Best Integrated Writing

Volume 4

Human Biomechanics II Course Project

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Nominated by: Dr. Joe Tritschler

Abdelaziz graduated from a high school in Kuwait in the top 10 % of his class. He came to Wright State University in 2014 and is a senior majoring in Biomedical Engineering. Abdelaziz has volunteered at the Union Hospital in Indiana and at a private clinic in Beirut, Lebanon. His volunteer work has influenced his career choice; his goal is to pursue a PhD and to become a college professor because he wants to share his love of science with future students.

Dr. Tritschler Notes:
This project represents impressive work from an international student with English as a secondary language in a highly technical field.

Abdelaziz Notes:
The biomechanics of the human body is complex and highly regulated by the nervous system. When people lose their extremities, they lose their ability to perform daily tasks, work assignments or the enjoyment of sports and various recreational activities. With extreme efforts, many people adapt to the lack of a part of their body and learn to compensate for it by using the other hand or foot, or other parts. However, due to the advances in biomedical engineering and neuroscience, it has become possible to replace the lost part with prosthetics that can perform many tasks under the voluntary control of the recipient. The purpose of my research was to test Human Arm Module PASCO ME-6807A, and determine some of the biomechanical characteristics, such as force, tension, instantaneous angular velocity, and acceleration vs. angular position required for various movements and arm positions in space. In the process of the experimental research, I determined the necessary force to develop instantaneous angular velocity and acceleration to achieve the positions in the robotic arm at the angles ranging from 67^o to 72^o. This range of angles does not only allow us to see the variance in the applied forces and resulting velocity, but also gives an idea of the complexity of a smooth and uninterrupted motion at the elbow joint. The project aims at helping develop the robotic prosthetics that would be maximally comparable with human arms. Additionally, on top of the technical characteristics of PASCO ME-6807 A, the reader would get the

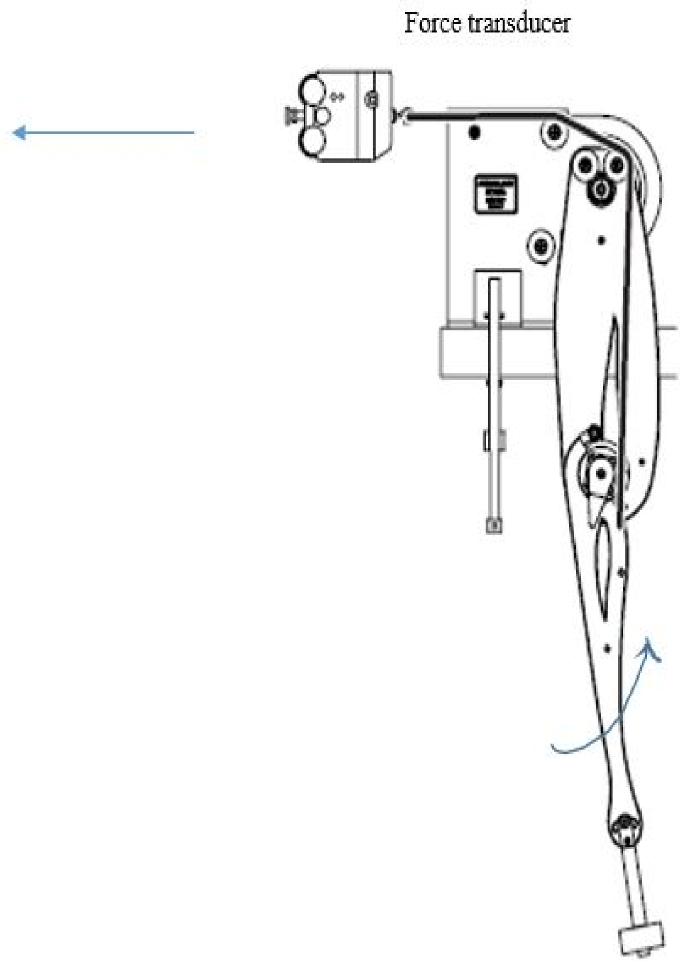
appreciation of the necessity of such "simple" movements as getting a glass of water or brushing hair that we normally do not even notice until we are deprived of them.

