EARLY DYNAMIC COLLISION AVOIDANCE SYSTEM

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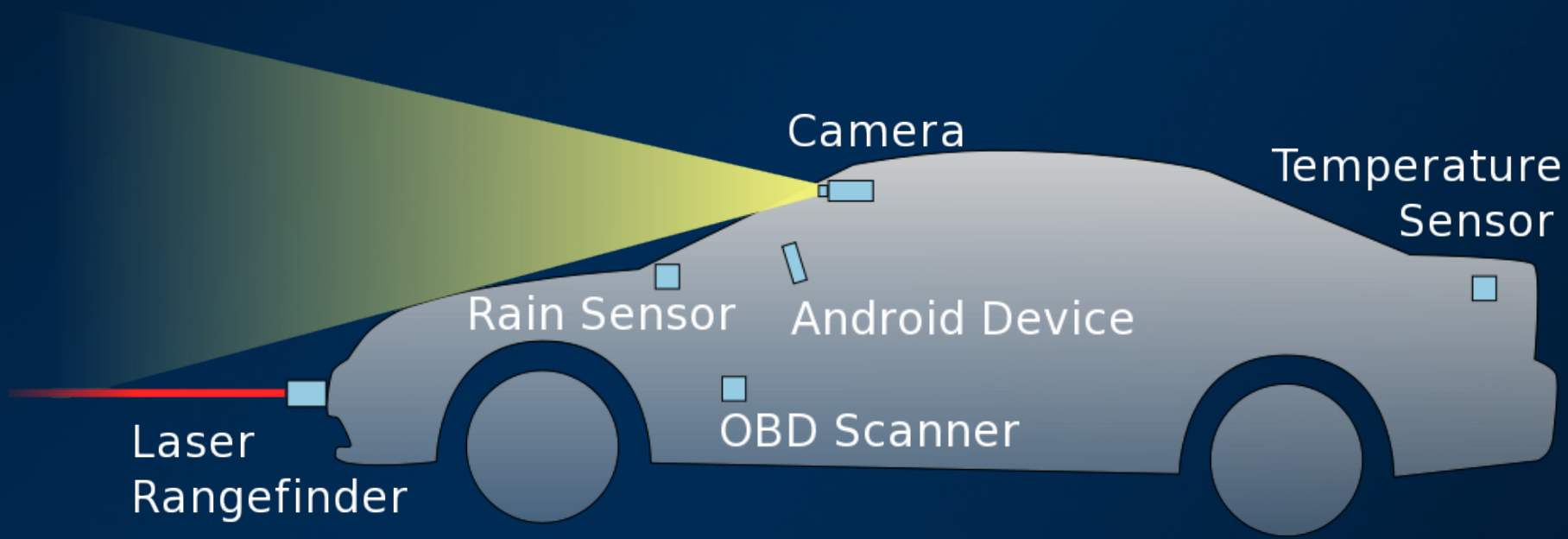
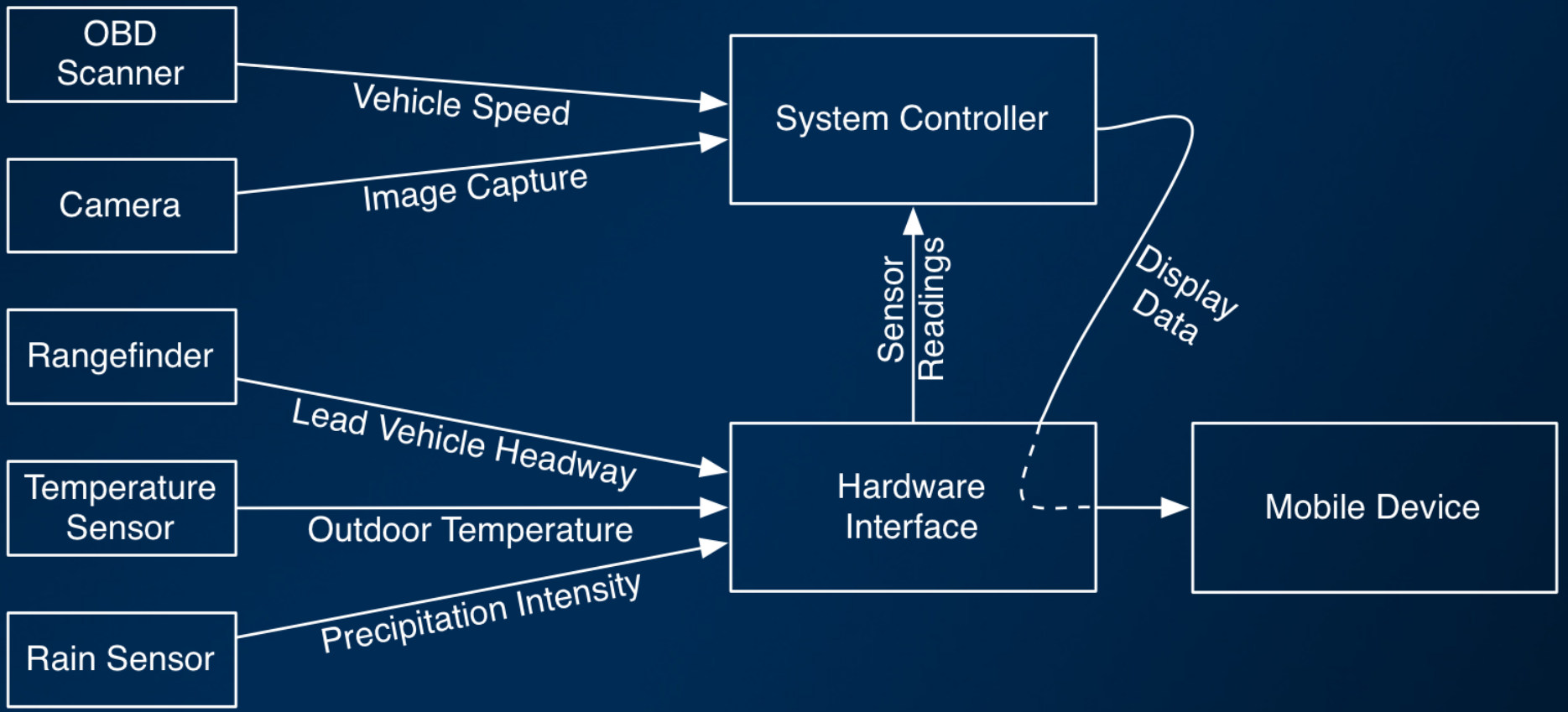
Project Overview

