Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

Team 36: Voice-Controlled Wheelchair Final Presentation

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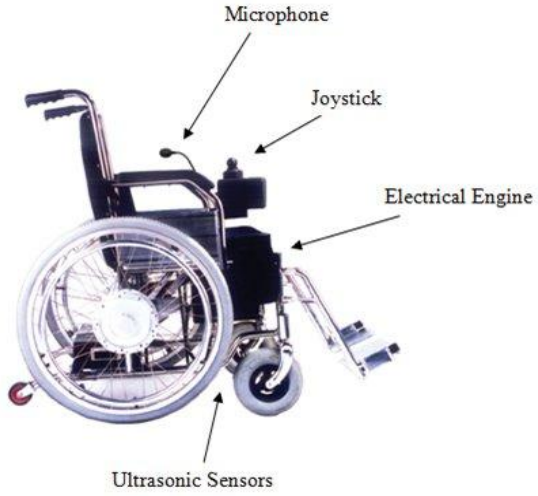
Project Summary

Problem:

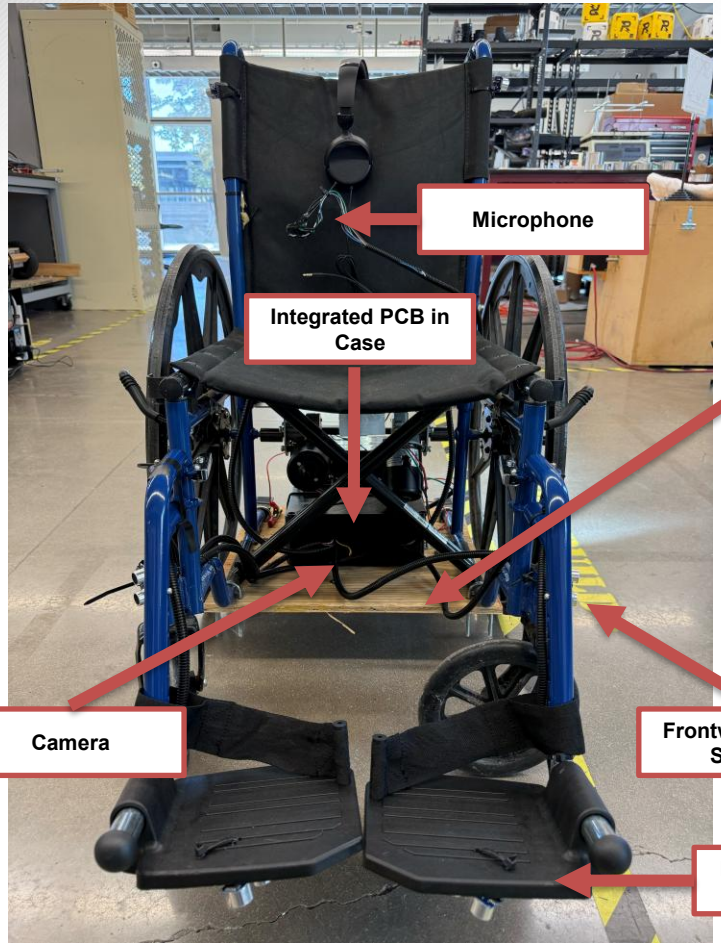
Many children who use wheelchairs face challenges operating manual controls, which can require caregiver assistance and limit independence in indoor environments.

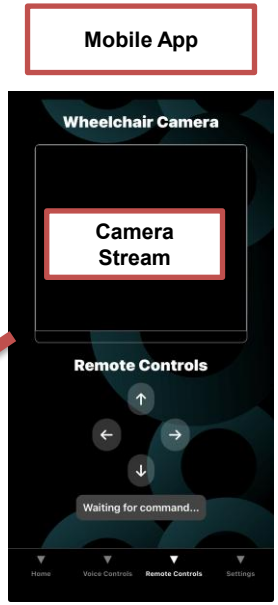
Proposed Solution:

