Midway Design Review

S.H.A.R.C. Simulated Hand and Arm Remote Control

Team 6

Connor Pope, Daniel Sheridan, Derek Caudill, Harrison Shecter

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Department of Electrical and Computer Engineering

Advisor: Professor Bardin

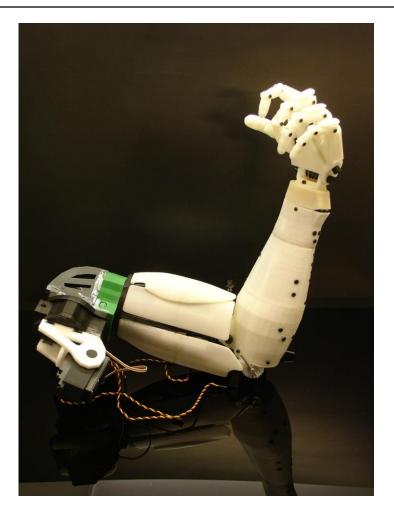
Project Description

- Our SDP team is going to design and build a system that controls a robotic arm wirelessly using wearable sensors.
- The robot arm is an open-source 3D printed design in order to focus our efforts on designing and building the controller



The Arm

- InMoov Robot Project
 - Open source
 - Directions on how to assemble the arm are provided
 - All parts and 3D models are given
 - Currently Built: Forearm, Wrist, Hand
 - Next: Bicep, Shoulder



Overall Requirements - Specifications

- 5 Degree of Freedom Arm movement
- Individual finger control
- Wireless communication between sensor glove and robot arm
- Maximum latency of 500ms
- Sensor glove/sleeve can be used by multiple users
- Compatibility with Portable Power Supply

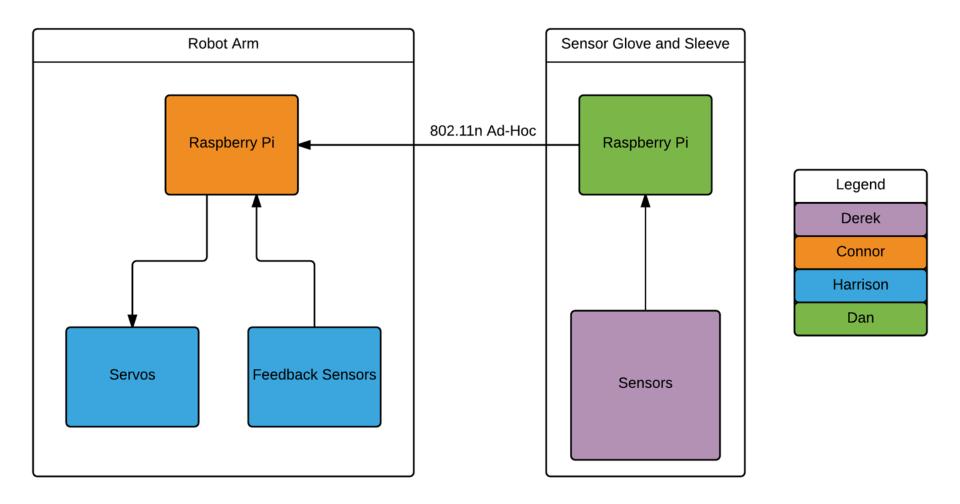


MDR Deliverables (from PDR)

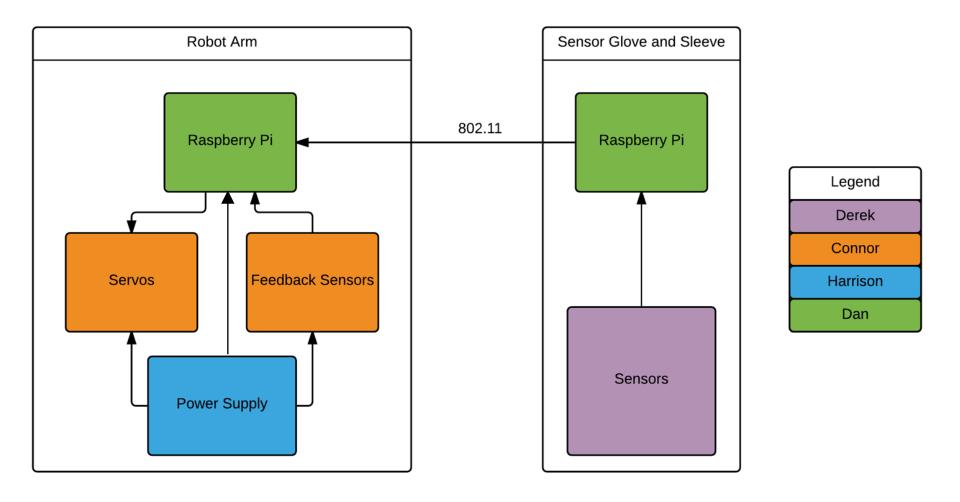
- "Functioning ad-hoc Wi-Fi communication between Raspberry Pi's (Dan)
- Sensor glove complete and sending signals to Raspberry Pi (Derek)
- Raspberry Pi on robot arm sending control signals to finger servos (Connor)
- Servo power supply for fingers and assembly servo calibration (Harrison)
- 3D printed and assembled robot hand/arm (All)"



