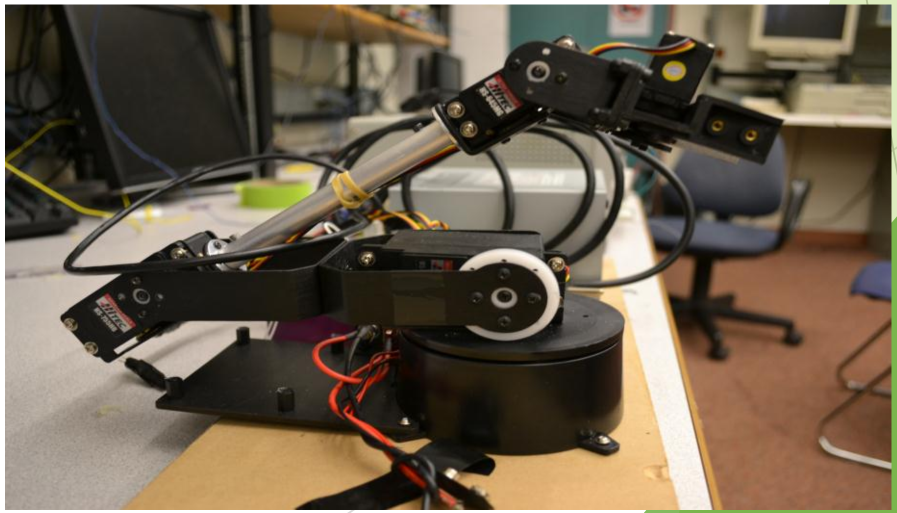
MotiCon

Motion Controlled Manipulator System (MCMS)

Vincent Wong
Kevin Wong
Jing Xu
Kay Sze
Hsiu-Yang Tseng
Arnaud Martin

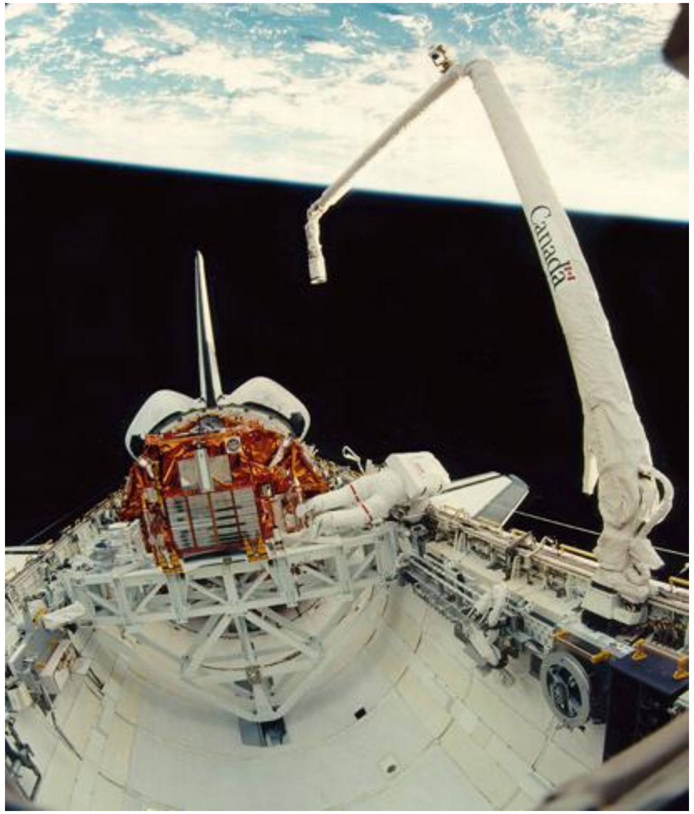


Agenda

- Motivation and Background
- System Overview
- Project Management
- Prototype Specifications
- Business Case
- Conclusion
- Acknowledgements