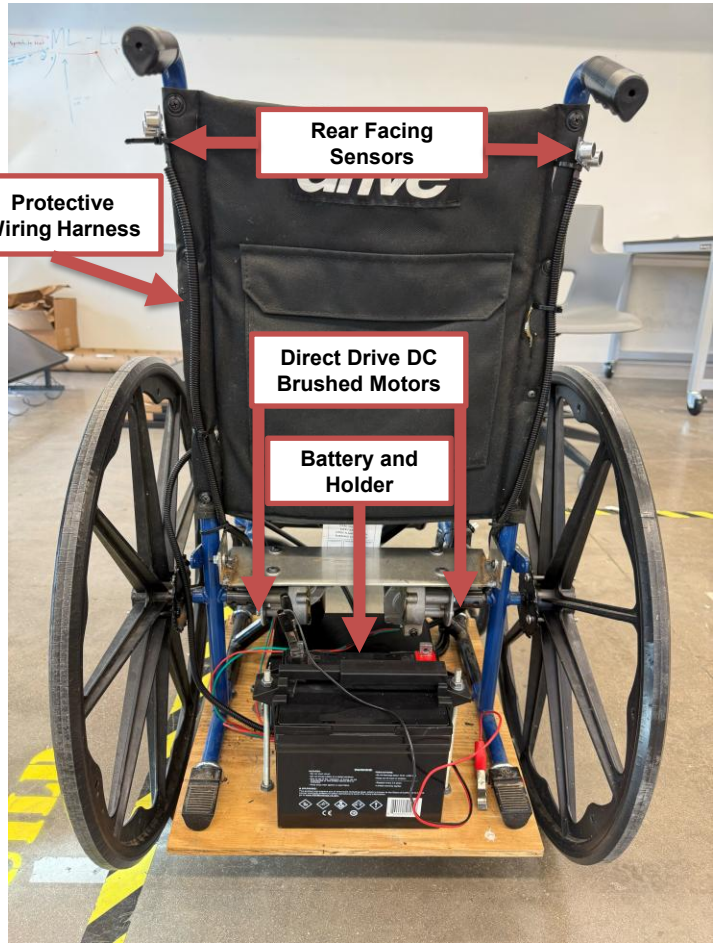
A voice-controlled navigation system enables hands-free indoor operation of the wheelchair, increasing independence, safety, and convenience for all users.



Project/Subsystem Overview

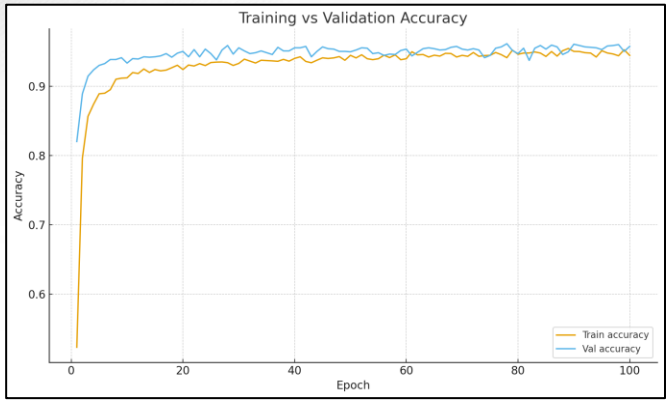






Voice Command Recognition

Saleem Joubran



	Measured	Target Specification
Validation Accuracy	96%	>90%
Validation Loss	0.17	<0.2