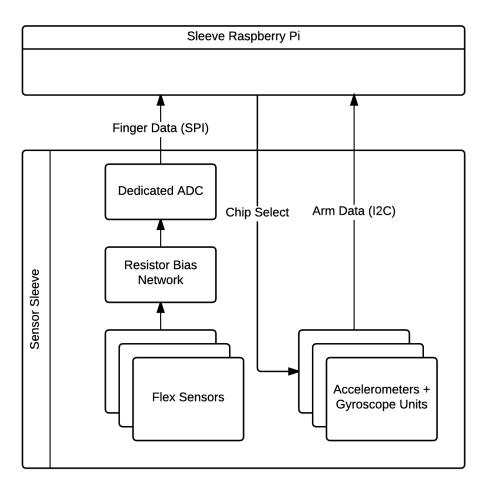
High Level Block Diagram (from PDR)



High Level Block Diagram (updated for MDR)



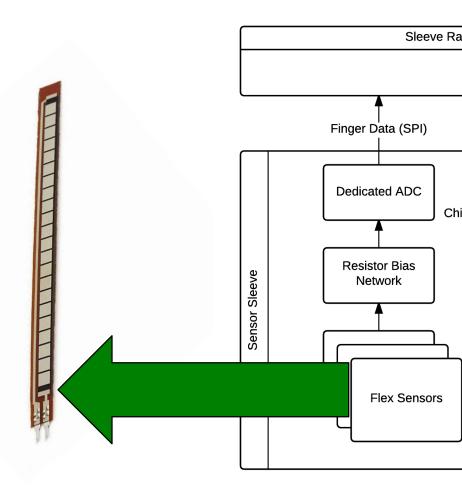
Glove, Sleeve, Sensors - Derek



- Proposed at PDR
- Fully implemented finger data path
- MCP3008 10 Bit ADC

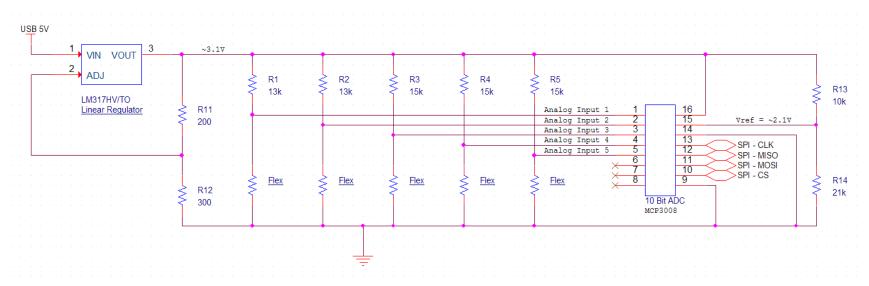
Glove: Sensors - Derek

- Flex sensor
 - Variable resistance based of bend of strip
- Voltage divider with flex sensor to measure finger movement
- Bias resistor values chose to maximize voltage swing



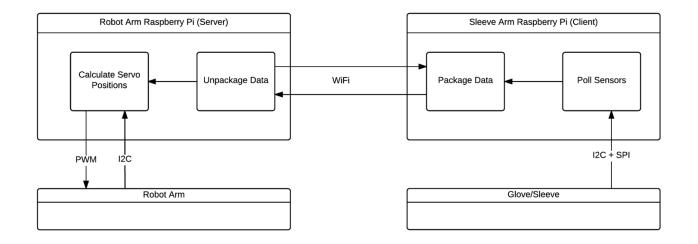
Glove: Circuit Schematic - Derek

- Power Finger signals
 - ADC inputs sample resistive dividers
 - Powered via USB 5V shared with RPI
- Average power consumption: 3.5W(RPI) + ~23mW(ADC network) = 3.523W



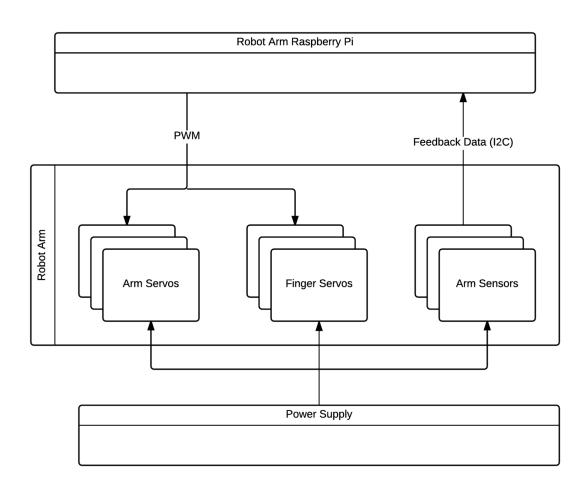
Glove RPi, Robot RPi - Dan

- Requirement: Low latency wireless communication between RPi's
- Network delay is between 3-5ms
- Robot Arm Pi acts as server that receives data from the Sleeve Pi (the client)





