Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

Team 28:
Smart Caller ID for Landlines
Bi-Weekly Update 3

Amy Chen
Scott Kevil-Yeager
Matthew Hebrado

Sponsor: Dr. Tod Cox
TA: Rohith Kumar

Project Summary

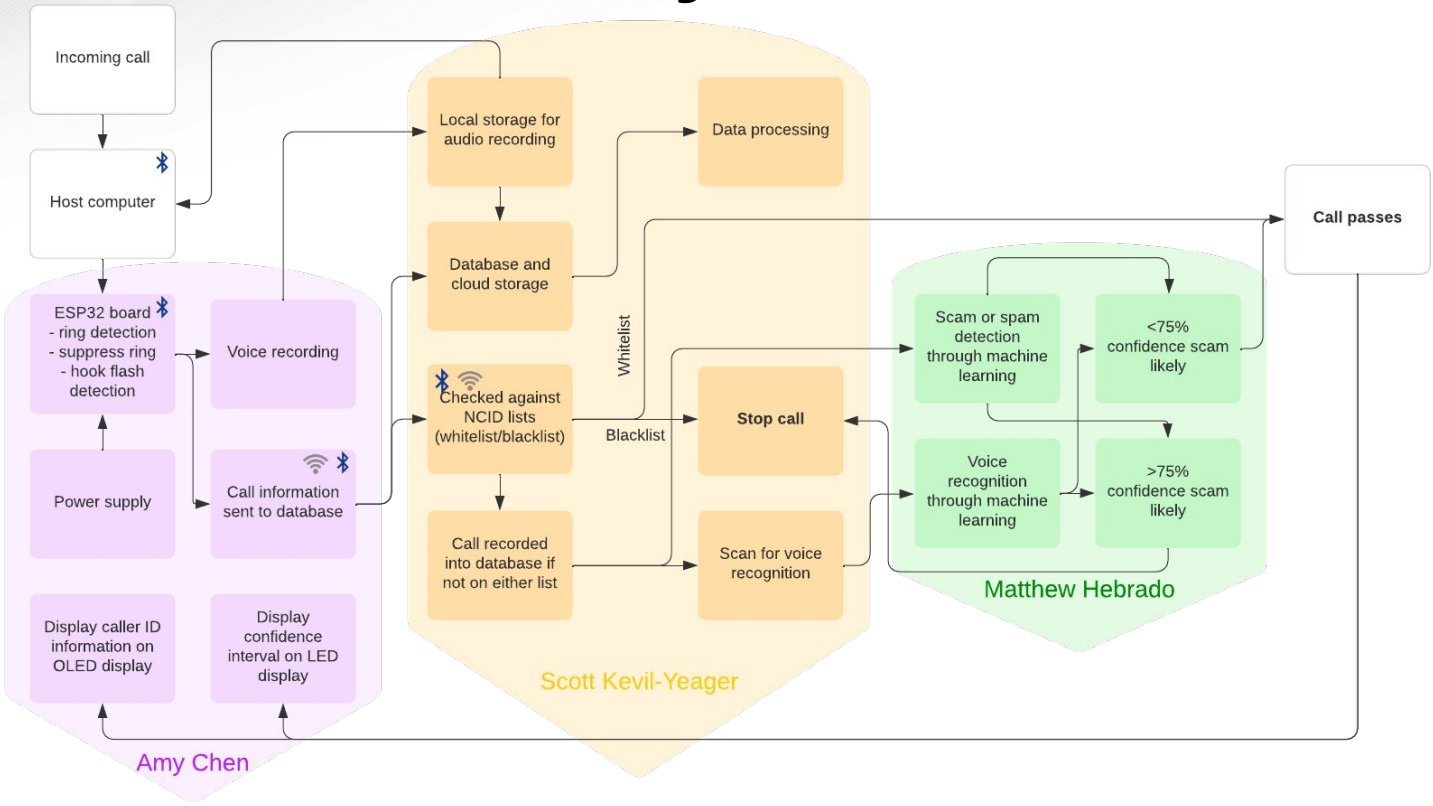
The Problem:

- In 2021, Americans lost $39.5 Billion to phone scams.
- Elderly citizens are frequently the target of scammers due to their use of landline phones.
- Scams can last for months before a relative becomes aware.

