Follow-Me Cart

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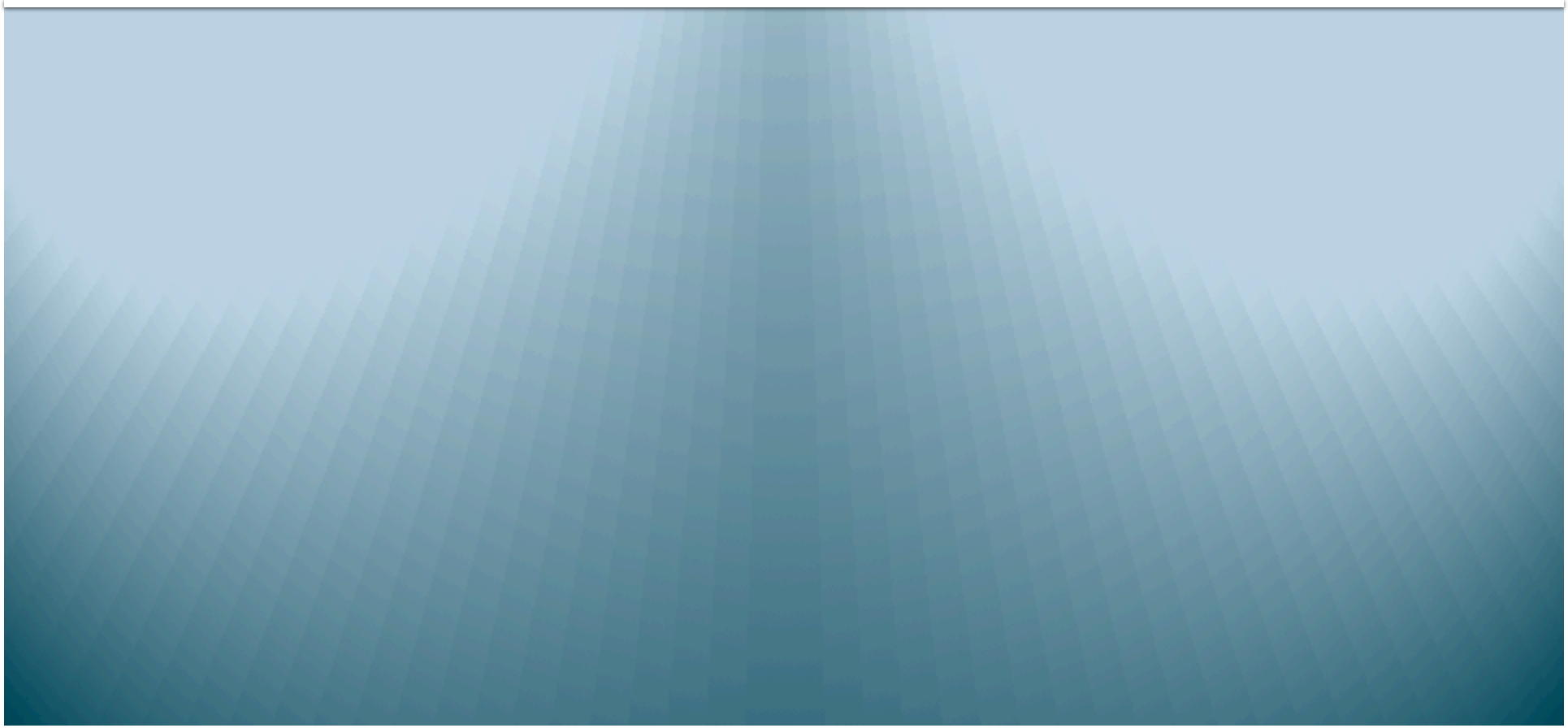
Outline

- Problem Statement
- Proposed Solution
- Design by Modules
- System Hardware Overview
- System Software Overview
- Results
- Budget
- Future Work
- Prototype Pictures

