallergenic material composition, biocompatible adhesives, feedback display, data sync with the cloud, compact circuitry, component design, dynamic force application, insulation for noise, water resistant, optimized sensor placing

CLINICAL NEED:

To develop an at home wearable device designed to manage upper limb spasticity in patients affected by brain injuries, strokes, spinal cord injuries and other similar conditions. By providing effective passive therapy during rest, the device aims to alleviate spasticity, enabling better functional use of the limb to support progress in the rehabilitation therapy process.

PRODUCT SPECIFICATIONS:

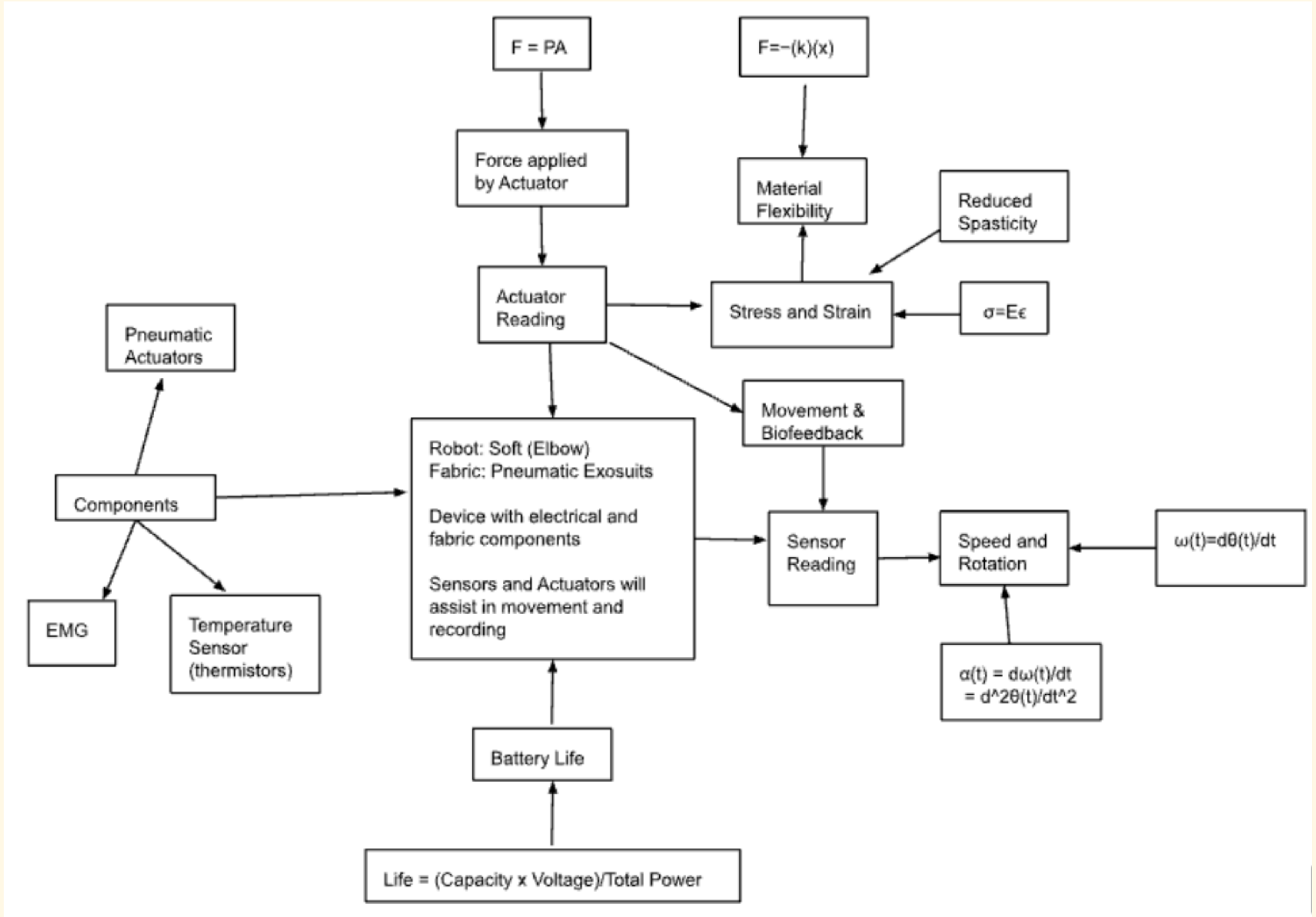
As for product specifications, the device will aid in decreasing the spasticity in the upper limb and aid patients during their stroke recovery. The overall functions concern providing passive stretching therapy and collecting real time data from the integrated sensors which will be viewable through a software application. The brace I will be made through padded fabric material which will allow for best skin compatibility and durability. The brace will be adjustable for each patient as well as reusable for hospitals to receive back and distribute to more patients. The sEMG sensors will be placed on the forearm of the device which will allow for proper readings and analysis to be done. As for cost and manufacturing processes, the target value is $400. Our device will ultimately maintain a smaller build and allow for patients to undergo a slower yet better efficient recovery process.

RELEVANT EQUATIONS:

Our technical model is similar to the Dynasplint device that is already on the market. We plan to add sensors that will collect EMG and ROM data and deliver information to clinicians to analyze. These sensors will assist clinicians in treatment of spasticity and the patients treatment progress.

Technical Model Description	Model Equations
Tension between the device and skin	$T = k \bullet x + F$
Charging/Discharging rate of a battery	$SOC = SOC(t_0) + \frac{1}{Crated} \int_{t0}^{t0+\tau} (I_b - I_{loss})dt$
Moisture (Sweat) Accumulation in Device	$M_{maxim} = \frac{Tol}{S-E}$ $(M_{rate\ acc})(t) \geq M_{maxim}$
The pressure of the device on the arm	$P = \frac{F}{A}$ P = pressure F = force A = area
Range of Motion on the Elbow Joint	ROM = θ_{max}-θ_{min}(Flexion Angle-Extension Angle) $\theta(t)=\int\omega(t)dt+\theta_0$

PRODUCT ARCHITECTURE:



DESIGN STATUS AND FUTURE WORKS:

Our team is currently refining the technical models of the embedded sensors of the brace. As there are many involved sensors, we hope to create an overall system where the operation is well executed, consistent, and allow for the best functionality of the device. For future works, we hope to work greatly and closer with the companies who will provide us the materials needed to physically build the device. We will also begin prototyping our device through software applications and learn in detail the internal and external systems of the device.

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QR CODES:

House of Quality

Gantt Chart

References