Live command accuracy in loud (>70dB) and quiet (<70dB) environments

	Measured	Target Specification
FAR	3.4% - 6.1%	<10%
FRR	3.5% - 9.3%	<10%

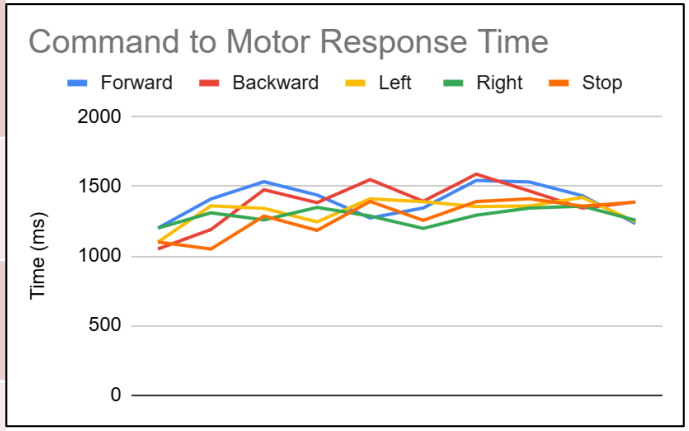
*FAR and FRR will continue to be adjusted through confidence thresholds in software

Voice Command Recognition

Saleem Joubran

Voice Command to Motor Measured Response Time

	Avg (ms)	Median (ms)	Desired Range (ms)
Forward	1394	1421	1100-1700
Backward	1383	1390	1100-1700
Left	1323	1357	1100-1700
Right	1286	1290	1100-1700
Stop	1282	1322	1100-1500
E-Stop button	200ms	205ms	<300ms



- All commands within allowable limit of when the word is spoken

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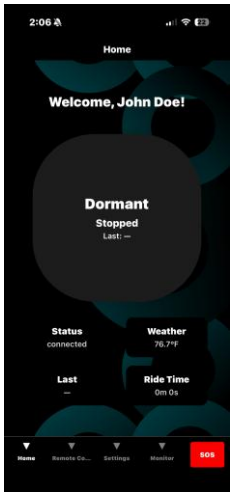
Mobile Control and Monitoring

Nishant Murali

App Design - Reliable, intuitive interface for manual wheelchair control and live monitoring

Key Design Features:

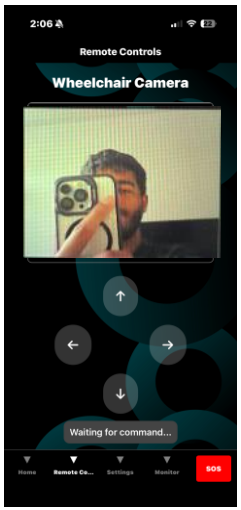
- Multi-screen UI with HTTP connectivity to the ESP32-S3 microcontroller
- Simple 4 command remote control layout and live video for situational awareness
- Emergency call function accessible within one tap

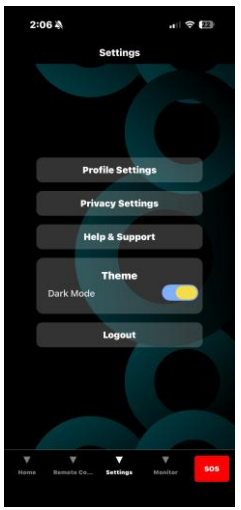


Camera Subsystem - Visual feedback for remote driver

Key Design Features:

- ESP32-CAM configured for MJPEG streaming at ~30fps over HTTP
- Tuned resolution (320x240) + compression for stable performance on low-power Wi-Fi





Mobile Control and Monitoring

Nishant Murali

Command Response Time

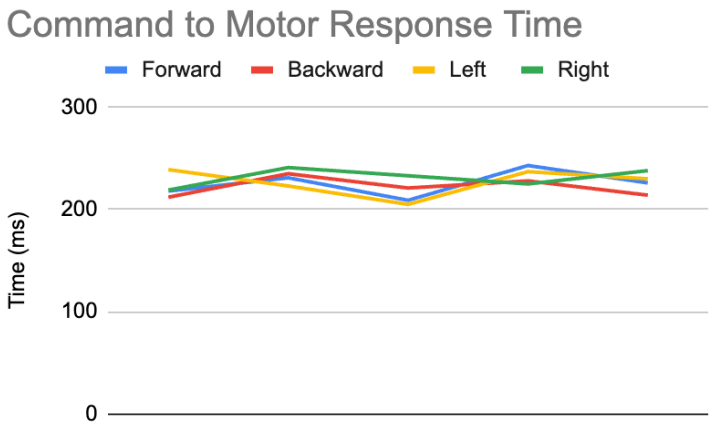
- Measured round-trip delay: app → ESP32-S3 → motor
- Tested across multiple driving commands
- Average response time: <250ms

