

Pegasus-21

Final Project Review

Senior Design Project

Spring 2016



PEGASUS 21

Our Team



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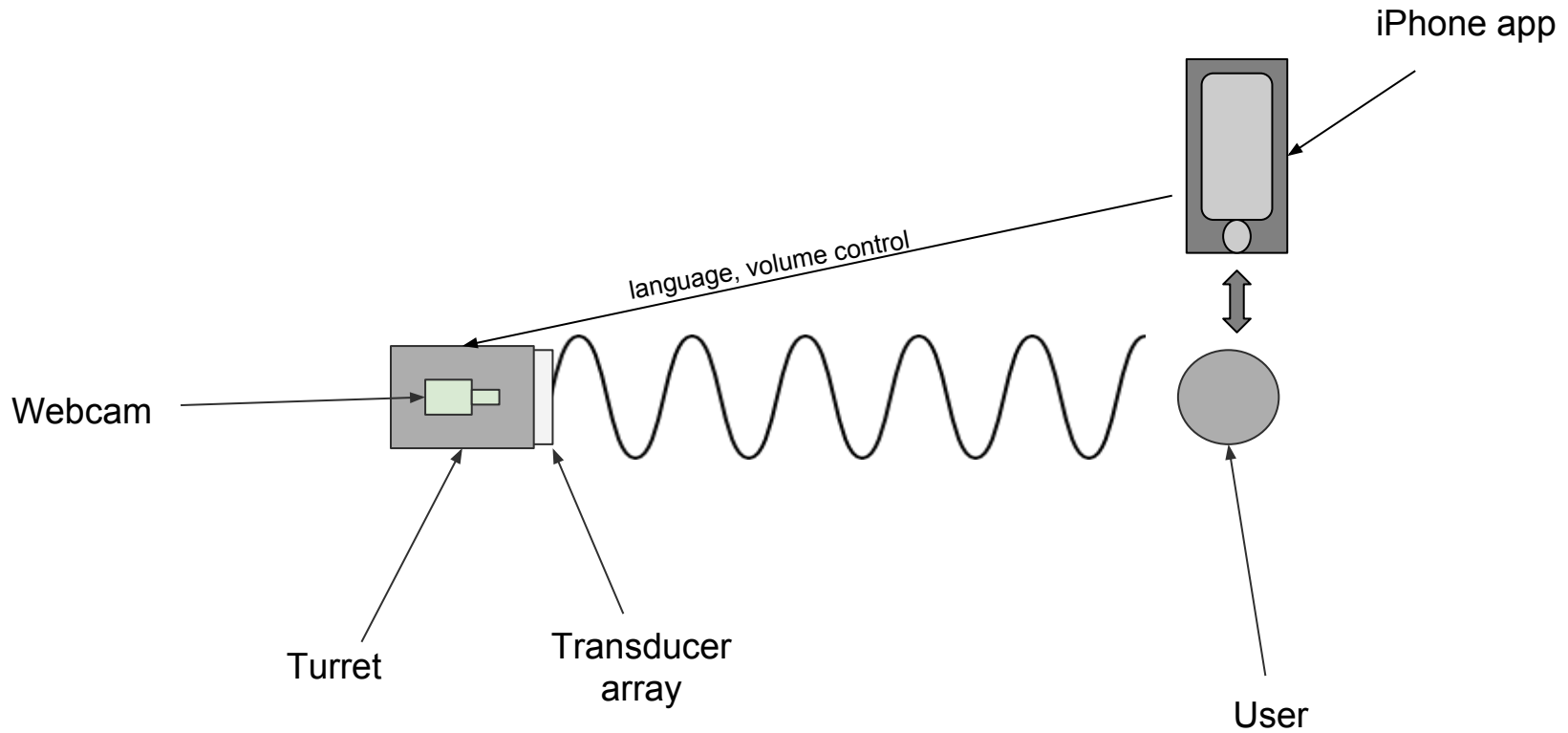