Our project:

- Helps avoid being scammed by using voice signature matching to detect impersonation scammers.
- Captures and records call data (caller ID, date/time,etc.) useful to authorities should a user fall prey to a scam.
- Integrates and augments NCID, an open source Caller ID notification program with >100K installed base

Subsystems


Incoming call
Host computer
ESP32 board
- ring detection
- suppress ring
- hook flash
detection
Voice recording
Power supply
Call information
sent to database
Display caller ID
information on
OLED display
Display
confidence
interval on LED
display
Amy Chen
Local storage for
audio recording
Data processing
Database and
cloud storage
Checked against
NCID lists
(whitelist/blacklist)
Whitelist
Blacklist
Stop call
Call recorded
into database if
not on either list
Scan for voice
recognition
Scott Kevil-Yeager
Call passes
Scam or spam
detection
through machine
learning
<75%
confidence scam
likely
Voice
recognition
through machine
learning
>75%
confidence scam
likely
Matthew Hebrado

Project Timeline

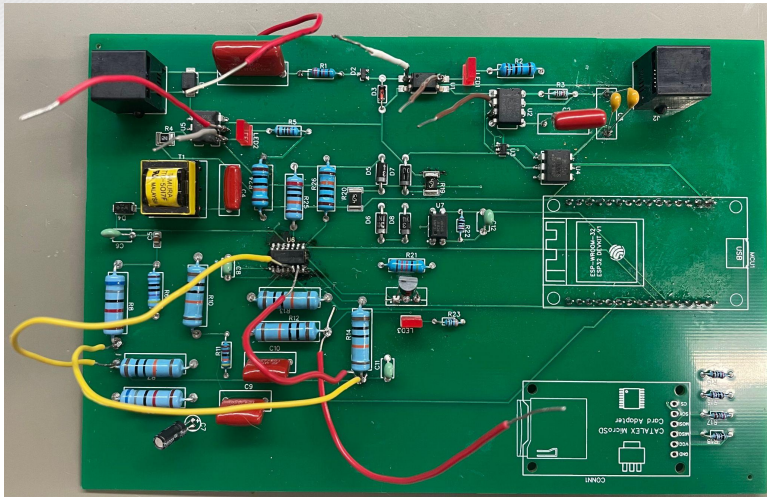
	8/31	9/7	9/14	9/21	9/28	10/5	10/12	10/19	10/26	11/2	11/9	11/16	11/23	11/30	Team Member	
Verify Hardware Subsystems															Amy	Key
Verify Database Subsystems															Scott	Ongoing
Verify ML Subsystems															Matthew	Complete
PCB assembly															Team	Planned
Database and ML Subsystem Integration															Team	Behind
Hardware and Database Subsystem Integration															Team	
Debugging and Validation															Team	