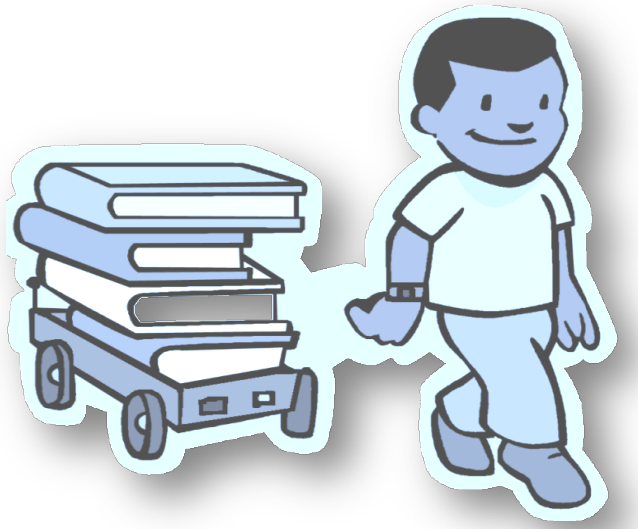
What's the problem?



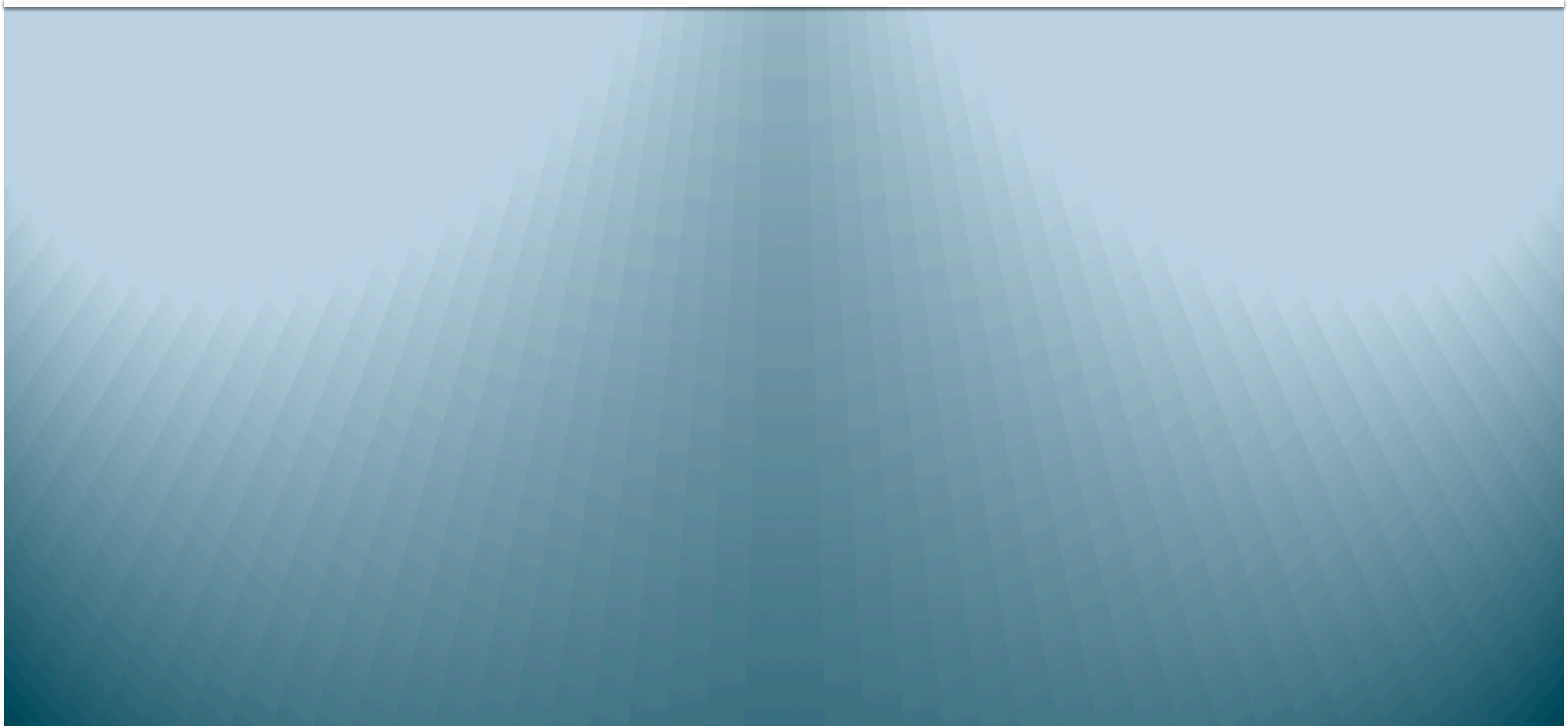
What do they have in common?

