Pegasus-21

Final Project Review

Senior Design Project

Spring 2016

Our Team

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EE

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EE

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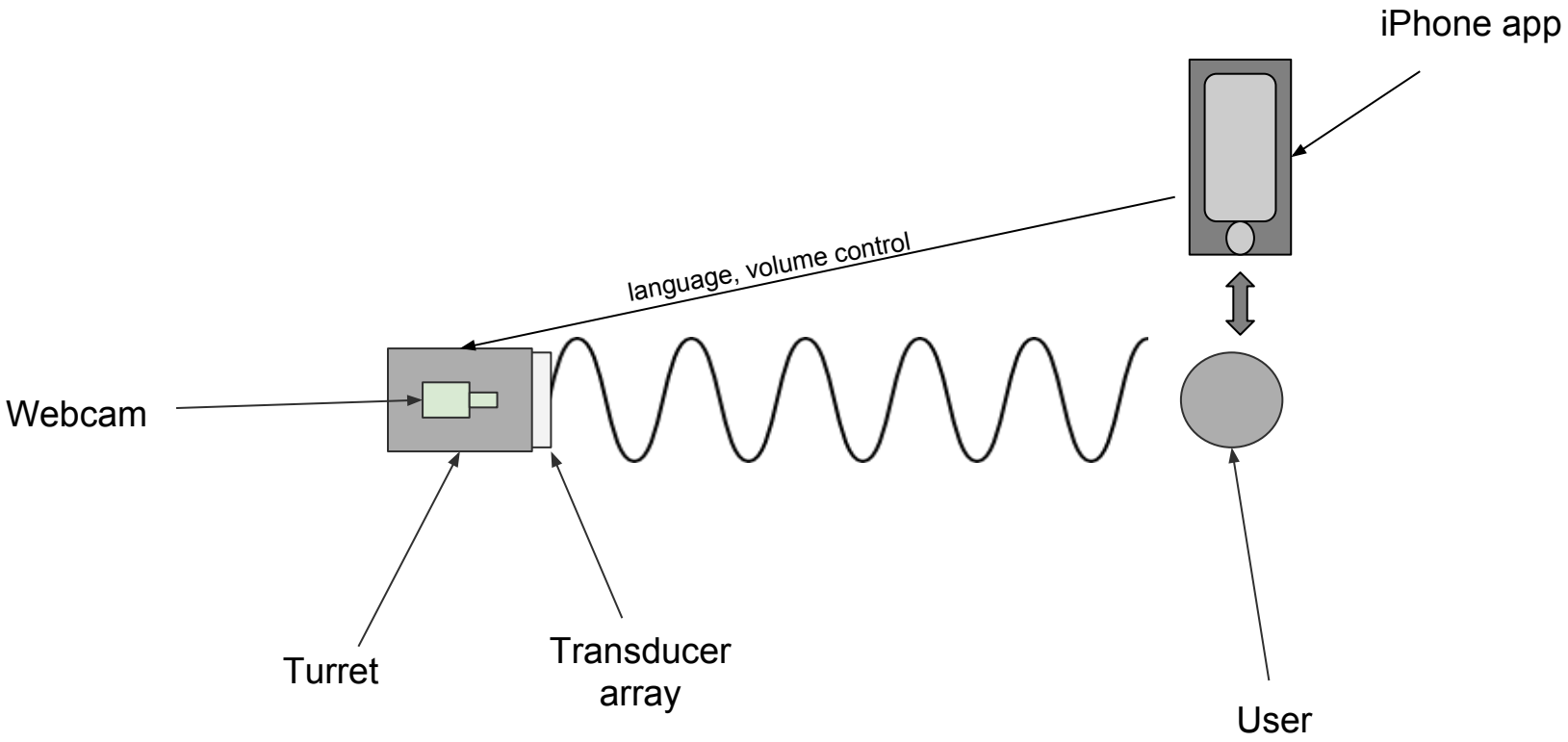
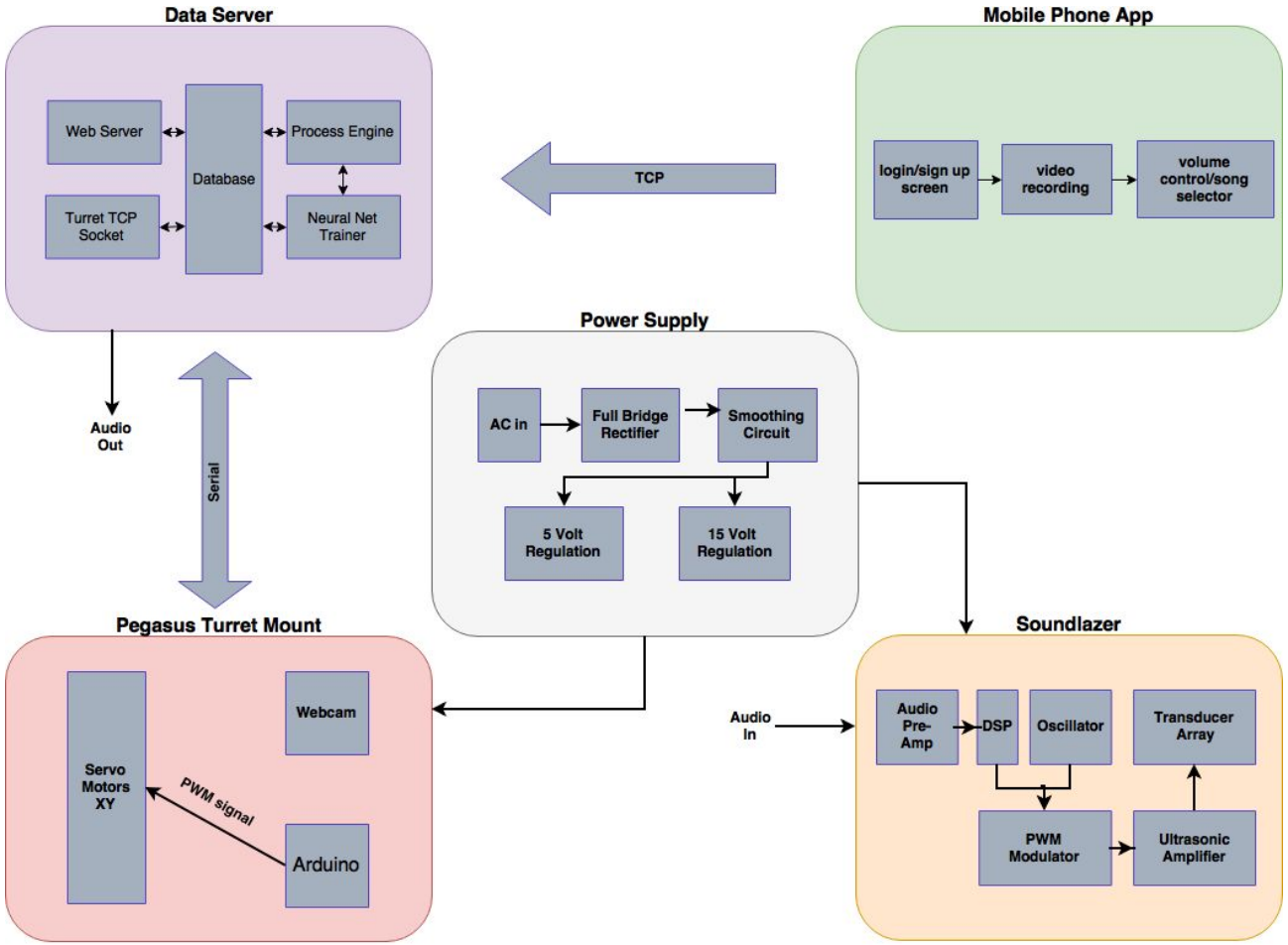
Imagine..

