Automoe:

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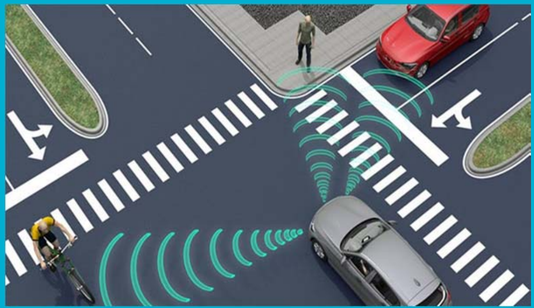
Background

- More than 50 major tech companies are working on Autonomous Vehicles:
    - Including Uber, Intel, Tesla, etc.

- Autonomous driving systems use cutting-edge wireless technology and sensors for navigation, collision avoidance, and communications

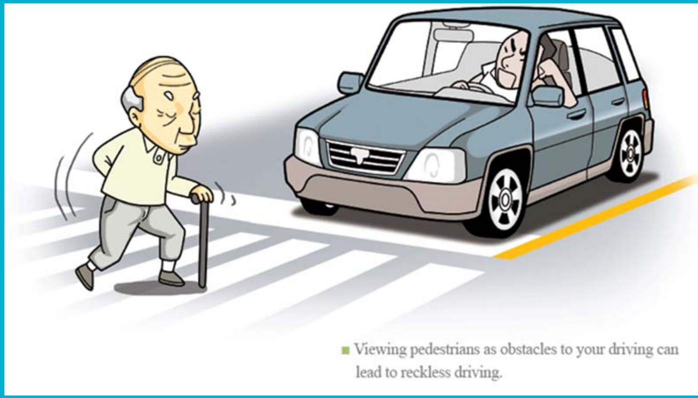
- Recent growth in predicted market value for autonomous vehicles highlights customers’ needs for safer transportation



Problem - Freq. accidents

Cause of accidents:

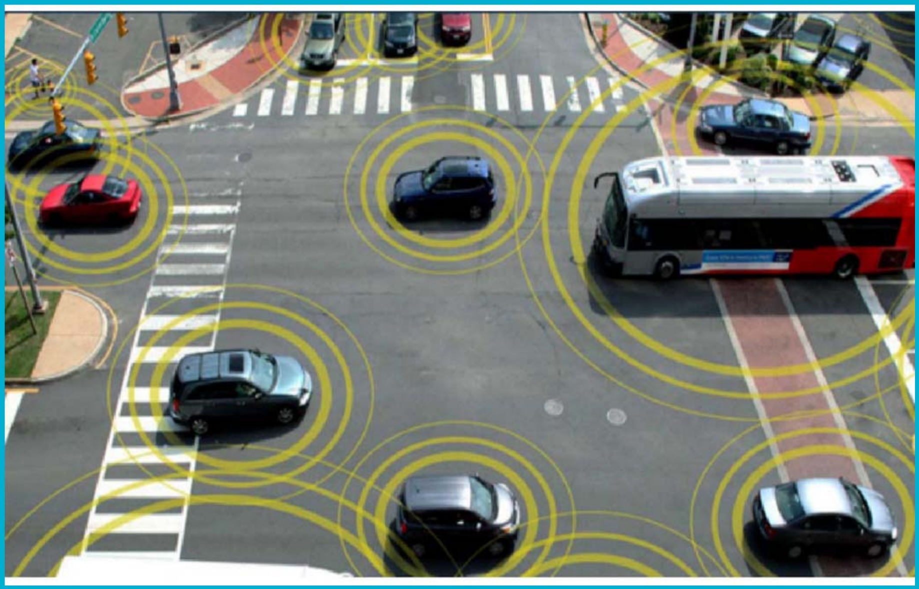
1. Blind spots
2. Distracted driving
3. Speeding
4. Driving under influence, recklessness



Problem

94% of accidents are cause of human error (NHTSA)

Can be prevented using successful implementation of autonomous vehicles



360 degree vision compared to human's 200 degree

Problem - why autonomous vehicles?