The Follow-Me Cart

- Identifies user uniquely
- Follows user
- Avoids stationary obstacles
- Sounds an alarm when:
  - User is not detected

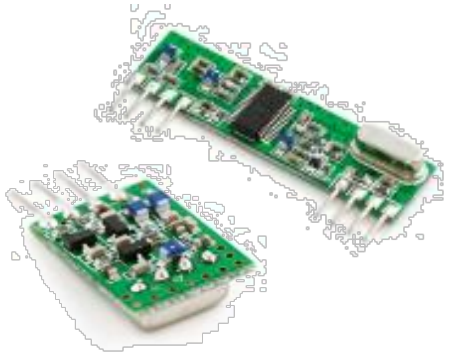


How it was done



User Identification

- Radio frequency transmitter/receiver
  - Sends/receives Identification number (16 bits)
- Communication using UART
  - 1.6kbps

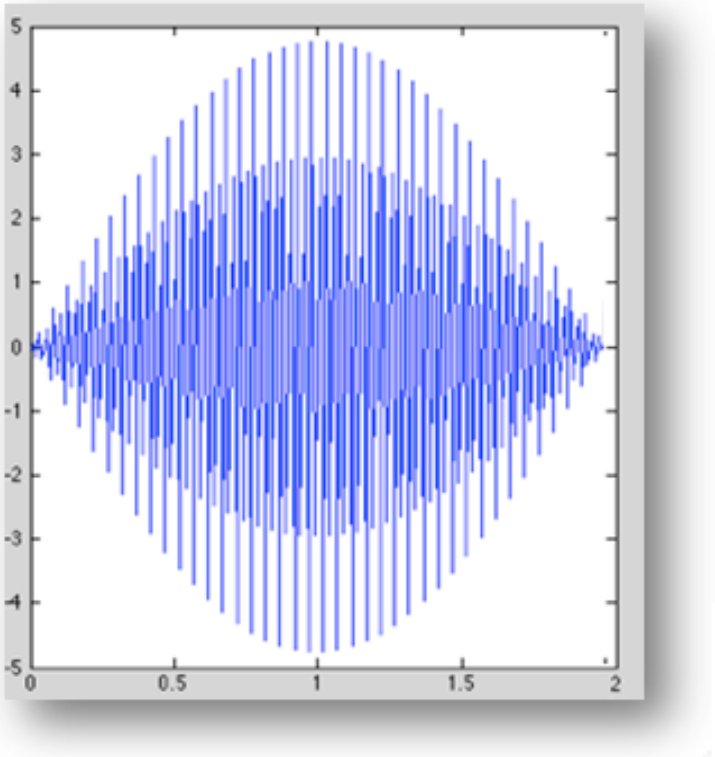


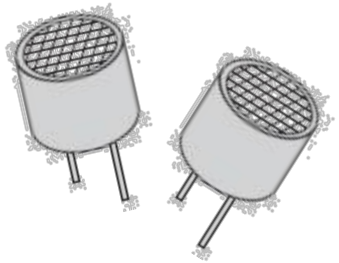
User Location

Phase Accordance Method

- Ultrasound transmitter sends sine waves which meet at an epoch

- Receivers get signal
  - Time of flight
    - Distance
    - Angle





Cart Movement

- Remote Control Car (RC)
- Two servo motors
  - Steering
  - Throttle
- Pulse Width Modulation
  - Period of 20ms
  - Duty cycle
    - 5% - left or forward
    - 10% - right or backward