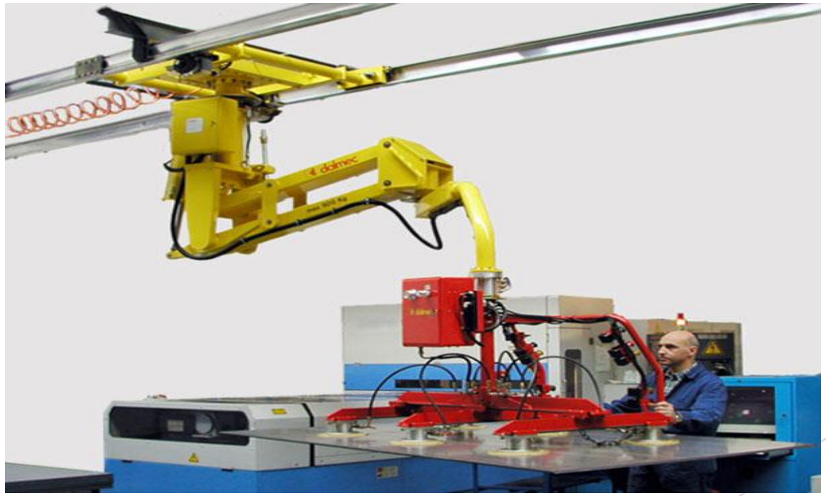
Motivation and Background

- Canada Arms in space



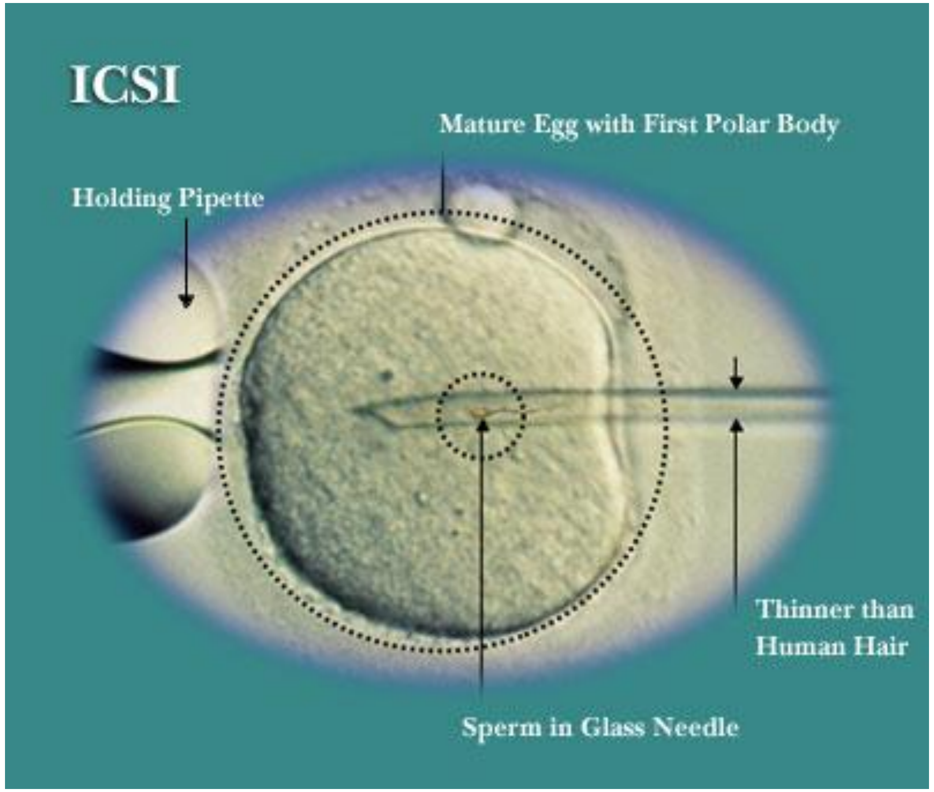
- Excavators - up to 1400 HP

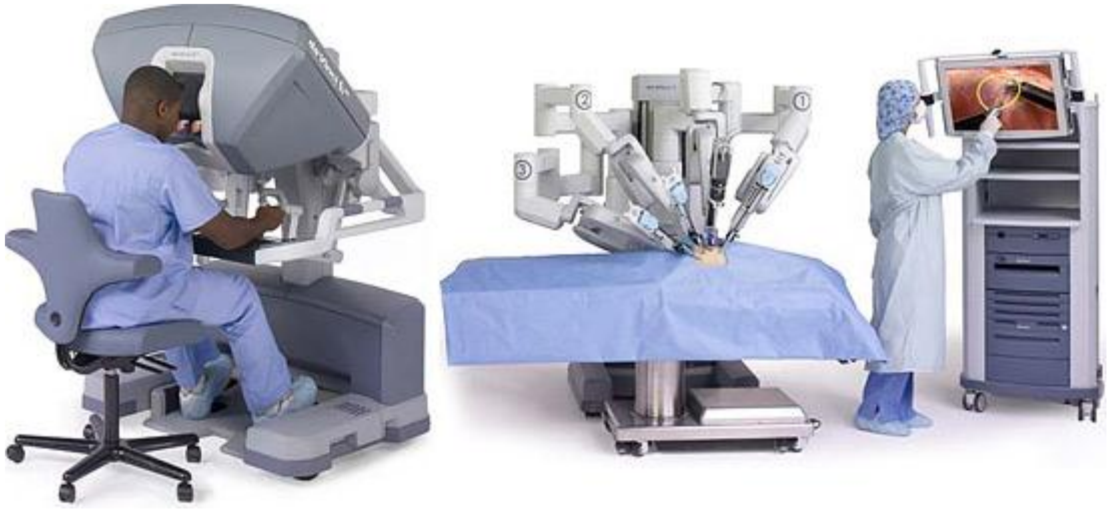
- Industrial Arms- up to 1300kg



Linear stage for ICSI

- Narrow market
- Micro-scale technology – expensive, hard to achieve, and too many Biomedical standards to gallop over





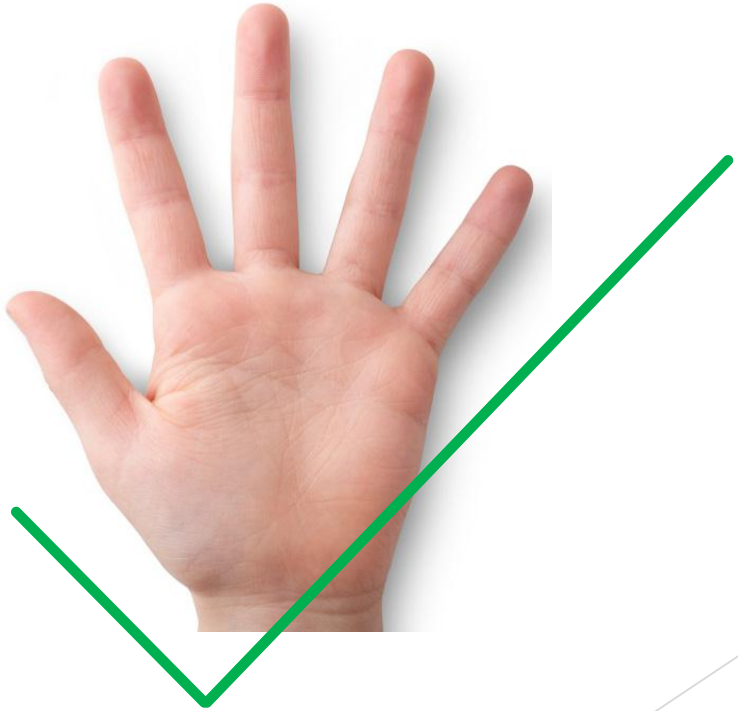
- Although we are not the first to do this, our success with this project in 1 semester gives us a promising start

- Practical use:
  - In industrial robotic arms
  - In excavators or construction arms
  - In robotic surgery arms

