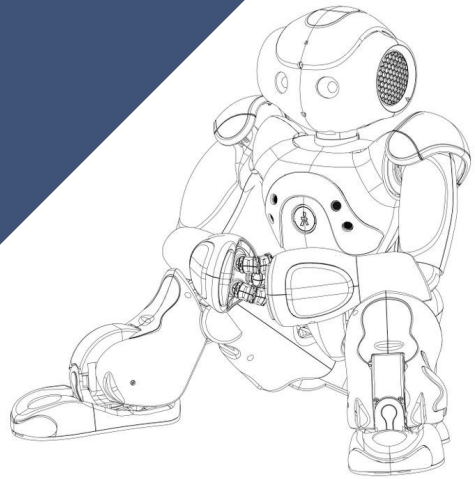
Visual and Aural Telepresence via NAO Robot



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Advisor: Dr. Seung-yun Kim

February 7th, 2018

TCNJ THE COLLEGE OF NEW JERSEY

Overview

Introduction

- Project Goals

Specifications

- System Block Diagram
- Quantitative Specifications

Tasks

- Schedule
- Task Breakdown

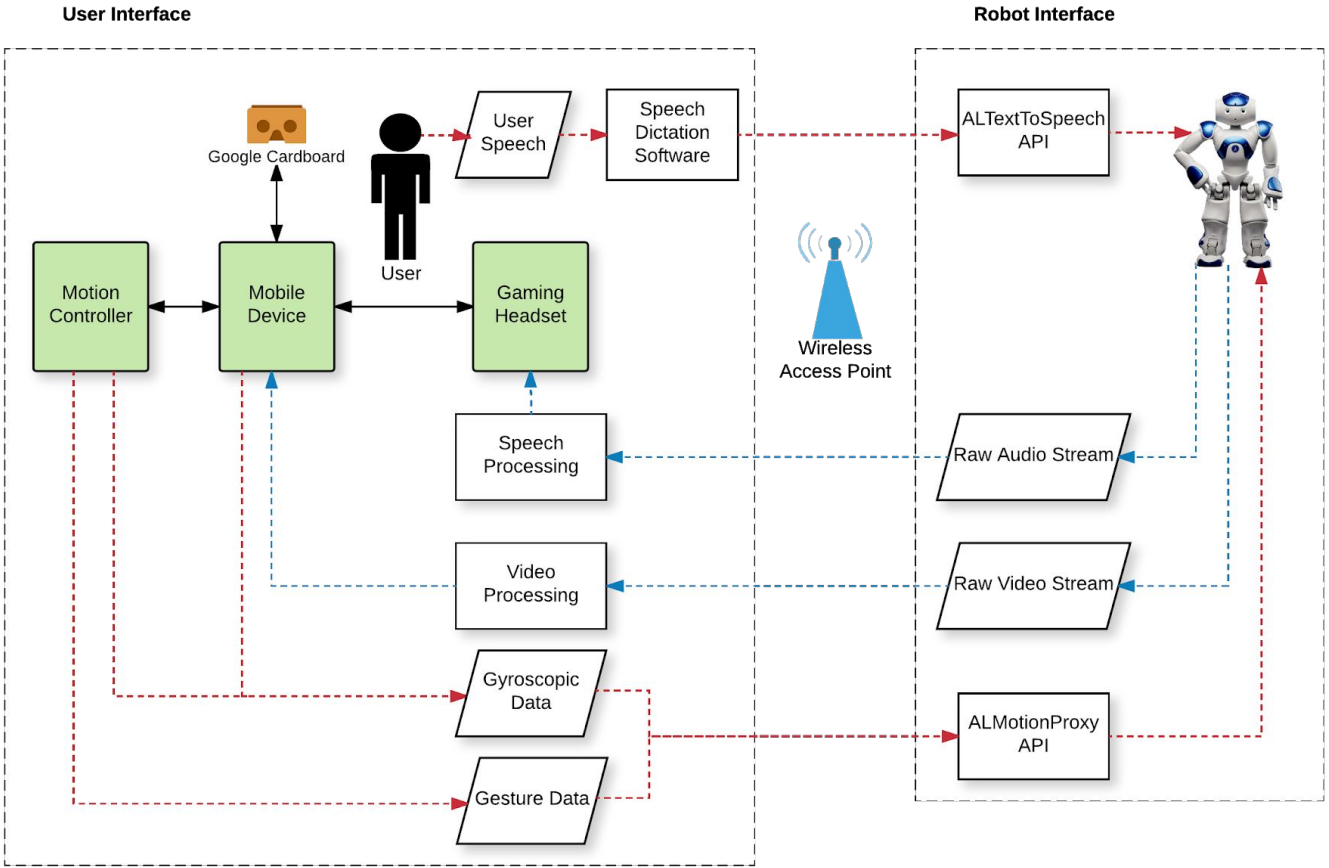
Project Management

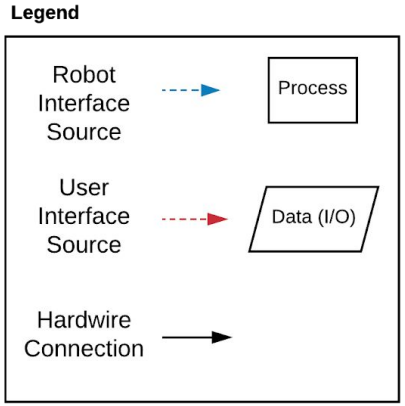
- Budget
- Projected Hours
- Open AIs

Project Goals

- To **aurally** and **visually** engage the user and audience using the NAO robot
- To develop **wireless communication** between the NAO and a user wearable headset
  - connecting movement using **gyroscope** data
- To develop a **web/mobile application** which receives a **live video and audio stream** from NAO
- To incorporate *Motion-Based Humanoid Robot Controller* project

Detailed Block Diagram





Quantitative Specifications

Field of Vision	60° horizontally by 50° vertically
Weight	Headset < 2.5 lbs Arm Controller < 1 lb
Battery Life/Power Consumption (robot system and user system)	1-2 hours
Video Resolution	320×240 pixels
Framerate	15fps

Tolerated Latency	<1 second
Movement sensitivity	TBD
Degrees of Freedom in Teleoperated Robot	6
Wireless Range	TBD
Wireless Transmission Reliability	TBD

Gantt Chart


January
February
March
April
May
7-Jan
14-Jan
21-Jan