Obstacle Detection

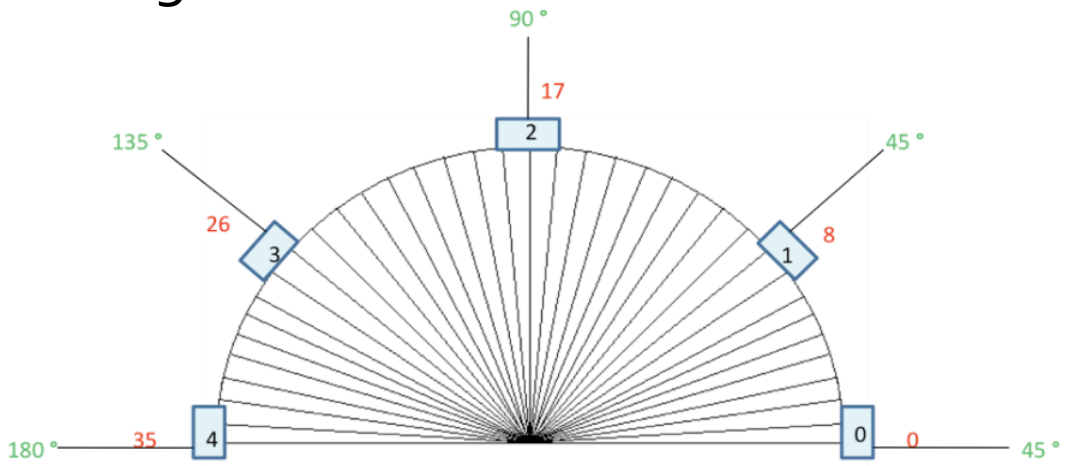
- Infrared proximity sensors
  - Provide obstacle distances for Obstacle Avoidance
- ADC output vs. distance is exponential
  - Data linearization:

$$\frac{1}{\text{Distance} + k} \quad \text{vs.} \quad \text{ADC}_{\text{out}}$$

  - Adjust *k* for linear correlation

Obstacle Avoidance

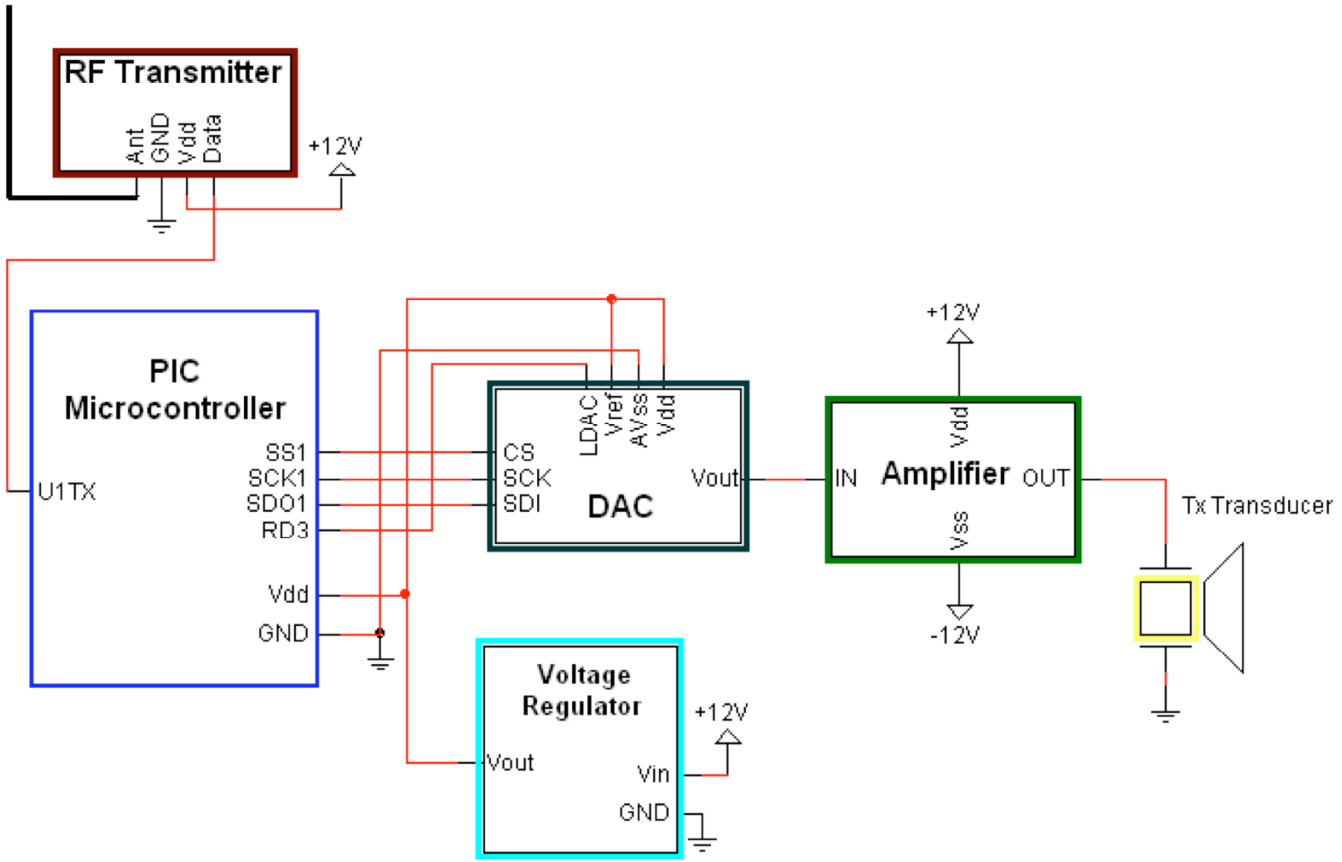
- 35 sectors: 5 degrees each
- Infrared sensors provide obstacle distances
- Fuzzy logic rules determine danger sectors
- User Location provides target angle (sector)
- Steering angle is determined using danger sectors and target sector