Zlatan Aksamija
Advisor

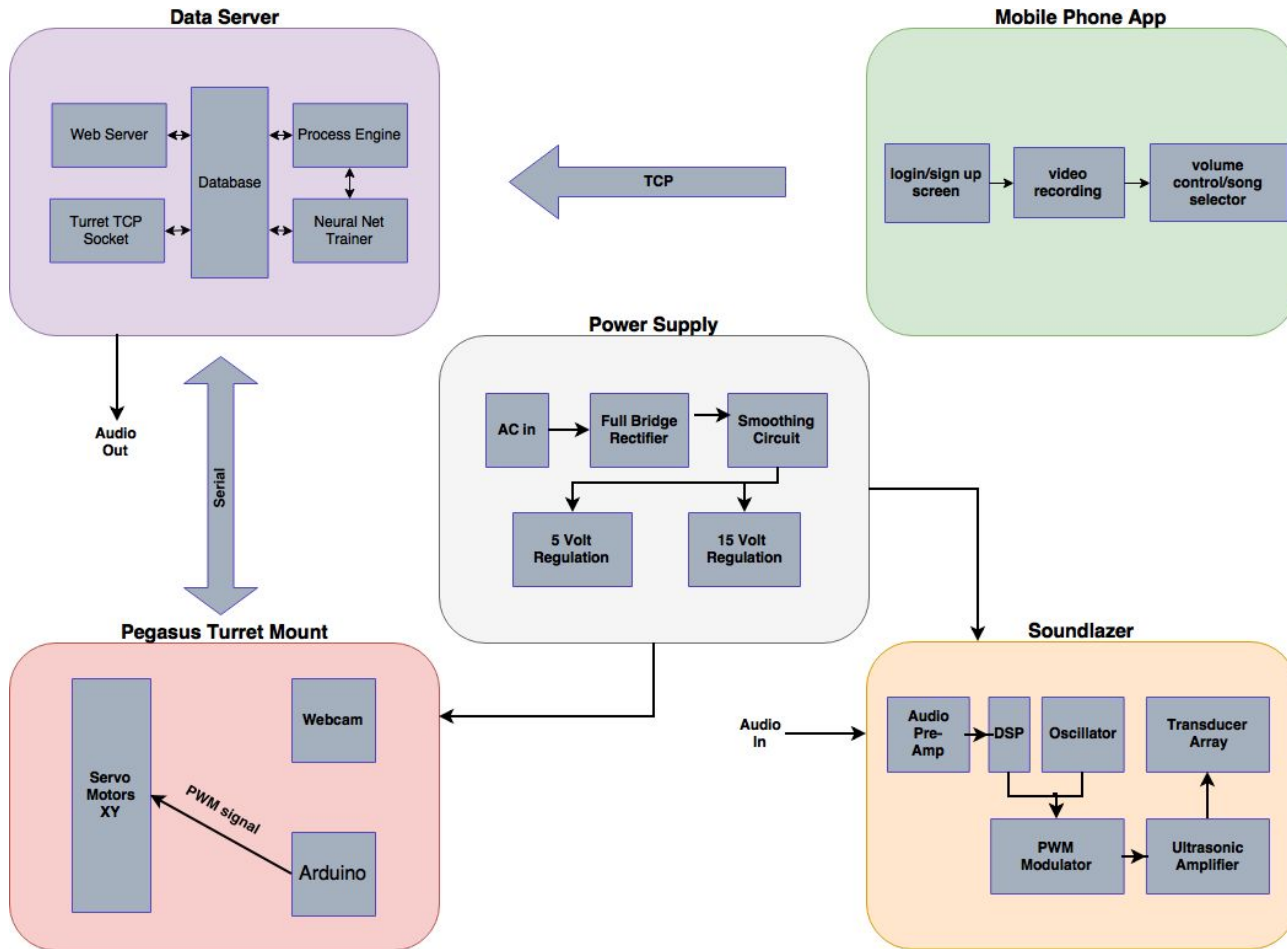
Imagine..



Pegasus-21



System Block Diagram



What's new?