Hardware Subsystem

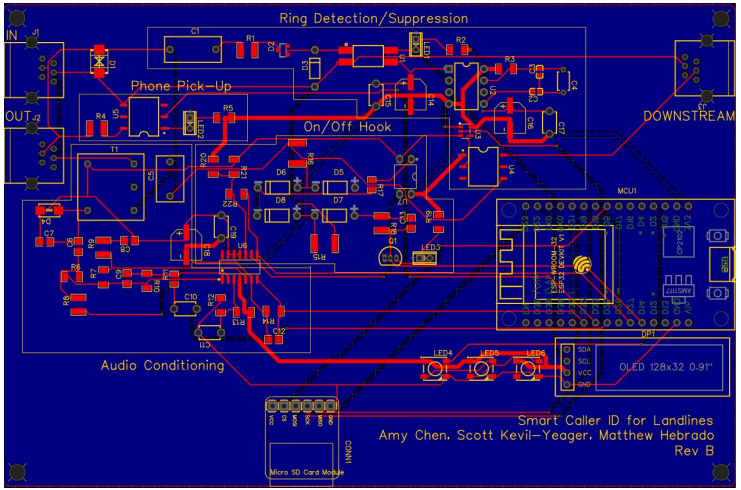
Amy Chen

Accomplishments since last presentation 65 hrs of effort	Ongoing progress/problems and plans until next presentation
• Tested, debugged, and reworked PCBs. • Made edits to PCB layout. • Made edits to schematic. • Added CID/CWID detection into MCU code.	Ongoing progress: • Order 2nd PCB • Add DTMF key detection to MCU code. • Begin integration with Scott's voice recording Problem: • Might have shorted power supply and ground on one PCB board.

Hardware Subsystem



New PCB Layout

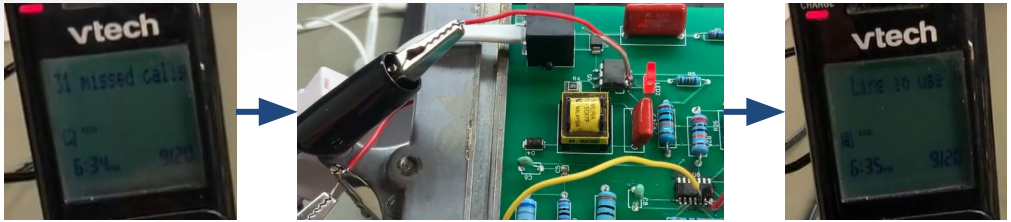


Edits to PCB:

- Cut traces and lifted pins on IC chip.
- Reconnected pins using jumper wires.
- Switched MOSFET from IRF530PBF to 2N7000

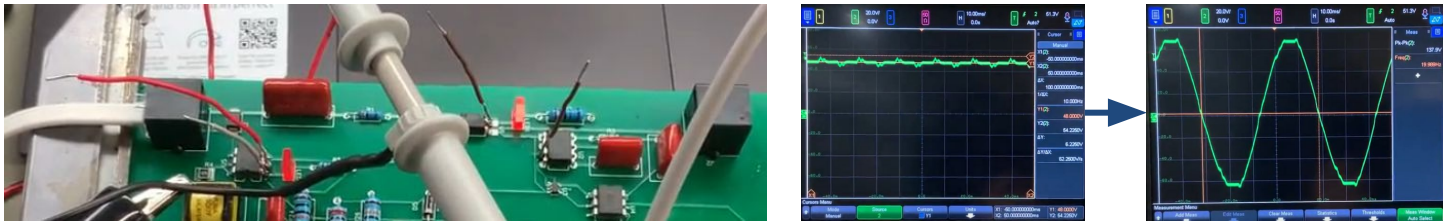
Hardware Subsystem

Phone Pick-up Subcircuit



LED2 lights up when phone pick up in detected -> line use to “in use”