System Overview

- Goals of our system:
  - Intuitive Control
  - Simplicity
  - Adaptability

- Intuitive Control

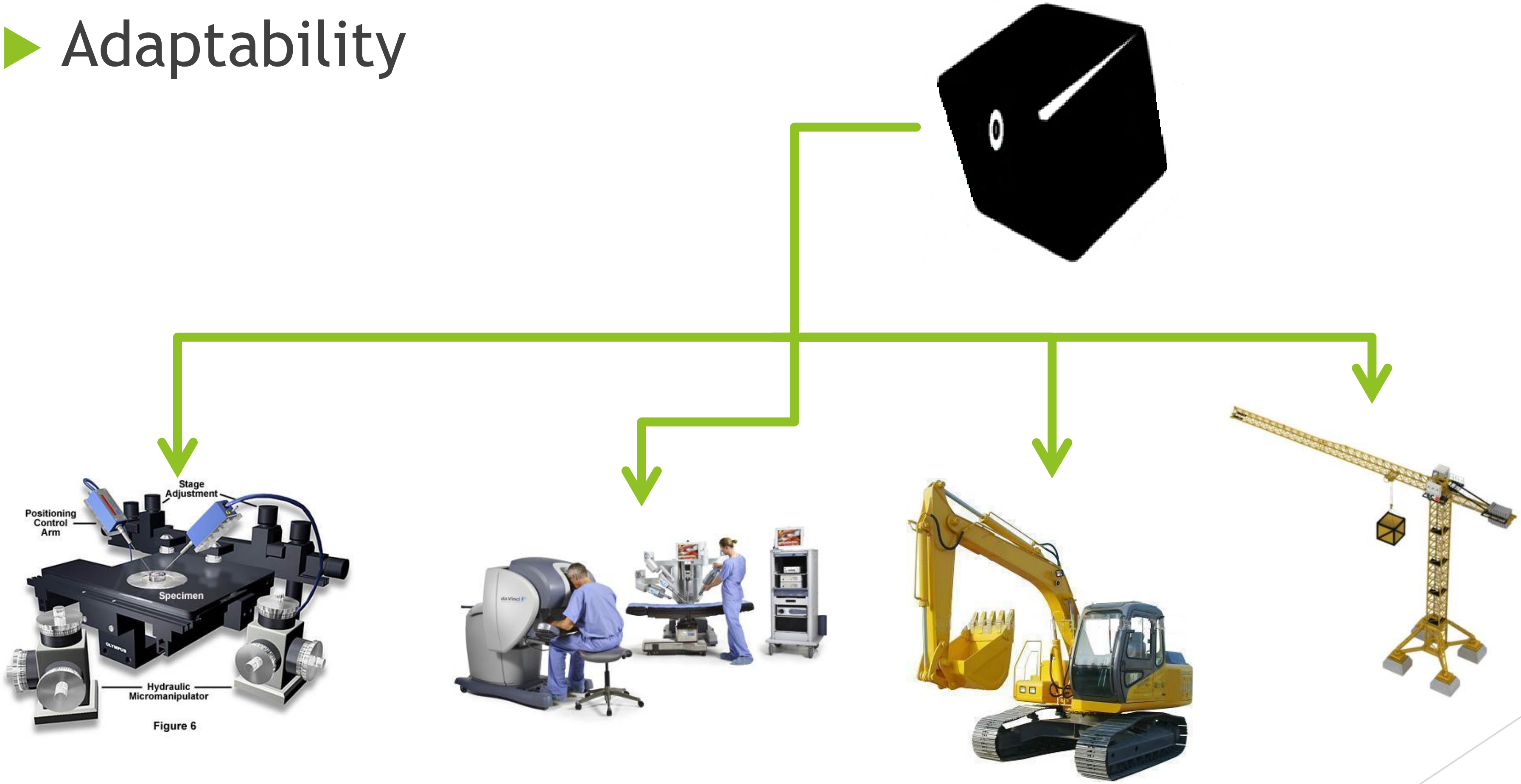


- Simplicity

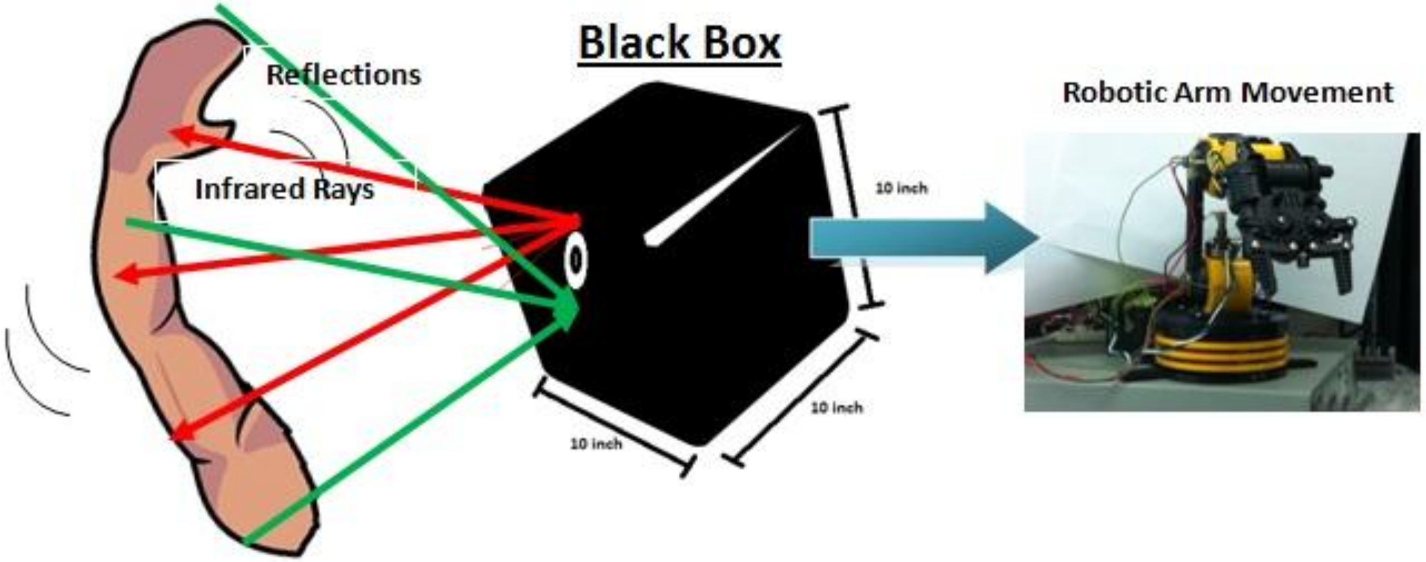

12
19
15
11
18
14
8
4
17
13
7
3
6
2
5
1


XBOX 360
KINECT
KINECT
for XBOX 360.

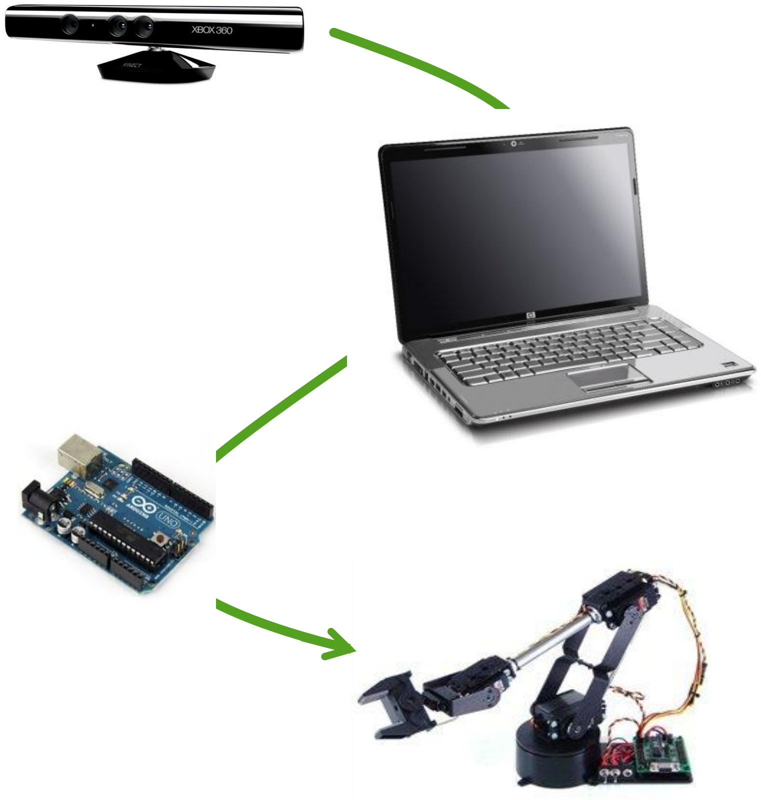
- Adaptability



- User-Level Overview



- High-Level Block Diagram of MCMS



Project Management

Allocated Budgets:

- Initial estimated budget: **$975**
- Funding and resources:
  - ESSEF: **$700**
  - Dr. Marinko Sarunic: Kinect
  - Kevin and Vincent: Arduino boards
  - Our own inventory: power supply, and wires, etc
- **$271.03** remaining from ESSEF funding

Team Dynamics:

- First Stage
  - Resourcing
  - Teams setup

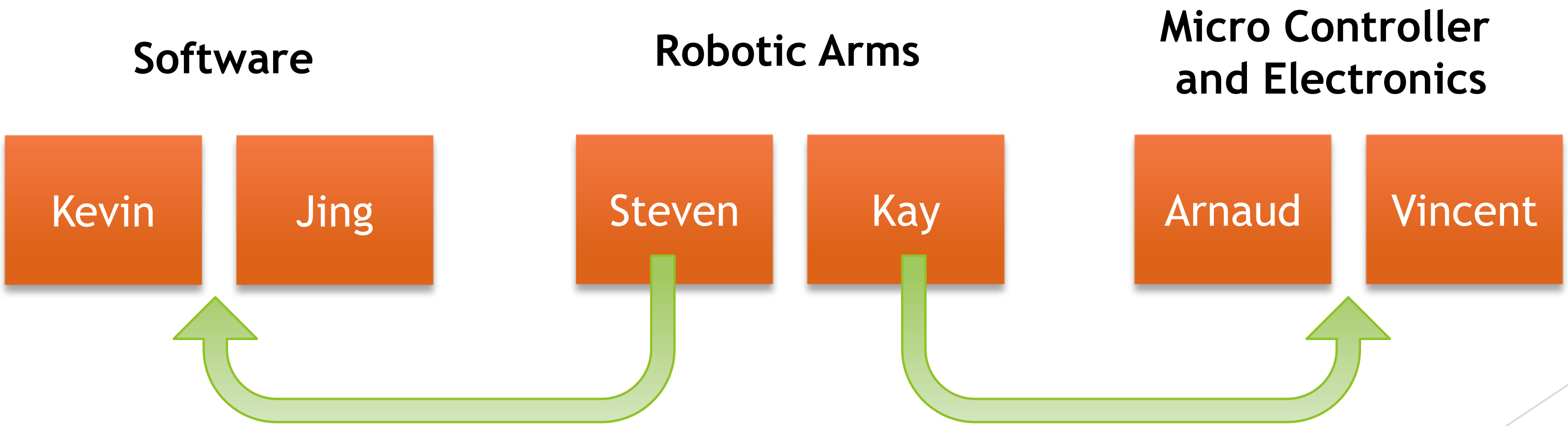
Software
- Kevin
- Jing

Robotic Arms
- Steven
- Kay

Micro Controller and Electronics
- Arnaud
- Vincent

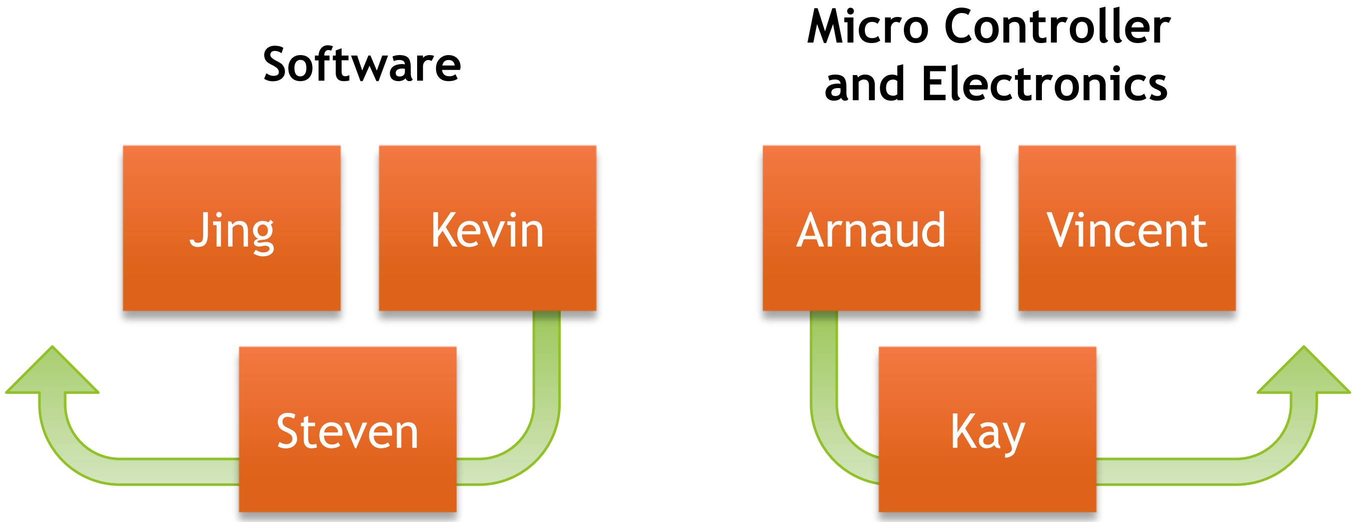
Team Dynamics:

- Second Stage
  - Implementation
  - Re-integration



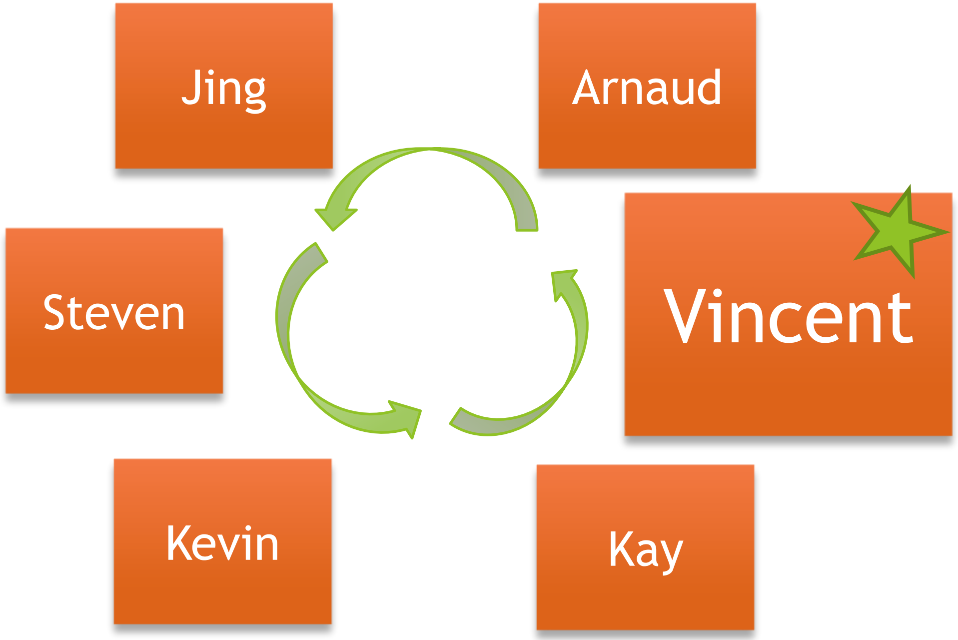
Team Dynamics:

- Second Stage
  - Implementation
  - Re-integration

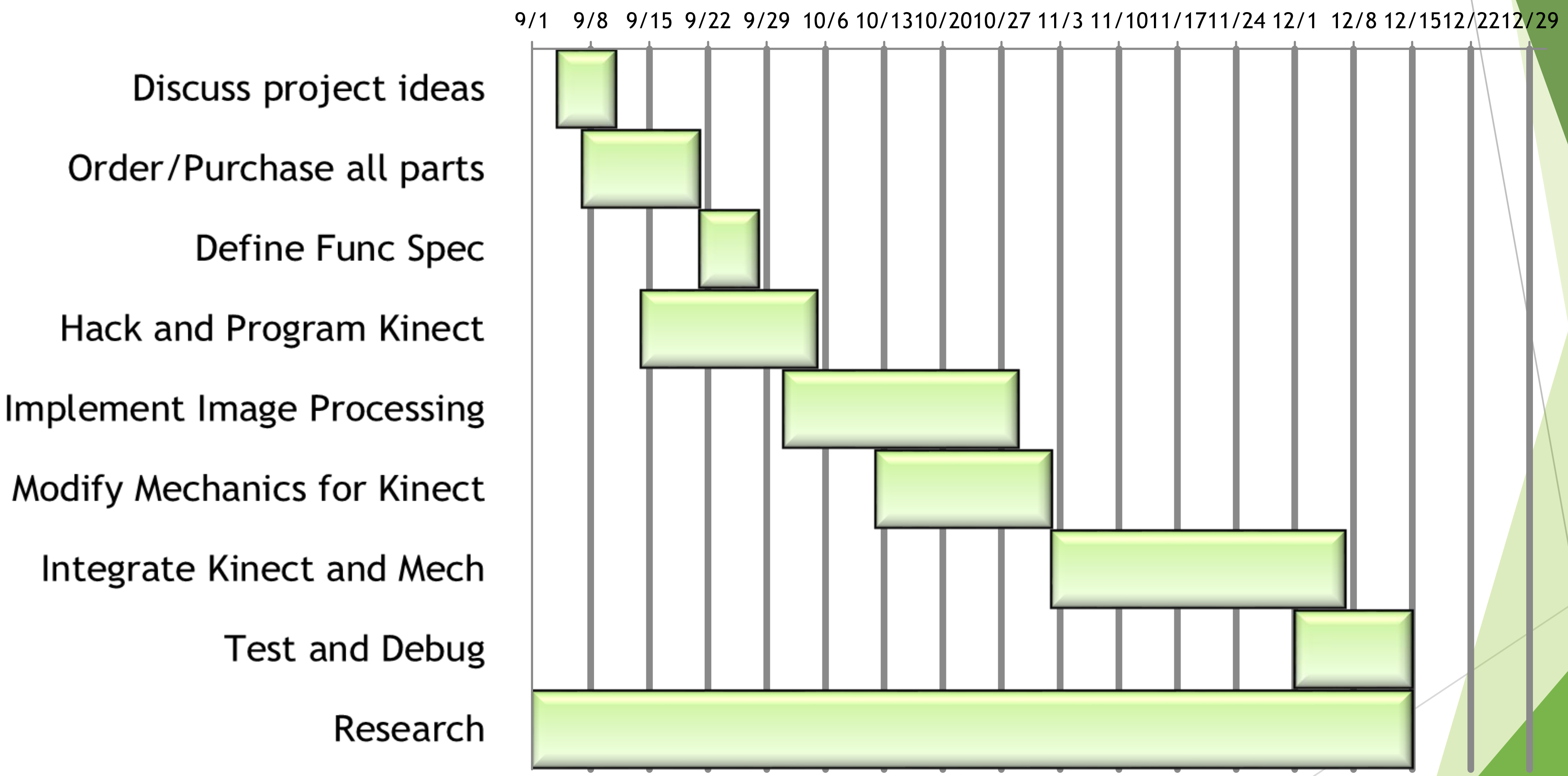


Team Dynamics:

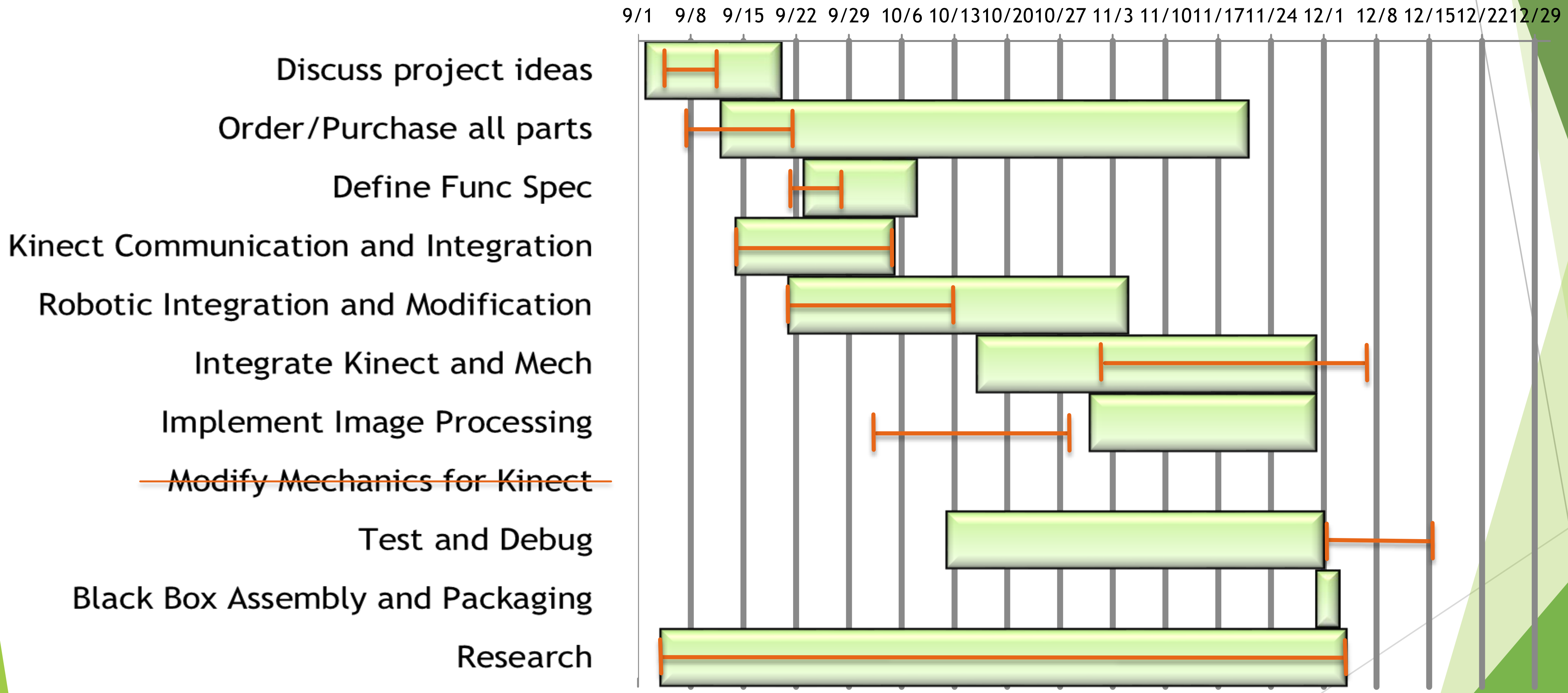
- Third Stage
  - Integration



Proposed Timeline



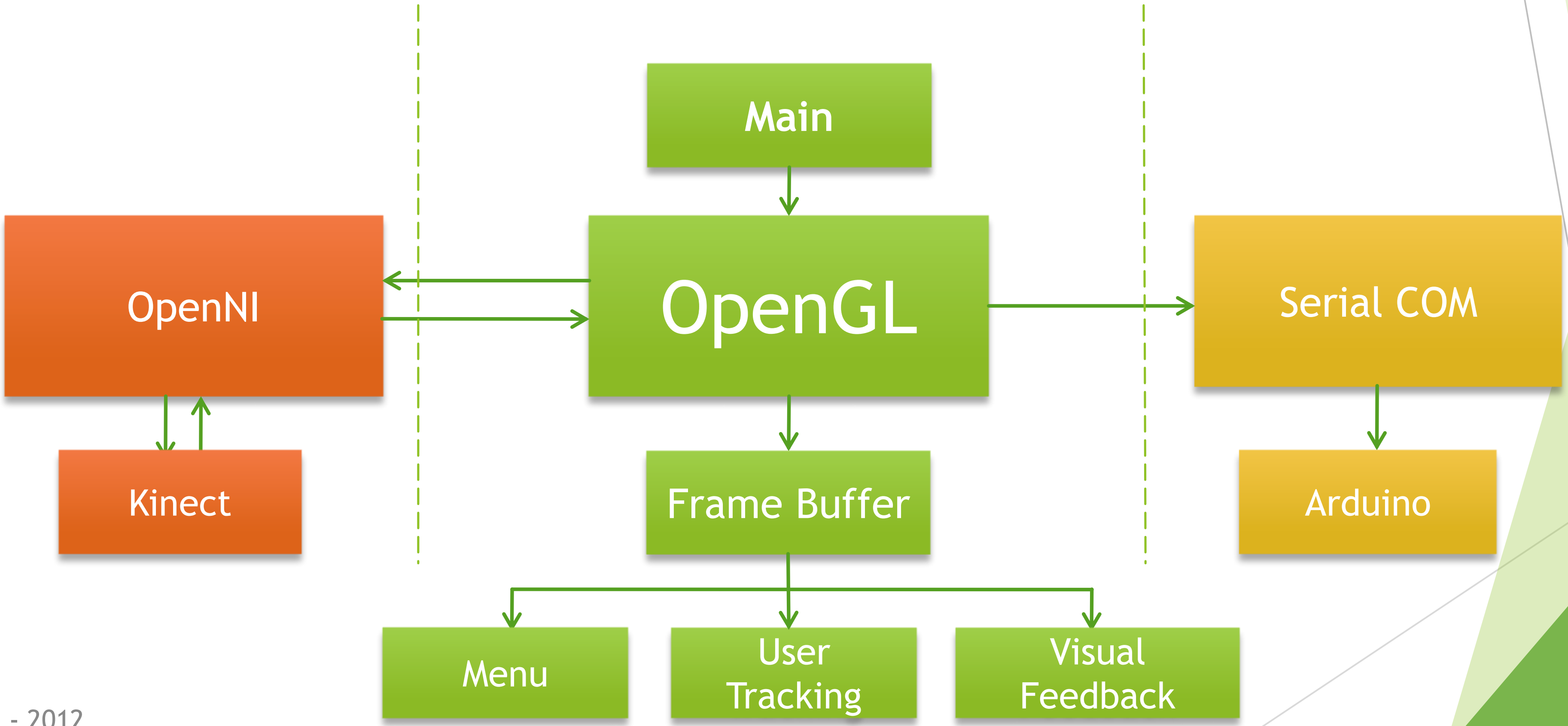
Actual Timeline



Prototype Implementation: Software

Software

- High Level Diagram of Software Design

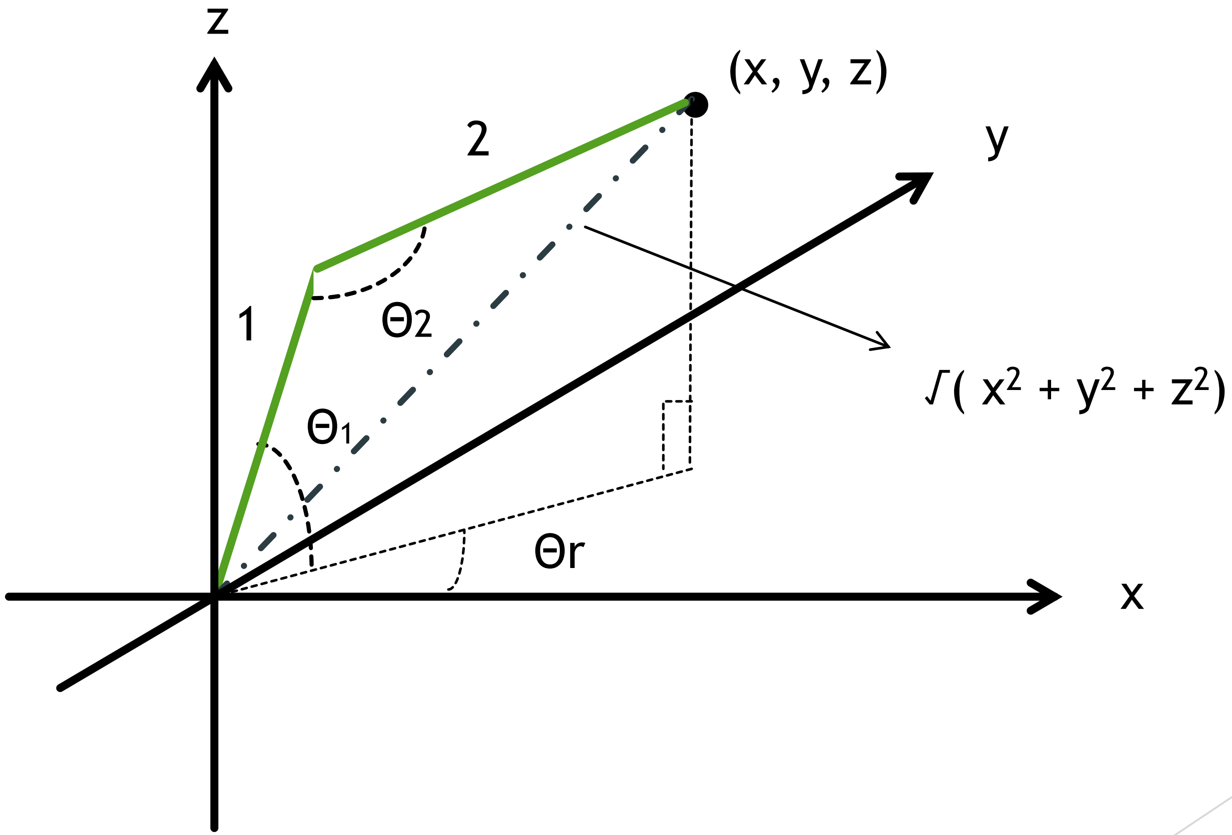


Prototype Implementation: Robotic arms and Inverse kinematics

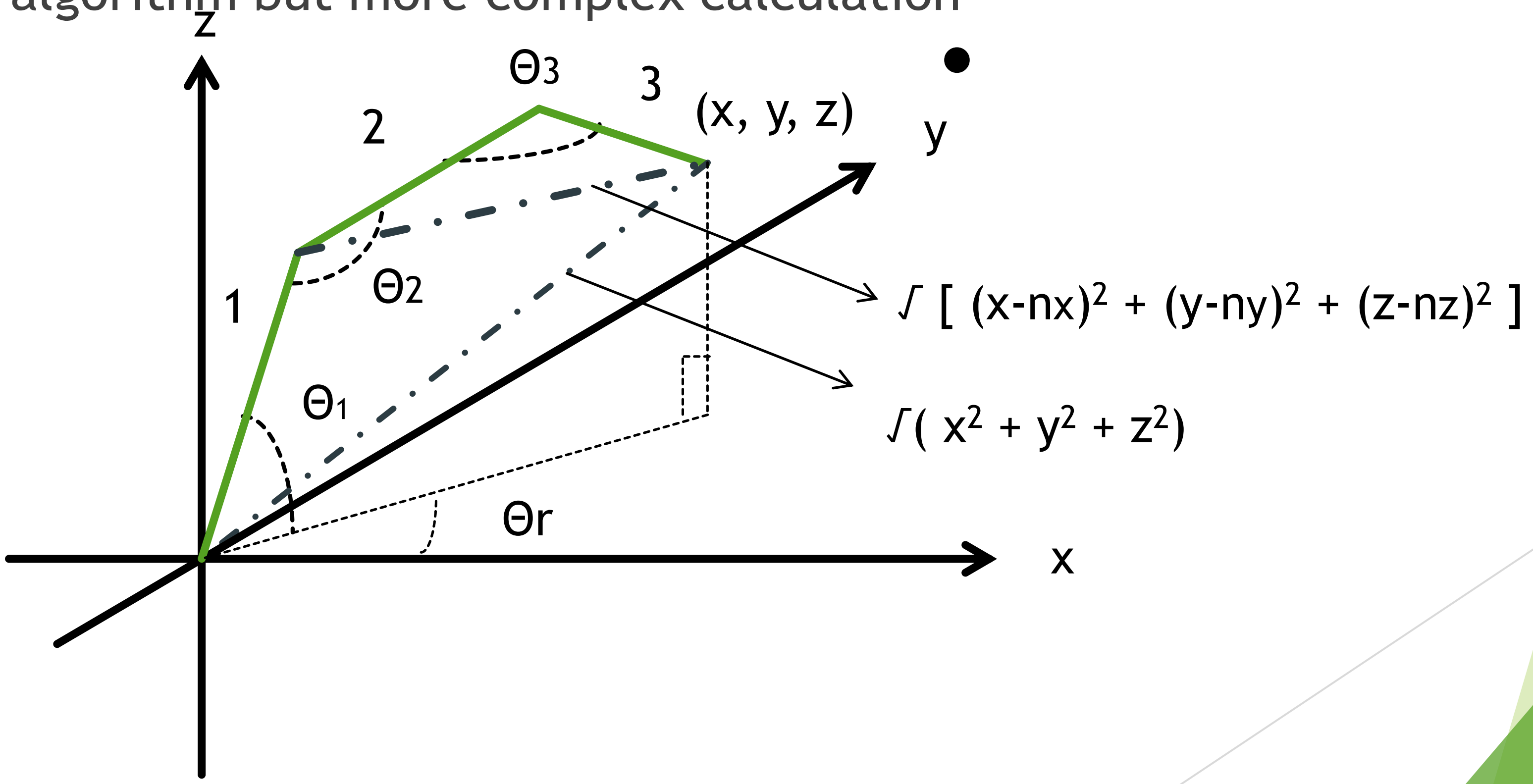
- **Robotic arm - *DC motor arm***
  - Low cost
  - Easy to implement
  - No feedback system

- **Robotic arm - *Servo motor arm***
  - High cost
  - More complicated signal input
  - Built-in feedback system

- Inverse kinematics - 3 degrees of freedom
