TEAM TERMINATOR ARM

AYOTUNDE ODEJAYI

MARK CHASE

MATTHEW CLARKE

EZANA DAWIT

CORY BETHRANT

BIBEK RAMDAM

April 7, 2016

HOWARD UNIVERSITY

Content

- Background
- Problem Statement
- Design Requirements
- Current status of Art
- Conceptual Designs
- Final Top Design selection
- Project final goal and deliverables
- Implementation, Test and Evaluation of the design
- Demo
- Resources and Budget
- Conclusion and Future work

HOWARD UNIVERSITY

Background

Objective

Design an inexpensive, non-invasive prosthetic arm controlled by electrical pulses from the brain

Motivation

Provide assistance to amputees

Cost: Traditional myoelectric prosthetics cost upwards of $3000, this would be assembled for less than one-tenth the price

HOWARD UNIVERSITY

Problem Statement

M

"Amputees deserve a normal life like everyone else. They require an inexpensive hand replacement that provides functionality comparable to the human hand. This should be light, comfortable, and reliable for everyday use."

We intend to produce a prosthetic arm utilizing electro-myographic methods.

HOWARD UNIVERSITY

Design Requirements

M

Customers

- Amputees with loss of forearm

Needs

- Inexpensive
- Hand with great degree of motion i.e comparable to the human hand
- Reliable to use for everyday activities eg writing, picking objects

HOWARD UNIVERSITY

Design Requirements

M

Advantages

- Cost-effective
- Non-invasive
- Easily detachable (advantageous for cleaning/general maintenance)

Required Items

- Terasic DE2i-150

HOWARD UNIVERSITY

Current Status of Art

- Traditional myoelectric prosthetics cost upwards of $3000, ours would cost about one-tenth the price

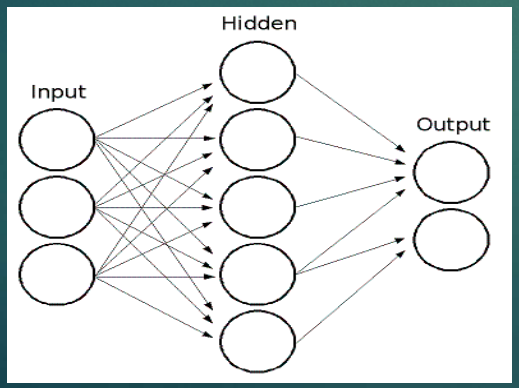
- e-NABLE has open-sourced design for hand-prosthetics that are purely mechanical

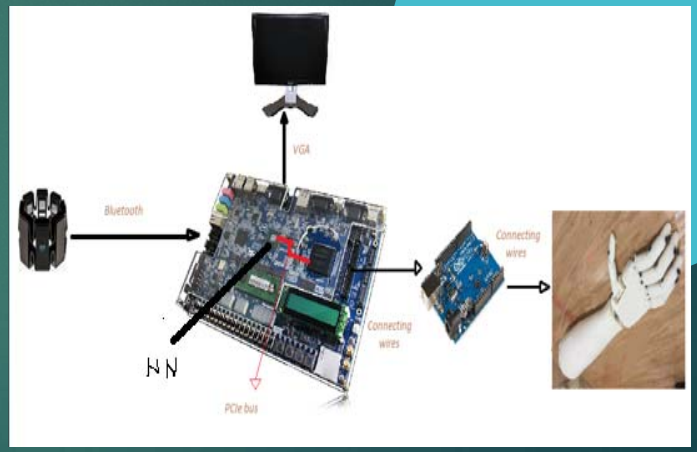
HOWARD UNIVERSITY

Conceptual Designs (Gesture Recog.)