Pegasus-21


iPhone app
language, volume control
Webcam
Turret
Transducer array
User

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

$$p(\theta) = \frac{p_0 J_1(k_a \sin\theta)}{k_a \sin\theta}$$

where...

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

p_0 = pressure on axis

a = piston radius

J1 = 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.)

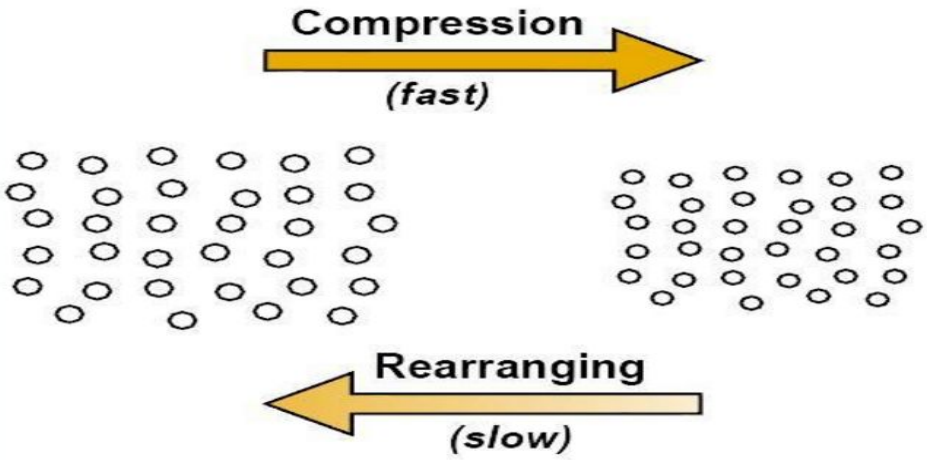
Sound From Ultrasound

Technology to create directional, highly focused soundbeams:

-An array of transducers emits ultrasonic carrier waves in the direction of target

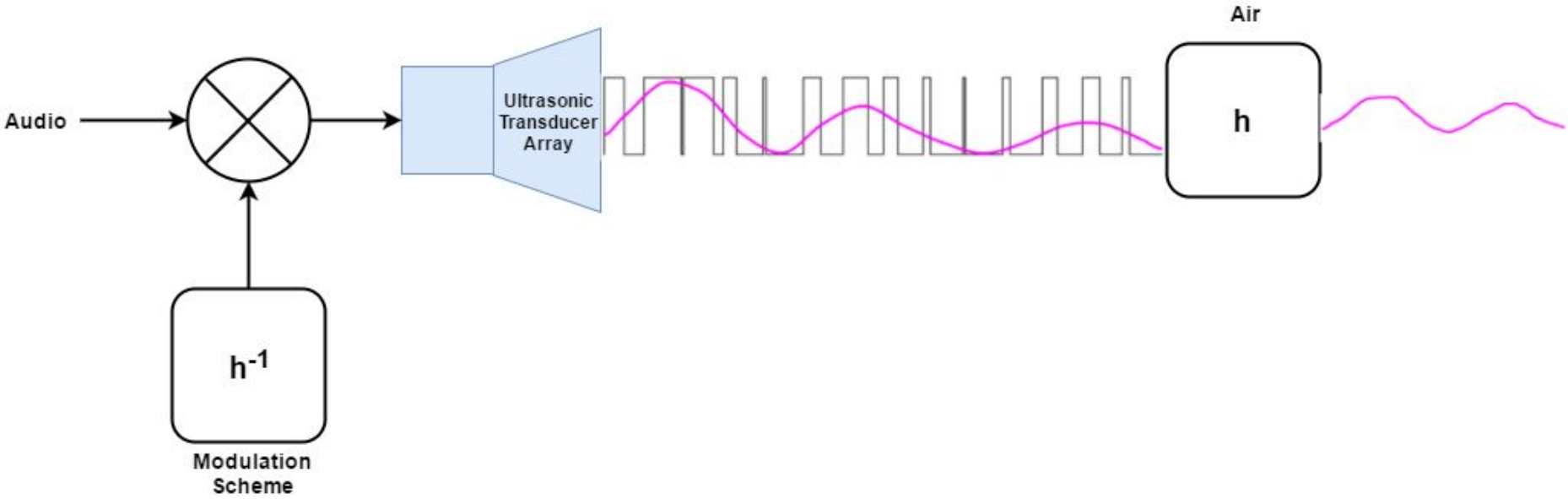
-Air, as a nonlinear medium, acts as a demodulator (no need for receiver)

-When the modulated wave reaches a person the modulated sound becomes audible



(Nema, “Ultrasonic Directive Speaker”)