  - Determine joint angles using end point calculations



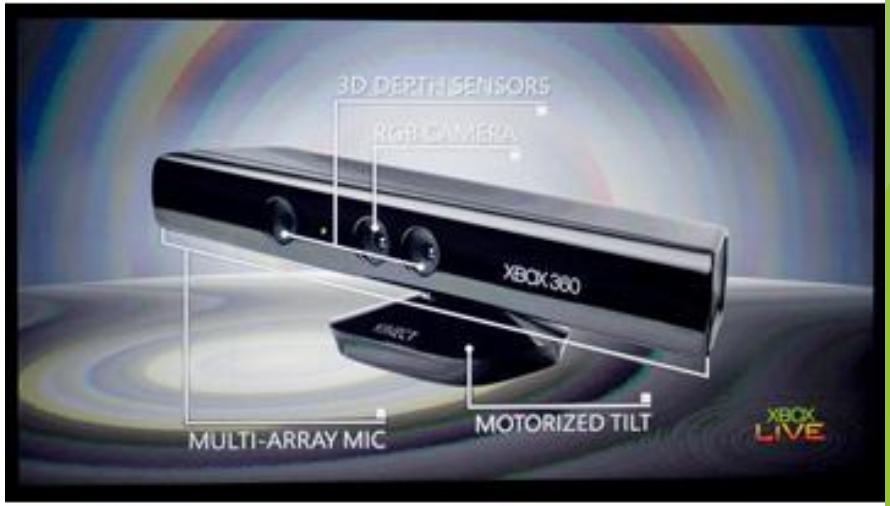
- **Inverse kinematics - 4 degrees of freedom**
  - Same as 3 degrees of freedom
  - Easy algorithm but more complex calculation



Prototype Implementation: Sensors and hardware

Kinect Sensor

- Infrared depth and color sensing
- Prime sensor chip - lines up every frame
- To determine the desired motion, image processing is taken place in the software

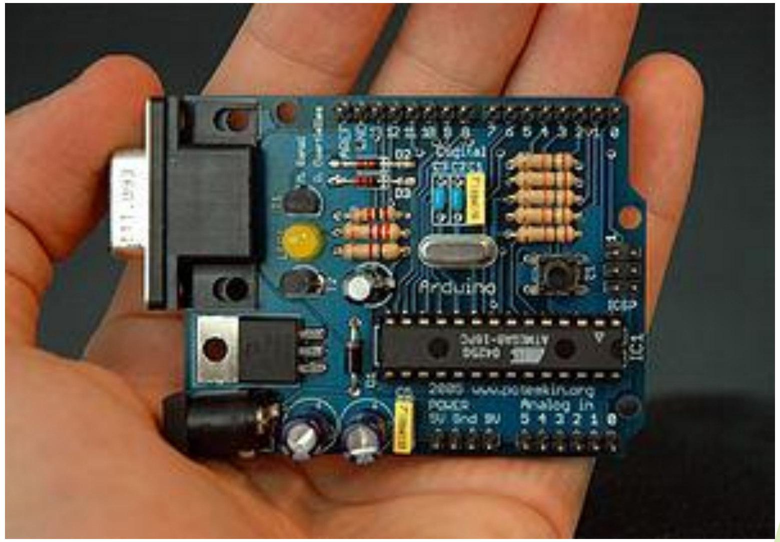


Potentiometers

- We need to install potentiometers on the DC motor arm as the feedback system
- These sensors can tell the current locations of each joint