- Relies on sensors and cameras to make decision
- Computers react faster than humans
- No distractions like smartphone, alcohol inebriation, and no emotion involved in decision making.
- Efficient travel because of automatic GPS navigation and efficient use of fuel

Problem - Issues with autonomy

- Privacy in question
- Software might be hackable
- Autonomous cars still need to deal with human driver in non autonomous vehicle whose future move might not be expected

Design Requirement

The final prototype should have following features:

- Adaptive speed control
- Rerouting
- Automatic braking
- Vehicle status info display
- Lightweight cybersecurity features
- Sharing real time data using wireless access technology
- Privacy aware communication

Design Requirement - compliance & safety

The design of AutoMoe should adhere to NHTSA and includes following features:

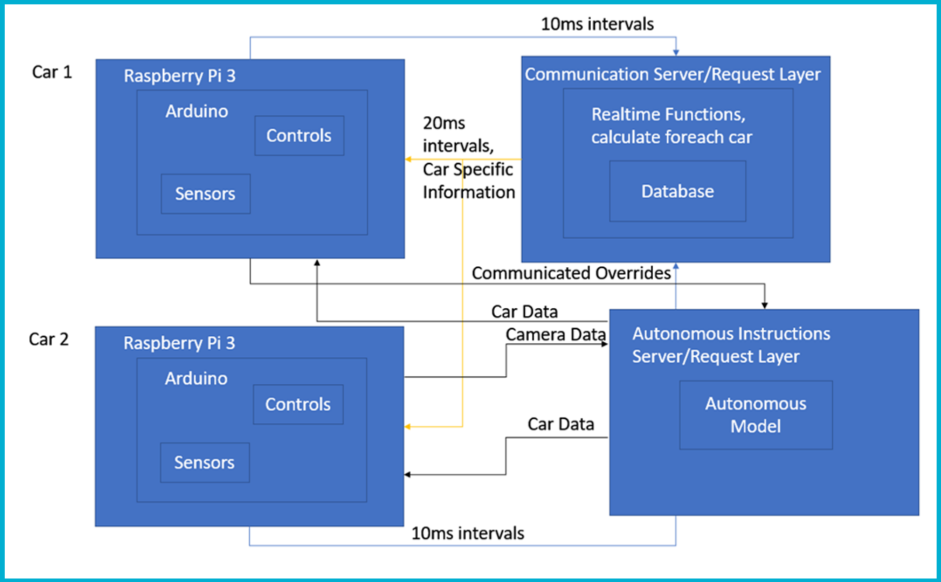
- Lane Keeping assist
- Adaptive cruise control
- Traffic jam assist
- Secure communication between devices

Hence, Vehicle to vehicle and vehicle to pedestrian collision will be limited

Constraints

- Available human resource: 6
  - 2 EEs, 2 CEs and 2 MEs
- Available financial resources
  - Limit to $800 for 2 prototype cars
- Driver vehicle interface:
  - Allow override for manual control in case of emergency
- Power:
  - Should use rechargeable Li-ion battery
- Compliance
  - Must not infringe existing patents