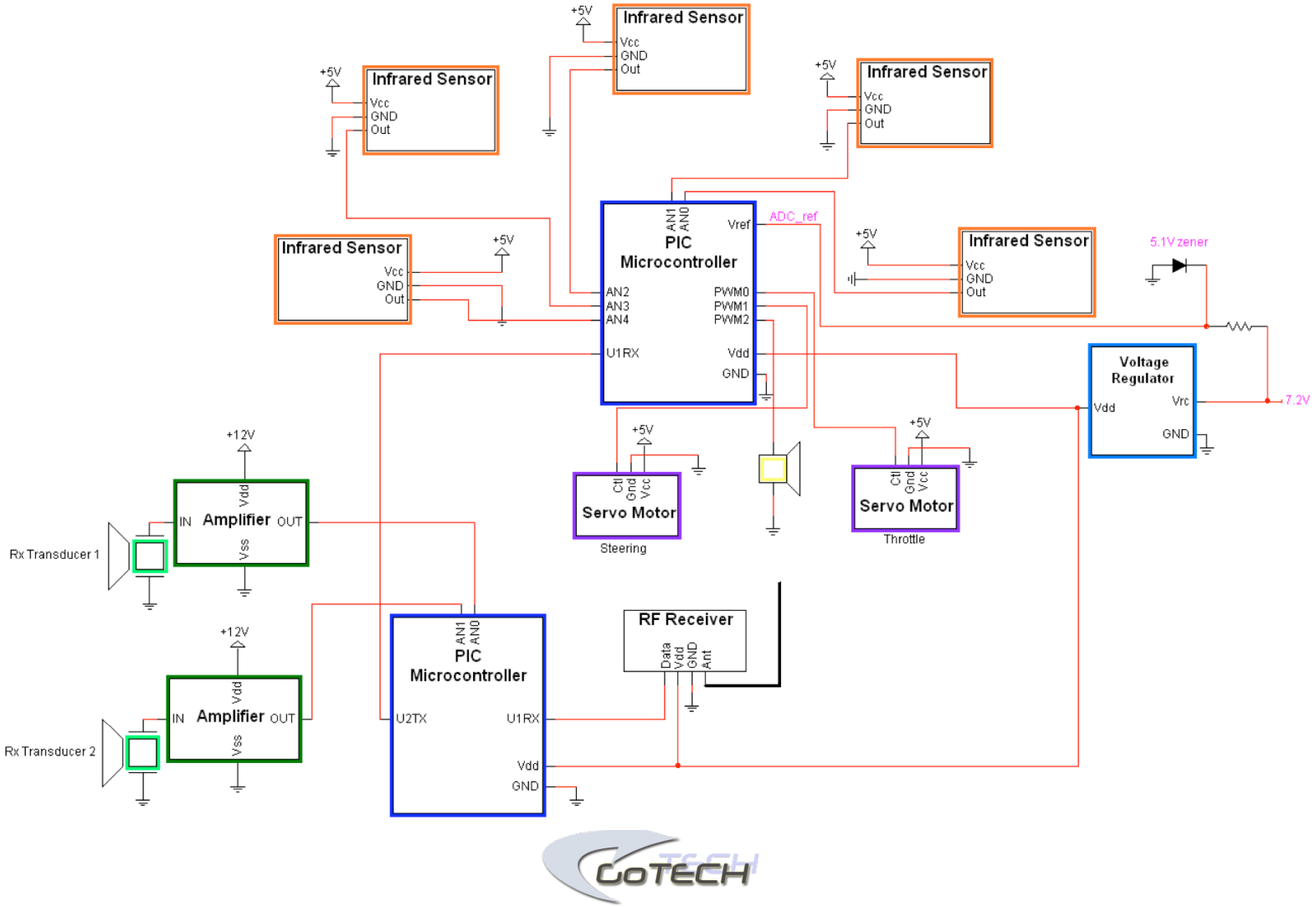
Movement Decision

- Obstacle Avoidance provides steering angle
- User Location provides user distance
- Decisions:
  - Adjust speed according to user distance
  - Turn according to steering angle
  - No data provided → Stop, Turn on alarm

