V2V Communication

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Outline

- Business Requirements
- Engineering Requirements
- Project Overview
- Logical Design
  - Intelligence System
  - Data Management System
  - Alert System
  - Communication System
- Finances

Business and Engineering Requirements

System will require minimal or no vehicle modification for installation and be designed as a Retrofit System.

a. Retrofit system will be compatible with Ford 2008 or younger vehicles due to the restriction of the Ford Open XC device
b. Ford Open XC will be connected to the vehicle's OBD-II Port to collect vehicle data needed for collision detection algorithm
c. System requires a USB port to provide the device with power.

System will maintain vehicle location relative to other vehicles.

d. System will use GSP to identify vehicle location
e. System will communicate vehicle position to vehicle within a 400 meter range due to Arada Locamate OBU communication range restrictions.
f. System will collect position information from vehicle within a 400 meter range due to analysis completed for collision detection algorithm.

System will detect front and rear end in lane collisions and side (left and right) intersecting collision conditions.

a. System will calculate vehicle velocity and trajectory path based on GPS data
b. System will send and receive velocity and trajectory path information to and from near by vehicles
c. Intersecting trajectory point, based on algorithm calculations, will qualify as potential collisions

System will alert driver of detected collision within adequate drive reaction time range.

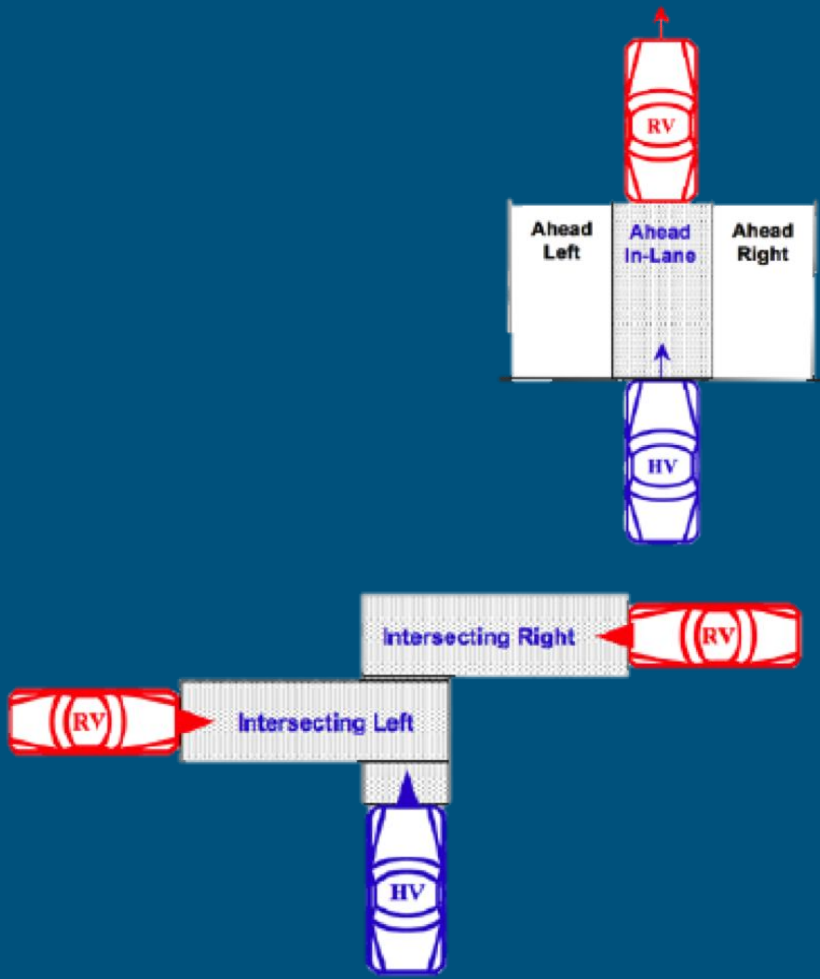
d. The system will alert drivers at least 10 seconds prior to reaching calculated collision point
e. Alert time will be based on speed and distance from collision point as calculated by collision detection algorithm.
f. Alert system will warn driver of collision type via audio interface triggered by collision detection algorithm.