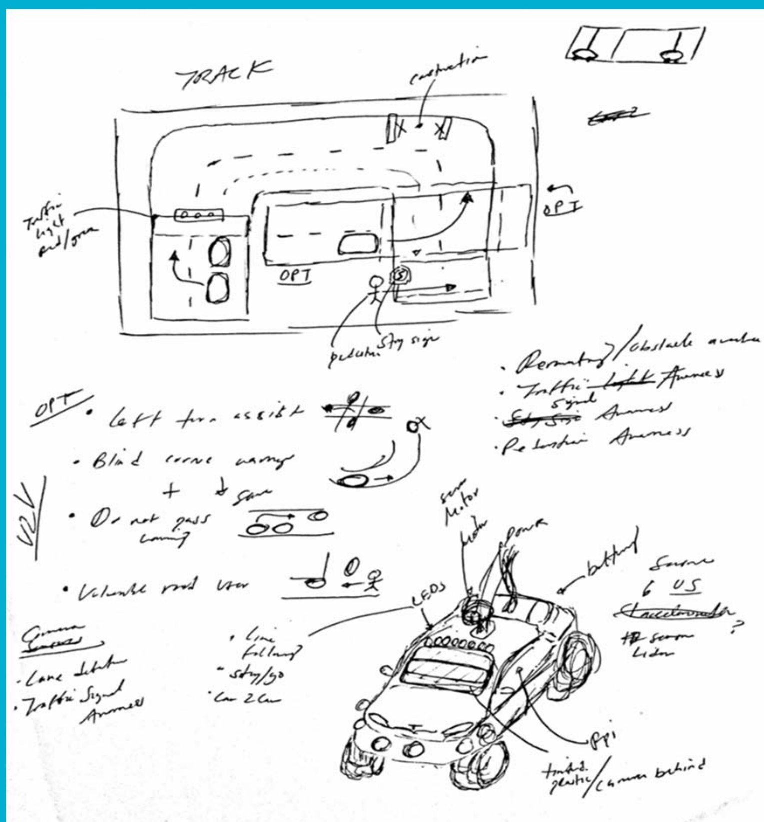
Individual Solution 1



Communication + Data Flow

- Server, low-latency
  - Record{car_id, timestamp, gps coordinates, }
  - Server-side processing
  - Clears server of data older than 20 seconds
- Client, RPi on Car
  - Serves location data periodically
  - Requests periodically for special instructions
- Rpi to Arduino
  - Sends controls
  - Default autonomous movement
  - Two non-default behaviours
    - Special Instructions from server
    - Special response to priority stimulus

Individual Solution 2



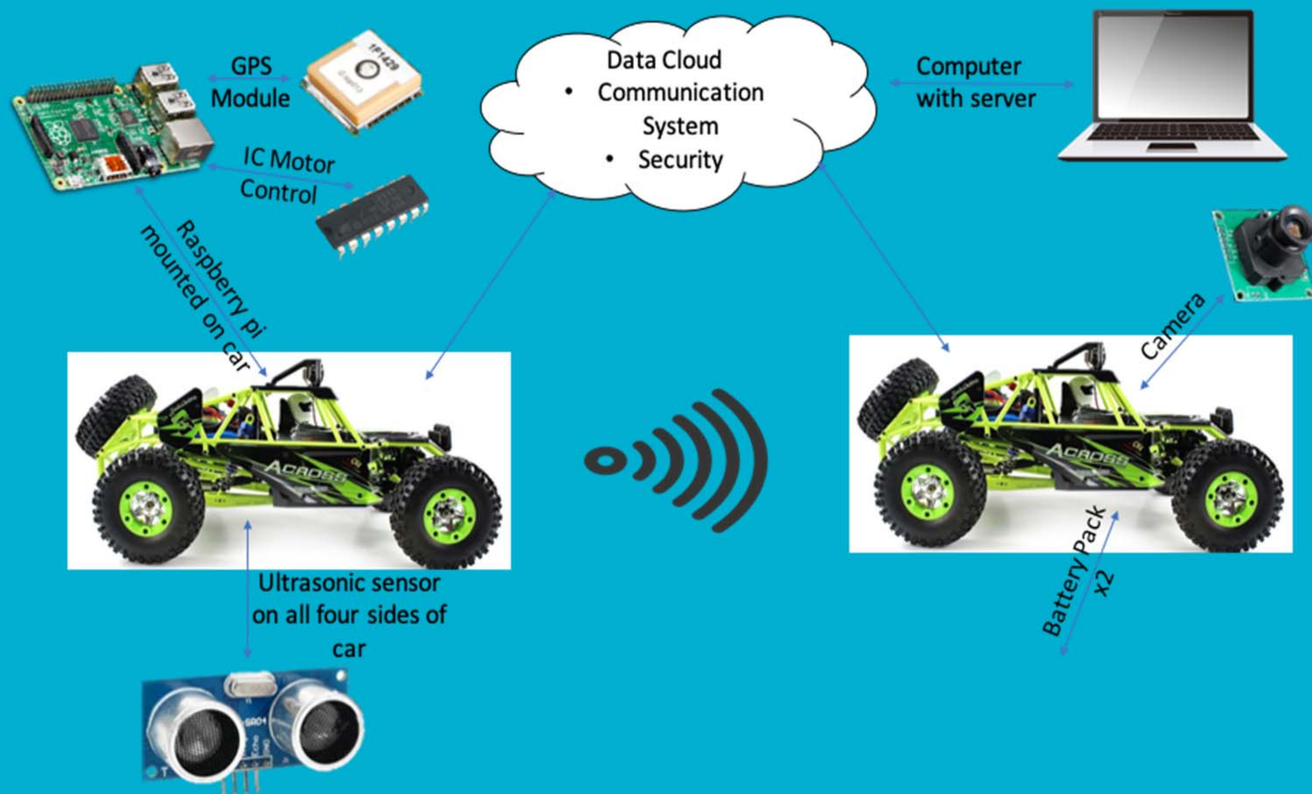
Smart-Car Abilities:

- Lane Detection
- Traffic Signal Awareness
- Obstacle Avoidance
- V2V Communication

Equipment:

- Raspberry Pi 3+
- Arduino Mega
- 1 Lidar sensor
- 8 Ultrasonic sensor
- Camera (behind windshield)
- Leds mounted atop roof above windshield
- Custom car frame/body to enclose/mount other equipment

Individual Solution 3



Individual Solution 4

Must-have Features:

- Self driving on artificial track
- Street sign detections (stop sign, traffic light)
- Collision avoidance

Input:

- Camera Module
- Ultrasonic Sensors

Mode of communication:

- bluetooth module/wifi module
- gps module

Processing:

- Computer hosted Server
- Receive data from raspberry pi
- Train neural network
- Make decisions based on the trained model

Motor Control:

- DC motor control IC L293D to control the speed of motor

Power Supply:

- Rechargeable battery packs to power RPi, motor control and car.

Top 2 Designs

Design 1: Combination of 1&2

- Equipment:
  - GPS Module, 8 ultrasonic sensors, camera module, RPi3, arduino, lidar sensor
- Test Cases:
  - Car must respond appropriately to walking pedestrian, stop signs, blind curve detection
- Power Solutions:
  - Overhead cables for constant charging
- Data Flow:
  - Ultrasonic sensors feed data to the arduino which will pass the data onto the rpi3 and then onto a laptop server along with camera feed.
  - The laptop will provide instruction based on the camera, along with other cars data in order for each car to decide what to do.

Design 2: Combination of 3&4

- Equipment:
  - 4 Ultrasonic sensors, Raspberry Pi, IC Motor Control, LCD screen, camera module, GPS module
- Test Cases:
  - Car must respond appropriately to traffic signals, a decelerating car ahead, switch lanes as needed.
- Power Solutions:
  - Two battery packs per car
- Data Flow:
  - Ultrasonic sensors feed data to the raspberry pi, and then onto the server with the camera data at fixed periodic interval.
  - The server provides instructions for the raspberry pi which controls the car's IC motor and controls the movement of the car.

Design 1: Pros & Cons

Pros	Cons
Modularity within the components ● Arduino controls movement ● ultrasonic sensor data collection ● RPI3 communicates with server Many sources for cross-validation ● improve security ● improves the structure 8 ultrasonic sensors provide more detection data.	● Server is a single point of failure. ● If the server malfunctions, the entire system fails ● Raspberry and Arduino combination adds cost ● The GPS is dependent on external sources ● GPS is impractical when training the model indoor ● Many variables with no clear way to rank the data

Design 2: Pros & Cons

Pros	Cons
Not as expensive ● Less Data to secure ● Less data to use ● Removable battery packs ● Charge/Usage time ratio is not ideal for testing Few things for the car to support ● parts can be placed on the car more efficiently LCD displays car data ● display relevant test data and real time data	Raspberry Pi expected to handle alot ● sensor data collection ● control movement of car ● communicate with server. Solely depends on 4 ultrasonic sensor for obstacle detection Displaying information is not useful for final product

Decision Matrix

Design	Cost (no tax)	Complexity, Amount of data	Security + Validation	Ease of development	Overall Score
1	7 ($547)	7	10	8	32
2	9 ($331)	10	7	6	32