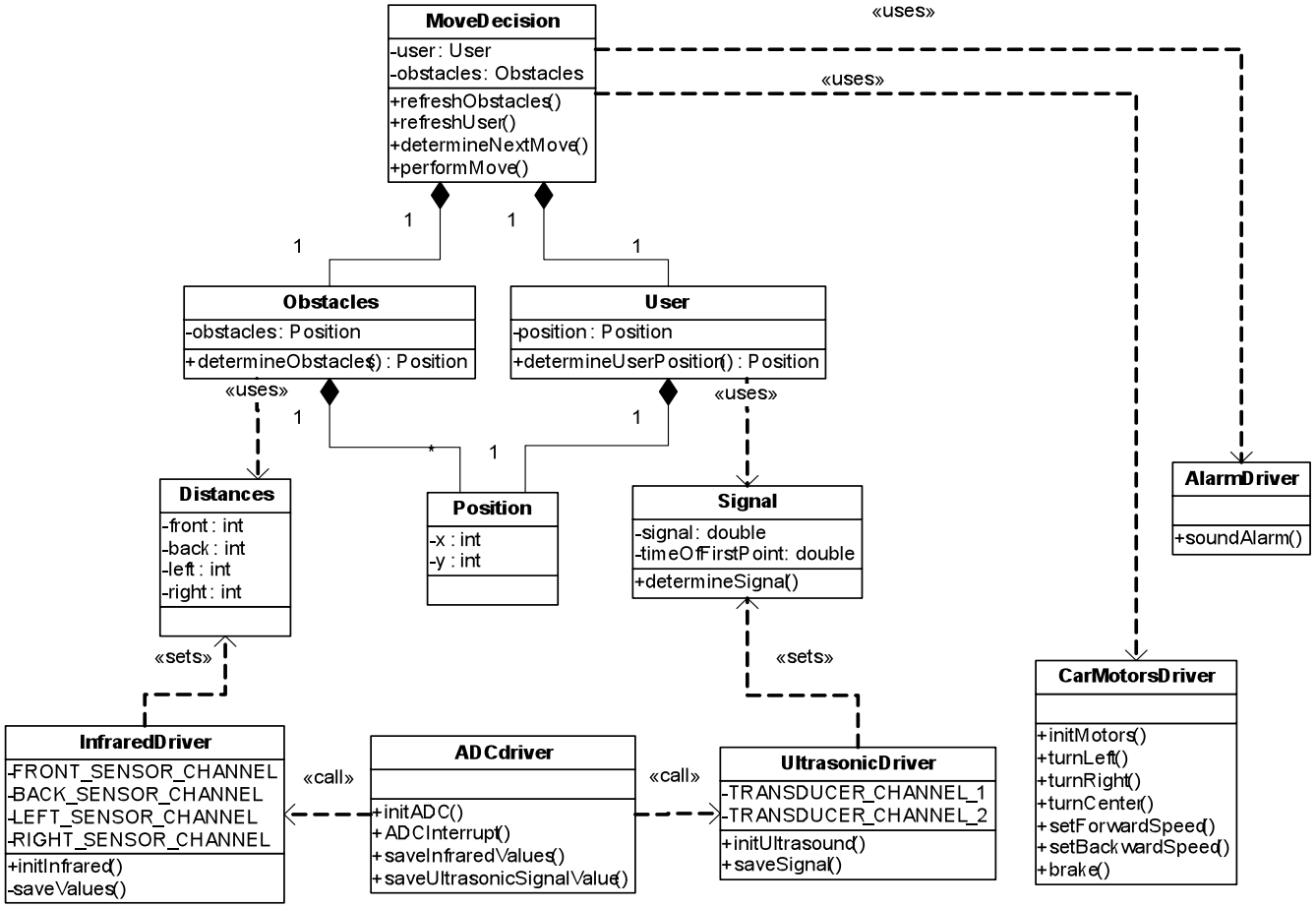
Transmitter Schematic



RC Car Schematic



Software Diagram



Results

Were we on time?

- User Identification re-design led to a significant delay with User Location
- Problem Solved through:
  - Resource re-allocation
  - Paralleled tasks
  - Extra working hours
- Project was completed on time

It works!

- Avoids obstacles 95% of the times tested
- Small user location calculation errors
  - Distance: +/- 7cm
  - Angle: +/- 5 degrees

- Integrated system
  - Follows user and avoids obstacles correctly for about 85% of the time.

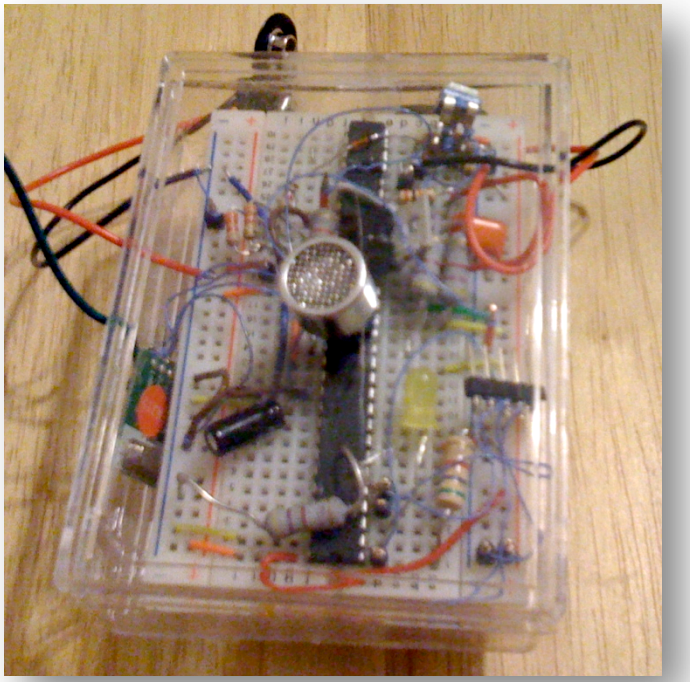
How much did it cost?

