

Vehicle Occupancy Detection System

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Introduction

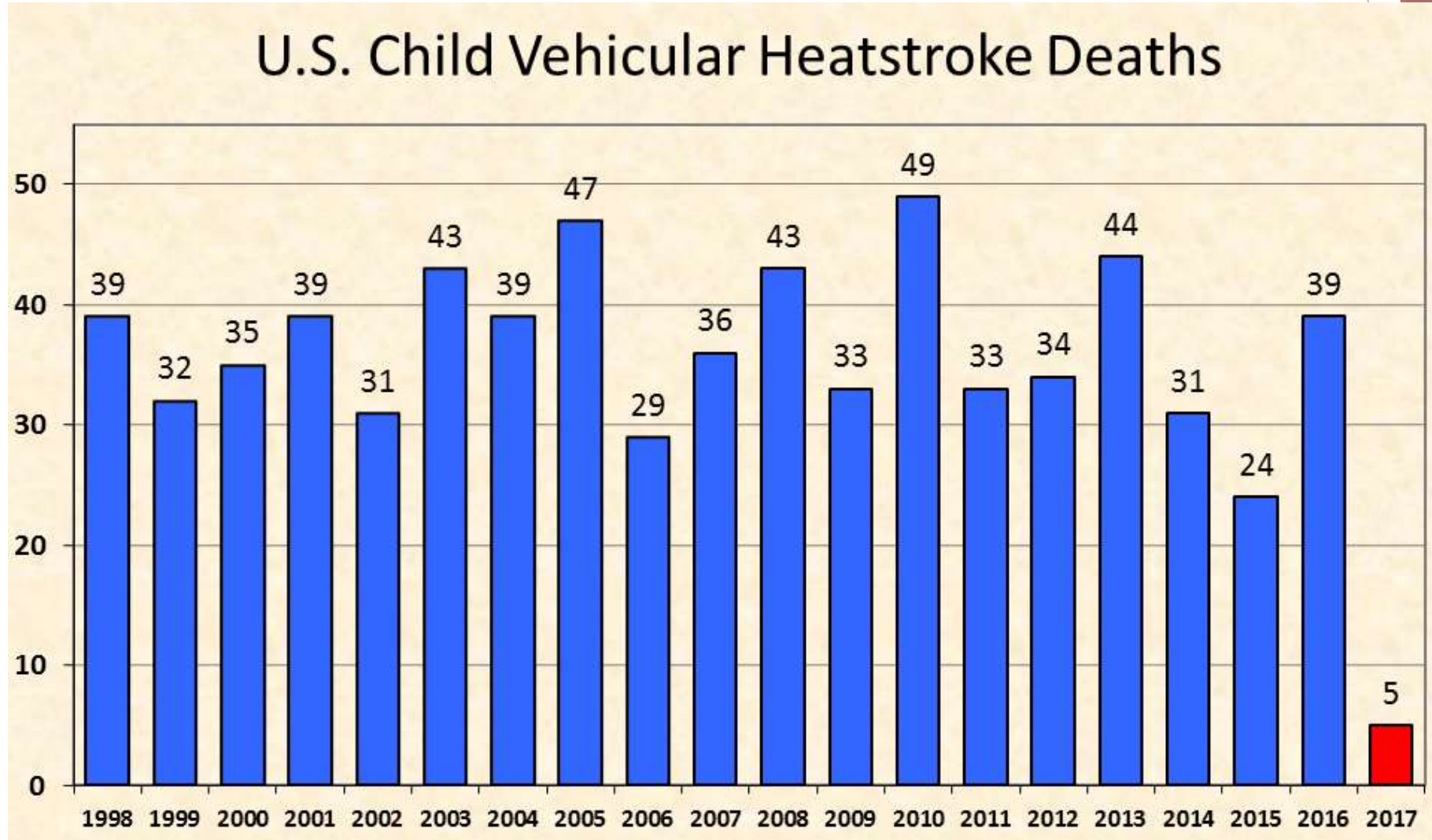


Figure 1. No Heat Stroke

Introduction



Video Courtesy of General Motors & San Francisco State University

Project Goals

1. Motion detection

- ▶ “Looking” for unattended occupant

2. Temperature Measurement

- ▶ Humidity needs to be incorporated
- ▶ Heat Index

3. Alerting

- ▶ SMS Text Message to contact list
- ▶ Additional alert within vehicle
 - ▶ Loud buzzer

