C.A.P.E.R.
Critical Design Review

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MEET THE TEAM!

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Project Description

- C.A.P.E.R. → Compact Animated Parrot with Enhanced Responsiveness
- Life-like parrot robot with base & realistic body
- Fundamental movements
  - Head tilt
  - Beak open and close
  - Body tilt
  - Wing and tail flap
- Voice response
  - AI generated responses
  - Voice detection

Motivation?

- Current robots and animatronics costs tens of thousands of dollars to produce and maintain
- Vast majority of smaller companies are not able to utilize robots for additional entertainment
- Most are massive (human size or larger!), so they are typically bolted to one spot and are unable to be moved
- Many entertainment robots are not responsive and are only there for aesthetics

Goals

- Ultimately, to create an affordable and portable entertainment robot that has smooth movement and conversational capabilities
- Affordability in comparison to existing entertainment robots and animatronics
- Ease of use
- Accessibility
- Quick response time
- Stretch goals:
    - Touch sensor implementation for more lifelike interactions
    - Increased sensitivity to surroundings for more realistic reactions and movements

Objectives

Realistic, smooth motion

- Life-like motions that mimic how a real life parrot would move via servo motors
- High quality human interaction
- Pre-recorded motion; both AI response and manual push button options available

Voice activation and speech detection

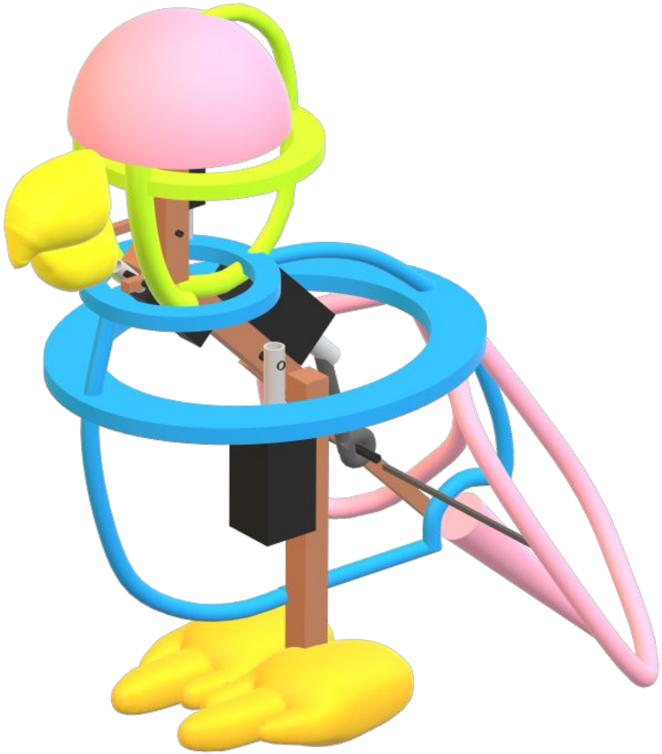
- Speech detection activates AI generated voice response
- Ability to carry a human conversation

Specifications

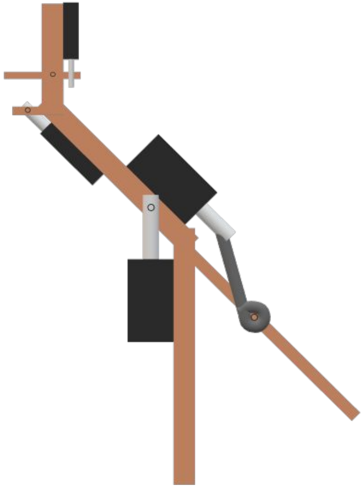
Table 2.1: Specifications

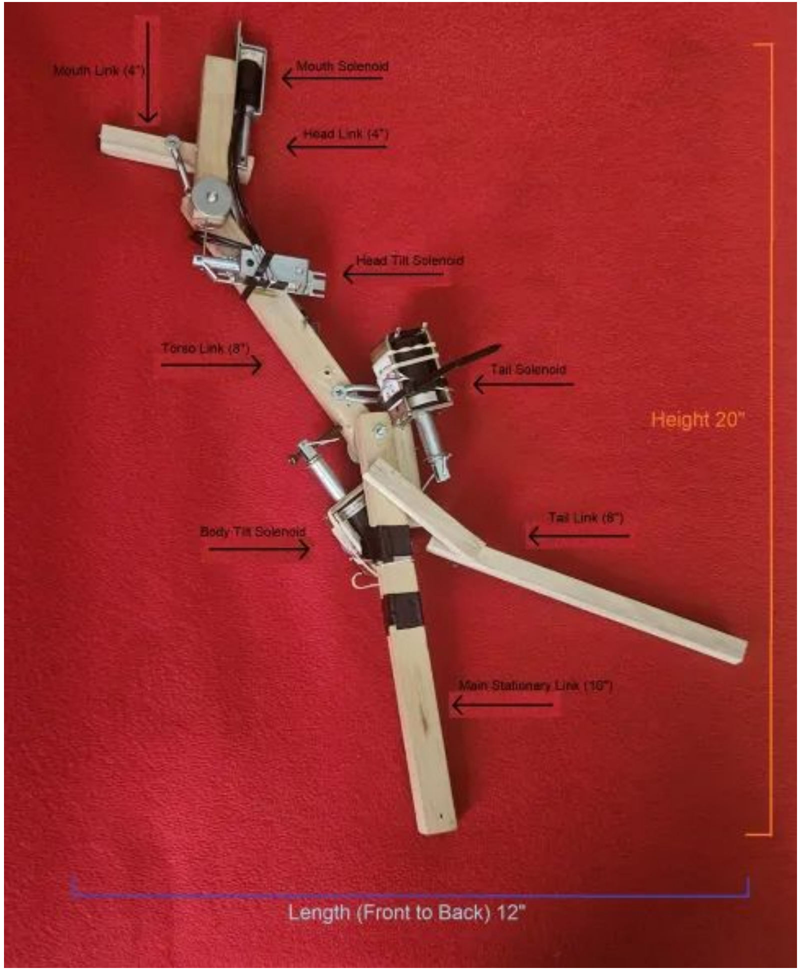
Hardware	
Movement capability	Solenoids should be able to move the joints in a way that makes the parrot life-like with fluid motions such as head tilt, mouth movements when speaking, wing flapping, etc. Head – 45 degrees Mouth – 50 degrees Body – 30 degrees Wings & Tail– 45 degrees each
Interactive modes	The selector switch will be used when the MIDI is inactive. The position of the switch will declare the mode the parrot is in. Turning the switch on would activate randomized movements for the head, body, and tail flap. Turning the switch off would activate total manual control using button inputs.
Dimensions	Around 1.5 ft tall. Maximum 2ft
Durability	Able to last at least two years with minimal maintenance
Weight	Maximum of 15 pounds.
Power Consumption	Maximum 40W
Cost Maximum	$1300
Response time to user input in push buttons	2 seconds
Software	
Voice Recognition	The parrot should be able to recognize when its name is called and respond accordingly with 80% accuracy.
Audio Response	Parrot should respond in a realistic manner with intelligible speech and 80% accuracy. Parrot should be easily understandable by the user.

Prototype Skeleton Design

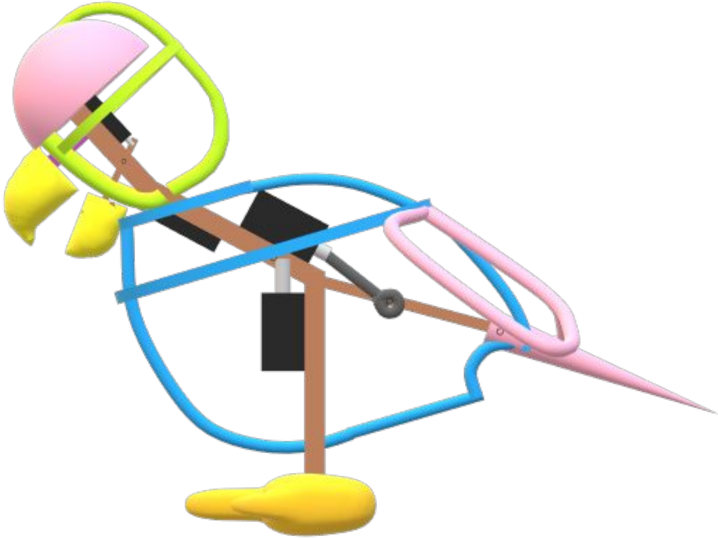


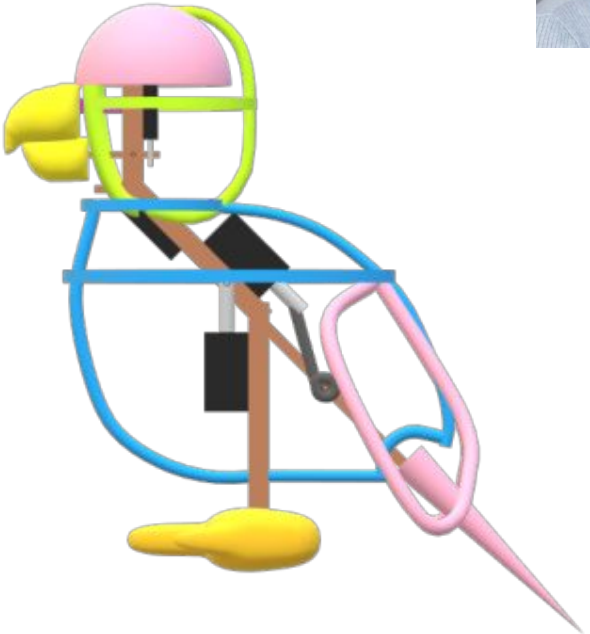
Materials:
Wood ⟶ internal frame
Solenoids ⟶ movement capability
Foam, rubber tubing, metal rods ⟶ internal shaping framework