- Data Server:
 - Research Rig
- iPhone App:
 - Redesigned, more user-friendly UI
 - Under-the-hood improvements: error handling, multithreading
- Power Supply:
 - Redesigned with a PCB
 - New components with higher current carrying capacity
- Turret:
 - 3D printed chassis and Soundlazer mount

Specifications

- Rotation Speed: 17°/sec
- Range: 10 ft
- Maximum Sound Intensity (Indoors):
 - On Axis: 65 dB
 - 5 ft Off-Axis: 52 dB
- Power Input: 2 x 120 V (Power Supply, Computer)

Demo



PEGASUS 21

Demonstration Guide

Server-Side

1. Turn on server
2. Accept Wi-Fi connection
3. Wait
4. Wait
5. Accept TCP connection
6. Wait
7. Train neural network*
8. Target Acquisition
9. Target Tracking
10. Change song and volume

Client-Side

1. N/A
2. Connect to “pegasus-server” Wi-Fi
3. Open app
4. Create new account*
5. Login
6. Take 15 sec video*
7. Wait for training*
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Development Cost

Part	# of pieces	Cost per piece	Total cost
Servo	2	\$9	\$18
Power Supply Parts	1	\$80	\$80
3D Printing	4	\$10	\$10
Desktop Rig	1	\$3000	\$3000
Webcam	1	\$40	\$40
SoundLazer	1	\$250	\$250
Total		\$3398	

Production Cost

Part	# of pieces	Cost per piece	Total cost
Servo	2	\$6	\$12
Power Supply Parts	1	\$25	\$25
3D Printing	4	\$5	\$5
TX2	1	\$400	\$400
Webcam	1	\$9	\$9
SoundLazer	1	\$150	\$150
Total		\$601	

Questions?...



Backup Slides



System Overview

- Users take a short video clip of their faces using our iPhone app
- This video is used to train our neural network to recognize a face
- Once trained, the turret mounted webcam searches for and tracks the user, focusing the audio beam in their direction
- Users use the iPhone app to select the language and control the volume of the audio

Some Background: Acoustic Directionality

-Directionality of sound correlates with the size of speaker compared to wavelength. The formula for far field directivity of a flat circular piston in an infinite baffle is

$$p(\theta) = \frac{p_0 J_1(k_a \sin \theta)}{k_a \sin \theta} \quad \text{where...}$$

$$k_a = \frac{2\pi a}{\lambda}$$

p_0 = pressure on axis

a = piston radius

J_1 = Bessel Function

θ = Angle off axis

-Piezoelectric transducers approximate the ideal acoustic piston

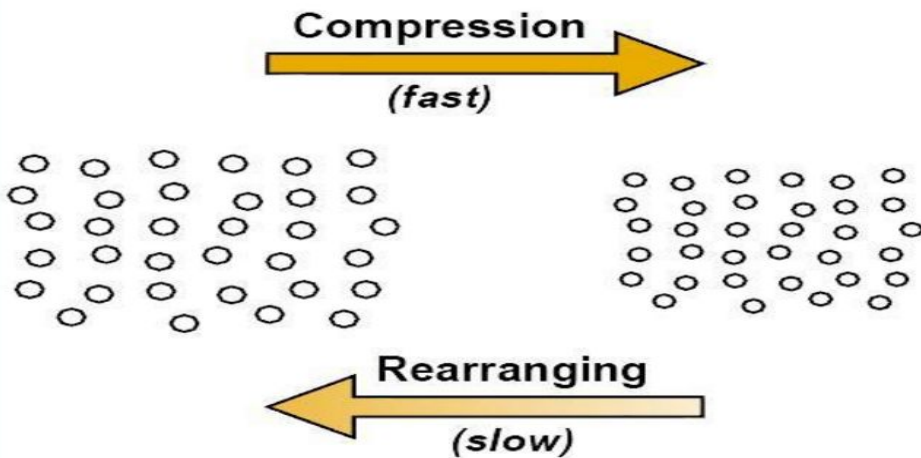
-Directionality is achieved by maximizing the piston radius and minimizing the wavelength

(“Loudspeaker” n.d.)