Robot Arm Assembly, Sensors - Connor

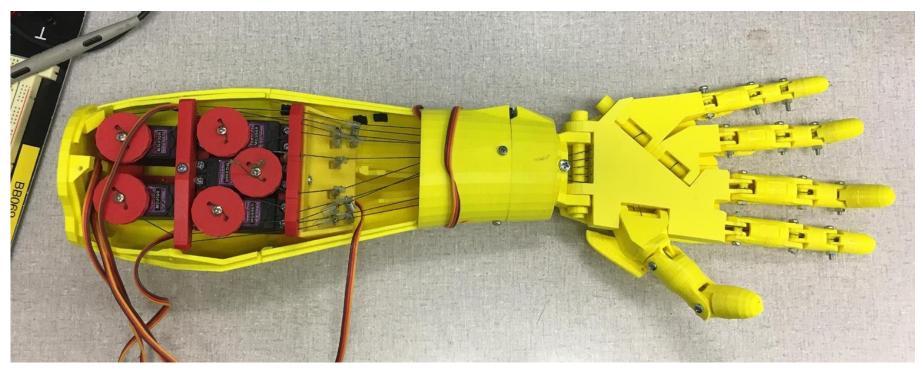


Proposed at PDR

Assembled Hand/Forearm w/Servos and Finger Actuation

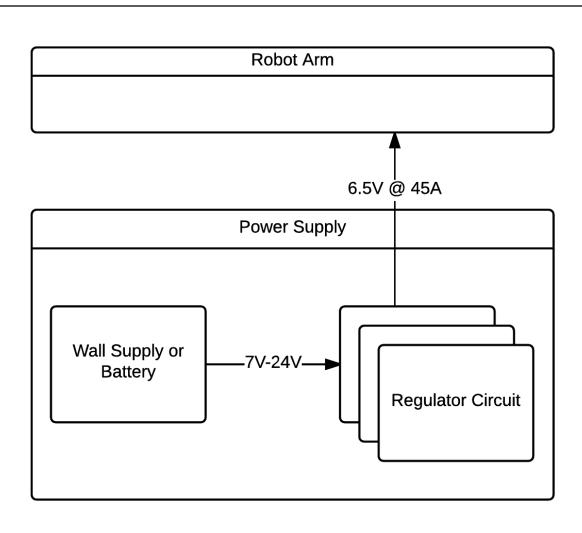
3D Printed w/uPrintSE Plus (in M5) - Material: ABSPlus - Acetone Fusing

Robot Arm: Assembled Hand, Forearm, Wrist



- Fully Assembled Forearm/Wrist/Hand
- x6 MG996r servos installed; actuation on all five fingers (grasping), actuation on wrist (rotation)
- Extension Springs -> Precise Tension

Power Supply - Harrison



Not Proposed for PDR -> New Addition

Sample Regulators MAX15035ETL + Adjustable Voltage, 15A Current

Custom Designed PCB with x3 to x4 Regulators On-Board

Compatible w/Varied Inputs: High Power Transformers, Portable High Voltage Batteries.

Power Supply: Regulator Schematic - Harrison

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180k 1 R3 R0402 USER PG00D	SKIPSKIP AC >YCC 37 VCC -37 VCC	/DD. -X. POND. POND. PO VDD LX5 PGND6 PGND7 P4 5 6 7 93	POND 15 POND POND 14 POND POND 13 POND POND 12 POND 12		



CDR Deliverables

Derek	 Fully Operational Accel/Gyro Sensor Sleeve Network I2C Communication to RPI USB 5V → 3.3V Regulator → Accel/Gyro Units
Dan	 Motion Capture Mode + Replay Reading Data from Accel/Gyro Sensors Mapping Accel/Gyro Data to % Duty Cycle Transform Chart
Connor	 Fully Assembled Bicep/Shoulder (Entire Thing) w/Elbow Actuation x1 D.o.F. w/Shoulder Actuation x3 D.o.F. Creation of % Duty Cycle Transformation Chart
Harrison	· Assembled & Tested Regulator PCB's · Input Voltages; 7V-24V \rightarrow Output Voltage: 6.5V · Proper Thermal Ventilation (Up to 45A)
All	\cdot Determination of need of feedback sensors on robot arm or not, and how we would implement that.

Challenges Going Forward

- Modifying the HS808BB Servos (Connor)
 - 3D Printed Parts: Assembly w/Acetone Fusing
 - Torque Values: HS808BB; Reasonable Safety
- Power Components: Output Cap w/Low ESR, and High Voltage Rated Caps (Harrisons)
 - PCB Design: Heatsinking & RF Shielding
 - PCB Assembly: QFN Soldering
- Increasing ADC resolution (Derek)
 - ADC Measure Range 0-2.1V
 - Voltage Divider Limits Approx. 1.1-2.1V
- Improved Finger Movement Model (Dan)
 - Look Up Table In Place of Linear Mapping

Follow us to SDP Lab for DEMO