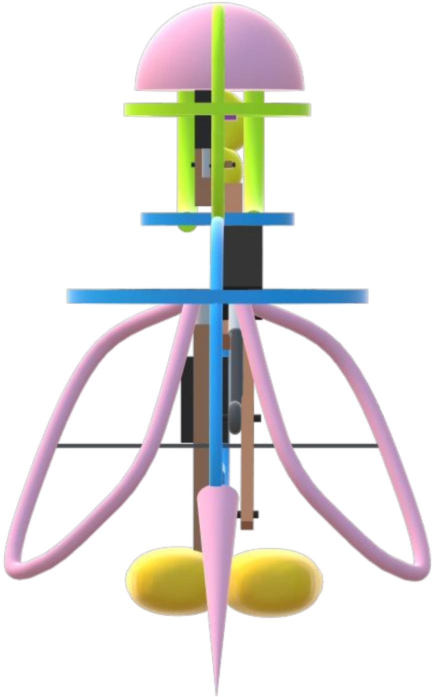

Mouth Link (4")
Mouth Solenoid
Head Link (4")
Head Tilt Solenoid
Torso Link (8")
Tail Solenoid
Height 20"
Tail Link (8")
Body Tilt Solenoid
Main Stationary Link (10")
Length (Front to Back) 12"

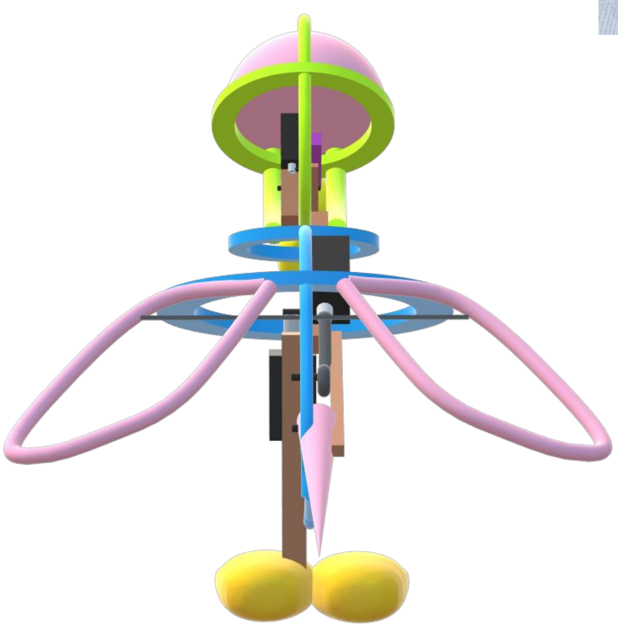
All four movements activated



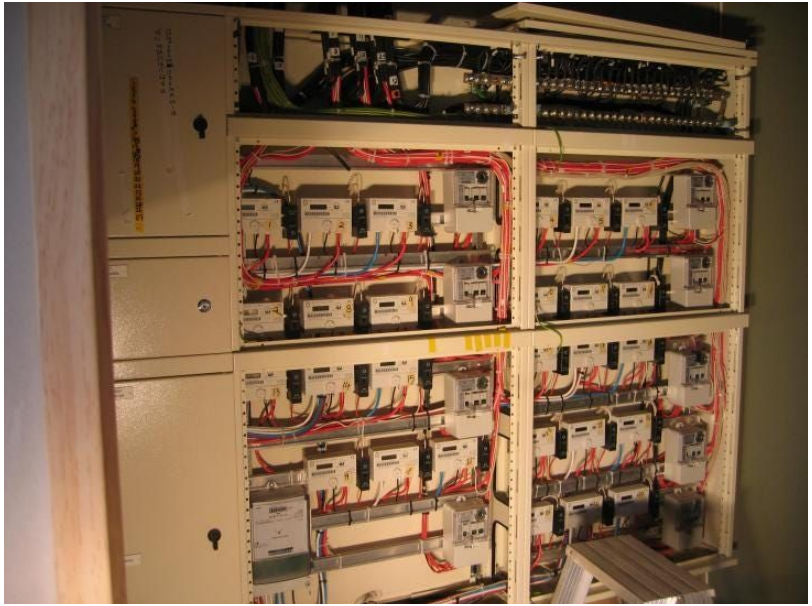


Resting vs Activated Wing Position





Operation Modes



Fully-manual live operation

- Push buttons

Partial-manual live operation

- Microphone control

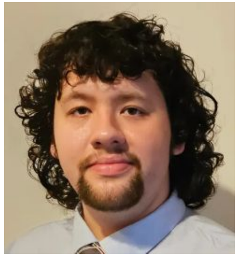
Pre-recorded sequence operation

- External playback device; digital audio workstation (DAW)
- Synchronized audio and movements

Unified conversation operation

- Detect human speech and respond synthetically

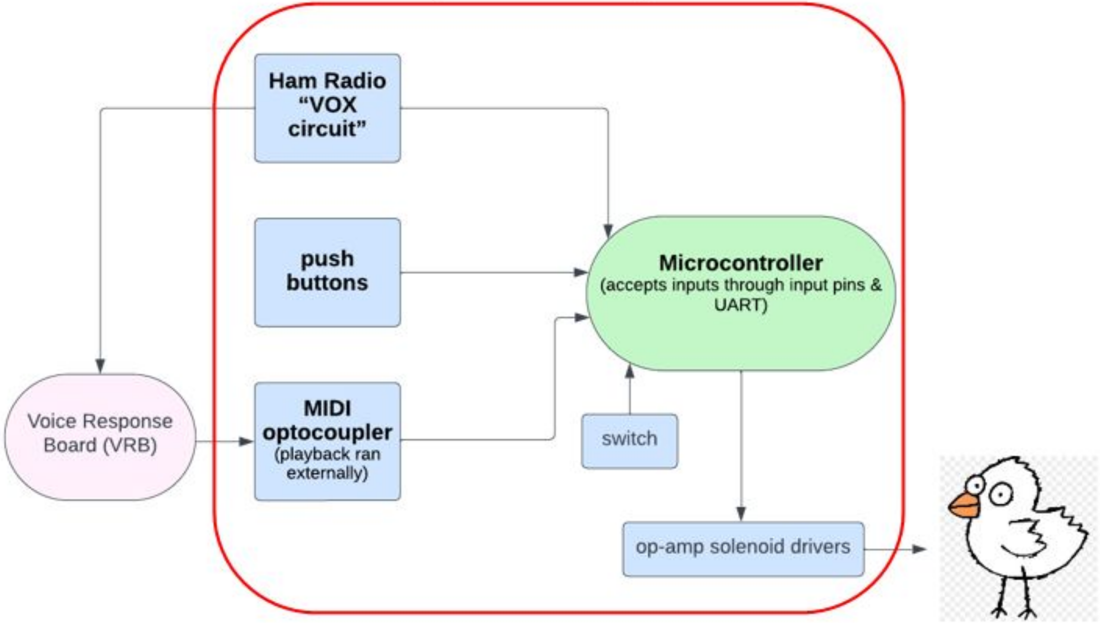
Main Block Diagram



Everything within the red outline is housed in the PCB and all require an external power supply (see individual subsection diagrams)

- ❖ Blue = peripheral circuits
- ❖ Pink = external devices
- ❖ Green = microprocessor chip

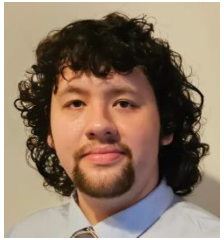
****all components are to be acquired*



IOCB

Input/Output and control board

- Microprocessor – MSP430G2553
- UART input stream processing
- Power supply for digital pins
- Peripheral circuits
    - Push buttons
    - Mode selector switch
    - MIDI optocoupler
    - Headers for external debugging
    - Power supply/regulators
    - VOX Circuit



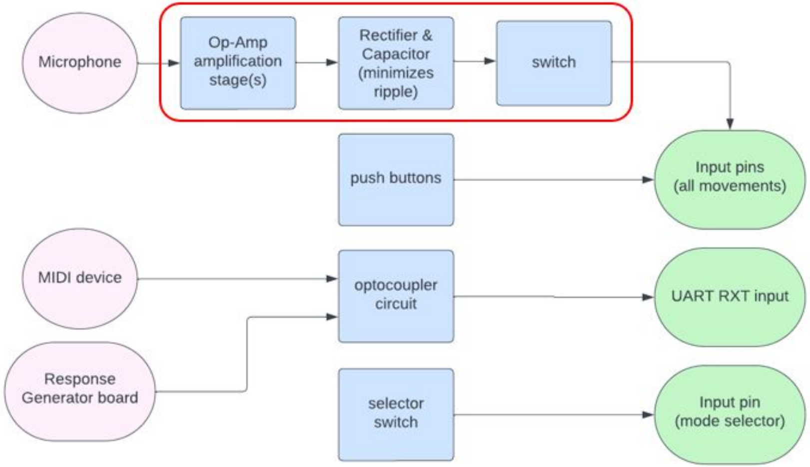
Input Control Board Block Diagram

Blue = on PCB; requires power supply

Green = microprocessor inputs

Pink = external devices (may require separate power supply)

Blocks within red outline → VOX circuit (see main diagram)