Sound From Ultrasound

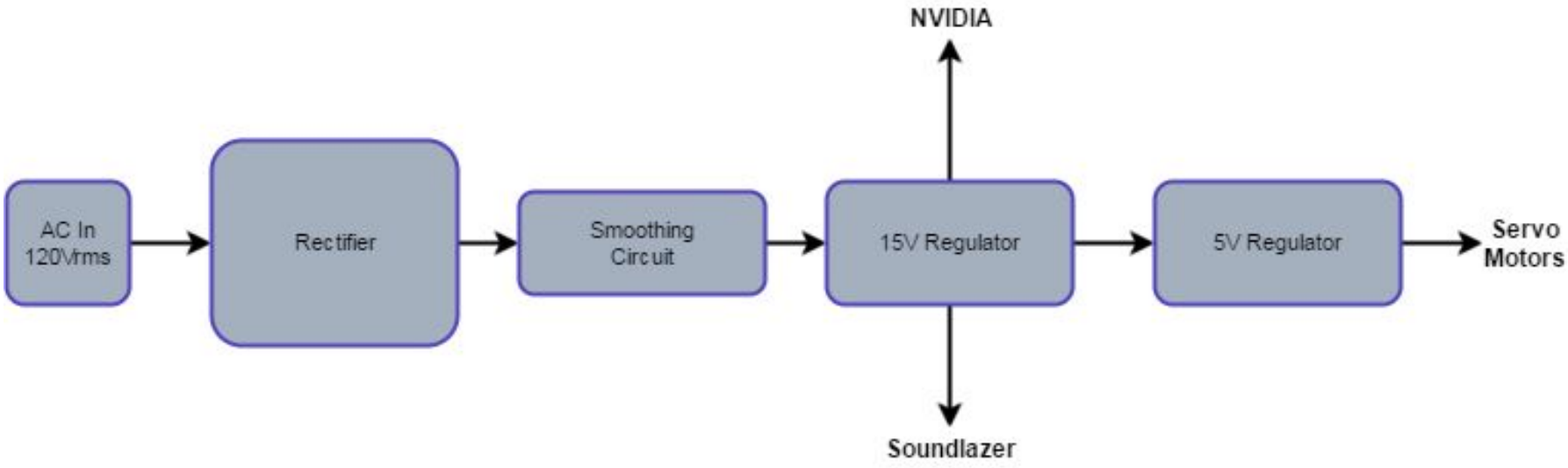


http://www.soundlazer.com/what-is-a-parametric-speaker/