4. Retrofit and integration capability

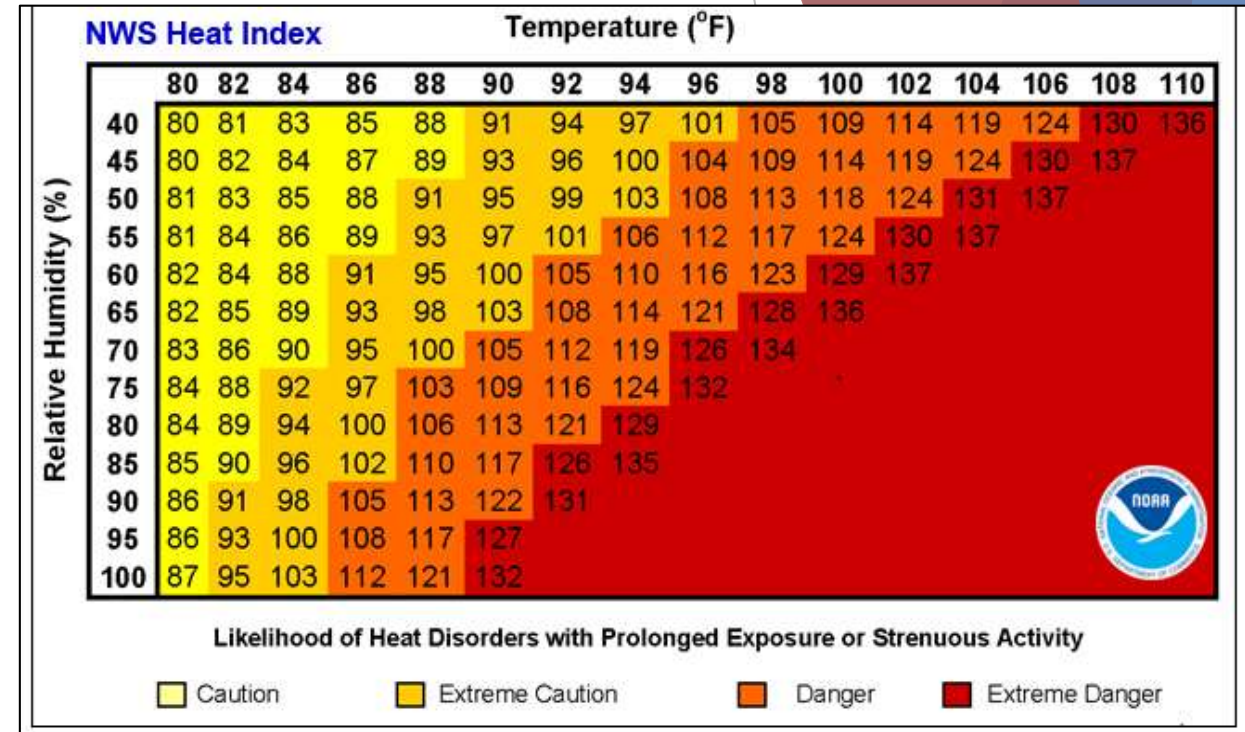


Figure 2. National Weather Service

Current Products on the Market

▶ Sense a Life

- ▶ Detects when adult leaves vehicle
 - ▶ Alerts driver to remove child
- ▶ Utilizes optical sensors and Bluetooth technology
- ▶ Prototype - not mass produced

▶ SensorSafe Embrace DLX Infant Car Seat

- ▶ Wireless receiver through car's On Board Diagnostic system (OBD)
 - ▶ Generally only works with cars manufactured after 2008
- ▶ Monitors chest clip on seatbelt
 - ▶ Detects if unbuckled while car is on or if still buckled when car is off



Figure 3. Huffington Post

Systems Overview

▶ Master Module

- ▶ Temperature/Humidity Sensor (Adafruit HTU21D-F)
- ▶ Bluetooth Master (BlueSMiRF Silver)
- ▶ Microcontroller (ATMega328P)
- ▶ Alert System
 - ▶ Text Messaging Module (Adafruit FONA)
- ▶ I²C Liquid Crystal Display

▶ Slave Module

- ▶ Passive Infrared Sensor (Parallax)
- ▶ Bluetooth Slave (HC-06)
- ▶ Microcontroller (ATMega328P)