System will be viable for drivers with disabilities; Deaf and Colorblind.

g. System will included visual and audio interface.
h. System visual interface will included flashing leds that will direct drives attention to collision location.
i. LEDs will be placed on both side mirrors and rearview mirror

Project Overview

- Develop a retrofit (non-autonomous) device to alert motorists of possible vehicle-to-vehicle collisions.
- Device will collect and calculate data and share it with nearby vehicles
- Constraints
  - Device compatible with 2008 and younger
  - System developed for lightweight Sedan
  - Collision detection accuracy threshold



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Logical Design

Dominic Eaton

System Breakdown

Intelligence System

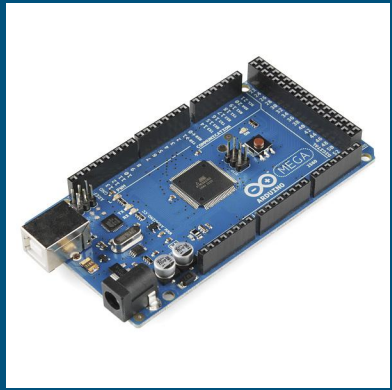
General Constraints

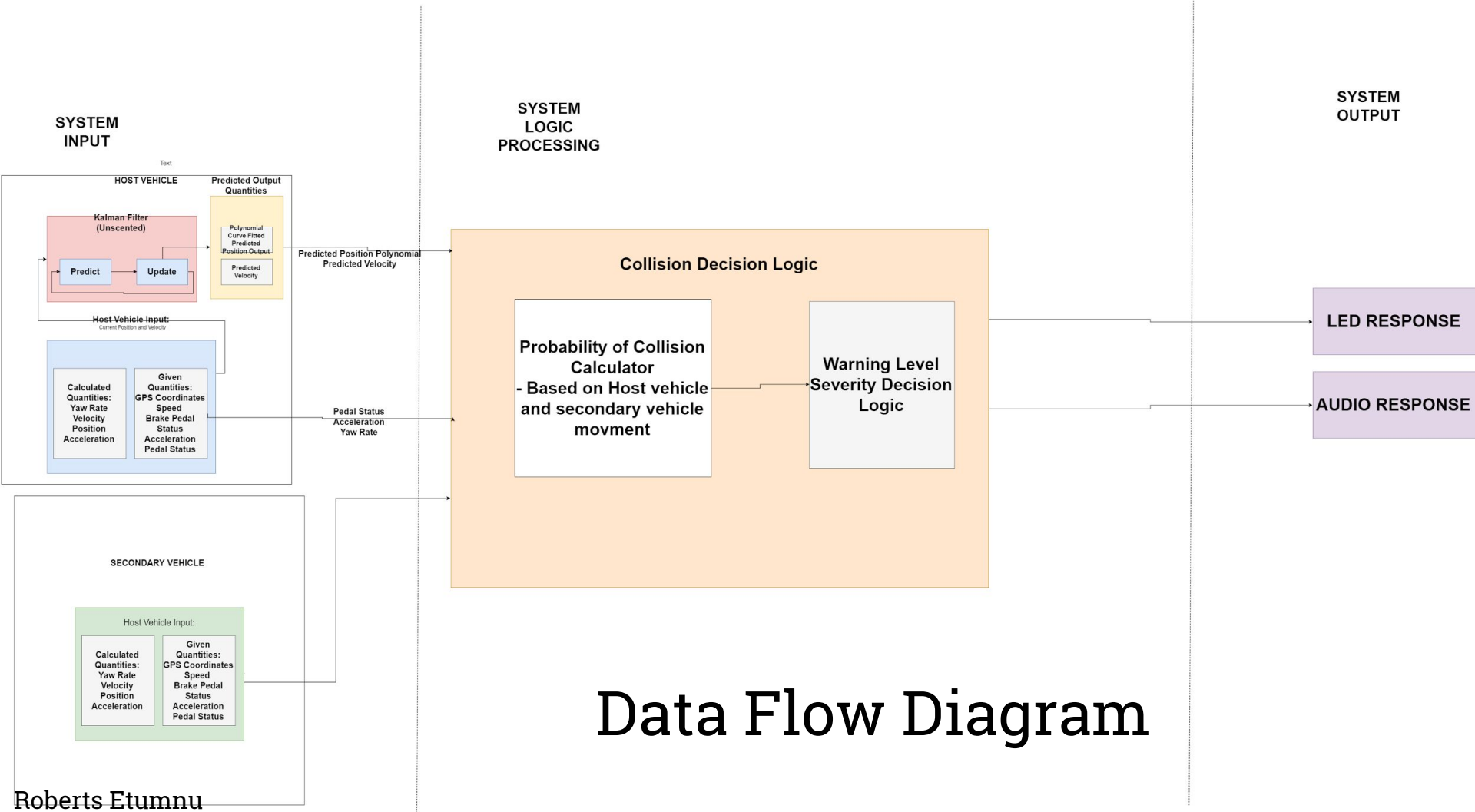
- Will issue warnings as early as 10 [s]
- Will have a prediction accuracy at average speeds up to 75 [mph] (31 [m/s]) and resulting distances of up to 350 [m]
  - Collision accuracy shall degrade after this threshold value is reached
- Will require a human perceptive response time of at least 2.5 [s]
  - Average driver response time is about 2.3 [s]
  - In the American Judiciary System uses a reaction time of about 1 [s]
- Will be used to manage pertinent calculations and handle decisions germane to collision avoidance and detection

Intelligence System (continued)

Device Constraints

- Will be implemented through a microcontroller
- Current selected option is the Arduino Mega
- Provide point of connection between alert system peripherals, communication and data management systems





Data Flow Diagram

Roberts Etumnu

Data Management System

Previous Device:

- NovAtel Span-CPT

  - GNSS and INS receiver
  - 3D positioning, velocity, and also attitude
  - Accuracy of centimeters.

