ELECTROYMOGRAPHY-BASED EXERGAMING IN A WHEELCHAIR

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Outline

- Barriers to cardiovascular fitness for individuals in wheelchairs
- Mobile fitness system overview
- Game descriptions
- EMG-driven design
- Design challenges
 - Utilizing multiple muscles
 - Encouraging appropriate exercises
 - EMG peak detection
- Future directions

Barriers to Cardiovascular Fitness for Individuals in Wheelchairs

- Health stats for people with spinal cord injury
 - Average life expectancy: 43 years¹
 - Average lifetime health care and living expenses = \$2-5M
 - Health problems
 - Obesity
 - High blood pressure
 - Infection

Barriers to exercise

- transportation
- access to adapted equipment
- social stigma



1: Krause, James S and Lee L Saunders. "Risk of Mortality and Life Expectancy After Spinal Cord Injury: The Role of Health Behaviors and Participation" Topics in spinal cord injury rehabilitation vol. 16,2 (2010): 53-60.

Mobile fitness for individuals in wheelchairs

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user history records and projections (goals)

Mobile Fitness Gaming Community



3 Games = 3 Exercises

Spinning



Boxing



Resistance



Design Specifications for Exergames

	Track	Boxing	<u>Resistance</u>
Targeted Muscle Groups	Bicep Tricep Anterior Deltoid	Bicep Tricep Anterior Deltoid	Bicep Anterior Deltoid
Exercise Classification	Cardio	Aerobic	Resistance
False alarm rate	N/A	< 5%	< 5%
Missed detection rate	N/A	< 5%	< 5%
Accuracy of metric	Speed of car % error < 10%	Calories burned % error < 10%	Integrated EMG % error < 10%

Racing Game

- Cardio-based workout
- Angular velocity of car driven by average EMG

 $x_n = a + r \cdot \epsilon \cdot cos(\theta_n)$ $y_n = b + rsin(\theta_n)$ $\theta_{n+1} = \theta_n + d\theta_n$ $d\theta_n = K \bullet s_n$ $s_n = EMG$ sensor value at time sample n K = scaling coefficient to adjust speed as a function of EMG level



Racing Game Demo





01 10 0010

\$ ¥{ இ ⊿ 78% 🗎 10:56 AM

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EMG: 200 - 20000

Replay Performance Game

Target Zones

aps To Complete: 0

00:50

PAST SESSIONS PM Performance gained: 3390779.00 49.92 sec carnivaltest-user3 01-12-2018, 6:43:17 PM CARNIVAL 27.53 sec Performance gained: 103926.57 01-12-2018, 6:44:25 PM monitortest1-user3 MONITOR Performance gained: 1973207.87 160.05 sec user2vuser3 CARNIVAL 01-12-2018, 7:09:55 PM Performance gained: 441504.60 27.13 sec Set Be B. P * T 15% 12:38 PM **Replay Performance Game** Target Zones EMG: 200 - 18000 6174 7185 aps To Complete: 2 00:32

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	kml1 Game: TRACK Lap Count: 2 Performance gained: 620447.00		10-07-2018, 2:33:15 PM 61.01 sec	\triangleleft	
	jcjgcjk Game: TRACK Lap Count: 2 Performance gained: 4126408.00		10-05-2018, 2:28:45 PM 32.31 sec		
	fxgvv Game: TRACK Lap Count: 0 Performance gained: 500060.00		10-05-2018, 12:24:07 PM 13.78 sec		
	hgdgcf Game: TRACK		10-05-2018, 12:06:40 PM		
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Boxing Game

punch count based on peak detection



Resistance "Carnival" Game





CARNIVAL

-

Performance gained: 441504.60

7:09:55 PM 27.13 sec









C) DU Resorder

DU Recorder

Closing Thoughts and Future Steps

- The app will improve overall quality of life
 - Ease of accessibility
 - Motivating and competitive
 - Accurate measure of fitness

Future plans

- Automate muscle calibration
- Closed beta for testing and feedback
- Deployment as a commercial product

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