- System that detects impending collisions
- Determines reaction time
- Weather detection
- Warns driver of impending collisions
- Designed for highway conditions
- Real-time headway time display
- Final cost of $1760

System Overview Diagram

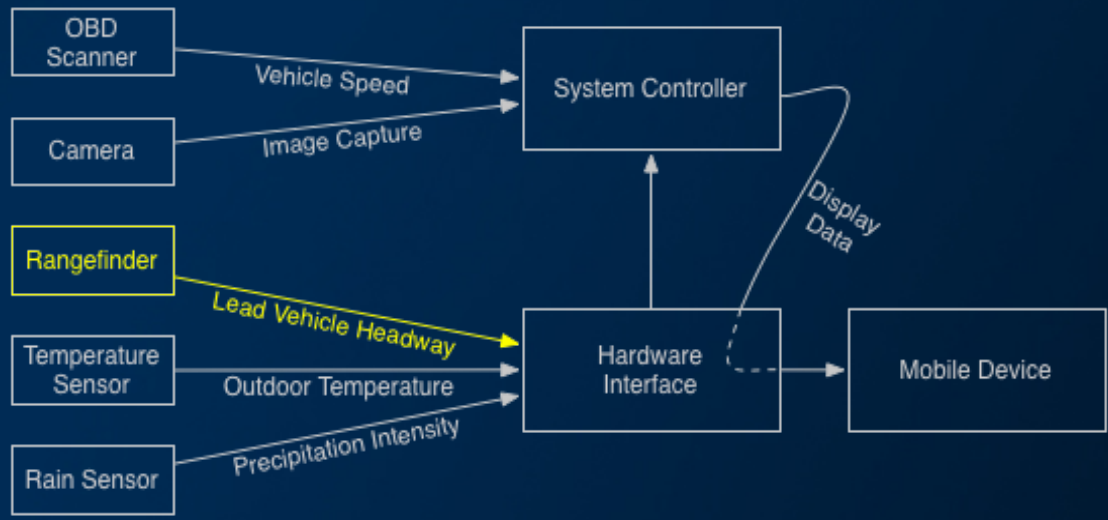


Block Diagram



Final Product: Laser Rangefinder

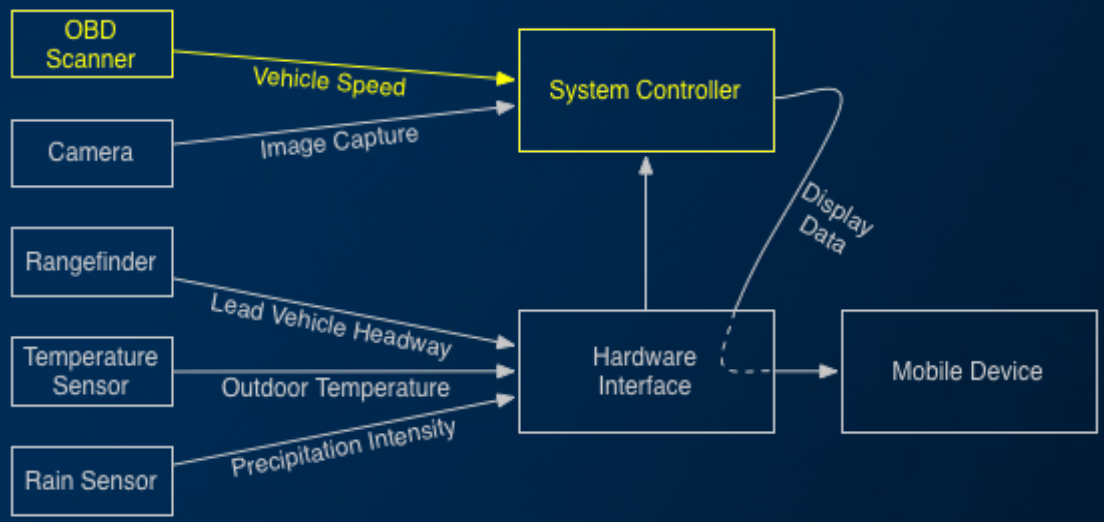
Laser Rangefinder RS-100 by Opti-Logic



- Opti-Logic RS-100 with increased rep rate
- 19200 baud serial connection to laptop
- Custom weather-proof enclosure

Final Product: OBD Scanner

OBD II Scanner



- Capable of querying any parameter provided by ECU
- 115200 baud serial connection to laptop