Prospective Device:

- Ford OpenXC

  - Connects to vehicle OBD-II(On-board diagnostics port II).

  - Reads data from the vehicle in real-time

Open XC - Data Collection

- Steering_wheel_angle (600 to +600 degrees)
- Vehicle_speed (0 to 655 km/h)
- Accelerator_pedal_position (0 to 100%)
- Brake_pedal_status Boolean (True == pedal pressed)
- Transmission_gear_position (States: first, second, third, fourth, fifth, sixth, seventh, eighth, reverse, neutral)
- Odometer
- Fuel_level
- Latitude (-89.0 to 89.0 degrees with standard GPS accuracy)
- Longitude (-179.0 to 179.0 degrees with standard GPS accuracy)

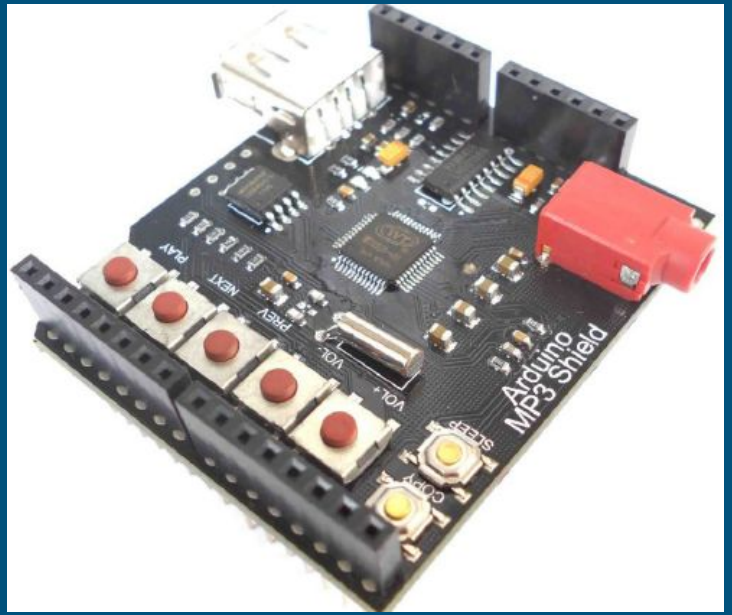
Alert System

Arduino MP3 Shield

- MP3 module
- Supports standard MP3 and WAV format audio files
- Supports three kinds of storage devices, including an USB Flash Drive

LED Sequence

- Will be located on both side view mirrors and on rearview mirror.
- LED in the direction of the collision will flash to direct drivers attention.
    - ie. rear end collision rear view mirror LED will flash



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Communication System

ARADA LocoMate Mini 2 OBU

- Constraints
  - Frequency: 5.7 - 5.925 GHz
  - Distance: within 400 meters

Communication System

WAVE - *Wireless Access in Vehicular Environment*

- **Multi-Channel**
  - **Control Channel**
  - **Service Channel**
- **Networking - IPv6**
- **Transport - UDP**

DSRC - *Dedicated Short-Range Communications*

- Benefits
  - Low Latency
  - High Reliability when Required
  - Priority for Safety Applications
  - Security & Privacy

Communication System

Protocol

- **SAE J2735**
  - Data Dictionary
    - 16 Messages
    - Our Focus - MSG_BasicSafetyMessage (BSM)

GPS Device

- Accuracy < 1m
- Embedded RF antenna
- Passive Probe
- Active Probe

Data elements/frames		Description	Remarks
Part I	DSRCmsgID		
Part I: BSM Blob (Octet string)	MsgCnt		
	TemporatyID		
	DSecond		
	Latitude		
	Longitude		
	Elevation		
	PositionalAccuracy		
	TransmissionAndSpeed		
	AccelerationSet4Way		
	BrakeSystemStatus		
	VehicleSize		
Part II	SafetyExtension		Optional
	VehicleStatus		Optional

Finances

- **Budget Allocated** - $10,000
- **Contingency Budget** - $2,000 -> reducing active budget to $8,000
- **Total Cost of Items** - $2,466.96
- **Remaining Balance** - $5,533.04

Questions?