Sound From Ultrasound

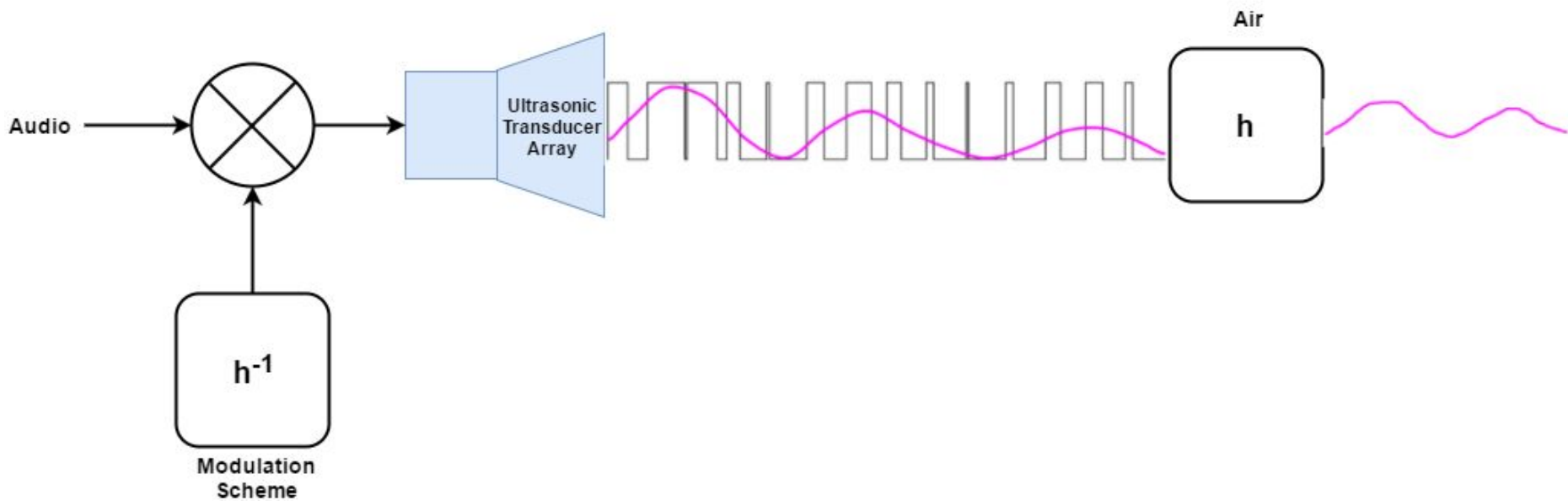
Technology to create directional, highly focused soundbeams:

- An array of transducers emits ultrasonic carrier waves in the direction of target
- Air, as a nonlinear medium, acts as a demodulator (no need for receiver)
- When the modulated wave reaches a person the modulated sound becomes audible



(Nema, "Ultrasonic Directive Speaker")