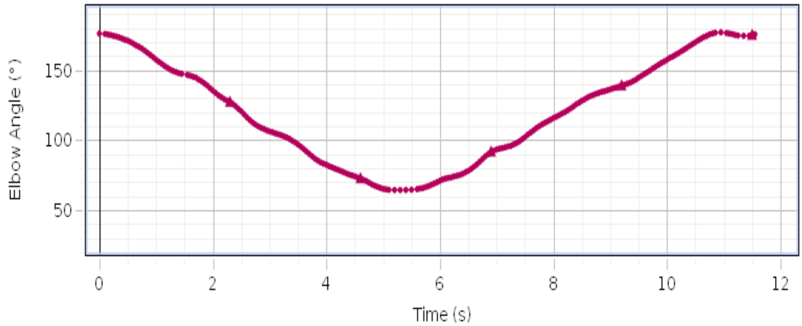
Introduction:

The following is a project for the Human Biomechanics II course for spring 2017 in which PASCO ME-6807A Human Arm Model is used to simulate the motion and force characteristics of a human arm Integrated potentiometers facilitate measurement of angular position at the shoulder and elbow. Force sensors measure tension in cords which simulate tendons pulling limb segments. The purpose of this project is to determine instantaneous angular velocity (ω) and acceleration (α) vs. angular position (θ), and also to determine joint force and tension in biceps tendon.

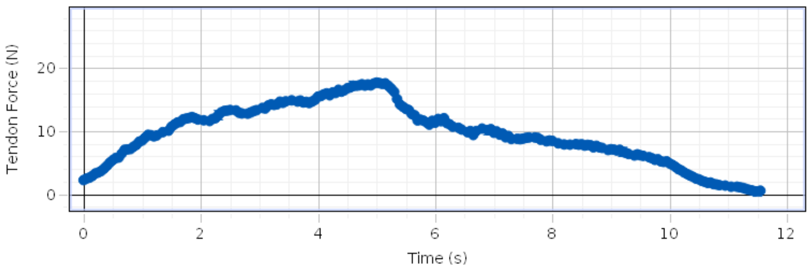
The following diagram is representing PASCO Human Arm Model Set-Up