Functional diagram

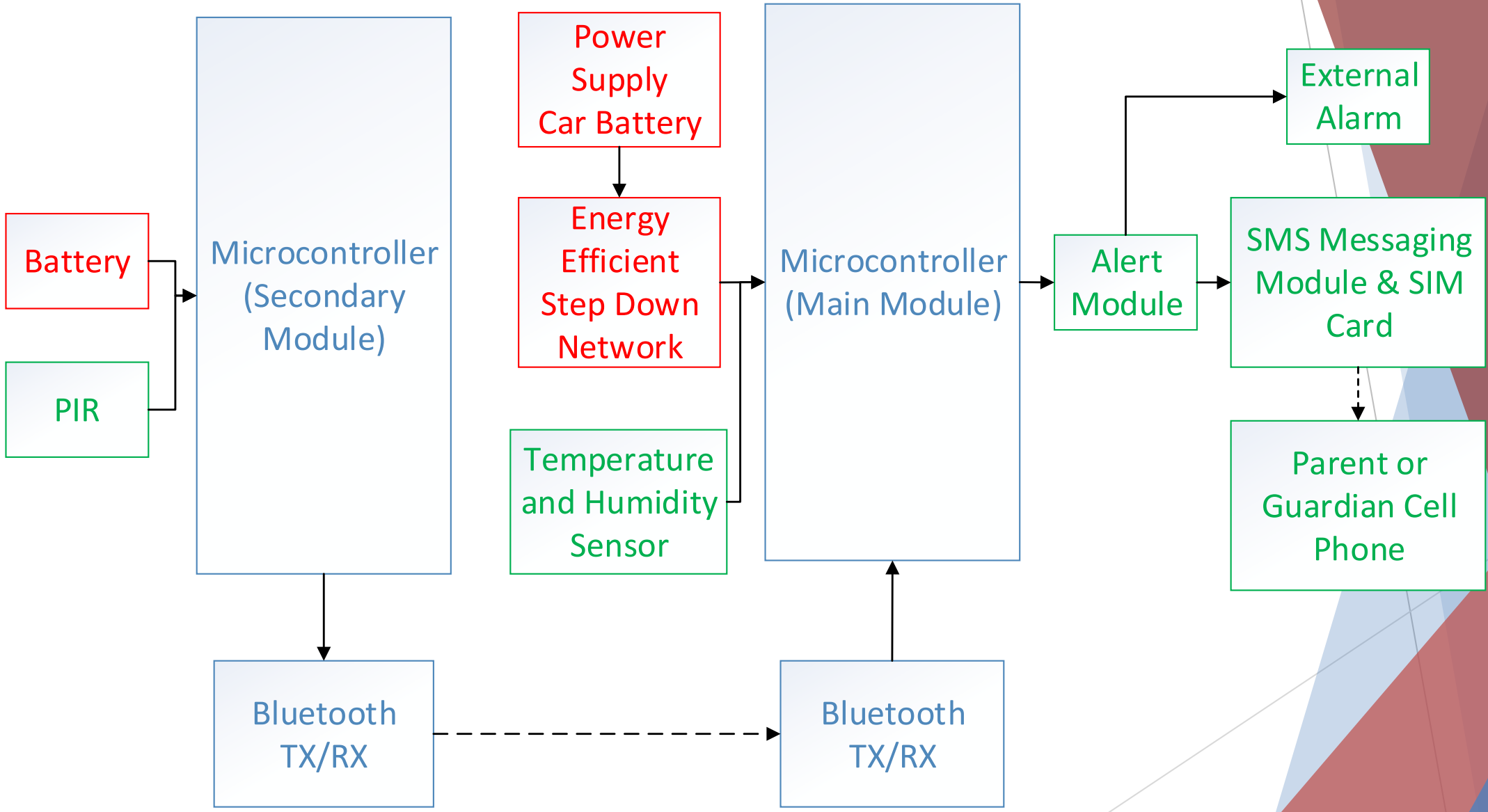


Figure 4. Functional Diagram

Software Design

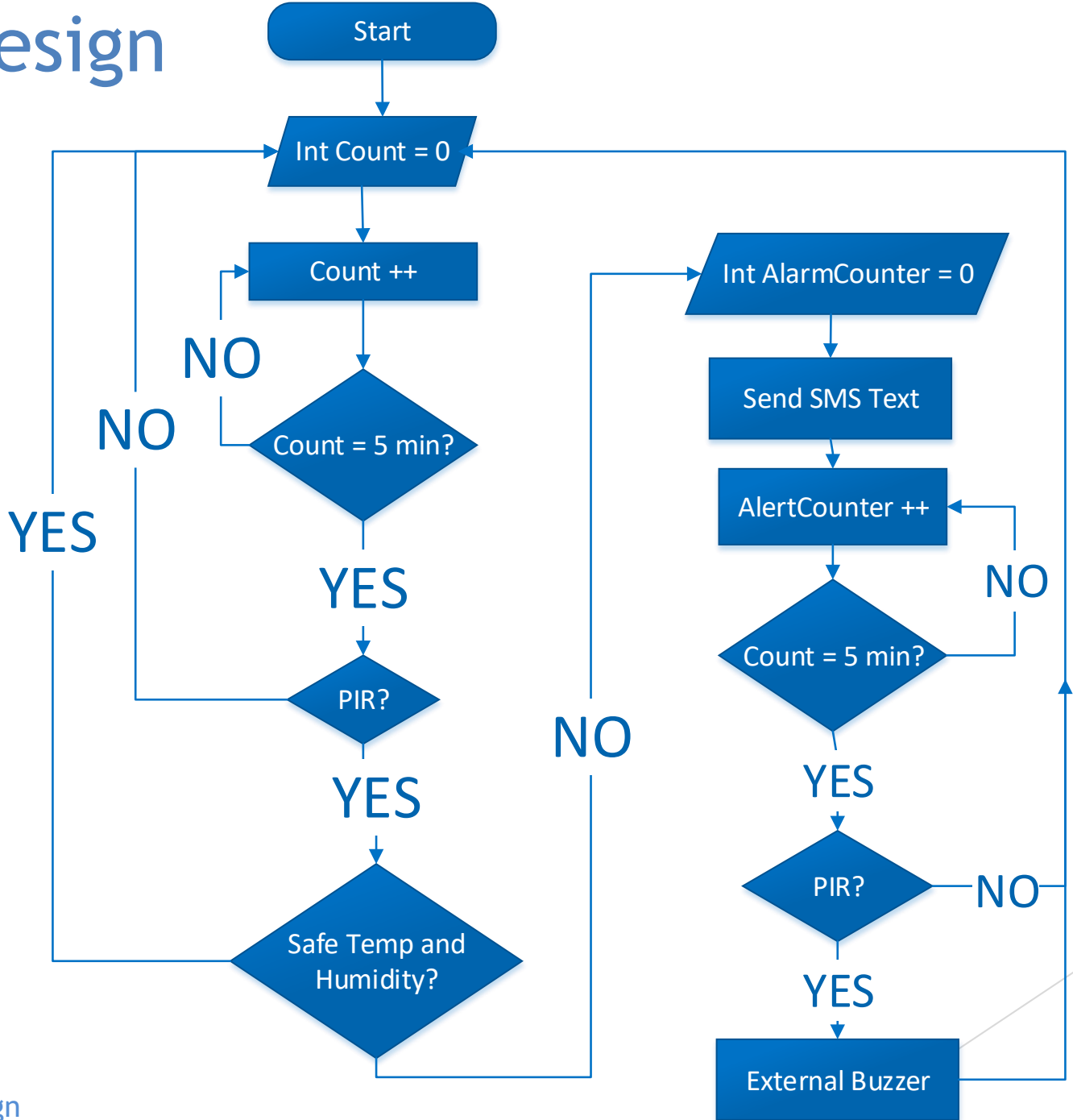


Figure 5. Software Design

Additional Considerations

- ▶ Environmental Conditions
 - ▶ Temperature and Humidity Operating Range
 - ▶ Humidity Range: 0-100%
 - ▶ Sensor Operation: up to 257° F
 - ▶ Overall Temperature Range: up to 122° F
- ▶ Widespread Integration Capabilities
 - ▶ Wireless communication
 - ▶ User-Friendly Installation