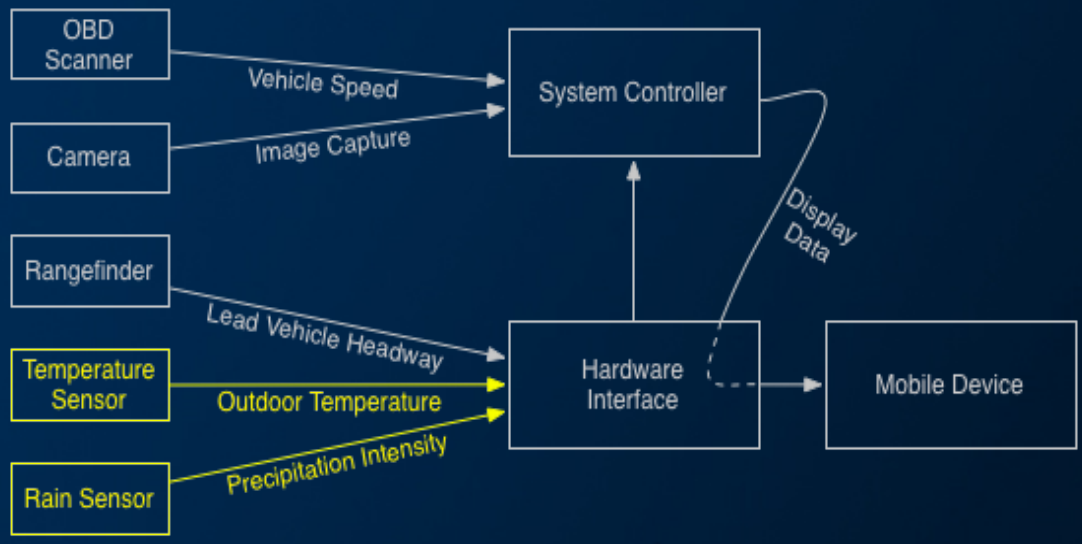
Final Product: Environmental Sensors

Hydreon RT-50A Rain Tracker

- Infrared detection of rain
- 5V Analog Output
- 10-bit accuracy

Sensirion SHT_15 Temperature/humidity sensor

- Digital 2 Wire interface/I^2C
- Response time < 1 sec
- Mounted inside chassis



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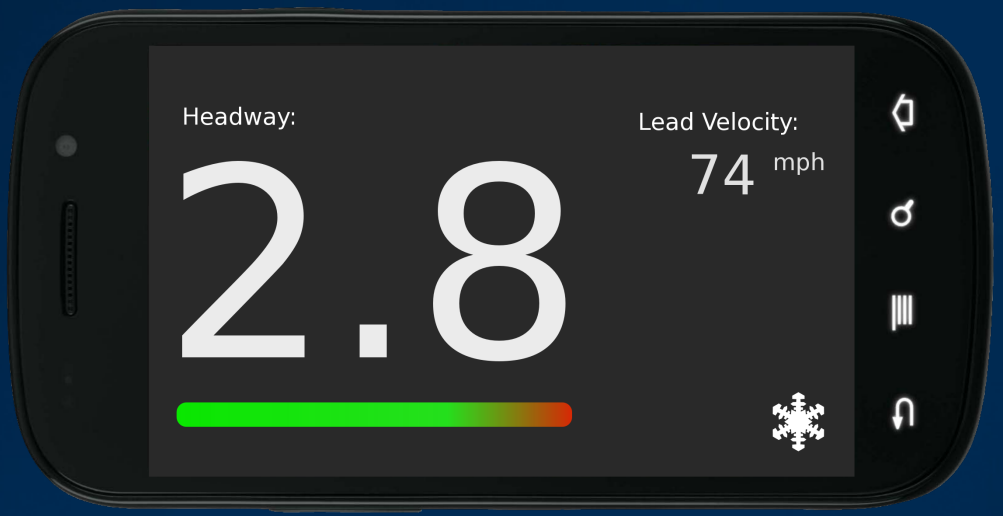
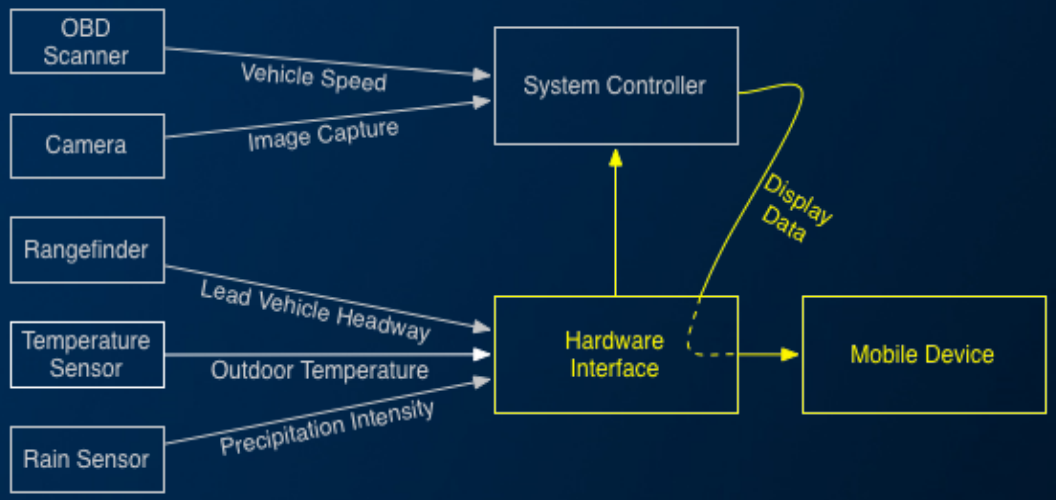
Final Product: Interface and Mobile Device