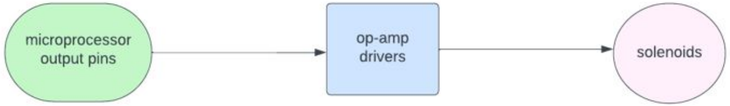


Output Control Board Block Diagram

Blue = on PCB; requires power supply

Green = microprocessor outputs

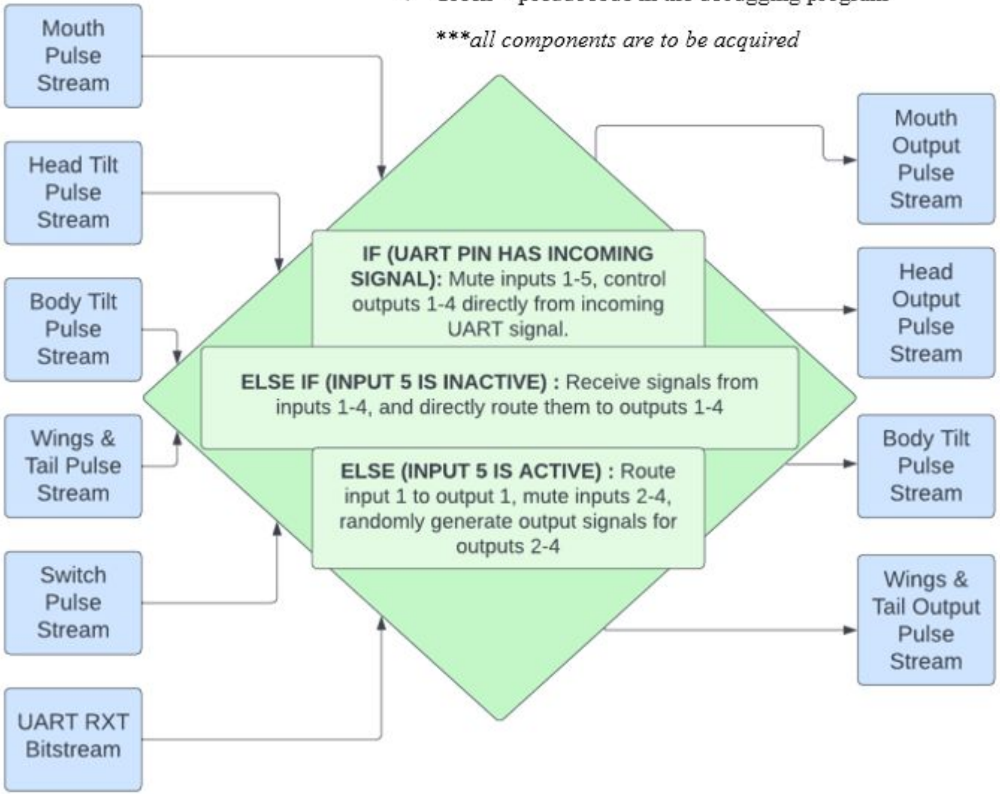
Pink = external devices (may require separate power supply)

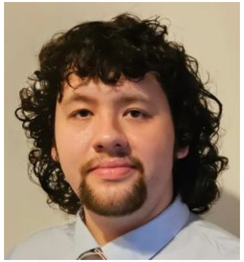


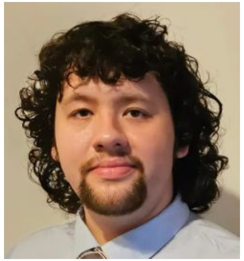
Microcontroller Software Logic

- Blue = I/O pins as seen by the **code/program**
- Orange = hardware & external devices
- Green = pseudocode in the debugging program

****all components are to be acquired*





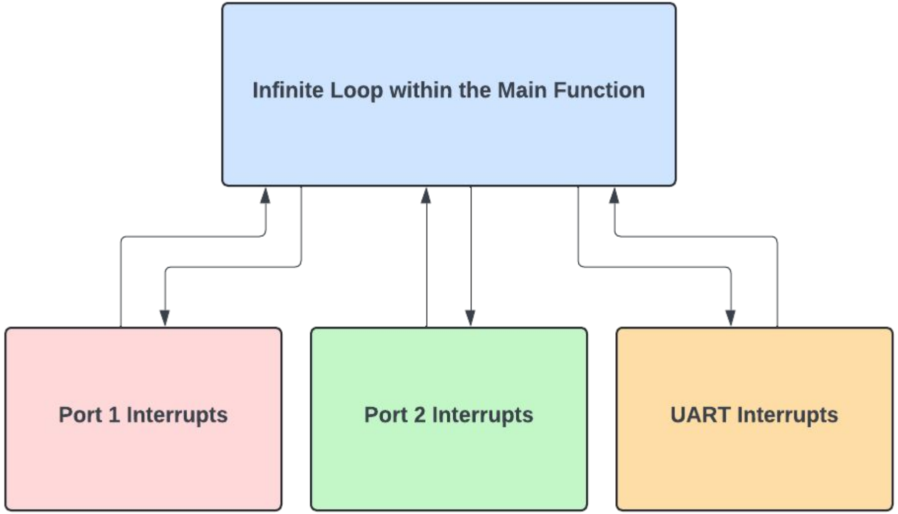


IOCB software

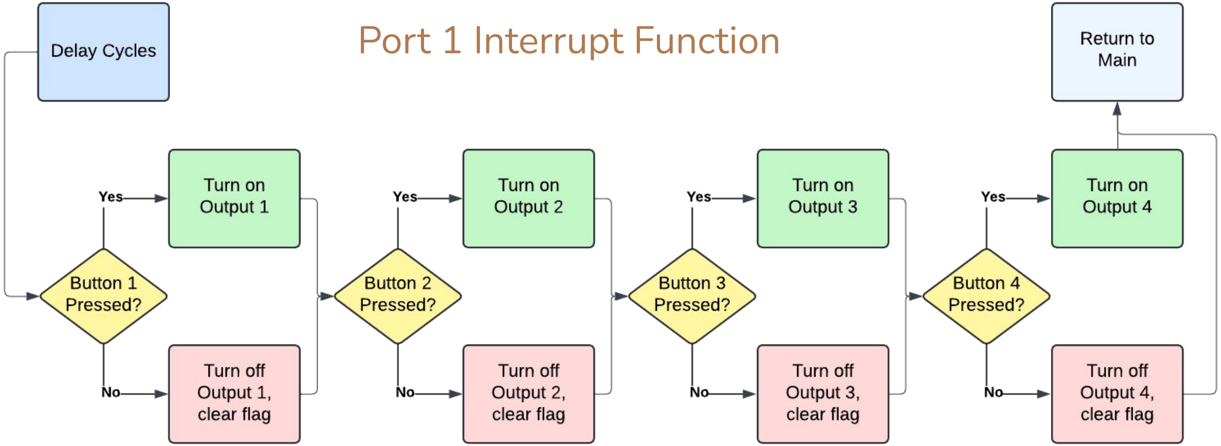
Inputs
- Mouth Pulse Stream
- Head Pulse Stream
- Body Pulse Stream
- Wings and Tail Pulse Stream
- UART MIDI Datastream
- Selector Switch Pulse Stream

Outputs
- Mouth Output Pulse Stream
- Head Output Pulse Stream
- Body Output Pulse Stream
- Wings and Tail Output Pulse Stream

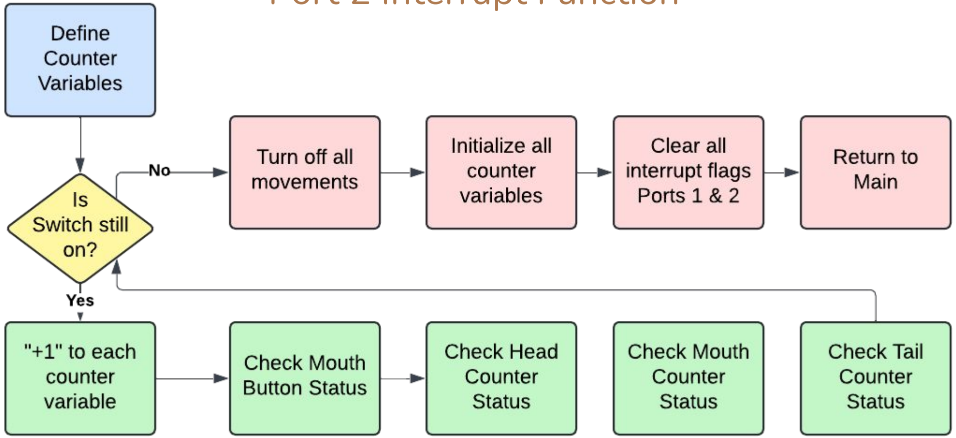
1. Define the “char” variables
2. Implicitly declare
3. Run the external “setUp()” function.
4. Define the four push-button input pins
5. Define the selector switch input pin
6. Set up the four outputs
7. Enable the global interrupts

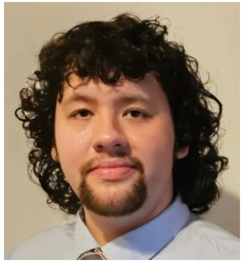


Port 1 Interrupt Function



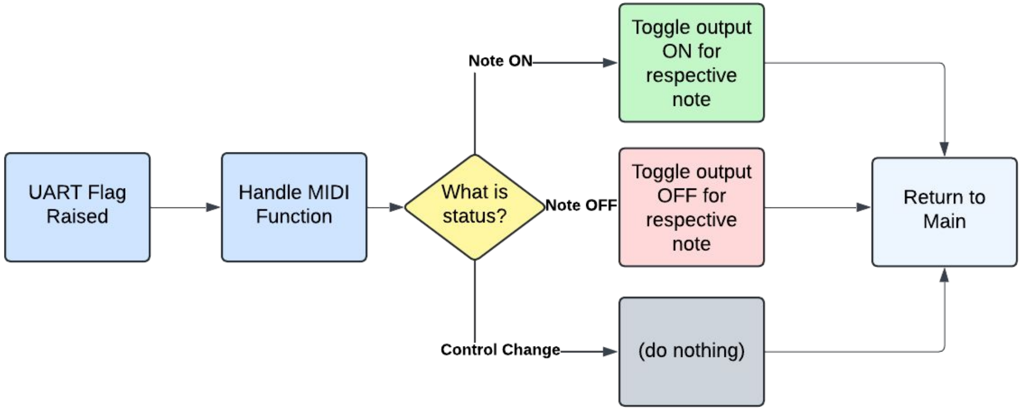
Port 2 Interrupt Function

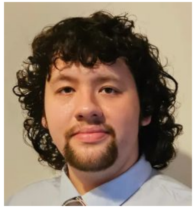




UART Interrupt Function: Pre-Recorded Sequences and Fully Live Operation

Message	Action
0x9# 0x3C 0x##	MOUTH OPEN
0x8# 0x3C 0x##	MOUTH CLOSE
0x9# 0x3E 0x##	HEAD DOWN
0x8# 0x3E 0x##	HEAD UP
0x9# 0x40 0x##	BODY DOWN
0x8# 0x40 0x##	BODY UPRIGHT
0x9# 0x41 0x##	TAIL UP
0x8# 0x41 0x##	TAIL DOWN