Master Schematic

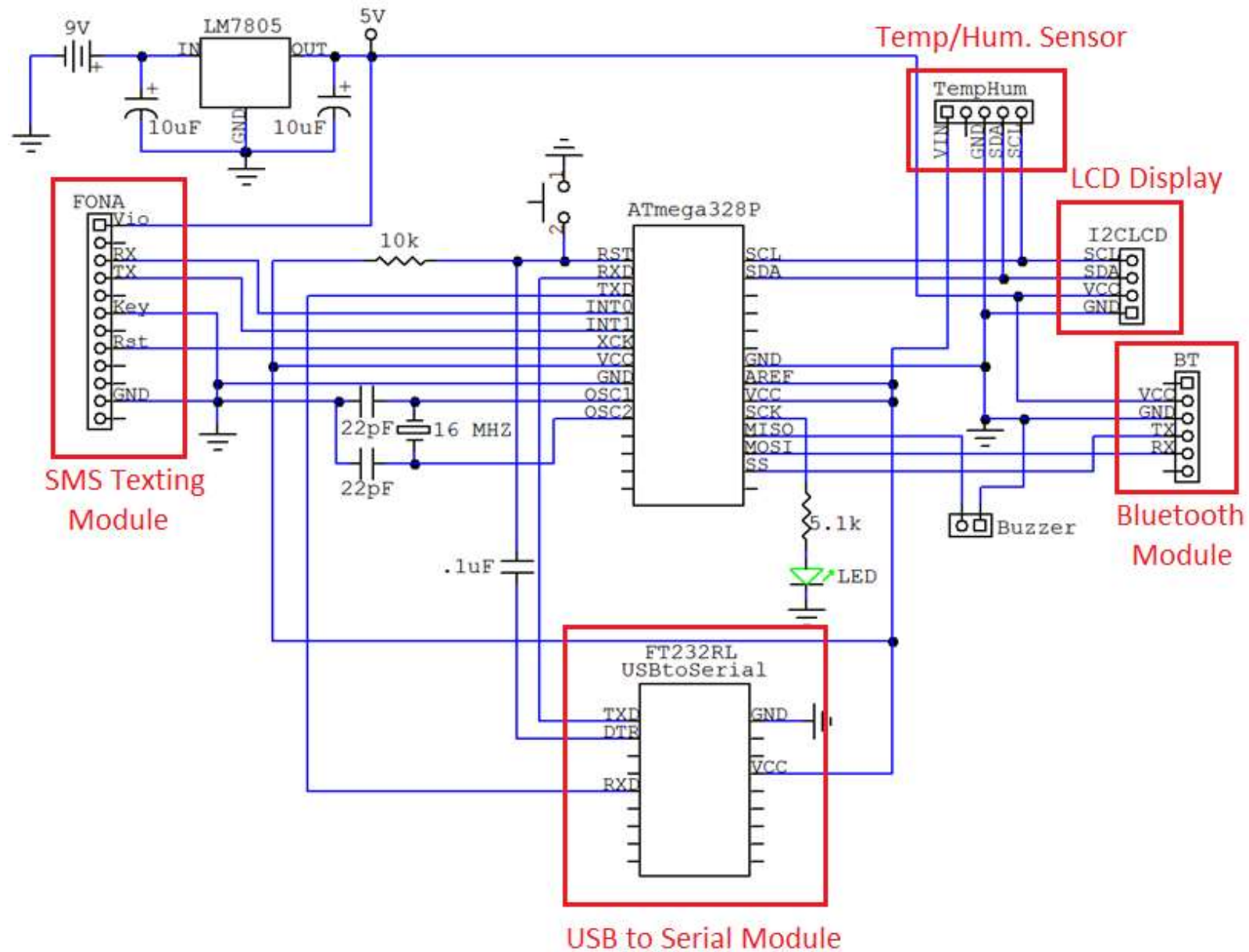


Figure 6. Master Module Schematic

Master Module