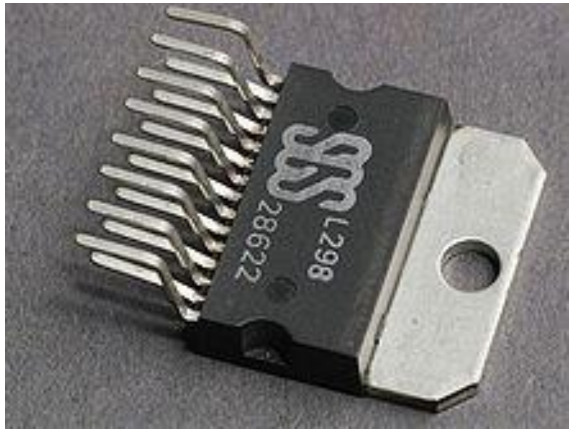
Arduino Micro-processor

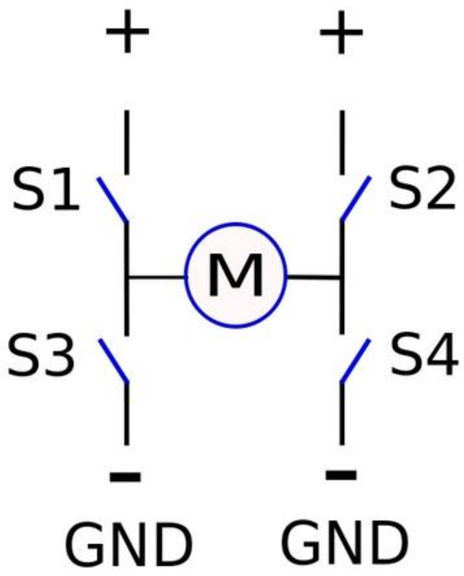
- A media to analyze the data of the current position and the desired position
- To calculate what voltage to send
- And the duration of the signal we send



H-bridge Circuit

- Only for DC motor arm
- High current, positive or negative voltage is needed to operate DC motor
- H-bridge and a Power Supply can provide enough power and correct polarity of voltages
- It works as a switch





Business Case and Potential Clients

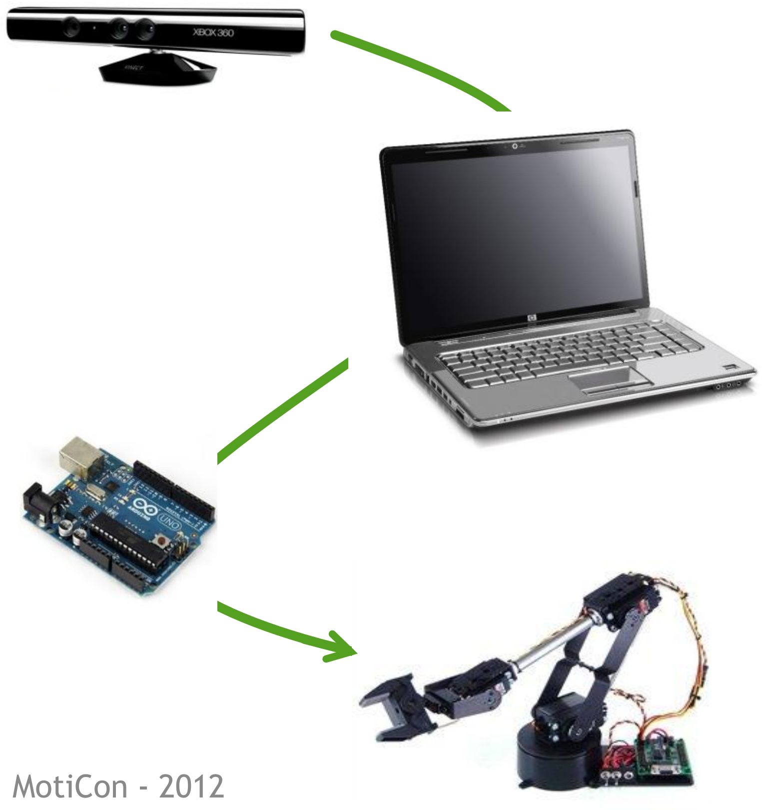

Business
Plan
$$$

- Improvement of the prototype
- Partnership with specific clients
- Creating funds with investors
- Creation of the product
- Adaptation for new applications

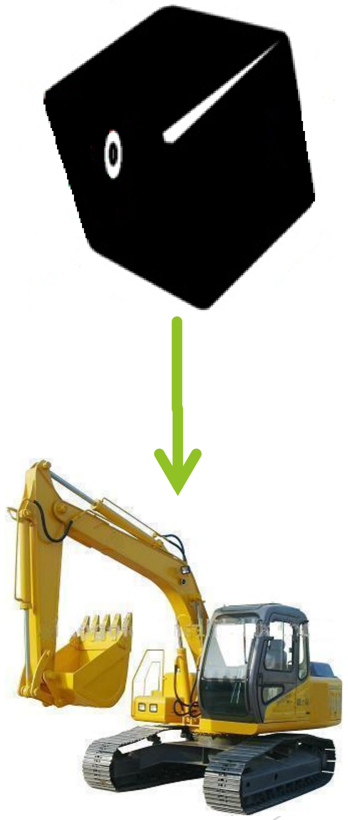
Future Improvements of Prototype

- Compensation of movement when gripping
- Distinction between hand and rest of body
- Feedback: Visual, tactile …
- Adaptation to a more industrial manipulator
- Safety
- Joints speed control
- Wireless control of the manipulator

From prototype…



…to product



Cost Estimation

Components	Price
IR sensor + Camera	$50
Microprocessor	$50
Microcontroller	$30
Circuitry	$10
Miscellaneous	$20
Manufacturing	$10
Workload	-
Total	$170

Potential Clients and Market

LIEBHERR

Leica MICROSYSTEMS

CAT

da Vinci Surgery

Product protection

- Patent on name and logo
- Intellectual property
  - Industrial Design
  - Software patent
- Protection of the product

Conclusion

Learning Experience

- Every member was able to see the entire project from start to finish
- Every member was able to experience different engineering sides
- Robotic is relatively new for every member
- Every member learned how to communicate with one another and work together to achieve milestones

Summary

- **Current problems with panel joystick and buttons:**
  - Non-intuitive
  - Complicated
  - Non-adaptable

Intuitive, Simple and Adaptable

"As far as the customer is concerned, the interface is the product." - Jef Raskin