Motion systems

Table 3.6: Motion Systems Part Comparison

Aexit	**Features** • Within voltage and current range as specified: 14.4W @24VDC • Suitable housing dimensions: 2.6" x 1" x 0.8" • Sufficient stroke length: 1.2" • 100g mass a piece. • Pull strength of approximately 35N • Spring loaded • Within budget range: $12 to $15 a piece
Ledex	• Well within power range at under 9 watts @ 24VDC • Housing dimensions of 2" x 1.5" x 1" • Smaller stroke length of 0.69" • 192g mass a piece • 124N pull force • Not Spring loaded
Uxcell	• Rated at 72W (when fully retracted) • Dimensions 1" x 0.75" x 0.66" • 10mm stroke • 10N force • Unspecified weight (smallest size of the selections) • Spring Loaded
RS Pro Linear	• 11W to 110W consumption from 10% to 100% DC supply • $21 a piece • 2" x 0.75" x 0.75" • 12mm stroke length • Not spring loaded • 25N pull force • Corrosion resistant coating

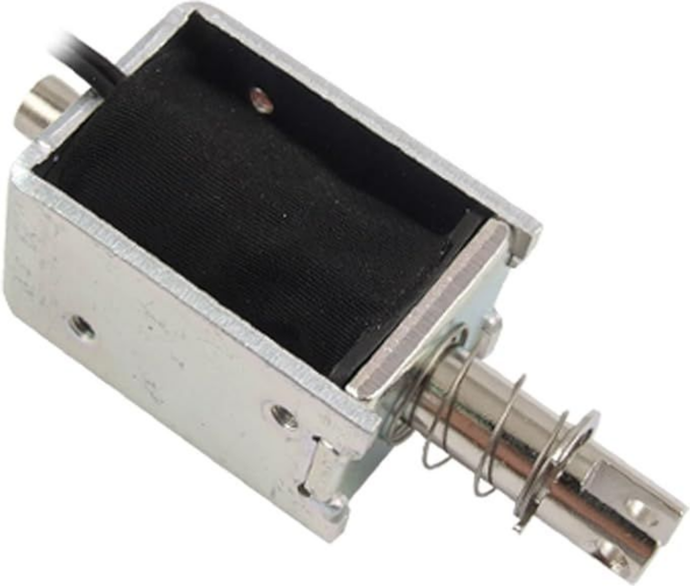
Table 3.5: Motion systems

	Pneumatics	**Servos**	**Geared DC Motors**	**Solenoids**	**Stepper Motors**
Cost	>$300 total not including compressor or valve bank	$20.00 not including controller	<$10.00	~$15.00	$13 for smaller sized motors
Size	As small as 3 inch length	From "Micro" to "Jumbo"	Similar to servo	Similar to pneumatic	4cm wide square housing
Self-Contained (all inside CAPER)	No, requires external valve bank and air compressor	Yes, but will require additional control board	Yes	Yes	Yes, but would require additional control board
Suitable for Outdoor Use	Yes	Only the expensive ones	No	Yes	Only if outer shell is resistant (no)
Controllability	On/Off	Speed and Position	Approximate Speed and Direction	On/Off	Digital step counting, no real time position sensing
Movement	Linear Stroke	Limited or Cont. Rotation	Continuous Rotation	Linear Stroke	Continuous rotation
Power	From 200W to 4KW air compressor	~5W each, (20W total)	~0.2W each (~1W total).	~4W each (16W total)	72W each (288W total)

Motion Systems

Solenoids → Gives CAPER the capability to move

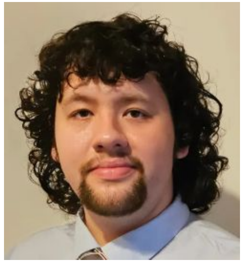
- Self contained
- Suitable for outdoor use
- On/off switch for controllability
- Power of approximately 18W each
- 100g mass a piece
- Spring loaded



Input Output Control Board

Table 3.7: Chip specifications

	MSP430G2553	Arduino ATMEGA328P	Raspberry Pi SC0914 (RP2040)
Speed	16 MHz	20 MHz	133MHz
Storage	16KB Flash	32KB Flash	264KB Flash
Pin Configurations	20 or 28 pins	21 or 28 pins	56 pins
UART	Yes	Yes	Yes
Debugging Hardware	Internal Bootstrap Loader using UART Bridge	debugWIRE	Done on PICO board
Software	TI Code Composer Studio	Arduino IDE	Multiple IDEs can work for this



Hardware selection

MSP430G2553	**Features:** • Pin layout: 20, 28 and 32 pin packages available • Package Size: 20-DIP • Low power modes: (4), can shut off all clocks and timers • Clock Modules: low frequency crystal and RC • Timers: one 16-bit timer • Serial Communication: UART, SPI, I2C, IrDA; automatic Baud-Rate detection • Analog to Digital: supports 10 bit conversions • Processing speed: up to 16MHz • RAM: 512B, 16KB Flash RAM • 16 bit architecture • Voltage: 1.8 to 3.6 VDC
MSP430FR6989	**Features:** • Pin layout: 80 or 100 pin • Package Size: LQFP (PN or PZ) • Low power modes: (3), shuts off all timers and clocks • Clock Modules: Low & high frequency crystals, DCO, MODOSC, and external • Timers; five 16-bit timers • Serial Communication: UART, SPI, I2C, IrDA; automatic Baud-Rate detection • Analog to Digital: 16 bit analog comparator, 12 bit ADC • Processing speed: 16MHz • RAM: 128KB FRAM, 2KB SRAM • 16 bit architecture • Voltage: 1.8 to 3.6 VDC • Code security: 128-Bit or 256-Bit AES Security Encryption and Decryption Coprocessor • Digital peripherals: 32-bit hardware multiplier, 3-channel internal direct memory access

Atmel ATMEGA328P-PU	**Features:** • Pin layout: 28 pin (others available, but this layout is easiest to work with) • Package Size: SPDIP • Qtouch library: 64 sense channels; capacitive touch buttons, sliders, and wheels • Clock Modules: Low frequency & full swing crystals, RC, external • Timers: two 8-bit, one 16-bit, and six PWM channels • Serial Communication: USART, SPI, and Phillips I2C • Analog to Digital: 6-channel, 10-bit (differs depending on package) • Processing speed: 20MHz (20 MIPS using single cycle instructions) • RAM: 32KB flash RAM, 2KB RAM • 8 bit architecture • Voltage: 1.8 to 5.5 VDC
ATMEGA2560	**Features:** • Pin layout: 100 pins • Package Size: TQFP or CGBA (25 pins per edge or 10x10 grid on bottom respectively) • Qtouch library: 64 sense channels; capacitive touch buttons, sliders, and wheels • Clock Modules: Low power crystal, LF crystal, Full swing crystal, internal RC, external • Timers: two 8-bit, four 16-bit, four 8-bit PWM channels & six-twelve PWM (2 to 16 bit) • Serial Communication: USART, SPI, 2-wire Byte Oriented serial interface • Six sleep modes, ADC noise reduction • Analog to Digital: 16-channel, 10-bit • Processing speed: 16 MHz (16 MIPS using single cycle instructions) • RAM: 256KB Flash RAM, 8KB RAM • 8 bit architecture • Voltage: 4.5 to 5.5VDC at 16MHz (as low as 2.7 for 8MHz) • JTAG compliance, extensive on-chip debugging support

Hardware selection

Table 3.12: Transistors vs Relays

	BJT (2N2222)	Relay (BESTEP)
Voltage Limits	5V (emitter to base). 60V (collector to base)	30V DC (triggers at exactly 3.3V)
Current Limits	800mA	10A
Switching Time	~150 microseconds	~10 milliseconds
Cost	$0.40	~$2.00

Table 3.13: Data Voltage Control Hardware Selection

	BESTEP	HiLetgo	Teyleten
Price	<$1	$5.89	$2
Config.	1 channel	1-8 channels	1 Channel
Power	10A 250VAC or 30VDC	10A 250VAC or 30VDC	10A 250VAC or 30VDC
Trigger V.	3.3V (5V options available)	5V or 12V (no 3.3V options)	3.3V
Connections	Raw Wire	Raw Wire	Raw Wire
Norm O/C	Open or Closed	Open or Closed	Open or Closed
Switch Delay	<20ms	*unspecified	<20ms

Microphone selection

Table 3.15: Microphone Circuit Style Comparison

Dynamic	- Dynamic microphones are the most common circuits you can find in a handheld microphone. Essentially a reverse speaker, dynamic mics use coiled wire and a permanent magnet to generate electrical waves from an incoming sound source. They **do not require an external phantom power supply**, are very lightweight and portable, and **relatively affordable** compared to other mics (anywhere from $50 to $300).
Condenser	- Condensers (the British-English term for Capacitors), rely on a pair of capacitor plates to generate soundwaves based on the gap between them. Unlike Dynamics, Condenser microphones do **require an external 70V phantom power supply** to produce signal, but are usually more articulate in the 10kHz range and higher. **Prices range from $100 to $4000+**, not including the price of the power supply.
Ribbon	- Ribbon mics are one of the oldest microphone styles you can still purchase, originating in the 1920s. Active and passive versions both exist, but they **CANNOT handle phantom power** (unless you want to instantly destroy them). In fact, they are the most fragile style of microphone on this list, and expensive too, **ranging as high as $7000 dollars.**

Table 3.16: Microphone Type Comparison

Behringer SL84C	Shure SM58	Pyle PDMIC 58	Samson Q8X
• $15 • Dynamic with cardioid pickup pattern • Sensitivity of 54 ± 2 dBV/Pa • 50-15kHz response	• $100 • Dynamic with cardioid pickup pattern • Sensitivity of –54.5 dBV/Pa • 50-15kHz response	• $22 • Dynamic with Cardioid pickup pattern • Sensitivity of -54dB ± 3 dBV/Pa • 50-15kHz response	• $100 • Dynamic with Cardioid pickup pattern • -54dB dBV/Pa • 50-16kHz response