Sound From Ultrasound

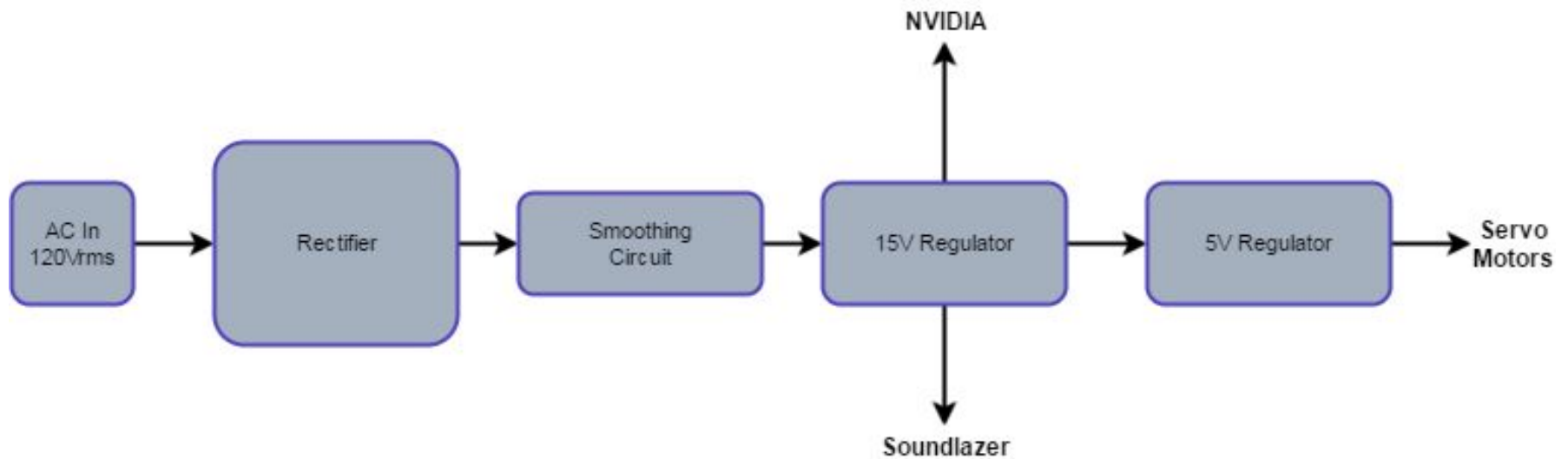


<http://www.soundlazer.com/what-is-a-parametric-speaker/>

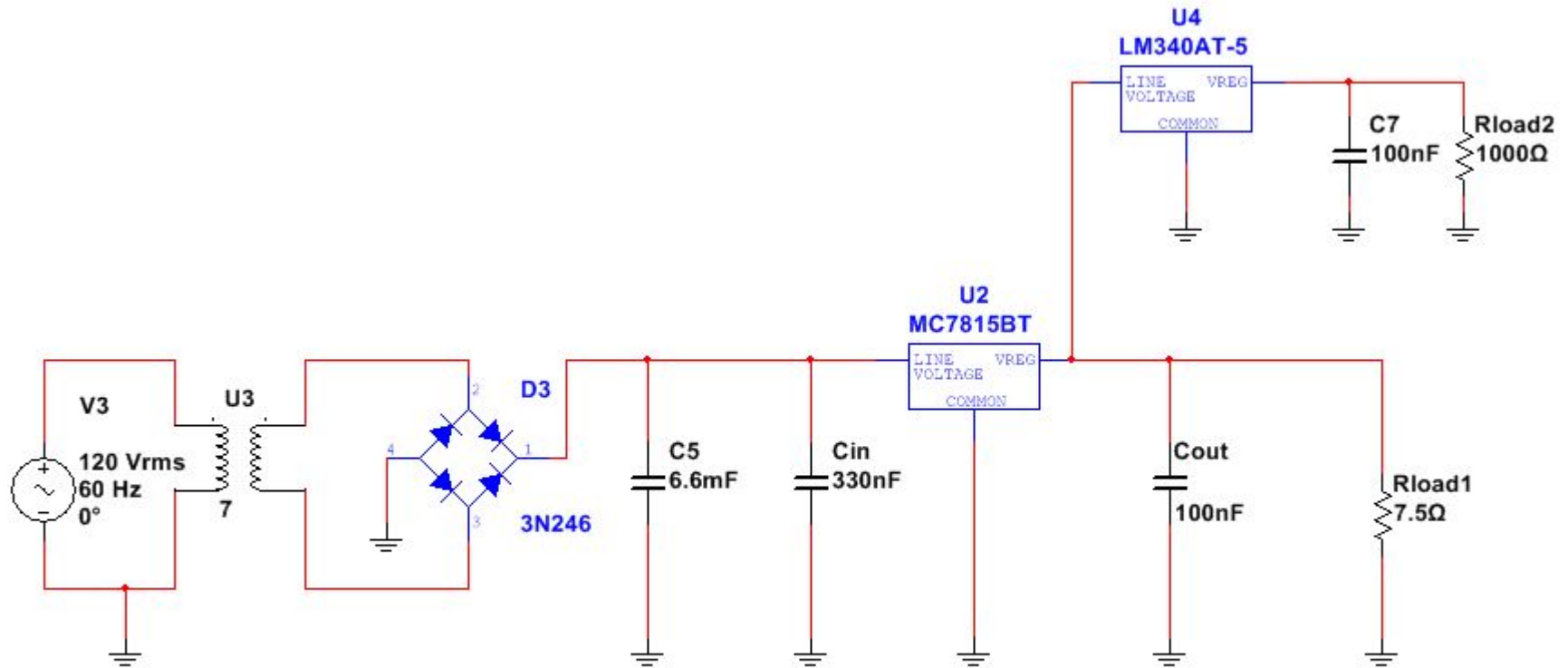
Data Server - Preexisting Technologies

- OpenCV: computer vision and media manipulation library (Python)
- OpenFace: facial recognition project
- Torch: scientific computing Framework (Lua)
- SciKit-Learn: machine Learning library (Python)
- dlib: highly optimized machine learning
- FFMPEG: converts video formats
- Basic socket and serial libraries: communication to other subsystems