Force transducer





Time vs. Elbow Angle



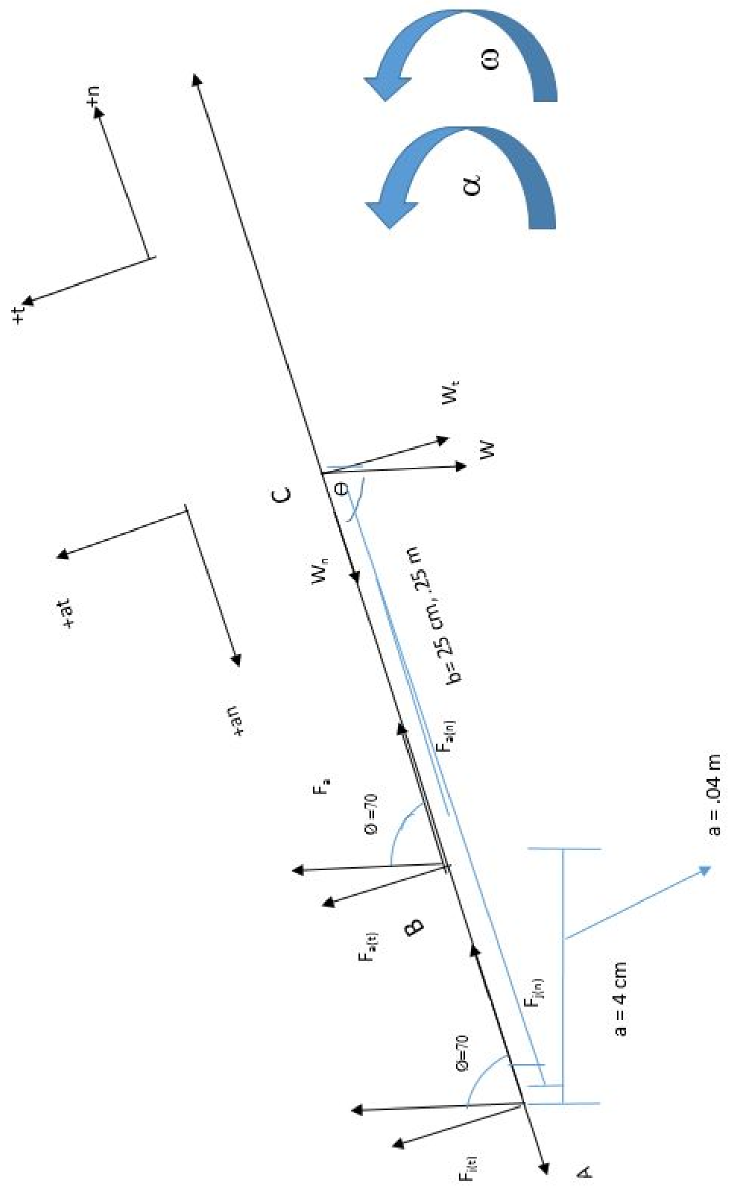
Time vs. Distal Biceps Tendon Force

αTable of Time, Tendon Force, Elbow Angle, ω and

		Run #9	Run #9	Run #9	Run #9	Run #9
	Time (s)	Force (N)	Elbow Angle (°)	Tendon Angle (°)	Angular Velocity 2 (rad/s)	Angular Acceleration 2 (rad/s²)
117	5.80	11.69	67.16	112.84	-0.3	-0.8
118	5.85	11.42	68.11	111.89	-0.3	-0.3
119	5.90	11.06	69.03	110.97	-0.3	-0.1
120	5.95	11.66	69.94	110.06	-0.3	-0.3
121	6.00	11.36	70.94	109.06	-0.3	0.6
122	6.05	11.96	71.93	108.07	-0.3	1.5
123	6.10	11.60	72.51	107.49	-0.2	1.3
124	6.15	12.08	73.05	106.95	-0.1	0.1
125	6.20	11.30	73.34	106.66	[illegible]	[illegible]


Shoulder Angle
Angle 1 (°)
Run #9
0.85°
Elbow Angle
Elbow Angle (°)
Run #9
175.50°
Distal BicepsTendon Angle
Tendon Angle (°)
Run #9
4.50°
ω (rad/s)
Angular Velocity 2 (rad/s)
Run #9
-0.2rad/s
α (rad/s²)
Angular Acceleration 2 (rad/s²)
Run #9
-1.6rad/s²

The following is the free body diagram of the human-arm at θ = 70⁰ from vertical.



Net Torque Equation = $\sum\tau = r\times F = I\times\alpha$

From the above free body diagram the net torque equation is

$a \times F_{a(t)} - b \times W_t \sin\varnothing = I \times \alpha$ [$\alpha = -1.6 rad/sec^2$ from the table above, $I = 0.0042$ Kg-m^2]

Given Data $a = 0.04m$, $b = 0.25m$, $\varnothing = 70^0$ $W_t = ma = 0.2 \times 9.8$

$0.04 \times F_{a(t)} - 0.25 \times 1.96 \sin 70^0 = 0.0042 \times -1.6$

$F_{a(t)} = 11.332$ N upwards

5. Equation for tangential forces

$F_{j(t)} + F_{a(t)} - W_t = ma_t$

$F_{j(t)} + 11.332 - 1.84 = 0.2 \times a_t$ **[$a_t = r\times\alpha = -1.6 \times 0.25 = -0.4 m/sec^2$]**

$F_{j(t)} + 9.492 = -0.08$

$F_{j(t)} = -9.572$ N negative sign implies opposite direction

For normal forces

$F_{j(n)} + F_{a(n)} - W_n = -ma_n$ [$a_n = r\times w^2 = 0.25\times0.2^2 = 0.01 m/sec^2$]

$F_{j(n)} + (4.14) - (0.66) = -0.2 \times 0.01$

$F_{j(n)} = -3.482$ N towards left

$F_j = (-9.527)^2 + (-3.482)^2 = \sqrt{102.888053} = 10.1433N$

$$\tan^{-1}\frac{Fjt}{Fjn} = \tan^{-1}\frac{-9.572}{-3.482} = 70.0101°$$

Experimental $F_j = 11.66$ at Ø = 69.94

So, percentage error = (experimental – theoretical)/ experimental ×100

So, percentage error = (11.66-10.1433)/11.66 = 0.13*100 = 13%

percentage error = 13% *so that means the values of experimental & theoretical are close by 13%