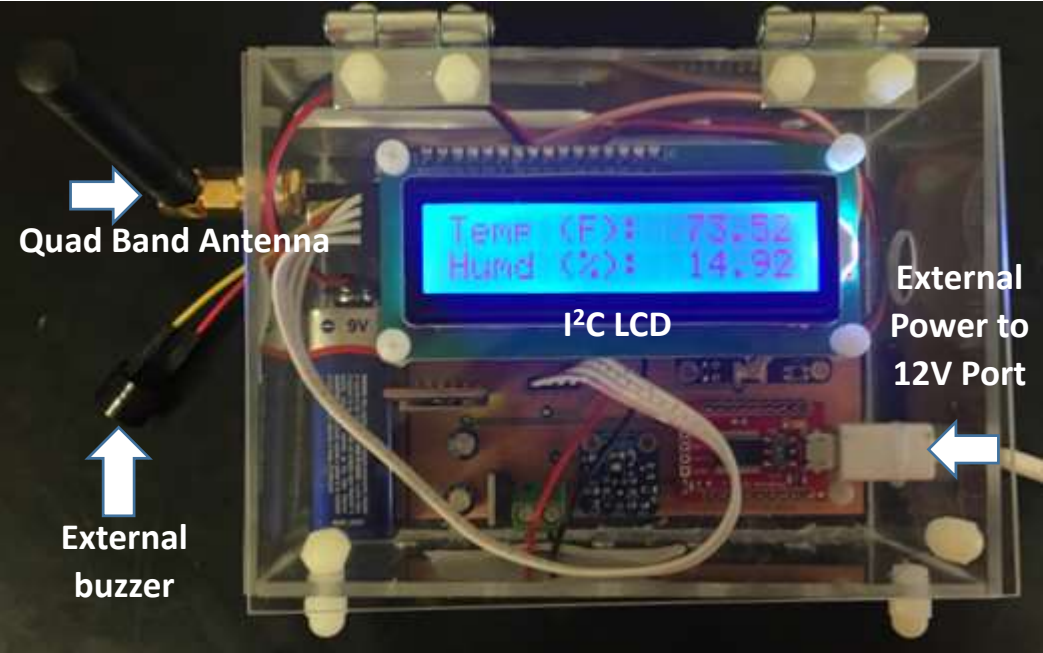


Figure 7. Outside of Master Module

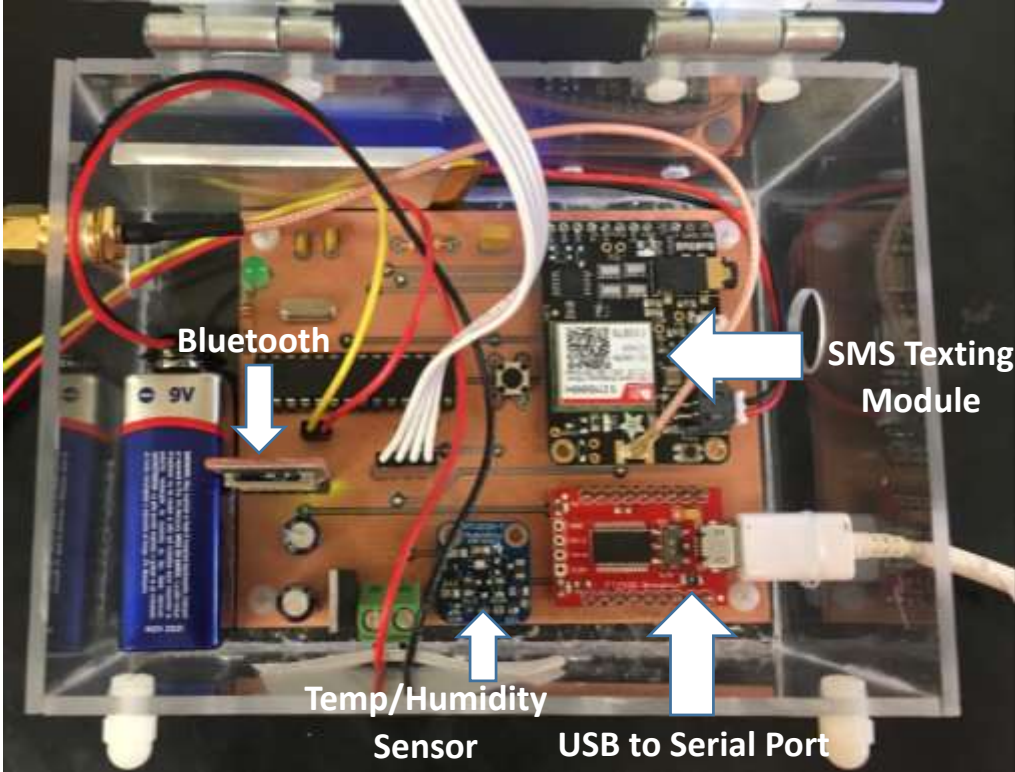