Ring Detection/Suppression Subcircuit



LED1 lights up/flickers when ringing is detected

*Initial ring is suppressed when FirstRing pin on MCU is HIGH

Hardware Subsystem

On/Off Hook Detection Subcircuit

On hook, ringing

On hook, silence

Off hook detected

Off hook

Hook flash detected

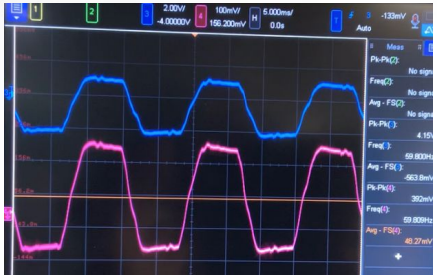
Off hook

On hook detected

Hardware Subsystem

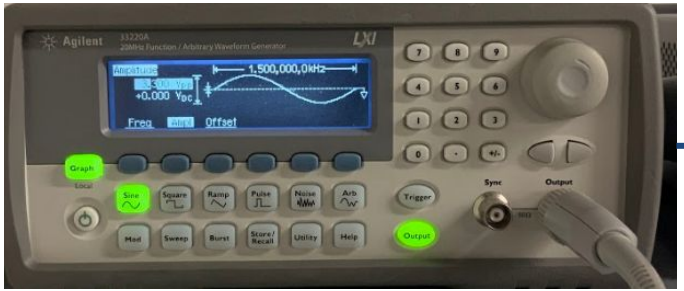
Audio Conditioning Subcircuit

Audio out from phone to ADC1 pin

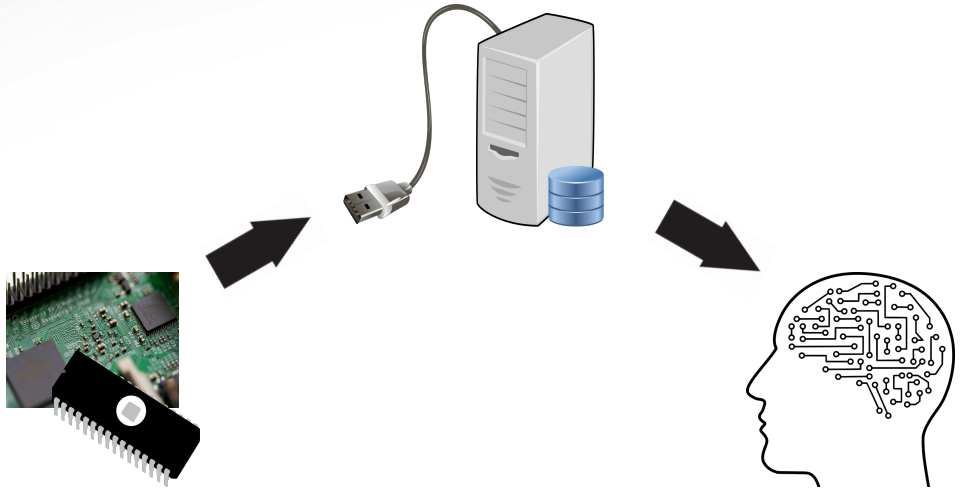


Blue: Phone
Purple: ADC1

Audio in from the DAC1 pin to phone



Database and Data Processing Subsystem Overview



The database and data processing subsystem acts as a bridge between the hardware and machine learning subsystems

The ESP32 sends that data through serialized JSON packets to the host computer where it is decoded and audio data is sent to the database to be stored

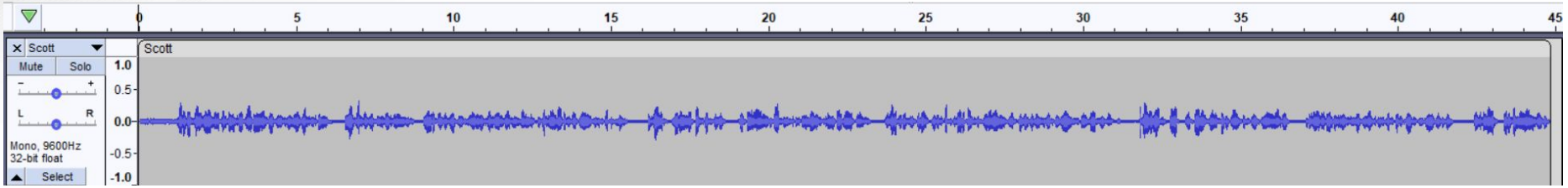
Database and Data Processing

Scott Kevil-Yeager

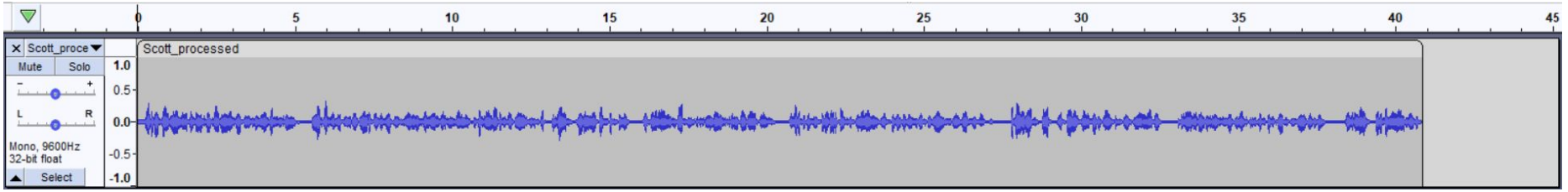
Accomplishments since previous presentation	Ongoing progress/problems and plans until next presentation
• Integration with Matthew • Re-soldering and replacing microphone for clearer audio data • Improved audio splitting for silence removal • Improved audio recording function • Helped with PCB testing	• Integration with NCID gateway protocol • Integration with Amy's subsystem - Directly recording audio from phone microphone through the PCB version A • Integration with Amy's subsystem - setting triggers for when to start recording audio/receive JSON audio packets