Fast Artificial Neural Network (FANN)

- Machine Learning Library
- 1 layer, 20 hidden neurons



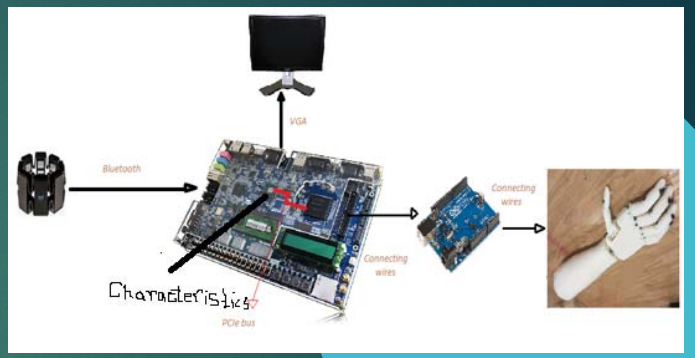


HOWARD UNIVERSITY

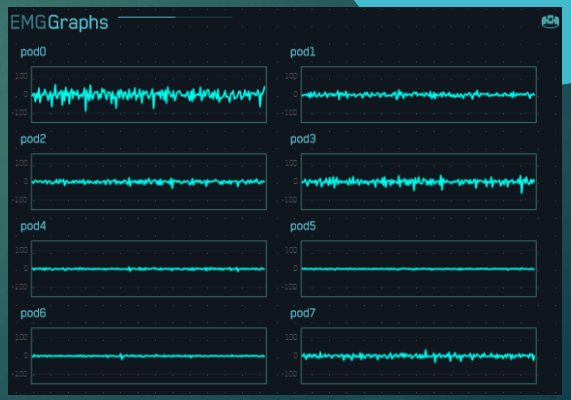
Conceptual Designs (Gesture Recog.)

Frequency Characteristics

- Gathered data from 30 subjects
- Predetermined classifiers



	rest	thumb	index	middle	ring	pinky	wrist
pod 0	82.67504	52.77045	50.32498	52.55339	47.64151	39.86805	68.10345
pod 1	97.21724	83.64116	81.70845	86.16527	77.92453	76.24882	87.83525
pod 2	99.91023	93.66755	95.45032	95.72888	94.33962	93.1197	90.90038
pod 3	99.91023	92.70009	96.19313	92.85051	92.26415	92.83695	71.83908
pod 4	99.28187	91.38083	87.65088	80.87279	63.01887	83.03487	46.7433
pod 5	97.307	91.55673	76.97307	79.29434	49.43396	77.19133	52.20307
pod 6	98.9228	93.22779	85.23677	85.51532	79.62264	76.53157	61.2069
pod 7	94.52424	79.50748	74.65181	70.00929	65.9434	68.42601	64.94253

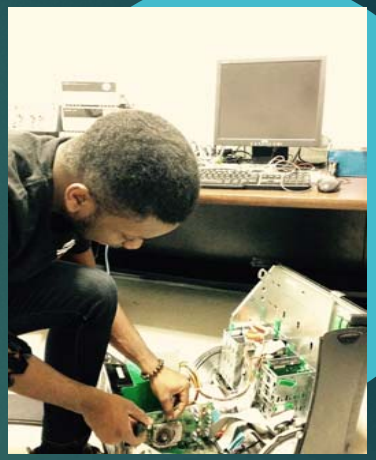


HOWARD UNIVERSITY

Conceptual Designs (Data Streaming)

External GPU

- External graphics card
  (Nvidia Quadro fx 3700)



BLE/Serial Protocol Implementation

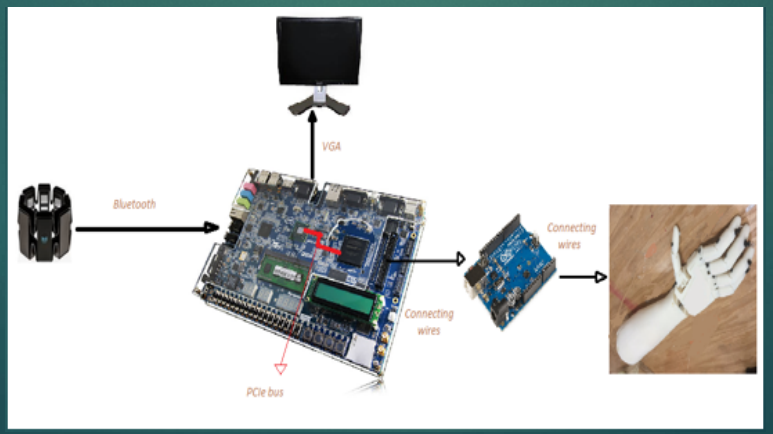
- Bluegiga API (Myo BLE module)/Serial Port communication
- Serial Port data access in client code