Figure 8. Inside of Master Module

Slave Module

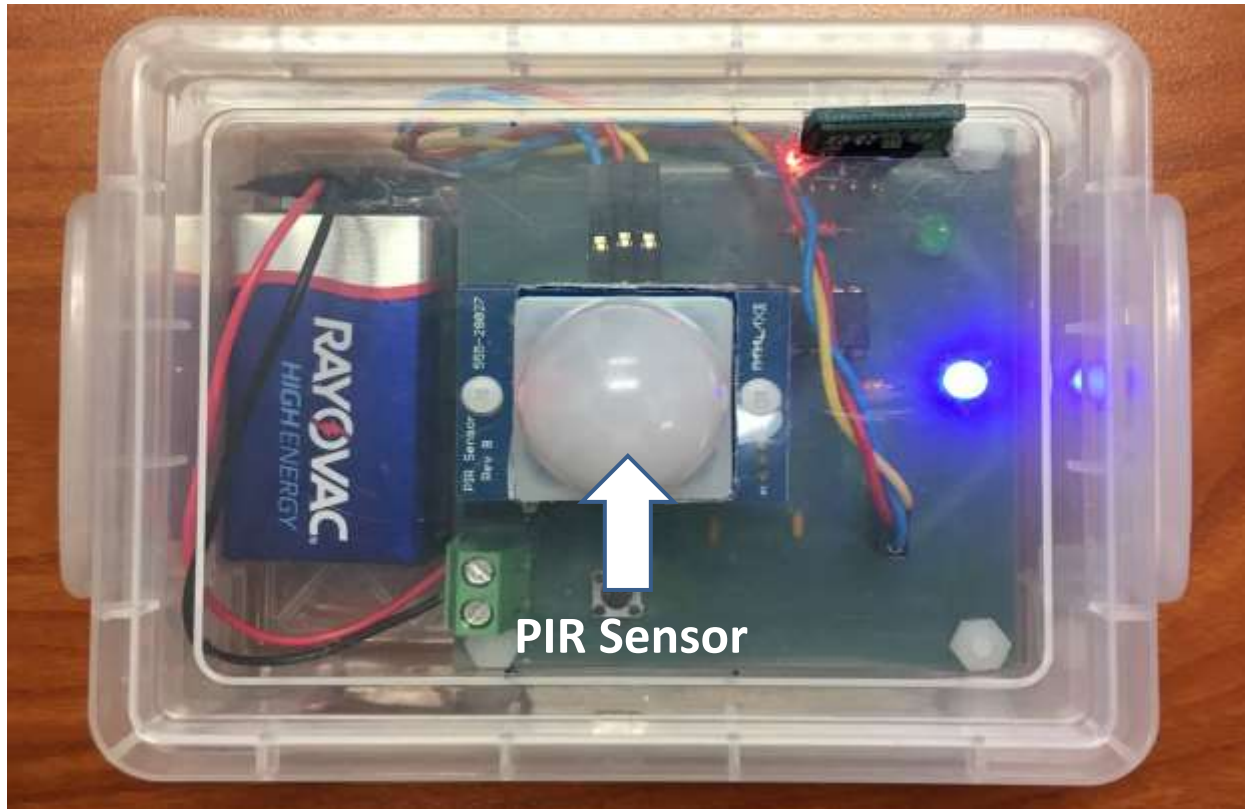