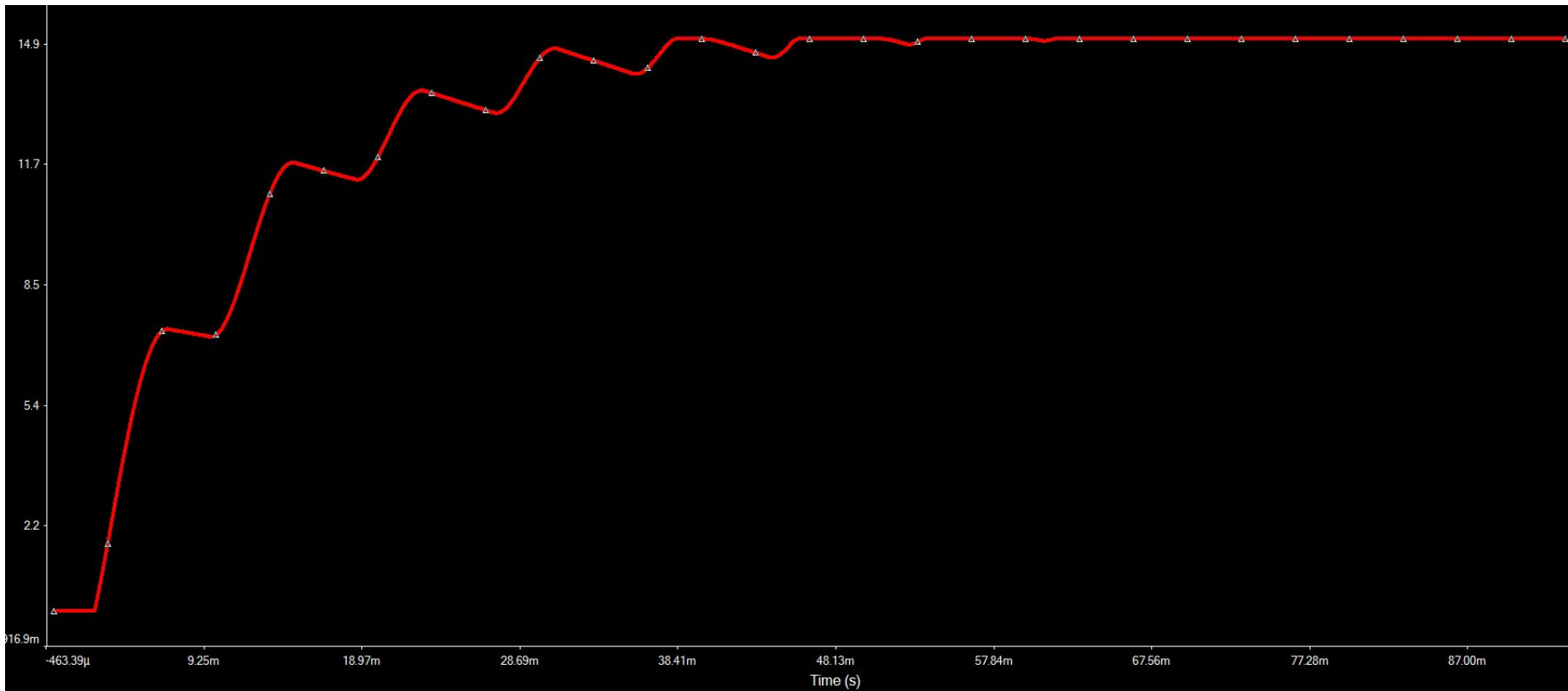
Universal Power Supply - Block Diagram