28-Jan
4-Feb
11-Feb
18-Feb
25-Feb
4-Mar
11-Mar
18-Mar
25-Mar
1-Apr
8-Apr
15-Apr
22-Apr
29-Apr
6-May
1. Preliminary Research & Design
2. System Design
3. Learn Programming Languages
4. Access Live Audio Stream
5. Access Live Video Stream
6. Dev of Website/Mobile App
7. Access Gyro Data on Mobile Dev
8. Wireless Communication w/ NAO
9. Purchase Components
10. Establish TTS Capability
11. Sync of Audio and Video
12. Preliminary Testing
Winter Break
13. Integrate Hardware & Software
14. 2016 Senior Project
15. Final Testing
16. Documentation
Completed Ahead of Time
Completed on Time
Projected
Projected but Already Completed
Experiencing Delays

Task 1: Preliminary Research and Design

August 27th - October 14th

- Research similar projects
- Determine a feasible preliminary design
  - Decide the mobile platform and research app development
  - Determine appropriate hardware and software

Task 2: System Design

August 27th - October 14th

- Create block diagram of the system
- Outline system specifications
  - Qualitative and quantitative goal specifications for the project

Task 3: Understand Necessary Programming Languages

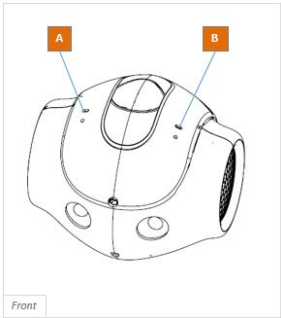
September 10th - October 14th

- Learn how to work with various programming languages needed for the project:
  - Python
    - NAOqi SDK
    - Flask (web framework module)
  - Front-End Languages
    - HTML/CSS
    - Javascript