Figure 10. Outside of Slave Module

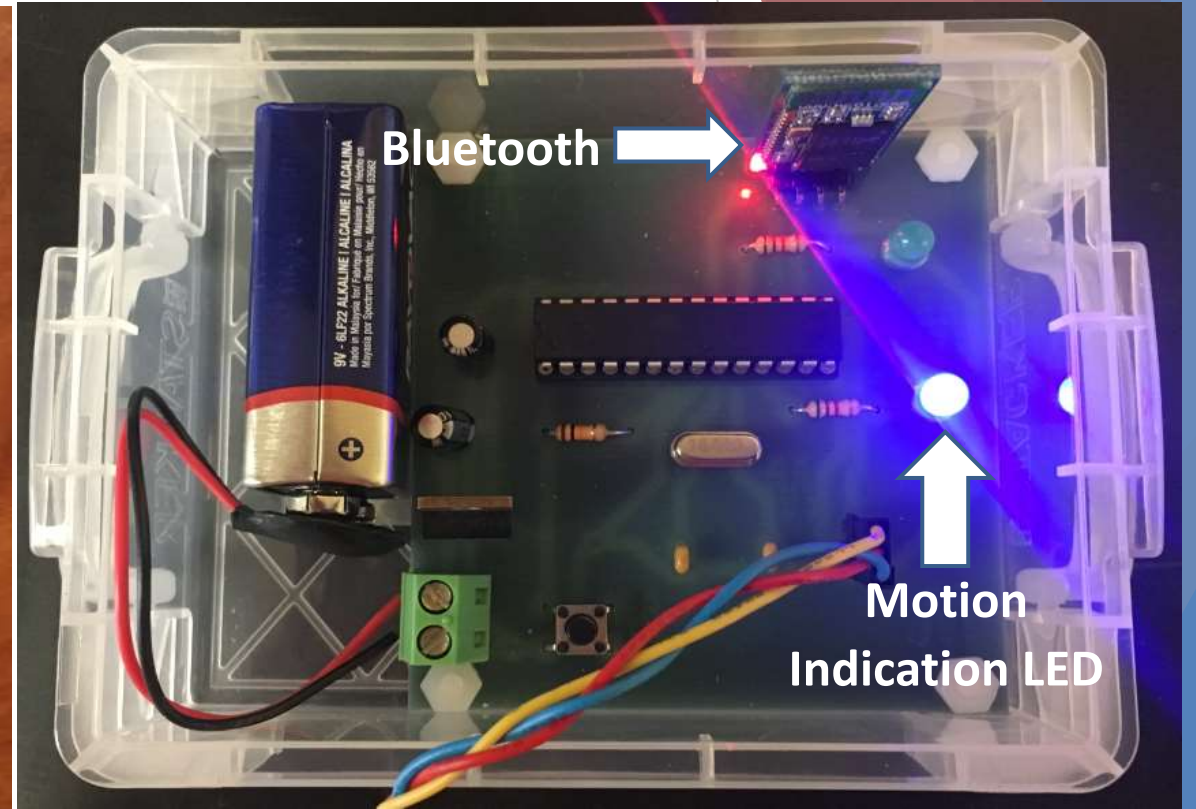
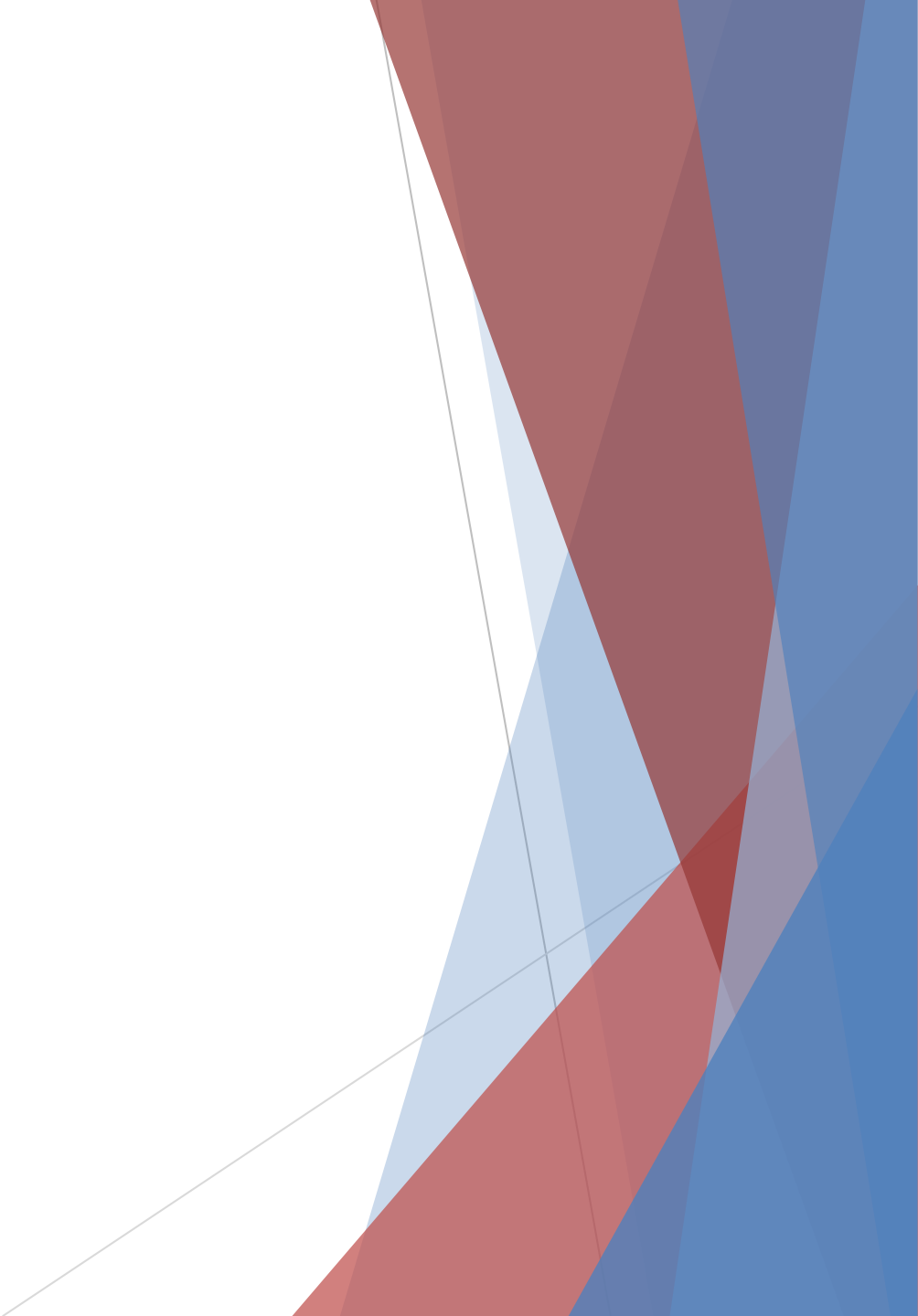