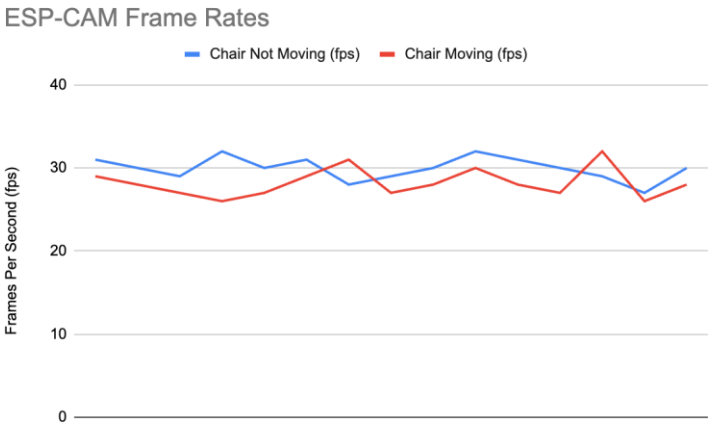
Camera Frame Rate

- Achieved 26–32 FPS consistently
- Frame rate remained stable during normal operation

Wi-Fi Range

- Tested range up to 70 yards
- Command response time did not change across the entire distance

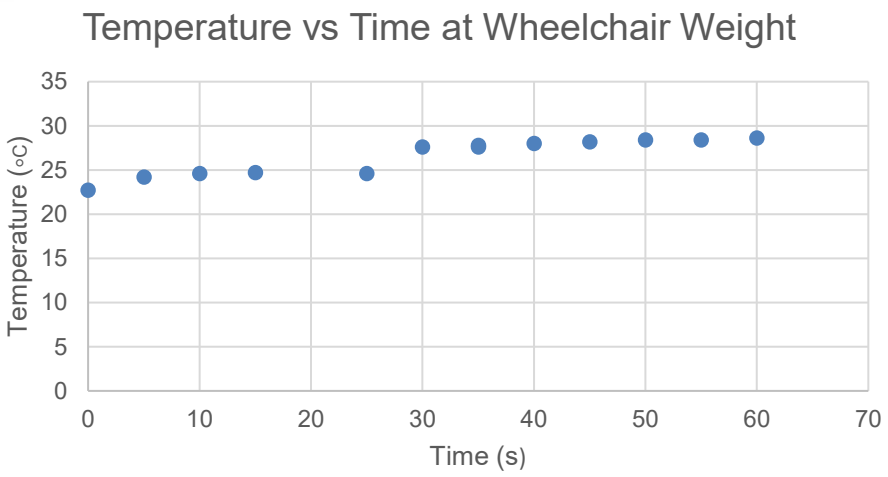


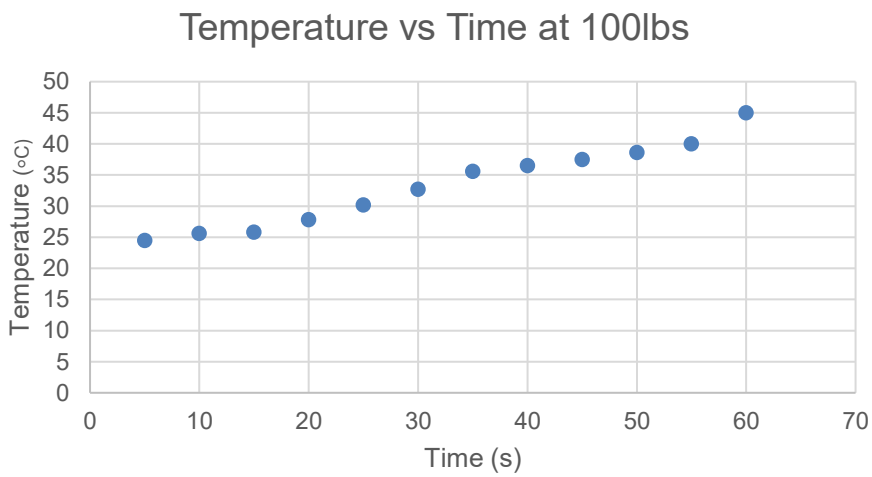


Motor Driver

Nathan Philipello

- Motor driver BJT's temperatures stay below 150 °C, even after 1 minute with 100 lb load.
- Load tests were done with weights placed on the wheelchair seat