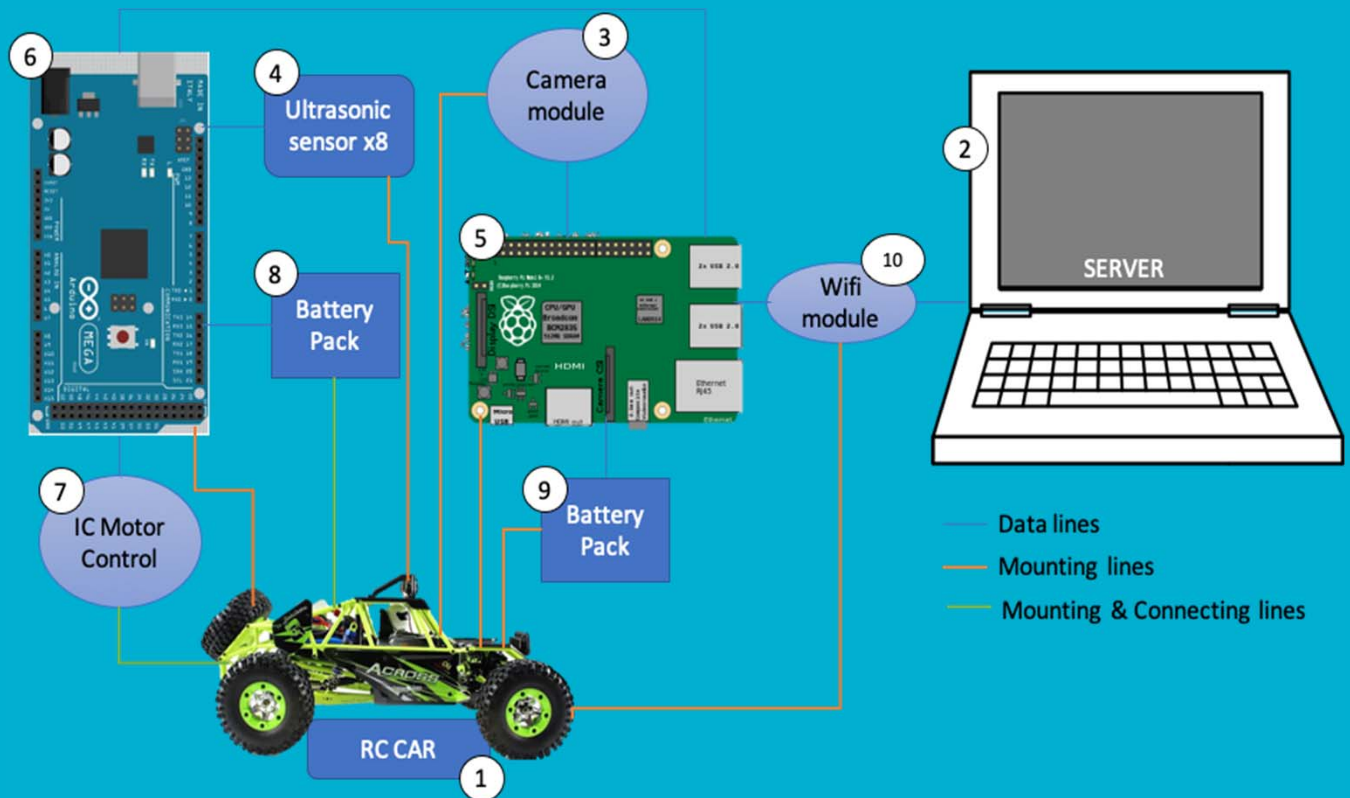
Selection

The top 2 designs tied so we decided to consolidate those two designs into the final.

We removed unnecessarily costly items an complexity by removing the lidar sensor.

The GPS module was deemed impractical due to the size of the grid

Top Solution



Top Solution

- Arduino Mega
  - Converts logical instructions to analogue instructions for the car
  - Controls the Motor Control IC connected to the cars motors
  - Also collects data from the 8 ultrasonic sensors
- Raspberry Pi
  - Collects data from the Arduino(Sensor data)
  - Collects data from the Camera Module
  - Sends both sets of data to the Server
  - Server serves request returning instructions
  - Sends logical instructions to the

Top Solution

- Neural Network
  - Hosted on the server, used to determine next movement
  - Move to the raspberry pi if possible
- Data Sharing
  - Communication through server to prototype
  - Move to a more local means such as using bluetooth or wifi
- Data Validation
  - Use other car information to validate present car’s data
  - Use ultrasonic sensors and camera data to cross-validate
- Test Cases (Primary)
  - Switch lanes as needed, slow down/stop behind vehicle in-front. Reroute around obstacles.

Conclusion

1. We aim to meet the customers' need for safer transportation by developing a secure autonomous car system

1. Our top design will use an R/C car and custom track to demonstrate the functionality of our system:
    a. Will consist of a raspberry pi, arduino, motor control chip, 10 sensors, and a camera