HOWARD UNIVERSITY

Final Top Design Selection

M

Design Matrix													
	Weight		Unit score	Aggregate		Unit score	Aggregate		Unit score	Aggregate		Unit score	Aggregate
Ease	5		2	10		3.5	17.5		3.5	17.5		2	10
Efficiency	4		2	8		5	20		3	12		4	16
Competition Constraints	4	FANN	5	20	Char	5	20	GPU	2	8	BLE	5	20
Space overhead	3		5	15		5	15		2	6		5	5
Design Preference	5		2	10		1.5	7.5		2	10		5	25
Total				**59**			**77**			**43.5**			**73.5**

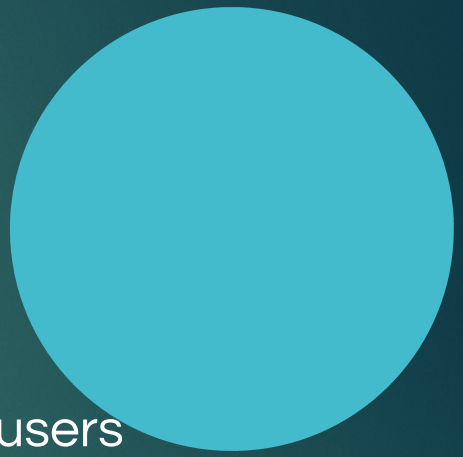


HOWARD UNIVERSITY

Final Goal and Deliverables

M

- Perfectly mimic any user gesture
- Significantly low response time
- Durable + sufficient battery life
- Robust system that works for a wide variety of users
- Amenable to daily use (Portable)

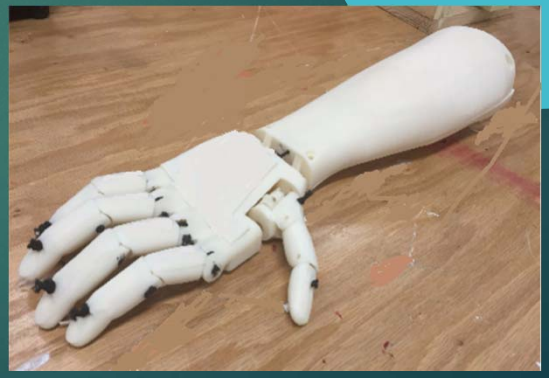


HOWARD UNIVERSITY

Spring 2016 Deliverable

M

- Respond accurately to a select number of input gestures
- Implement arm functionality on the Intel platform



HOWARD UNIVERSITY

Implementation, Test & Evaluation

- Hand Design (Matthew Clarke, Bibek Ramdam)
- Software development (Ayotunde Odejayi)
- Electrical and Computer hardware (Ayotunde Odejayi)
- Bluetooth Low Energy, BLE (Mark Chase, Cory Bethrant)
- External GPU (Ayotunde Odejayi, Mark Chase)
- Data science (Ezana Dawit)
- Project Management/Admin (Bibek Ramdam)