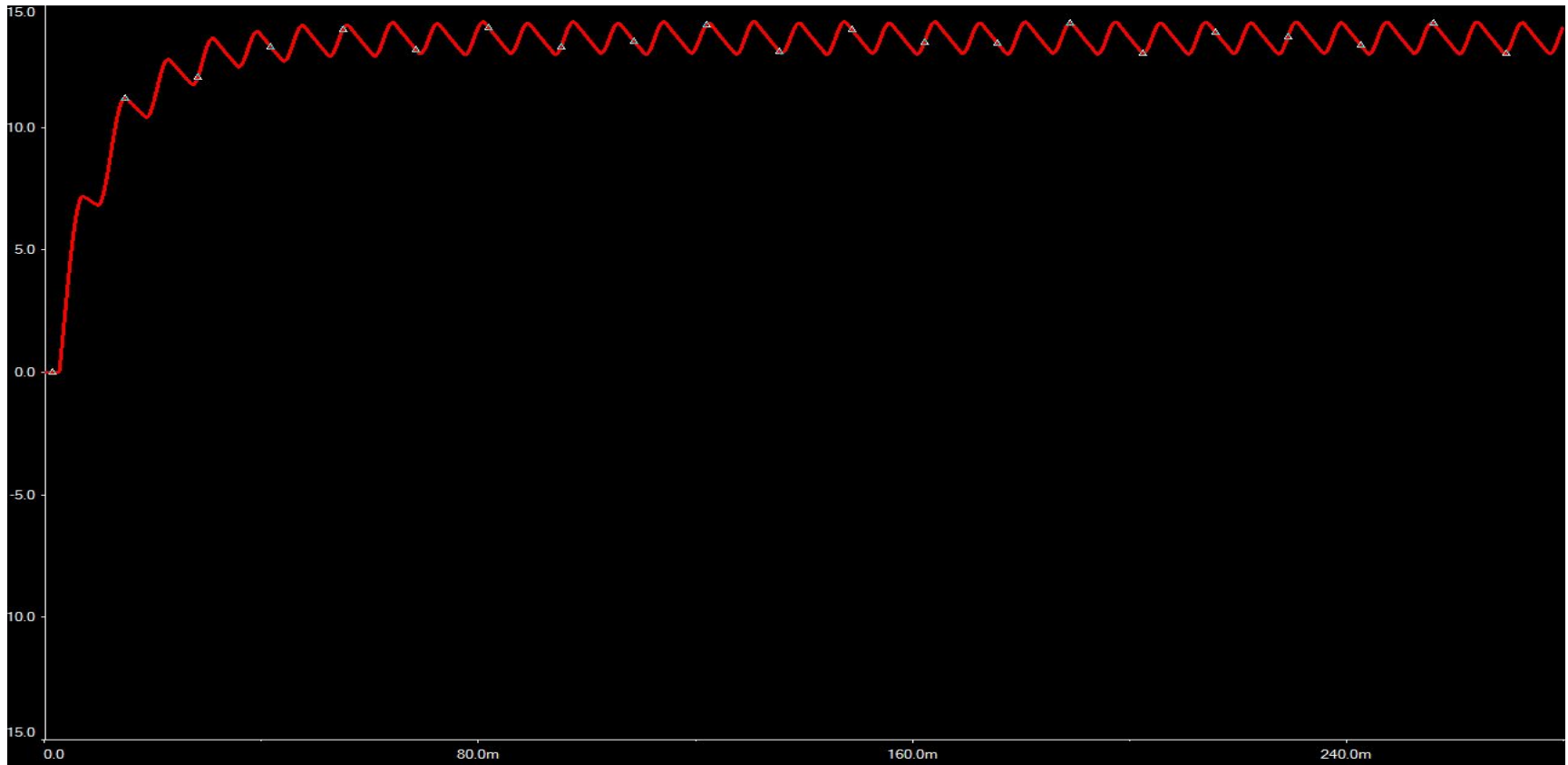
Universal Power Supply - Circuit Diagram