Task 4: Access Live Audio Stream

~~*October 8th - October 28th*~~ → *October 1st - November 25th*

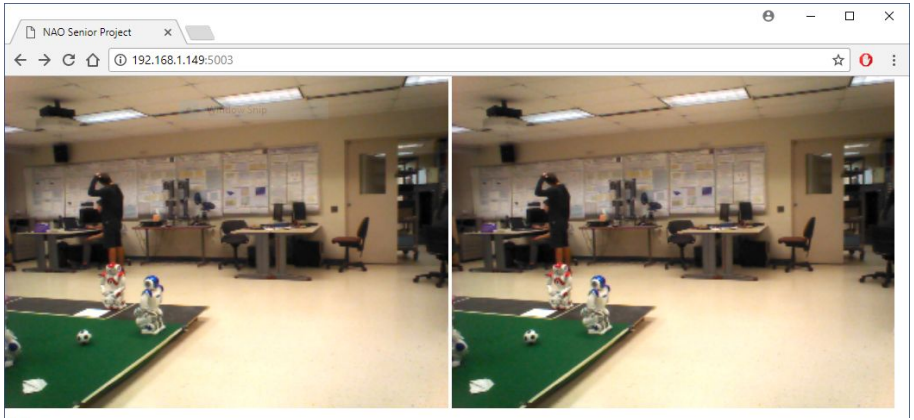
- Access NAO audio buffers from NAO's microphones
- Using NAOqi ALAudioDevice API
  - Subscribe to the buffer containing microphone channels
  - Pass these buffers to the web application using Flask



Task 5: Access Live Video Stream

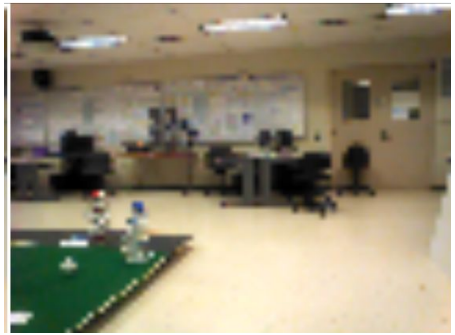
~~*October 8th - October 28th*~~ → *September 17th - September 30th*

- Access the video stream through the web
- Using NAOqi ALVideoDevice
  - getImageRemote function to return a video feed



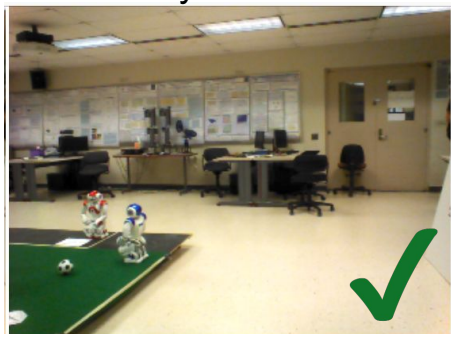
Resolution Examples

Resolution: 40x30
Latency: 0 seconds

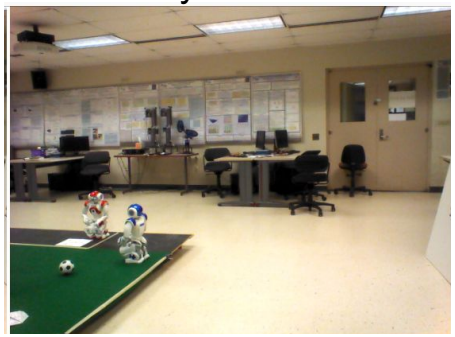


Resolution: 80x60
Latency: 0 seconds

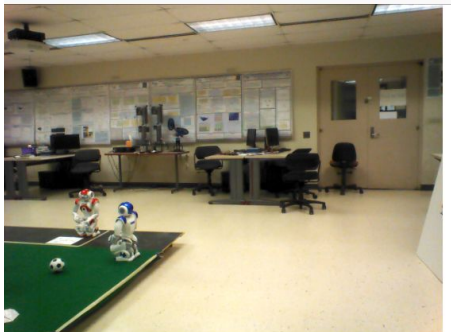
Resolution: 160x120
Latency: 0 seconds



Resolution: 320x240
Latency: ~0.6 seconds



Resolution: 640x480
Latency: ~3 seconds



Resolution: 1280x960
Latency: ~10 seconds

Task 6: Development of Website/Mobile App

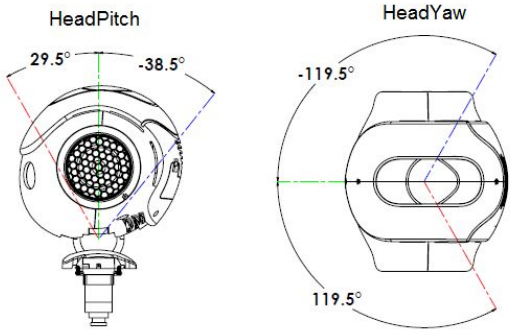
~~*October 8th - March 10th*~~ → *September 24th - April 21st*