Database and Data Processing

Voice recordings through ESP32:



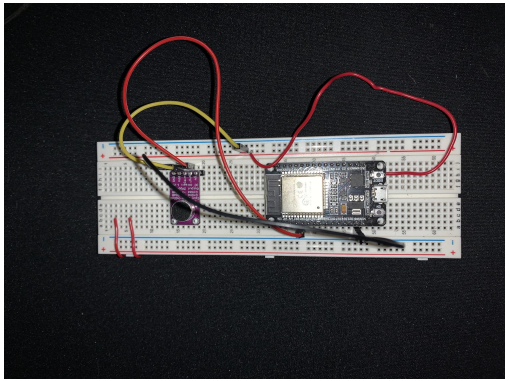
After removing silence



Database and Data Processing

Future plans:

- Finalize integration with Matthew's subsystem and begin testing to ensure proper functionality



ESP32 bread boarded microphone (new):

Additional plans:

- Create NCID gateway test files for final release
- Continue commenting and documenting code for a README file at the end of the semester
- Dynamically configurable settings
- Playing audio through DAC (fax tone)
- Handshake between host PC and ESP32

Machine Learning

Matthew Hebrado

Accomplishments since previous presentation 18 hrs of effort	Ongoing progress/problems and plans until next presentation
• Optimized the file organization to improve runtime • Began integration with Scott ○ Manually working with files he creates • New training files to closer match what would be recorded from the landline handset	• Receive and send files to the database with code • Improve the matching percentages on the new training files • Help debug silence removal code

Machine Learning

Figure 1: Without organized file path

```
Calculating Averages:
Testing Amy's Files:  96.9047619047619
Testing Scott's Files:  82.51851851851852
Testing Matthew's Files:  91.71666666666667
```

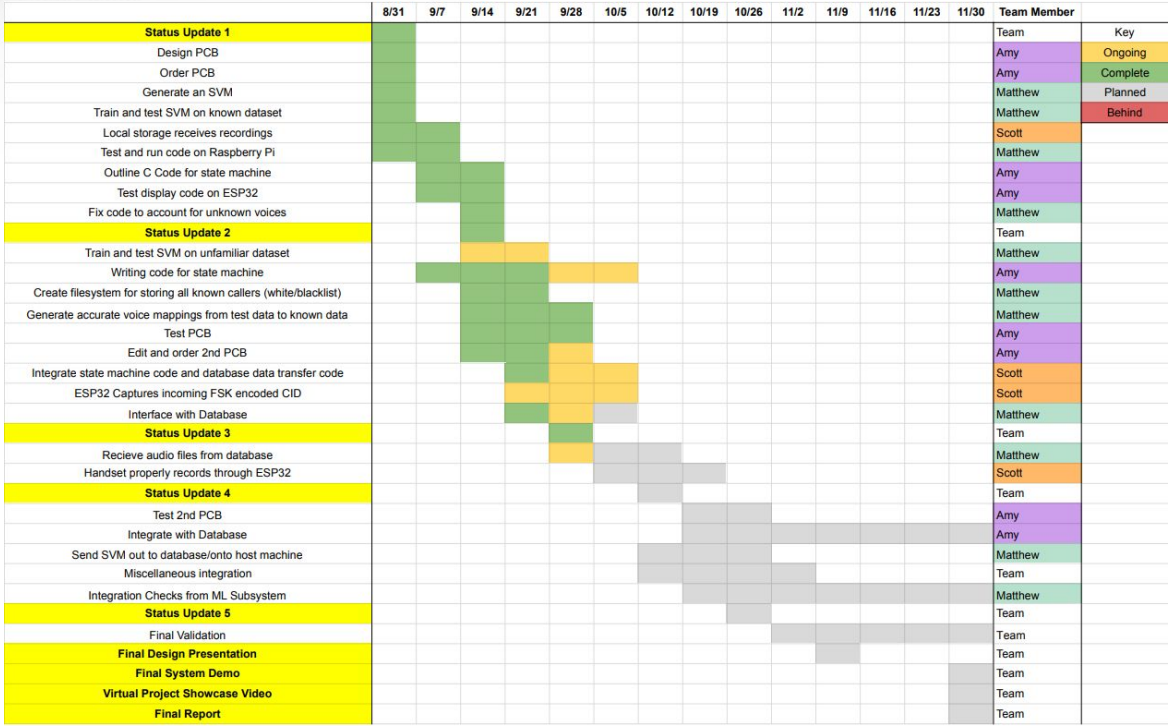
Figure 2: With organized file path

```
Calculating Averages:
Testing Amy's Files:  96.82926829268293
Testing Scott's Files:  84.24528301886792
Testing Matthew's Files:  93.40677966101696
```