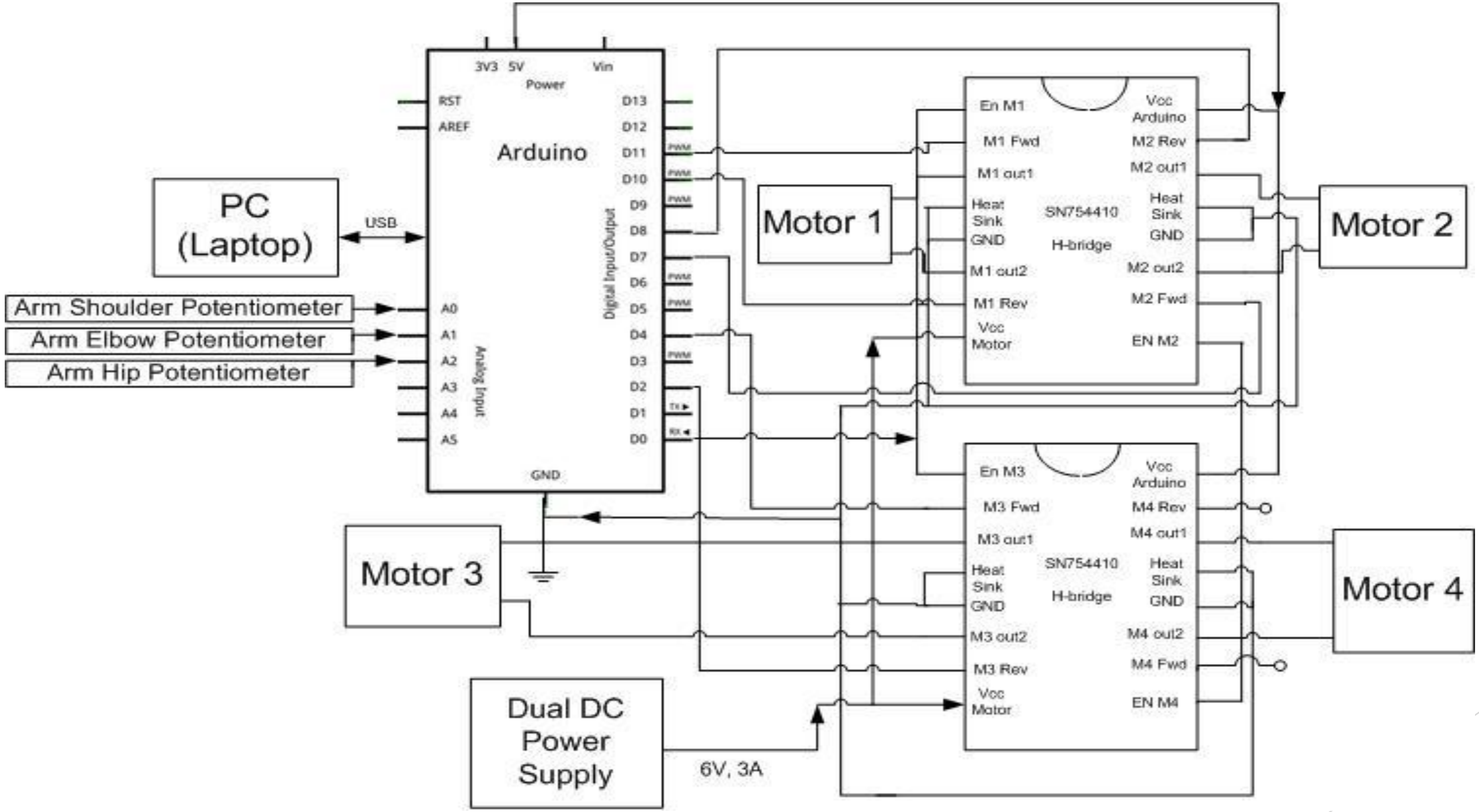
- We would like to thank :
  - Our professors, **Steve Whitmore and Andrew Rawicz**, for their teaching and encouragements.
  - The TA's involved: **Michelle**, **Jamal and Ali** for their input into our ENSC 305 documents
  - **Marinko Sarunic** for sponsoring our Kinect sensor
  - **ESSS** for providing us with funding from the endowment funds

References

1. Grochow, Keith et al. Style-Based Inverse Kinematics. University of Washington and University of Toronto. 2004.
2. Borenstein, Gregg. Making Things See: 3D Vision with Kinect, Processing, Adruino, and Makebot. O'Reilly. Media Inc. 2012.
3. Texas Instrument. SN754410 Quadruple Half-H Driver. November 1995. http://www.ti.com/lit/ds/symlink/sn754410.pdf
4. OWI Inc. Robotic Arm Edge. Accessed September 20th, 2012. http://www.owirobot.com/robotic-arm-edge-1/
5. Lynxmotion. Lynxmotion AL5d Robotic Arm. Accessed October 15th, 2012. http://www.lynxmotion.com/c-130-al5d.aspx

Questions ?

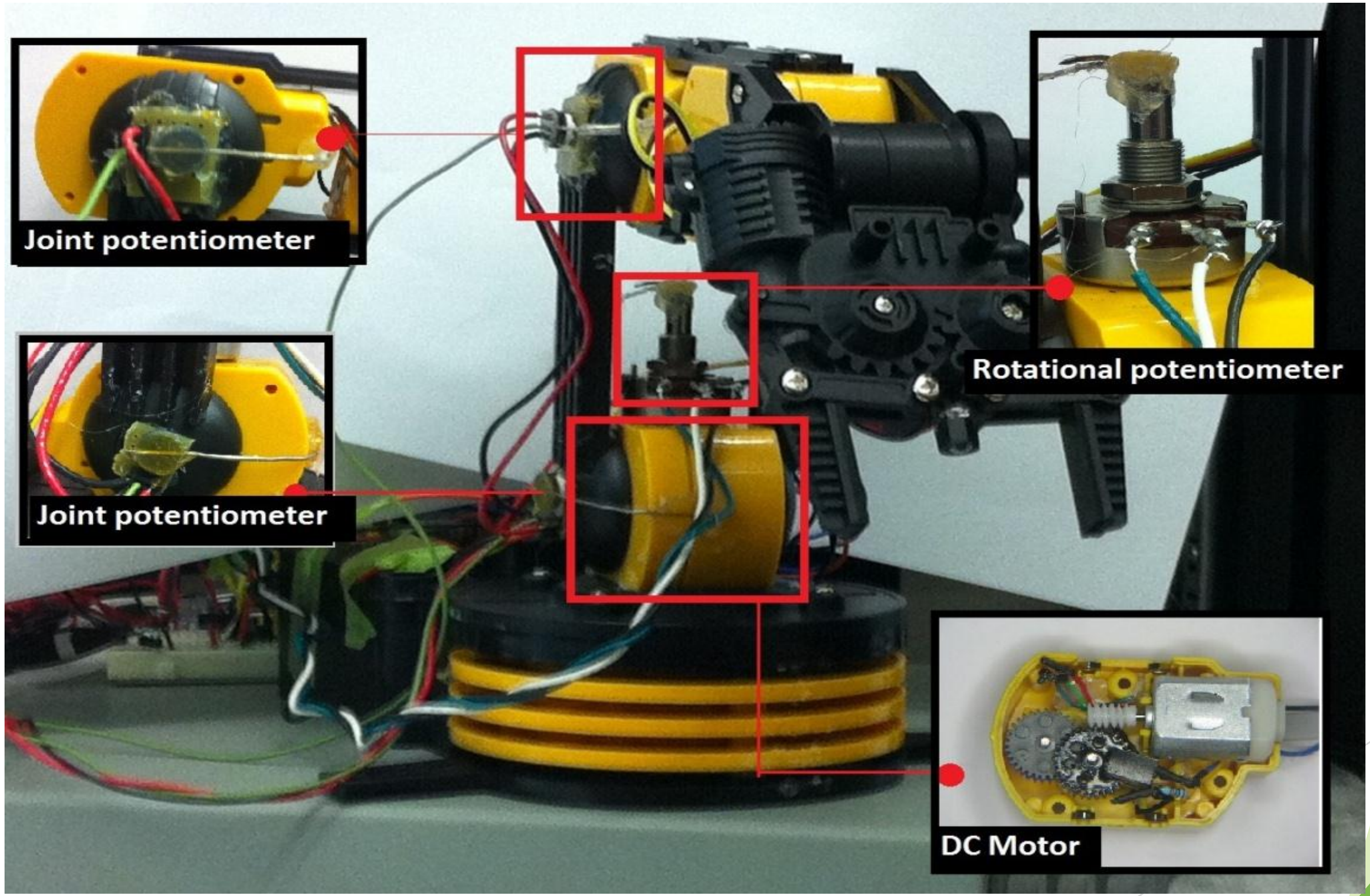
Appendix A: Circuit Layout



Appendix B: Complete BOM

Callout	Qty/Kit	Part #:	Description	Unit Cost	Subtotal:
KINECT	1	N/A	Microsoft Kinect IR and RGB Sensor	$124.20	$124.20
ROBOT1	1	OWI-535	DC-motor Robotic Arm Kit	$68.65	$68.65
ROBOT2	1	LYNX-AL5D	Servo-motor Robotic Arm Kit	$302.77	$302.77
DBATT	4	N/A	D-size Batteries	$2.80	$11.20
ARDMIC	3	UNO	ATmega328 Based Arduino UNO Microcontrollers	$33.60	$100.80
H-BRI	5	SN754410NE	Logitech HD Pro Webcam C920	$2.13	$10.67
H-SOC	5	N/A	1x40 Header Socket	$0.89	$4.48
H-GLU	1	N/A	Hot Glue Gun Sticks	$2.24	$2.24
G-GUN	1	N/A	Hot Glue Gun	$5.60	$5.60
PERFB	3	N/A	81-Row Perf Boards	$5.21	$15.63
POT1	1	COM-09939	10kΩ Rotary Potentiometer	$0.95	$0.95
POT2	3	335T-1-103LF	10kΩ thumbwheel trimpot	$0.50	$1.50
PLYWOOD	1	N/A	30cm x 30cm Ply Wood	$4.48	$4.48
Total			**$653.17**		

Appendix C: OWI DC-motor Arm



Appendix D: Servo-motor Arm

Appendix E: Inside Kinect