HOWARD UNIVERSITY

Implementation, Test & Evaluation

- 3D printed & assembled hand

- Prototyped motors with FPGA controls

HOWARD UNIVERSITY

Implementation, Test & Evaluation

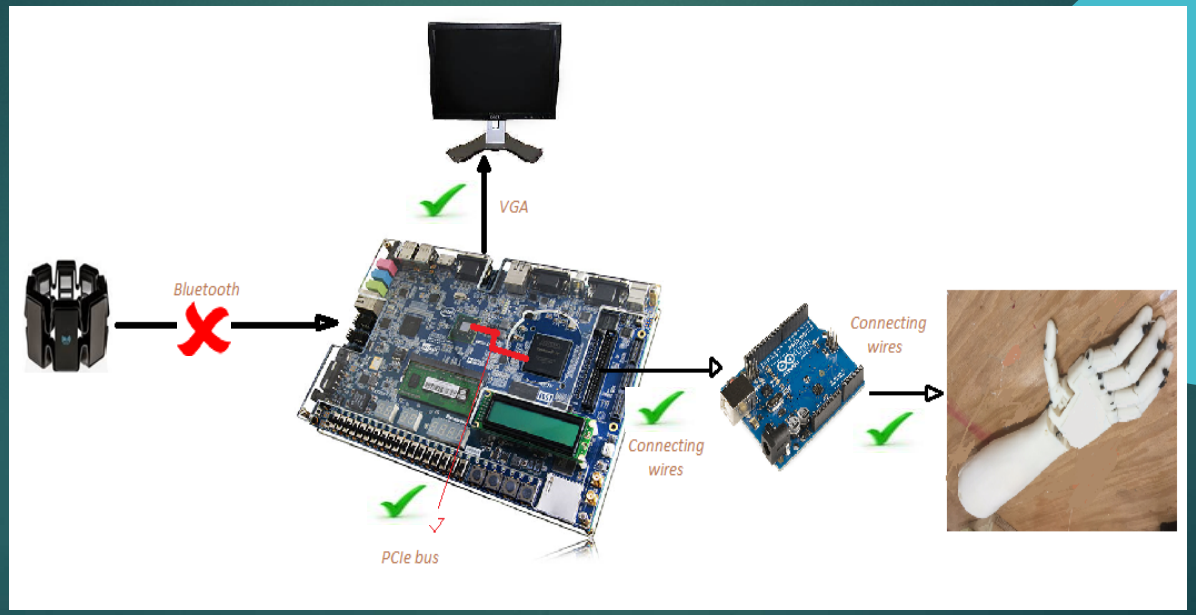
- Implemented PCIe bus communication using a BYTE (eg. 1000 0000) in one-hot mode to encode data for all gestures

- Prototyped with for loops testing all gestures in main code on Intel Atom

HOWARD UNIVERSITY

Implementation, Test & Evaluation

Design Architecture



HOWARD UNIVERSITY

Demo

HOWARD UNIVERSITY

Resources and Budget

M

- 3mm ABS filament: $34.99
- 9v Battery: $7.48
- Servos: $15
- Myo armband: $199
- Elastic cord: $6.99
- Rivet: $9.52
- DE2I board (Intel Atom + Altera FPGA): Donated
- Total (excluding DE2I): $272.98

HOWARD UNIVERSITY

Conclusion

M

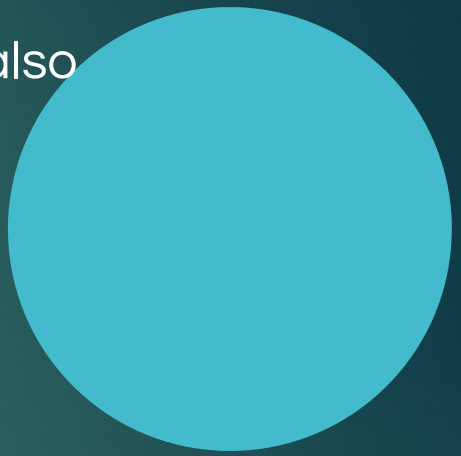
- Characteristics classifiers needs improvement
- System crashed while implementing external GPU
- Servo handles need adjustment
- Supplying power to servos and Arduino via batteries

HOWARD UNIVERSITY

Future Work

M

- Work on incorporating more functionality and also complete documentation
- Incorporate more portable design
- Decrease lag-time
- Provide a state of the art prosthetic



HOWARD UNIVERSITY

Image Source:
http://slaterzurz.com/practice-areas-2/nursing-home-abuse-and-neglect/nursing-home-negligence-questions/

HOWARD UNIVERSITY