- Create a website (which can be accessed using a phone)
- Develop alternative system implementation in a mobile application (iPhone and Android devices)
- Design a user interface navigable through the headset controller
- Will add start button after headset is in place to activate the system

Task 7: Access Gyroscope Data on Mobile Device

October 8th - October 28th

- Use HTML5/Javascript to access gyroscope data through the phone



Task 8: Establish Wireless Communication with NAO

~~*October 15th - December 9th*~~ → *September 17th - December 9th*

- Establish connection over Wi-Fi to the NAO
- Simultaneously send and receive data with NAO

Task 9: Purchase Components

October 8th -

- Purchase a headset with a high fidelity microphone
- Purchase two Google Cardboard VR headsets
  - Purchase materials to incorporate VR head strap

Task 10: Establish Text-to-Speech (TTS) capability

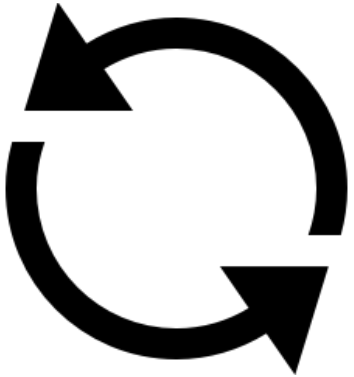
October 22nd - December 9th

- Use a Python script to take user speech, convert it to a string, and send the string to the robot to recite
  - Utilize speech_recognition and pyaudio packages
    - speech_recognition package uses Google Speech Recognition API
  - Use NAOqi ALTextToSpeech API to allow the robot to say the input string

Task 11: Synchronization of Audio and Video

~~*November 5th - December 9th*~~ *January 28th - March 24th*

- Develop multiplexer for proper live audio and video mixing
- Adjust latencies and/or framerate when out of sync
- Investigate GStreamer, FFmpeg, and other video processing support libraries
- Audio pre-processing for near real-time streaming

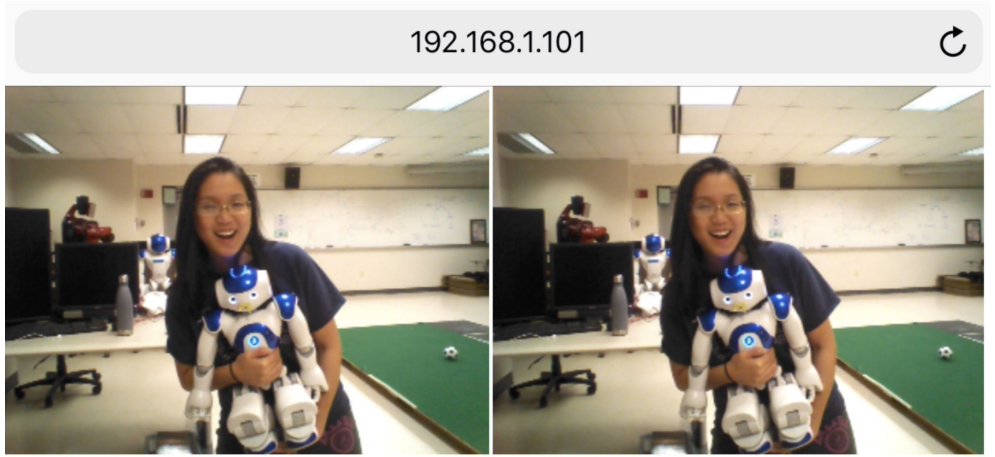


Task 12: Preliminary Testing

November 5th - November 25th

- Test components individually for unit functionality
  - Tested live video, audio, head control using gyroscopic data, text-to-speech

```
y: 16
z: 36
init y: 1
init z: 360
```



Task 13: Integration of Hardware and Software

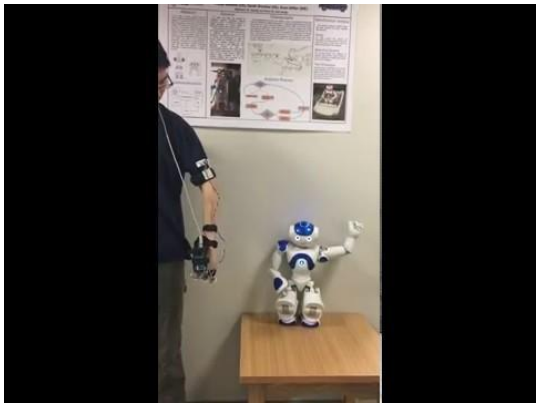
~~*January 21st - March 3rd*~~ → *February 18th - April 14th*