Figure 11. Outside of Slave Module

Final Design - Working Product



Explored Alternative Solutions

- ▶ Detecting an Occupant:
 - ▶ Infrasonic
 - ▶ Pressure Sensor
- ▶ Wireless Communication:
 - ▶ Radio Frequency Identification
- ▶ Integration:
 - ▶ Utilize On-Board Diagnostic System
- ▶ Alarming:
 - ▶ Utilizing the car's existing alarm

Design Process

- ▶ Testing of sensors on Arduino Uno Development Board
 - ▶ PIR, Temperature/Humidity Sensor, FONA
- ▶ Constructed “Master” and “Slave” Prototypes on Breadboards
 - ▶ Refined Wireless Communication
 - ▶ SMS Module testing in Cheyenne
- ▶ Created Printed Circuit Board (PCB)
 - ▶ Soldered components from breadboard to PCB
- ▶ Final Testing
 - ▶ Within vehicle

Final Cost

Part	Purpose	Units	Cost/Unit	Total Cost
HTU21D-F	Temp/Humidity Sensor	1	\$14.95	\$14.95
ATMega328P	Communication	2	\$4.54	\$9.08
FONA Module	SMS Texting	1	\$39.95	\$39.95
HC-06	Wireless Communication	1	\$8.06	\$8.06
Quad-Band Antenna	SMS Texting	1	\$2.95	\$2.95
Passive Infrared Detector (PIR)	Occupant Detection	1	\$12.99	\$12.99
Lithium Polymer Battery	Power	1	\$9.95	\$9.95
USB to Serial breakout	Power	1	\$14.95	\$14.95
LCD screen w/ I ² C converter	Display	1	\$9.99	\$9.99
Other Components	Misc.	x	\$10	\$10
Packaging - 1	-	1	\$2	\$2
Ting	SMS Texting	1	~\$9	\$9
Ting Subscription	SMS Texting	1	~\$9	\$9
Packaging - 2	-	1	\$22	\$22
Total:				\$174.87

Table 1. Final Cost

Future Considerations

- ▶ Implement Multiple PIR Modules
 - ▶ Reduce false positives
- ▶ Upgrade to 3G FONA Module
 - ▶ Better cell phone service
 - ▶ Relay GPS coordinates to law enforcement
- ▶ Only on when vehicle not in use
 - ▶ Pressure sensor under driver's seat
- ▶ Monitoring Circuit
 - ▶ Alert via text with low battery warning
- ▶ Voice call out rather than loud buzzer
 - ▶ “Occupant trapped in vehicle”

In Conclusion:

- ▶ Significant accomplishments:
 - ▶ Wireless communication
 - ▶ Incorporating sensors
 - ▶ Troubleshooting

Acknowledgements

- ▶ We would like to thank:
 - ▶ Dr. Jerry Hamann
 - ▶ Vic Bershinsky
 - ▶ George Janack
 - ▶ Fellow senior design students

Questions?

The background features a series of overlapping, semi-transparent triangles in various shades of blue and red, creating a dynamic, abstract geometric pattern on the right side of the slide.

Module Within Vehicle