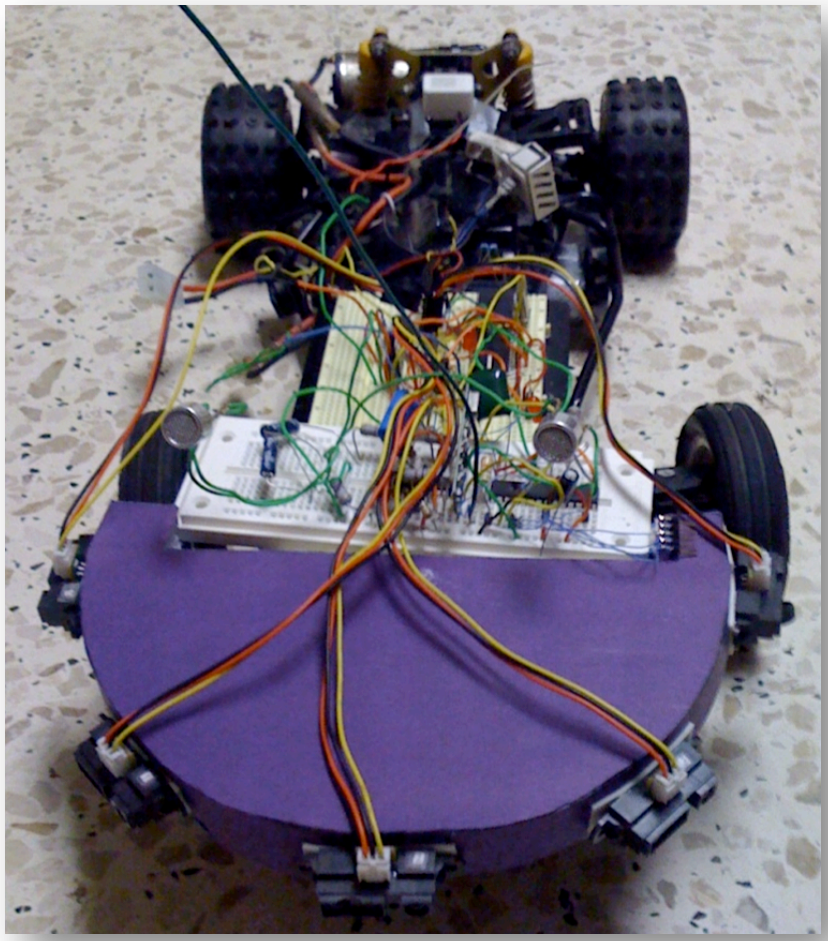
Total Project Cost	
Total Personnel Cost:	$20,785.56
Total Materials Cost:	$315.74
Subtotal Project Cost:	$21,101.30
Overhead (110%):	$23,095.12
Total Project Cost:	$44,312.73
Proposed Project Cost:	$44,090.68
Difference:	$222.00

Future Work

- Add infrared sensors to reduce blind spots
- Enable cart to recognize dead ends
- Incorporate cryptography to prevent third-party tracking
- Physical and mechanical design of the cart

Follow-Me Cart Prototype





References

- Y. D Kwon and Jin S. Lee. "**An Obstacle Avoidance Algorithm For Mobile Robot: The Improved Weighted Safety Vector Field Method**". 1995, IEEE 10th International Symposium on Intelligent Control.

- Ayumu Kaneko, Yusuke Sugano, Koji Yatani and Masanori Sugimoto. "**Fast and Accurate Positioning Technique Using Ultrasonic Phase Accordance Method**". Graduate School of Frontier Sciences University of Tokyo.

Questions?