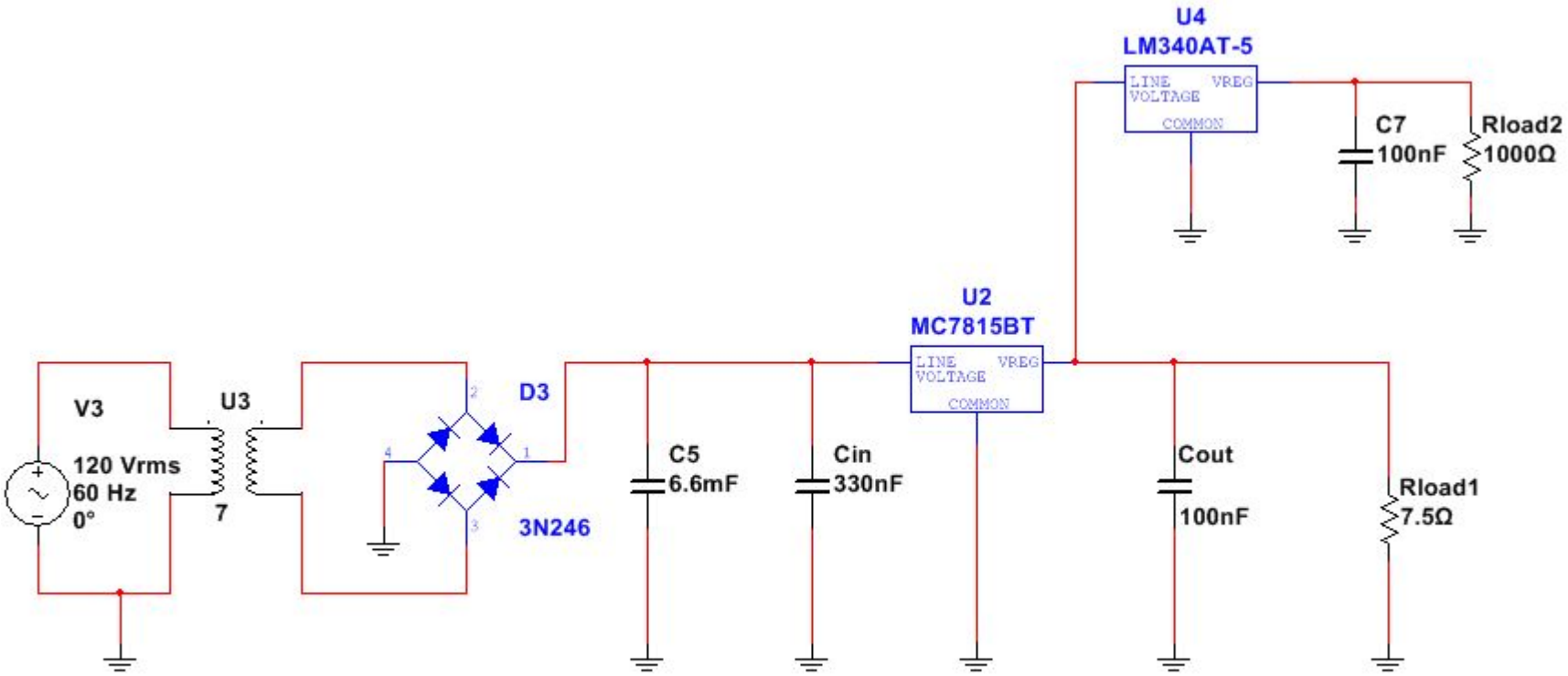
Data Server - Preexisting Technologies

- 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

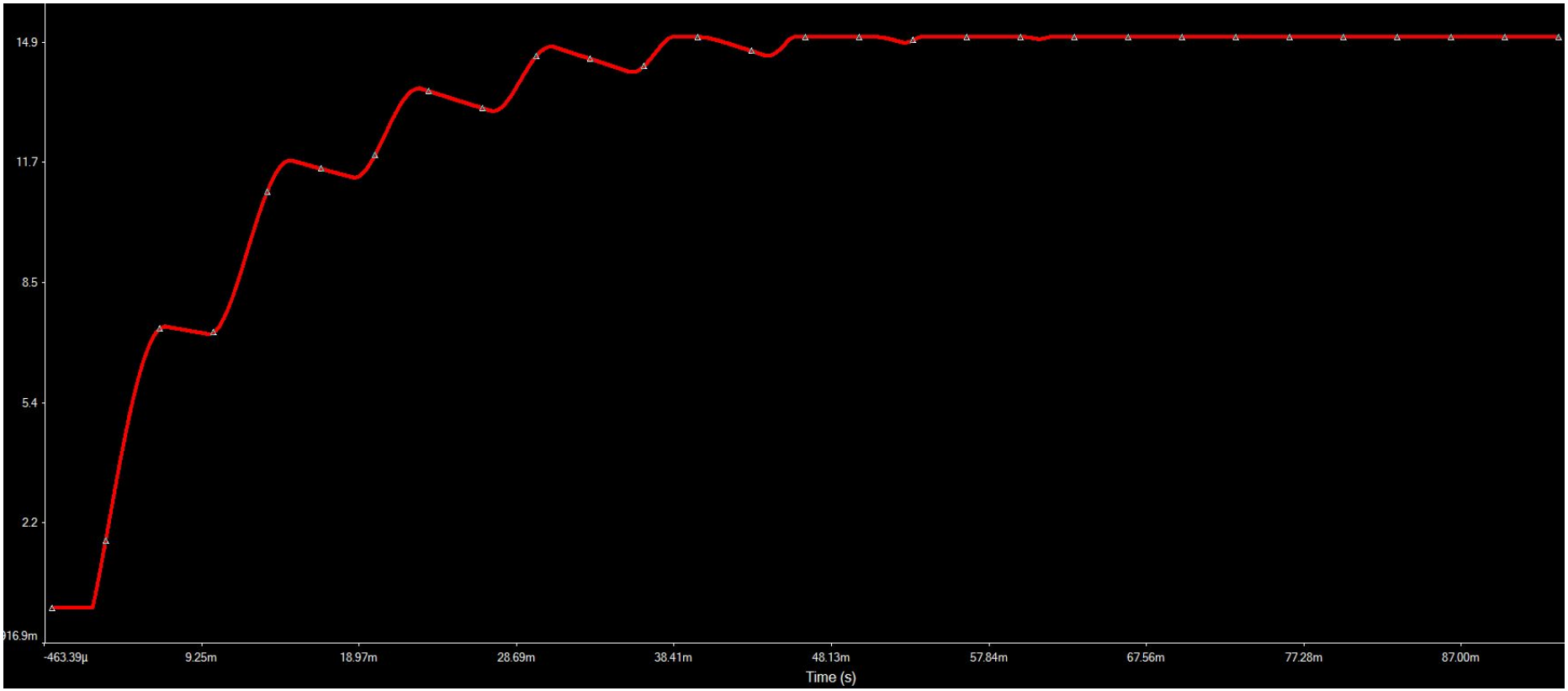