Power supply

Table 3.17: Power Supply Comparison

MEAN WELL LRS-150-12	MEAN WELL HRP-150-12
• Package dimensions: 6 x 3.81 x 1.18 inches • Output voltage: 12V • Max output wattage: 150W • Working temperatures: -30~+70C • Safety approvals: TUV EN 62368-1, UL 62368-1 • Fanless design; convection cooling • Over Temperature Protection • Cost: $20-30 (typical, depending on vendor)	• Package dimensions: 6 x 3.81 x 1.5 inches • Output voltage: 12V • Max output wattage: 150V • Working temperatures: -40~+70C • Safety approvals: UL 62368-1 • Fanless design; convection cooling • Cost: $50-60 (depending on vendor)

Communication protocols

Table 3.18: Communication Protocol

	UART	I2C	SPI
Synchronization	Asynchronous; requires transmitter and receiver to operate on same baud rate.	Synchronous; controlled by master serial clock, shared with slave.	Synchronous; master clock signal sent to slaves on separate lines.
Duplex	Half or Full-duplex	Full-duplex	Full-duplex
Slaves per Master	2 transceiving devices	128 slaves for 7 bit addressing, 1024 for 10 bits.	2-3 slaves per master
Directionality	Bidirectional; Tx to Rx for both devices	Bidirectional, two serial lines	Bidirectional; MOSI to MISO between master and slave(s)
Wires per Channel	1 per direction (2 in total)	Two serial lines; all slaves connected	7 lines going into master, 4 going into slaves, all interconnected
Speed	460kbps	100kbps	>100MHz
Error Detection	Parity bits (parroty bits in this case 😀)	ACK/NACK bit	All hardware-based

Board selection

Table 3.10: Hardware vs Server Offloading

Aspect	High-Cost Edge Hardware	Server Offloading
Best performance to cost ratio	❌	✅
Best software scalability	❌	✅
Best hardware upgradability	❌	✅
Best pipeline simplicity	✅	❌
Best usage latency	✅	❌
Best educational opportunity	❌	✅

Device	Price (USD)	CPU/GPU	RAM	Storage	Performance (GFLOPs)	Language
Nvidia Jetson Nano	$149.99	Quad-core ARM A57 / 128-core NVIDIA Maxwell	2/4 GB	microSD	500	Cuda and OpenCL
Google Coral Dev Board Mini	$99.99	MediaTek 8167s SoC / IMG PowerVR GE8300	2 GB	8 GB eMMC	32 (32-bit)/64 (16-bit)	OpenCL
BeagleBone AI-64	$187.50	Texas Instruments TDA4VM	4 GB	16 GB eMMC	160 (out-of-box) 8000 (requires models bit customized)	OpenCL

Software selection

Table 3.19: MIDI Program Comparison

Reaper: Regarded as one of the best DAWs out there for music production, Reaper covers all the bases to get this project off the ground	**Features:** • 64 bit audio processing • 128 channel MIDI capacity • Hundreds of MIDI after-effects • $60 non-commercial license price • Compatible with all major plugins VST, VST3, etc.
Studio One: Another great choice for audio editing, Presonus Studio One allows for intensive recording and editing of both MIDI and audio files.	**Features:** • Easy to understand GUI • Built in "Beat Maker" MIDI tool • Compatible with all major plugins VST, VST3, etc. • One time license fee of $99 for basic edition
Waveform Free: The incredible features the other DAWs boast are relatively moot, as this project relies solely on MIDI capability. A completely open-source option should be able to get the job done just as well; Waveform Free is a fantastic example. The 12th edition of this software allows for multitrack audio and MIDI mixing; with an easy to understand GUI and window layout	**Features:** • 3rd party plugin compatibility • Onboard MIDI libraries and editing tools • Allows for optional expansion packs @ $50 each

Software selection

Table 3.20: Features comparison

	Tensorflow	Pytorch	MCT
Has toolkit for embedded conversion	✓	✓	✗
Supports CUDA	✓	✓	✓
Supports CPU	✓	✓	✓
Supports OpenCL	✓	✓	✗
Supports OpenGL	✗	✓	✗
Best Ease of Use	✗	✓	✗

Software selection

Table 3.21: ASR vs LLM/SLM vs TTS

Pipeline Module	Criteria	Model Type
ASR	Highest Quality	Transformer
	Cheapest	HMM
	Best Cost-to-Performance	CNN for feat. extraction and transformer for modeling
LLM or SLM	Highest Quality	Transformer
	Cheapest	LSTM
	Best Cost-to-Performance	Transformer + LSTM
TTS	Highest Quality	Transformer
	Cheapest	GAN
	Best Cost-to-Performance	Transformer

Table 3.22: tradeoff

Name/Value	**Whisper-Small**	**Wav2Vec2-Large-960 h**
Size on disk (MB) [Minimize]	483.6	1262
Size during compute (GB) [Minimize]	0.976	1.484
WER (%) [Minimize]	3.54 (clean+dirty)	1.7 (clean) and 2.925 (clean+dirty)

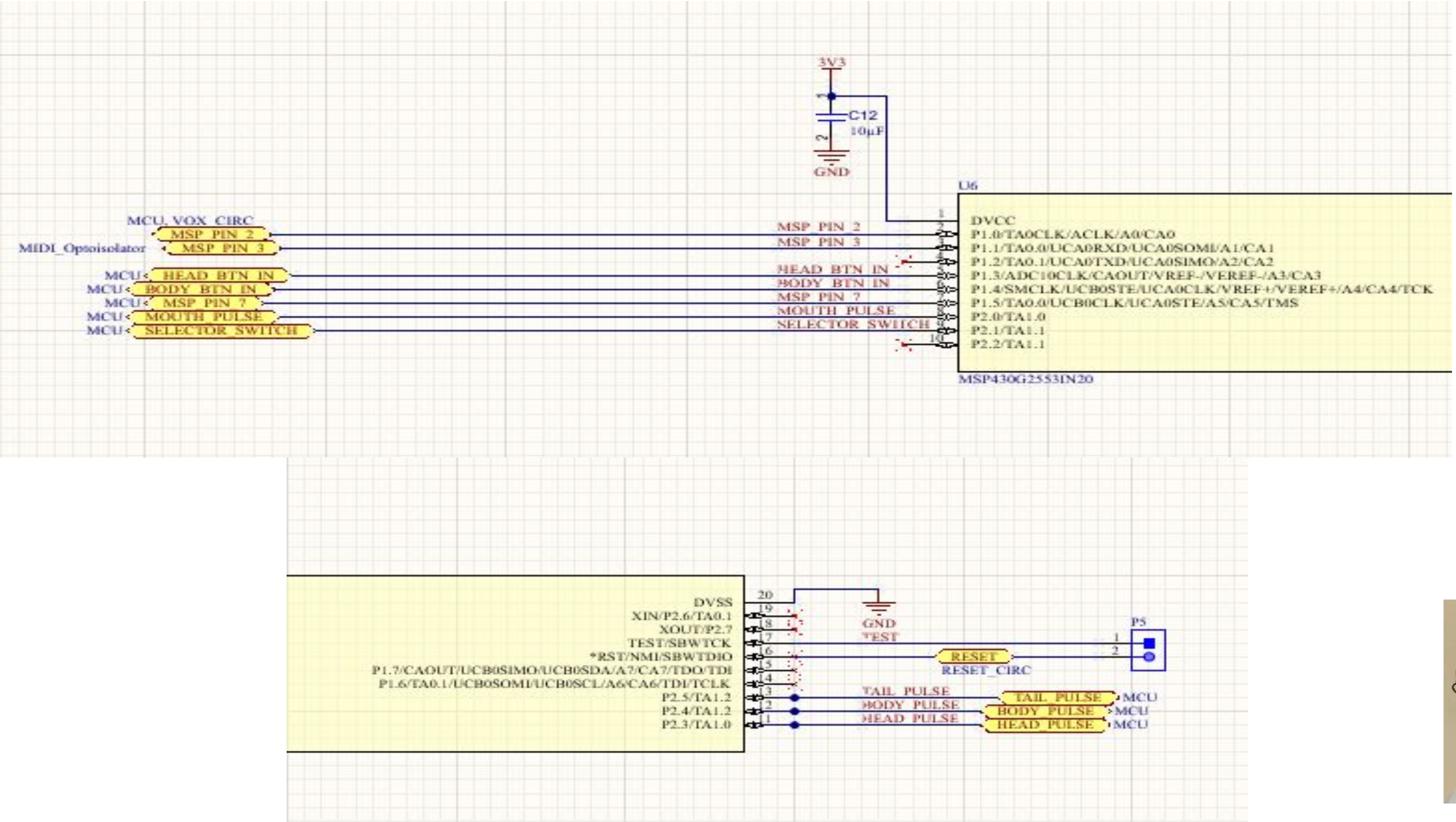
Software selection

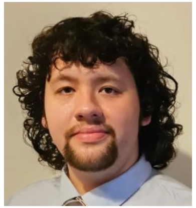
Table 3.23: Model comparison

Model Name	Size During Compute 4-bit quantized (GB)	Context size (tokens)	MMLU Score (%)	Open-Source
Mistral 7B Instruct	7GB	8192*	60.1	✅
Meta's Llama 2 7B	7GB	4096	45.3	✅
Meta's Llama 7B	7GB	4096	35.1	✅
OpenAI's ChatGPT 3.5 Turbo	N/A	16384	70.0	❌

Device	Capacity (GB)	Price ($)	Read/Write Speed (MB/s)
Lexar 128GB Micro SD Card, microSDXC	128	14.41	100/30
SanDisk Ultra 32GB UHS-I/Class 10 Micro SDHC Memory Card	32	9.26	100/48
SAMSUNG EVO Select Micro SD-Memory-Card	256	22.99	130/130