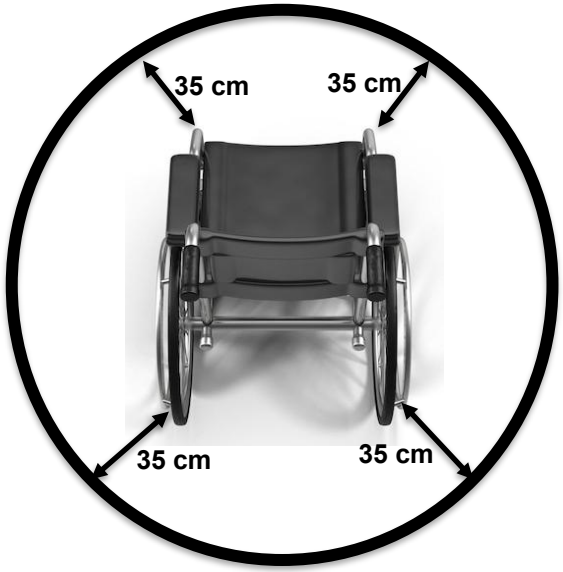


Sensors

Nathan Philipello

- All sensors were tested for stop time.
- Sensors stop the wheelchair if an obstacle is within 35 cm.
- Downward sensors stop if the detected distance is outside a 5 cm tolerance.
- Tests were conducted on various surfaces.

Sensor Number	Time to Stop (S)
1	1.07
2	1.05
3	1.02
4	0.9
5	1.15
6	1.15



Surface Type	Will it Stop?
Glass	Y
Metal	Y
Dry Wall	Y
Person	Y

Motor Driver & Sensors

Nathan Philipello

Challenges and Solutions:

Oversized Drive Shaft Coupling

- Replace with a properly sized shaft coupler that is a clamping (split-collar) type for improved securement over set-screw design.

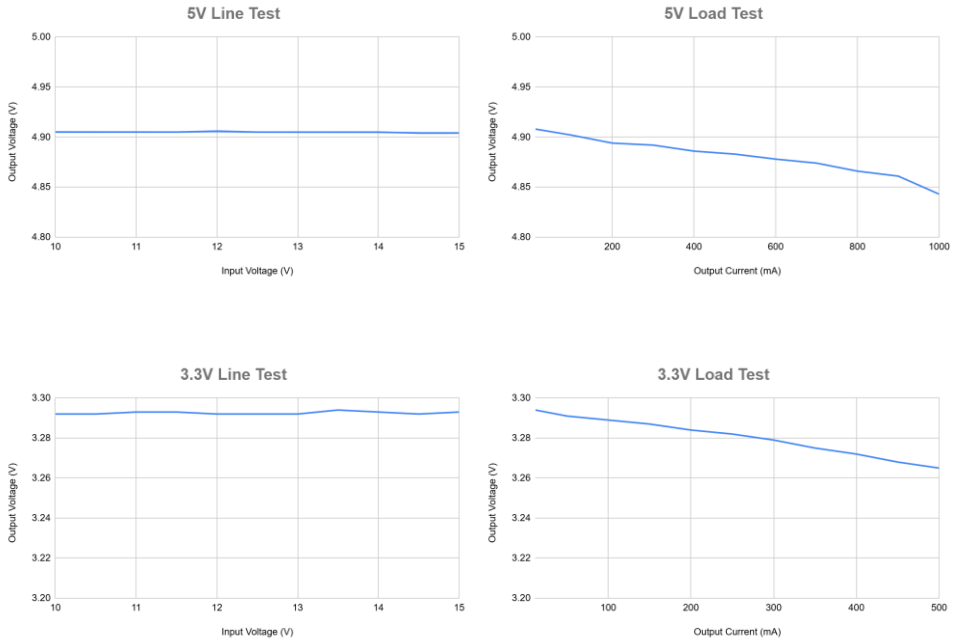
Sensors Responding Too Slowly

- Optimize timing in the control code to increase sensor polling frequency, allowing for faster cycling and improved responsiveness.