Universal Power Supply - Block Diagram



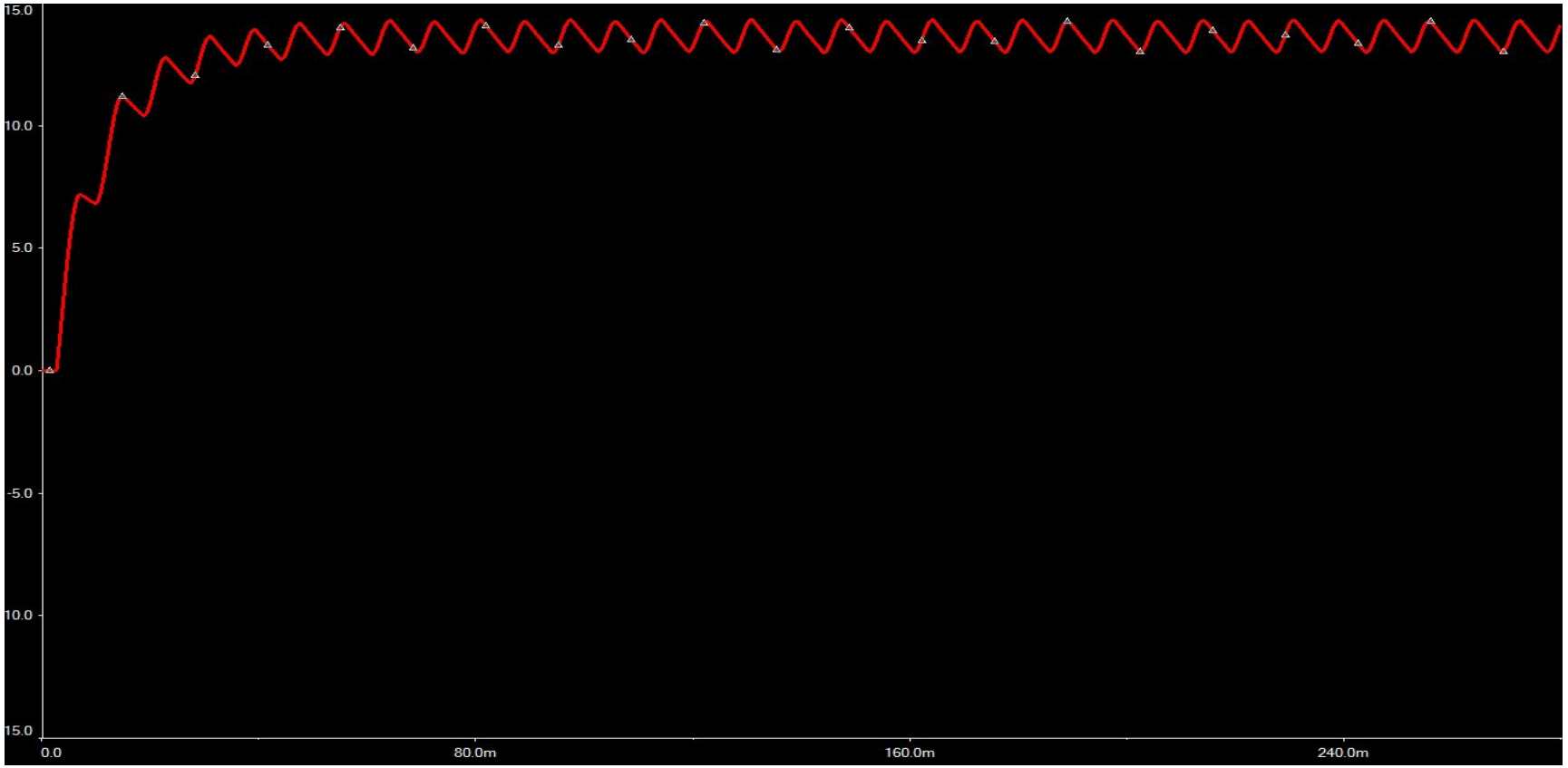
Universal Power Supply - Circuit Diagram