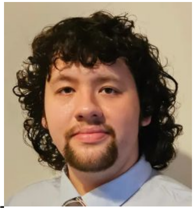
MCU chip connections

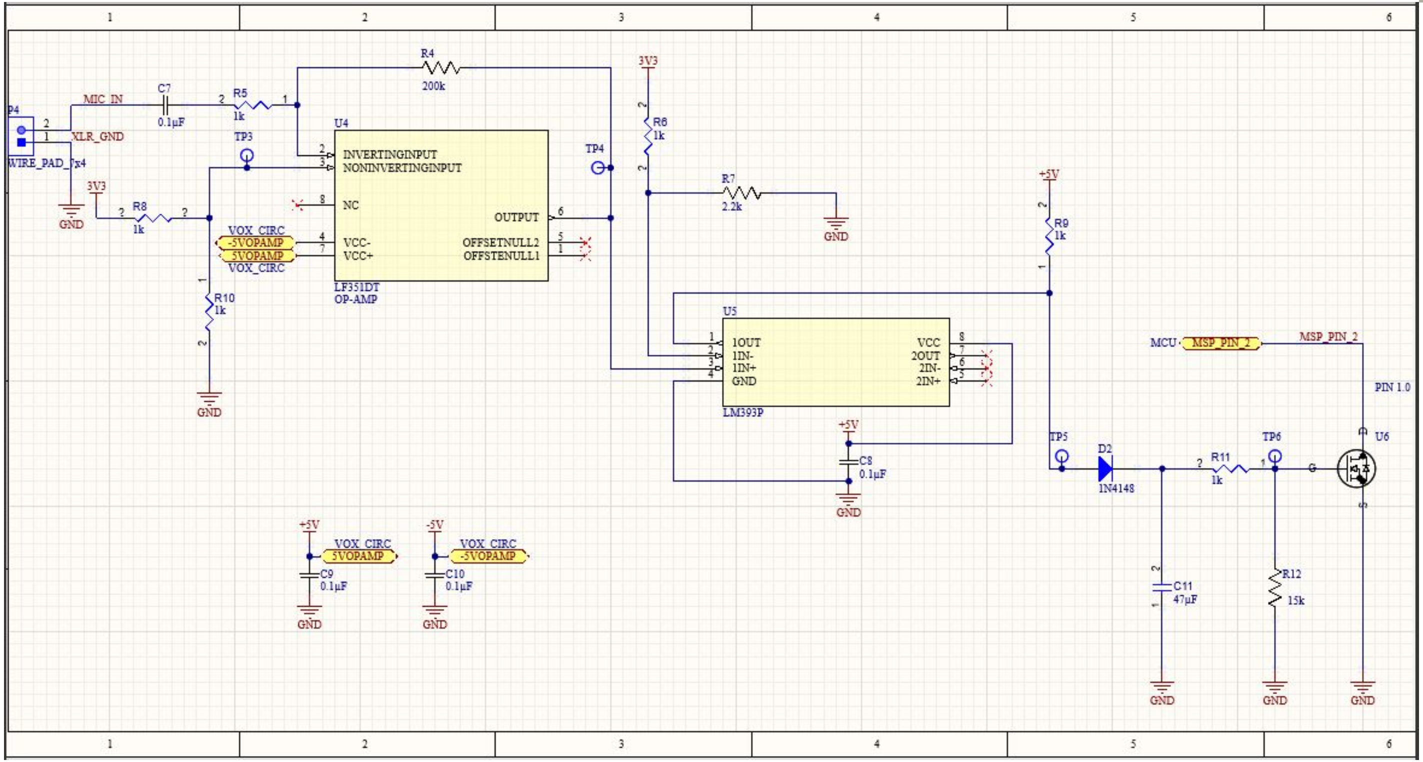




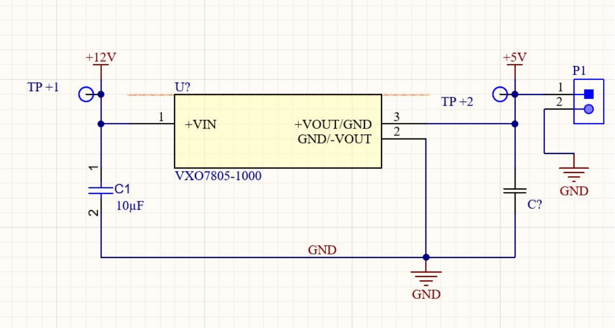
Ham Radio VOX Circuit

Voice activated switch for hands free mouth actuator movement and voice response board voice detection.

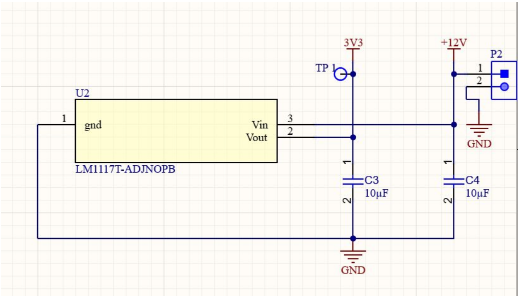




Voltage Regulator Circuits

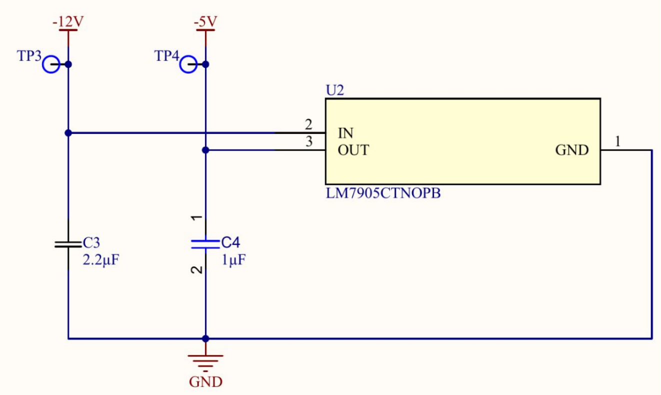


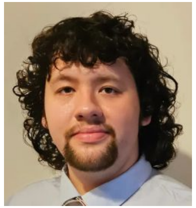
+5V regulator using the VXO7805

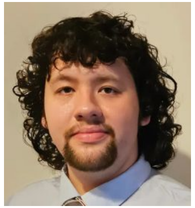


+3.3V regulator using the LM1117

-5V regulator using the 7905







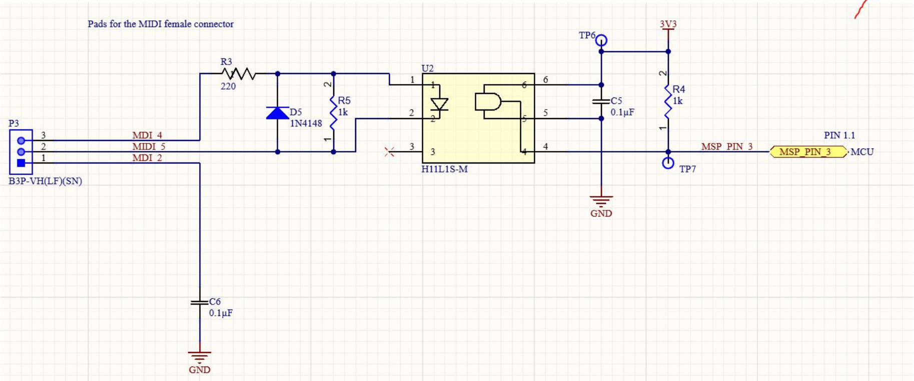
MIDI Optocoupler

UART communication

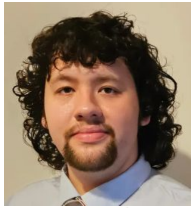
Controls movements with familiar standardized language

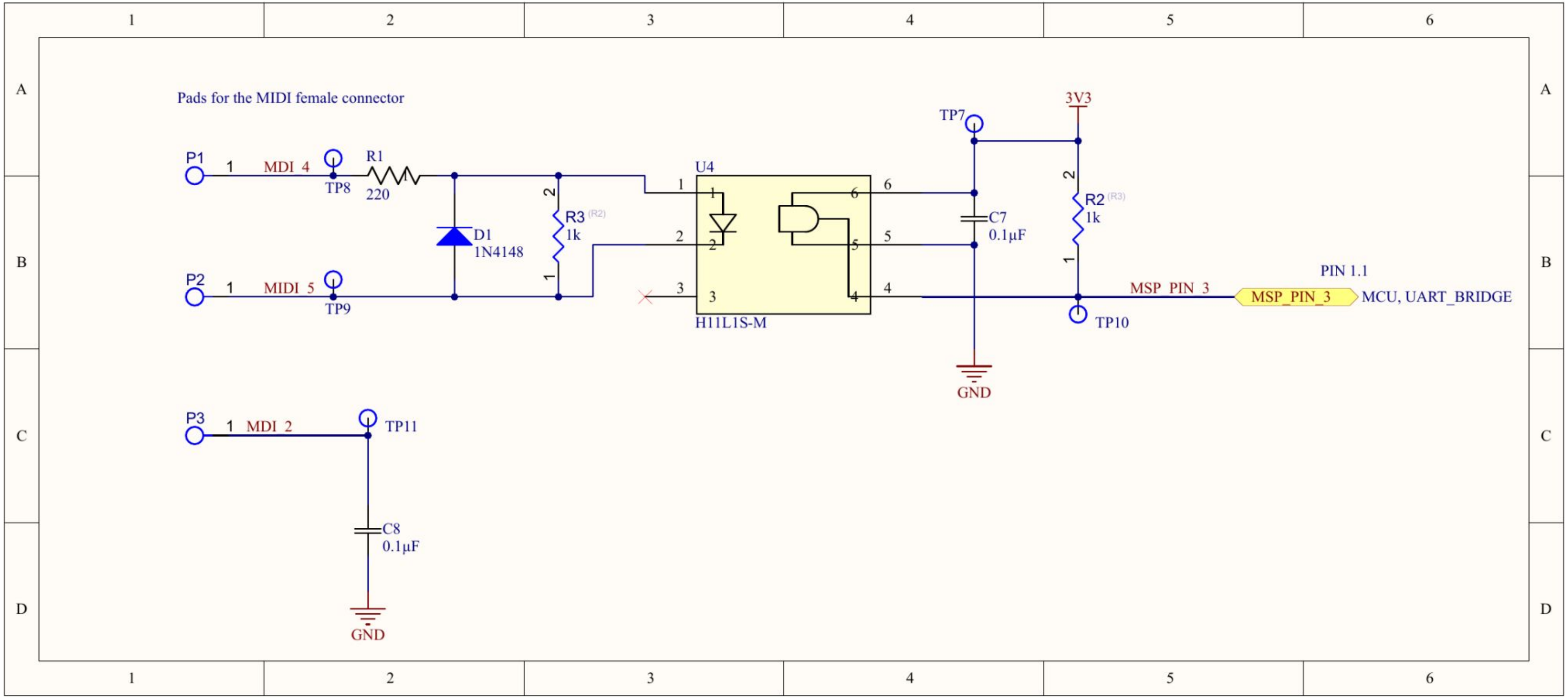
Does not require complete synchronization between devices