Voltage Ripple at 1 Ampere

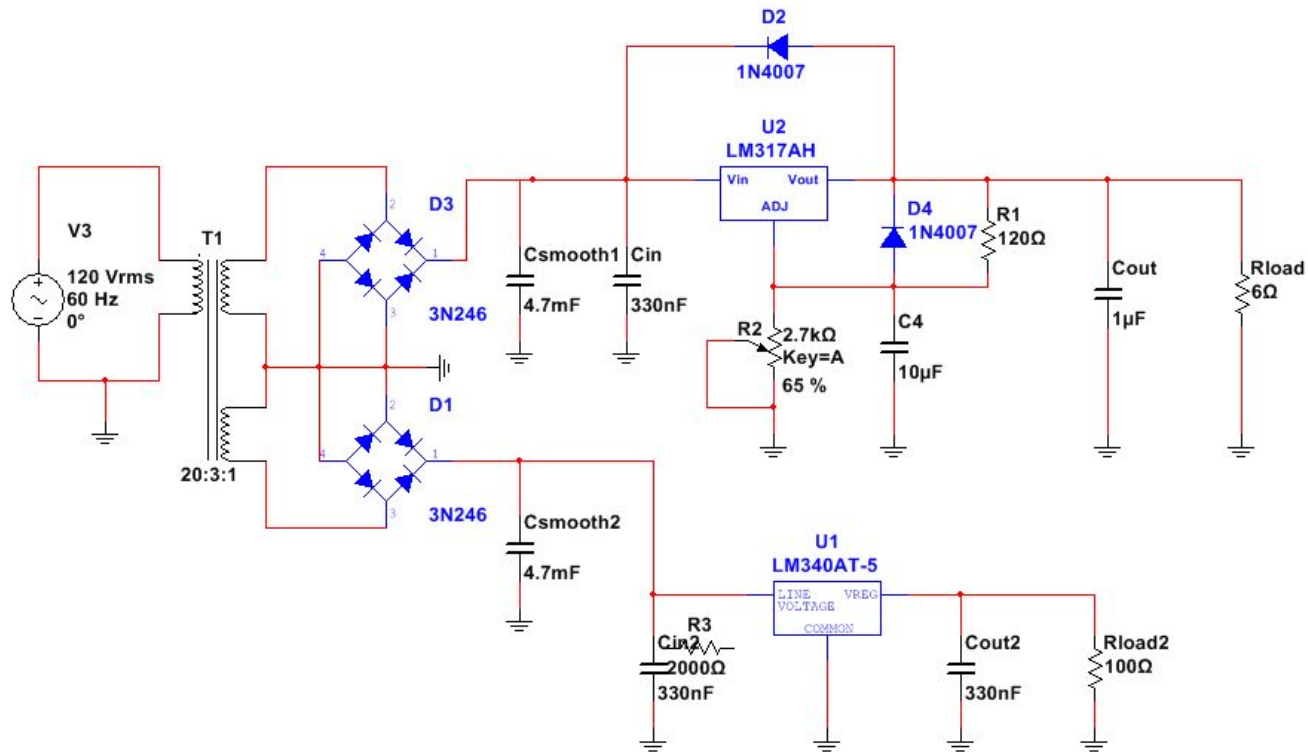


Voltage Ripple at 2 Amperes (Max Current)



Vripple = 1.2 Vpk-pk @ 120Hz

Universal Power Supply - Circuit Redesign



Data Server - Overview

- Receives user information from the iPhone application
- Communicates over serial with the turret to run the facial recognition and determine the appropriate servo positions
- Multiprocessing enables us to run the iPhone server process separate from the turret process
- Utilizes processor affinity
- Trains/stores neural network

iPhone App - Overview

- Provides a user interface to interact with the system
- Has two main functionalities:
 - Allows the user to train the neural network by sending a video to the server
 - Allows the user to control the volume and language of the audio

iPhone App - Specs

- Development: Xcode 8.2, Swift 3
- TCP connection with data server
- Username, language and volume settings are sent as simple strings
- Video file is sent to the server in .mov format
- Multithreaded: communicating with the server runs off the main thread
- Used frameworks: SwiftSocket, CoreData, MobileCoreServices, SwiftSpinner

Universal Power Supply - Overview

- Linear Regulating Power Supply
- Capable of supplying 30 Watts
- Two voltage levels
- Low noise and low ripple

Pegasus Turret - Overview

- Controls direction of the camera & audio beam
- Locks and tracks a specific user

Pegasus Turret - Functionality

- Webcam sends live video to server
- Server sends back updated X & Y position to Arduino
- Arduino turns servos to the Updated position
- Arduino and Soundlazer are powered from Power Supply

Pegasus Turret - Specs

- Serial connection between Arduino and TX1
- Serial connection between Webcam and TX1
- Rotation angles:
 - In X direction: 0 - 180
 - In Y direction: 0 - 130
- PWM signal from arduino controls the servos
- Used library: “Servo.h”: Allows easy communication between the Arduino and the servos

Pegasus Turret - What's new?

- 3D printed chassis and Soundlazer mount

Soundlazer - Measured Performance

SPL at 7 Feet		
	Indoors	Outdoors
On Axis	65dB	63dB
5ft	52dB	48dB

SPL at 30 Feet		
	Indoors	Outdoors
On Axis		55dB
5 ft.		47dB