- Integrate all software modules interfacing with hardware
- Ensure ability to wear all user interfacing devices (VR headset and Gaming headset) with web application running
- Assembly of headset
  - Optimal comfort and durability
- Synchronization of gyroscope and video streams

Task 14: Incorporation of 2016 Senior Project

~~*January 21st - March 3rd*~~ → *February 11th - March 31st*

- Provide support for both:
  - Leg control (discrete), using a gesture sensor
  - Arm control (differential), using accelerometer, magnetometer, and gyroscope
- Resolve previous years problems communicating to the Arduino in COM



Task 15: Final Testing

~~*March 4th - April 21st*~~ → *March 18th - May 5th*

- Test system against our quantitative specifications
- Test system in different environments and scenarios
  - Areas with low Wi-Fi connectivity, high levels of noise, different human operators, etc.
- Debugging
- Fine-tune components to create the most comfortable and intuitive experience

Task 16: Documentation

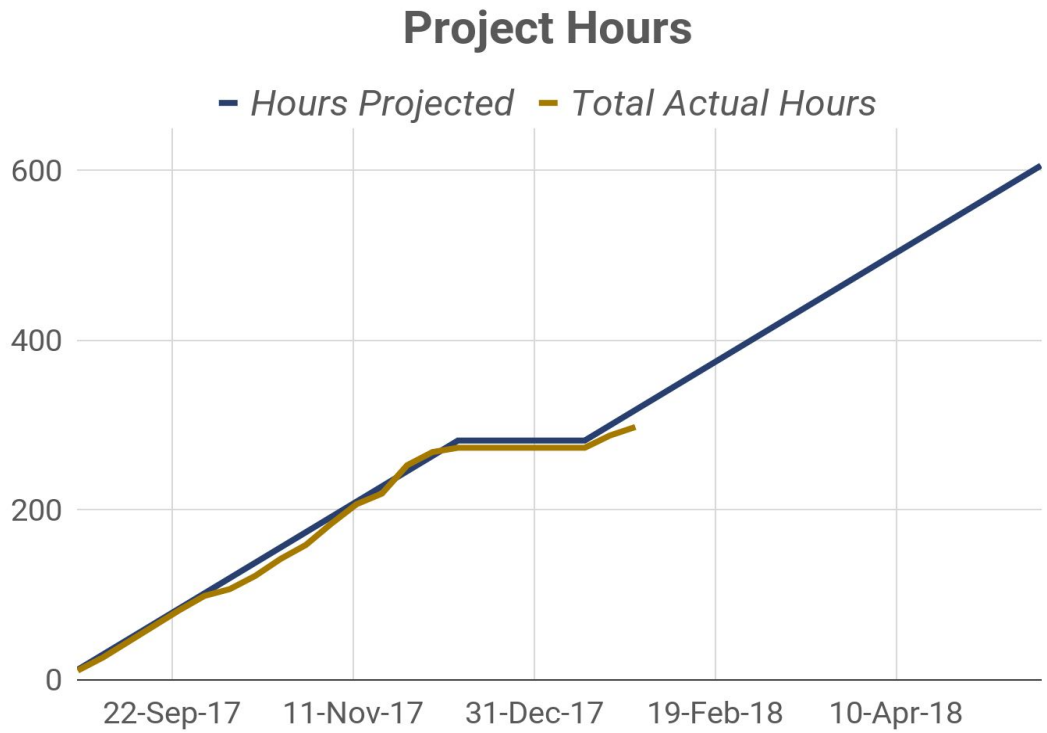
Ongoing throughout whole project

Budget

Total Budget: $300

Item	Quantity	Cost per Quantity ($)	Total Cost ($)
Gaming Headset	1	$ 128.46	$ 128.46
Google Cardboard	2	$ 19.99	$ 39.98
NAO Robot	1	$9,500.00	N/A
Miscellaneous (extra parts)	N/A	N/A	N/A
Total Cost			$185.70

Projected Hours



Open AIs

Action Item	Assigned To	Due Date
Speak with Joe Zanetti about VR Headset Assembly	Chelsea, Theresa, Daniel	TBD
Update Website With Current Progress	Theresa	February 13th
Summarize Work Plan to Advisor	Chelsea, Theresa, Daniel	February 8th

Questions?