Easily implemented

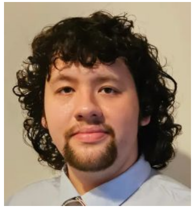


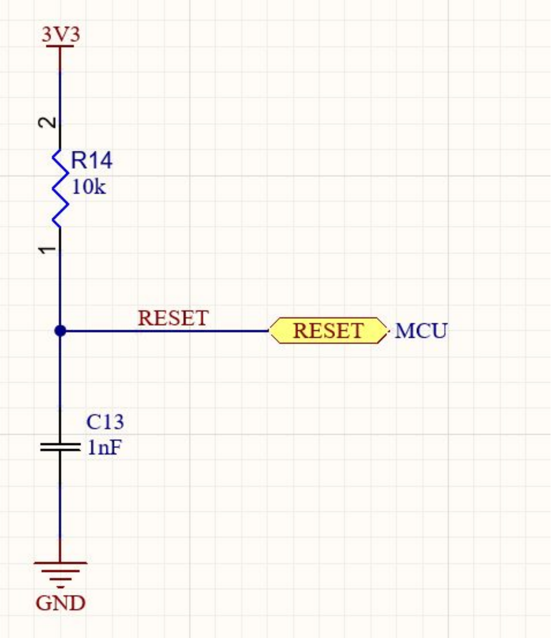
UART optocoupler circuit



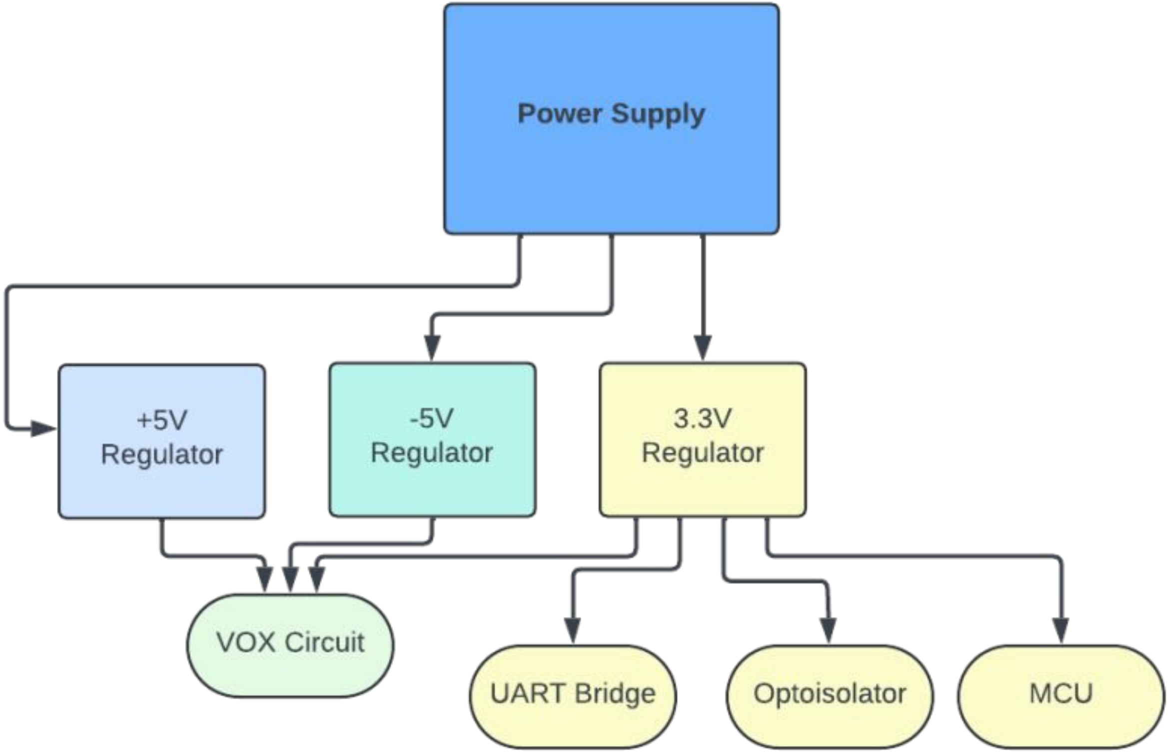


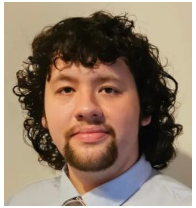
Reset circuit





Switching Power Supply – 12V



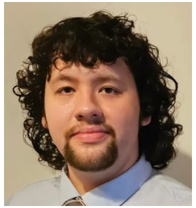


Voltage Regulator

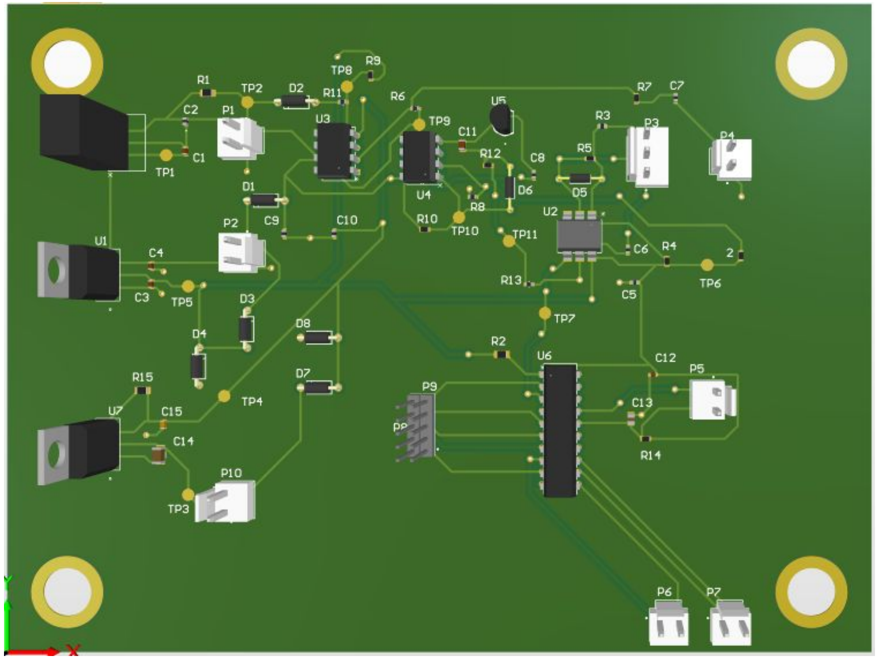
Capacitor Values

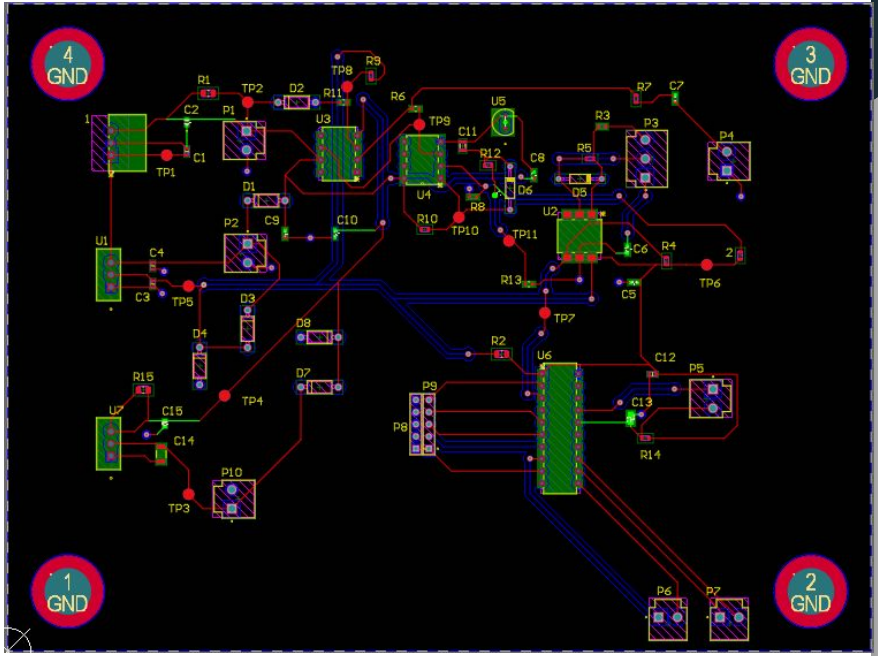
Chip	Input Shunt Capacitor	Output Shunt Capacitor
LM1117T-3.3	10uF	10uF
VXO7805	10uF	22uF
7905	2.2uF	1uF

- Provides voltages for the MCU and IOCB peripherals
- Multiple circuits used to prevent overheating from current
- Powered directly from the 12V power supply