Parts Ordering Status

Name	Status	Name	Status
820nF	Received	604Ω	Received
100nF	Received	620Ω	Received
4.7uF	Received	470Ω	Received
100pF	Received	100kΩ	Received
0.33uF	Received	68kΩ	Received
MicroSD Card Adapter	Received	43kΩ	Received
TISP4350H3BJR-S	Received	10kΩ	Received
BZX84B33VLYT116	Received	4.7MΩ	Received
1N4148	Received	40.2KΩ	Received
SMAJ5.0CA-E3/61	Received	3.3kΩ	Received
1N4004-T	Received	100kΩ	Received
0.91_OLED_128x32	Received	200kΩ	Received
DS1133-S60BPX	Received	TTC-5017F	Received
TJ-L257FGHRMFCSFLC2R-A5	Received	LTV-817S-TA1	Received
WS2812C/W	Received	LMC555N	Received
IRF530PBF	Received	SN74LV1T08DBVR	Received
ESP-WROOM-32 DEVKIT V1	Received	PLA192STR	Received
22KΩ	Received	PC817X3NSZ9F	Received
1KΩ	Received	LMV824M/TR	Received
10.7KΩ	Received	PCB	Received

Execution Plan



	8/31	9/7	9/14	9/21	9/28	10/5	10/12	10/19	10/26	11/2	11/9	11/16	11/23	11/30	Team Member
Status Update 1															Team
Design PCB															Amy
Order PCB															Amy
Generate an SVM															Matthew
Train and test SVM on known dataset															Matthew
Local storage receives recordings															Scott
Test and run code on Raspberry Pi															Matthew
Outline C Code for state machine															Amy
Test display code on ESP32															Amy
Fix code to account for unknown voices															Matthew
Status Update 2															Team
Train and test SVM on unfamiliar dataset															Matthew
Writing code for state machine															Amy
Create filesystem for storing all known callers (white/blacklist)															Matthew
Generate accurate voice mappings from test data to known data															Matthew
Test PCB															Amy
Edit and order 2nd PCB															Amy
Integrate state machine code and database data transfer code															Scott
ESP32 Captures incoming FSK encoded CID															Scott
Interface with Database															Matthew
Status Update 3															Team
Recieve audio files from database															Matthew
Handset properly records through ESP32															Scott
Status Update 4															Team
Test 2nd PCB															Amy
Integrate with Database															Amy
Send SVM out to database/onto host machine															Matthew
Miscellaneous integration															Team
Integration Checks from ML Subsystem															Matthew
Status Update 5															Team
Final Validation															Team
Final Design Presentation															Team
Final System Demo															Team
Virtual Project Showcase Video															Team
Final Report															Team