Voltage Ripple at 1 Ampere

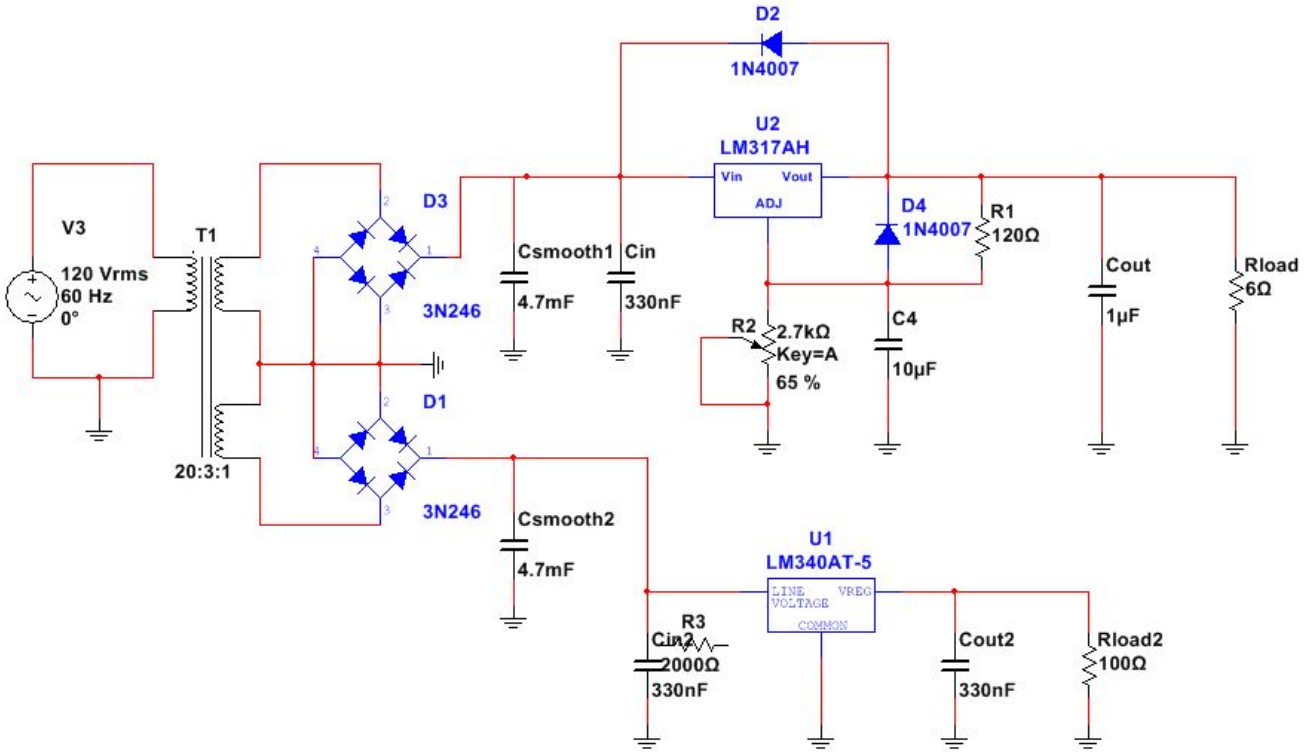


Voltage Ripple at 2 Amperes (Max Current)



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