Power

Juan Alcala

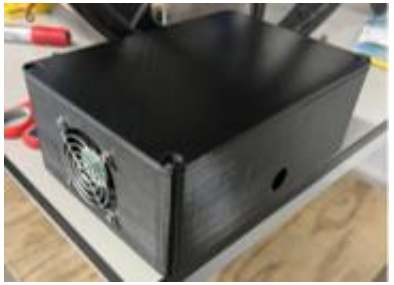
- 3.3V supply pin on the ESP32 was temporarily used in place of the 3.3V converter
  - Discovered a manufacturing defect on the board, 3.3V buck fully functional and reinstated
- Converter load and line testing is satisfactory; results of testing are shown on the right

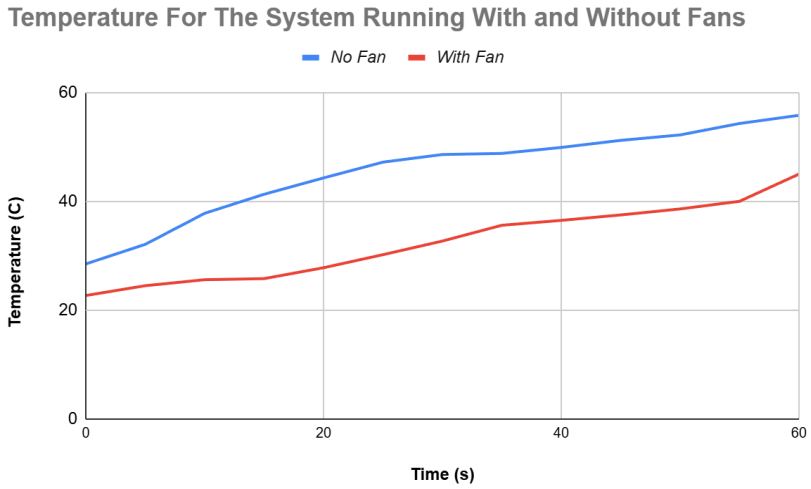


Power

Juan Alcala

- Motor driver components were running hot, 55 C at the end of the testing period
  - Cooling fan on enclosure helped cool electrical components down to 22 - 40 C
  - Tested wheelchair on a slight incline while operating with a 100lb load





- The enclosure promotes good airflow; clear path between intake and exhaust fans

Integrated System Results

Scenario	Criteria	Result
Obstacle Avoidance (Crowd)	Sensors stop wheelchair within 6 inches of obstacle	Success rate of stopping in crowd
Complete System Failure	If voice commands, sensors, and app do not respond, E-stop overrides the system	E-Stop stops motors in ~200ms
Voice Command Accuracy (Noisy environment)	Voice commands respond with an >80% accuracy	82% accuracy when noisy
App Takeover	If caretaker does not have view of the wheelchair, can remote into camera.	App response time <250 Camera provides ~30 FPS
Ramp	Handles 5° inclines, maintaining safe thermal performance under 150 °C	Can travel up ramp at 2 mph

Conclusions

Changes from CONOPS:

- Weight limit reduced from 200 lbs. to 100 lbs.
- Heatsinks and fans have been added onto the PCB
- A digital microphone with a built in ADC instead of analog
- The control app now utilizes Wi-Fi connectivity instead of Bluetooth
- A user accessible emergency stop button has been added
- Got rid of the “Unknown” class in the model

Current Status:

- Integration complete
- Validation testing to be completed in 1 week