Key
Ongoing
Complete
Planned
Behind

Validation Plan

Validation Plan

Test	Detail	Data	Status	Responsible Student
Device powers on	Turns on Raspberry Pi and ESP32	Turns on	Complete	Amy Chen
Display powers on	Displays caller ID information		Complete	Amy Chen
Ring detect	LED1 lights up when detection occurs	48 V DC to sine wave	Complete	Amy Chen
Ring suppress	Initial ring is suppressed		Complete	Amy Chen
Phone pick up	LED2 lights up	LED lights up when CAL* is grounded	Complete	Amy Chen
Audio Conditioning Out	Phone audio to ADC1 pin		Complete	Amy Chen
Audio Conditioning In	DAC1 pin to audio		Complete	Amy Chen
Detect off-hook/on-hook	LED3 lights up when detection occurs		WIP	Amy Chen
Detect hook flash on ESP32	Detect hook flash in firmware		WIP	Amy Chen
Arduino IDE	Set up Arduino IDE		Complete	Amy Chen
Decode CID/CWID on ESP32	Decode CID/CWID information in firmware		WIP	Amy Chen
Decode DTMF and FSK on ESP32	Decode DTMF and FSK in firmware		WIP	Amy Chen
OLED program	Code for OLED display		Complete	Amy Chen
WS2812B program	Code for LED light		Complete	Amy Chen
Control WS2812B	Test code on LED light		Complete	Amy Chen
Implement audio code on ESP32	Load code onto ESP32		WIP	Amy Chen
Retrieve file from database	The file will be in the given or created directory that the user has input		Complete	Scott Kevil-Yeager
UI works as expected, allowing users to input test folder directories	UI works as expected, allowing users to input test folder directories		Complete	Scott Kevil-Yeager
Upload folder	Files in given directory will be counted, processed, named, and uploaded to the database automatically		Complete	Scott Kevil-Yeager
Listen to recording	Properly allows the playback of recording audio through the host machine, this assumes that the host machine will have a speaker		Complete	Scott Kevil-Yeager
Error checking	If a folder directory or file directory is incorrectly given then a message is given and the user is prompted for another input		Complete	Scott Kevil-Yeager
Delete recording in database	Given a valid name the function removes a single entry from the database		Complete	Scott Kevil-Yeager
Delete local recording	If a folder path and file name are given then the function will delete the local file		Complete	Scott Kevil-Yeager
pyAudioAnalysis	Removes periods of silence in recordings to reduce file size		Complete	Scott Kevil-Yeager
Local storage receives recordings			Complete	Scott Kevil-Yeager
ESP32 Captures incoming FSK encoded CID			WIP	Scott Kevil-Yeager
Write state machine for possible states			WIP	Scott Kevil-Yeager
Handset properly records through ESP32			WIP	Scott Kevil-Yeager
Integrate with ML subsystem			WIP	Scott Kevil-Yeager
Integrate with NCID			WIP	Scott Kevil-Yeager
feature extraction on a wav file	uses pAA to do feature extraction on a wav file and prints the names of all features extracted	log of all features extracted from a given wav file	Complete	Matthew Hebrado
genereate files used to train SVM	take a source file and split it into 1 sec intervals	several wav files are produced that are 1 sec long	Complete	Matthew Hebrado
graph feature comparisons	based on the feature extraction graph is generated that displays a comparison of the two speakers		Complete	Matthew Hebrado
create SVM classification file	does feature extraction on all files in a directory and creates SVM file		Complete	Matthew Hebrado
run tests/predictions from known speakers		~80% accuracy accross the board	Complete	Matthew Hebrado
run tests/predictions from unknown speakers			WIP	Matthew Hebrado
code runs on pi		svms are generated and output is printed	Complete	Matthew Hebrado
send file to database			WIP	Matthew Hebrado
recieve file from database			WIP	Matthew Hebrado

Thank You!

Additional Data

Added in case the professor asked for additional information about a subsystem, and placed at the end to avoid cluttering preceding slides