First PCB layout

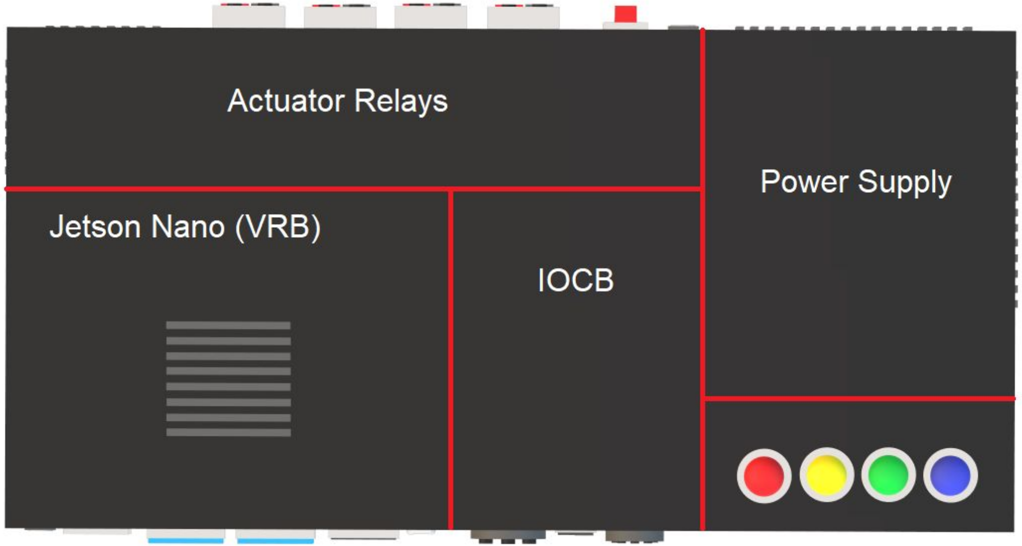




Chassis Layout

- Stores the IOCB, VRB, actuator relays, and DC power supply in one location
- Protects circuit boards
- Support structure

Potential Layout



UCM – Unified Conversational Module

Conversation is enabled via mode select and allows CAPER to respond to user speech while moving according to features of response audio.

Two main parts:

- Edge – VRB
- Cloud – Server

Voice Response Board

NVIDIA Jetson Nano

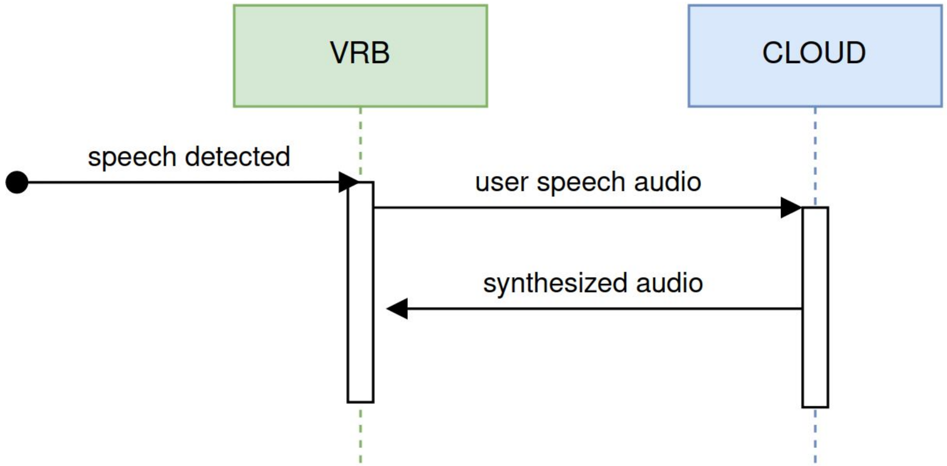
- Superior processing speed
- Greater I/O bandwidth
- IO Pins which allow for dynamic interaction with the other boards

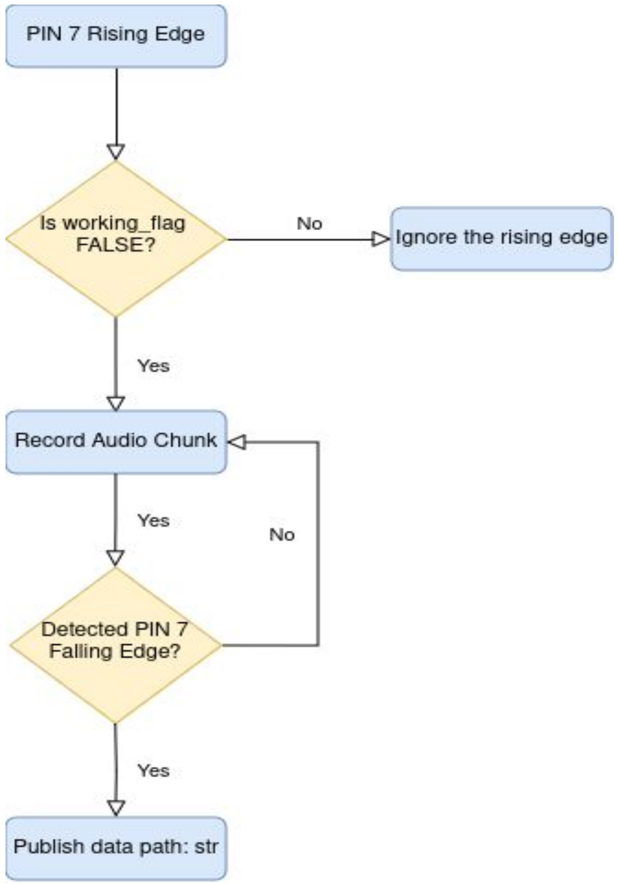
Edge VRB Software

Function:

- Communicate via a socket to a linux server running the AI system in real time
- Create movement commands for CAPER based on the mel spectrogram of the received audio

The main objective of the software is to allow the VRB to detect audio, send audio to cloud, and receive audio back to broadcast via while also creating movement commands.


VRB
CLOUD
speech detected
user speech audio
synthesized audio


PIN 7 Rising Edge
Is working_flag FALSE?
No
Ignore the rising edge
Yes
Record Audio Chunk
Yes
No
Detected PIN 7 Falling Edge?
Yes
Publish data path: str

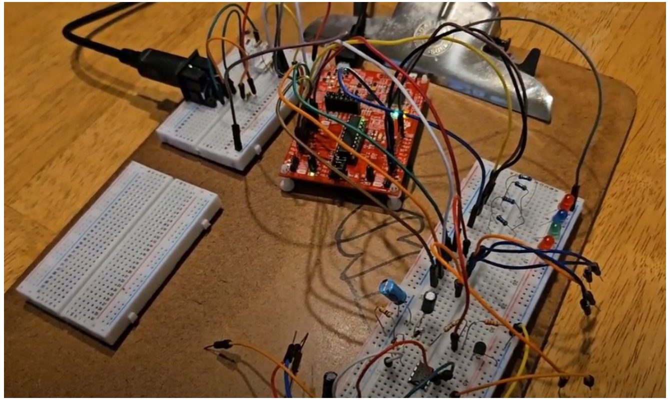
Cloud Server Software

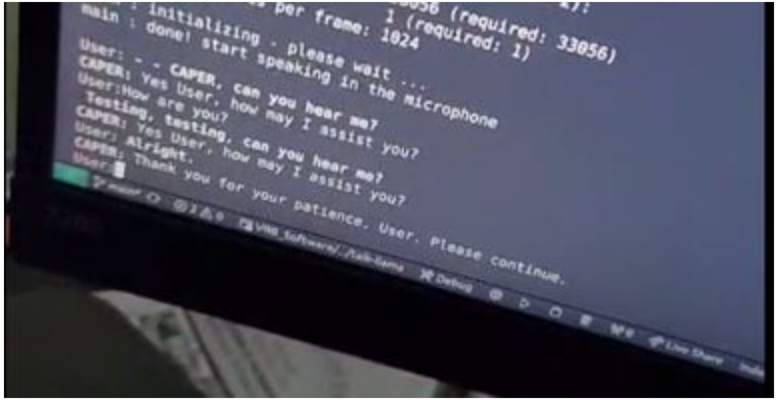
Pipeline with three AI systems:

- Whisper Small | User Speech -> Text
- Mistral 7B Instruct 4-bit | Text -> Response Text
- SpeedySpeech | Response Text -> Response Audio

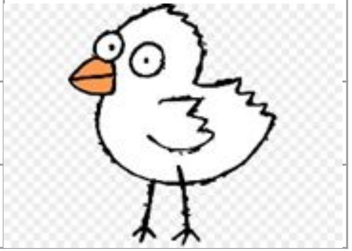
Talks to the VRB via a websocket receives User Speech and responds with Response Audio

Prototyping





Work Administration table

Task	Primary	Secondary
AI implementation	Paco	Kellen
Embedded systems	Billy	Sarah
Circuits	Billy	Kellen
PCB Design	Kellen	Paco
Documentation	Sarah	Everyone
Organization	Sarah	
Construction	Sarah	
Project Lead	Billy	

Current Progression

Completed circuits

Completed PCB design

Frame built

MIDI tested and functioning

Server Software nearly complete

VRB Software nearly complete

VOX circuit update in progress

Milestone Chart

Progress	Percentage	Visual Representation
Research	90	IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
Design	85	IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
Parts Acquisition	50	IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
Software	60	IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
Testing	70	IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
Overall	60	IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII

Remaining Tasks

Order PCB Design

Complete and test code

Transfer code on boards

Putting all the hardware together

Building the shell of the parrot

Budget (pg 1 of 2) – mechanical materials not included

Progress	Percentage	Quanitity	Unit Costs
volt regulator	LM7805CT	1	$1.87
volt regulator	LM7905CT	1	$1.61
volt regulator	LM1117T-ADJ	1	$1.19
microcontroller	MSP430G2553IN20	1	$2.81
optoisolator	H11L1SMIS-ND	1	$1.04
op amps	LF351DT	2	$1.06
Solenoids	f190412ae059347	4	$12.25

Budget (pg 2 of 2) – mechanical materials not included

8x8 wooden block base	N/A	1	$12.50
Nvidia Jetson Nano	900-13448-0020-000	1	$156.88
relay modules	SRD-03VDC-SL-C	1	$9.99
microphone	SL 84C	1	$14.90
speakers	DS6500M	1	$36.99
amplifier	LP-2020AD	1	$30.00
power supply	LRS-150-12	1	$16.00
SD memory card	EVO select 256GB	1	$22.99
wifi adapter	N150	1	$10.99

Questions?