Android GUI and Alert
- Android Open Accessory Development Kit
- Interpretation of data from Arduino

Arduino Mega ADK
- Sensor data collection and dissemination to Android
- Serial communication with computer





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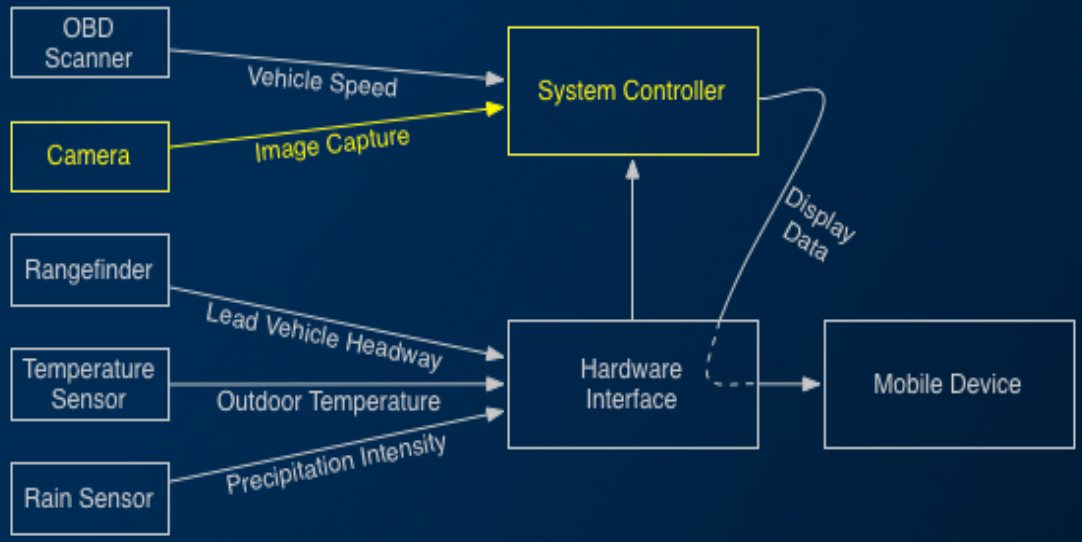
Final Product: Computer Vision



- Logitech C-600 Webcam
- Detects presence and position of lead vehicles
- Provides context for distance readings

Asynchronous Fused Kalman Filter

Time update equations:

$$\hat{x}_k^- = A\hat{x}_{k-1}^-$$
$$P_k^- = AP_{k-1}A^{\mathrm{T}} + Q$$

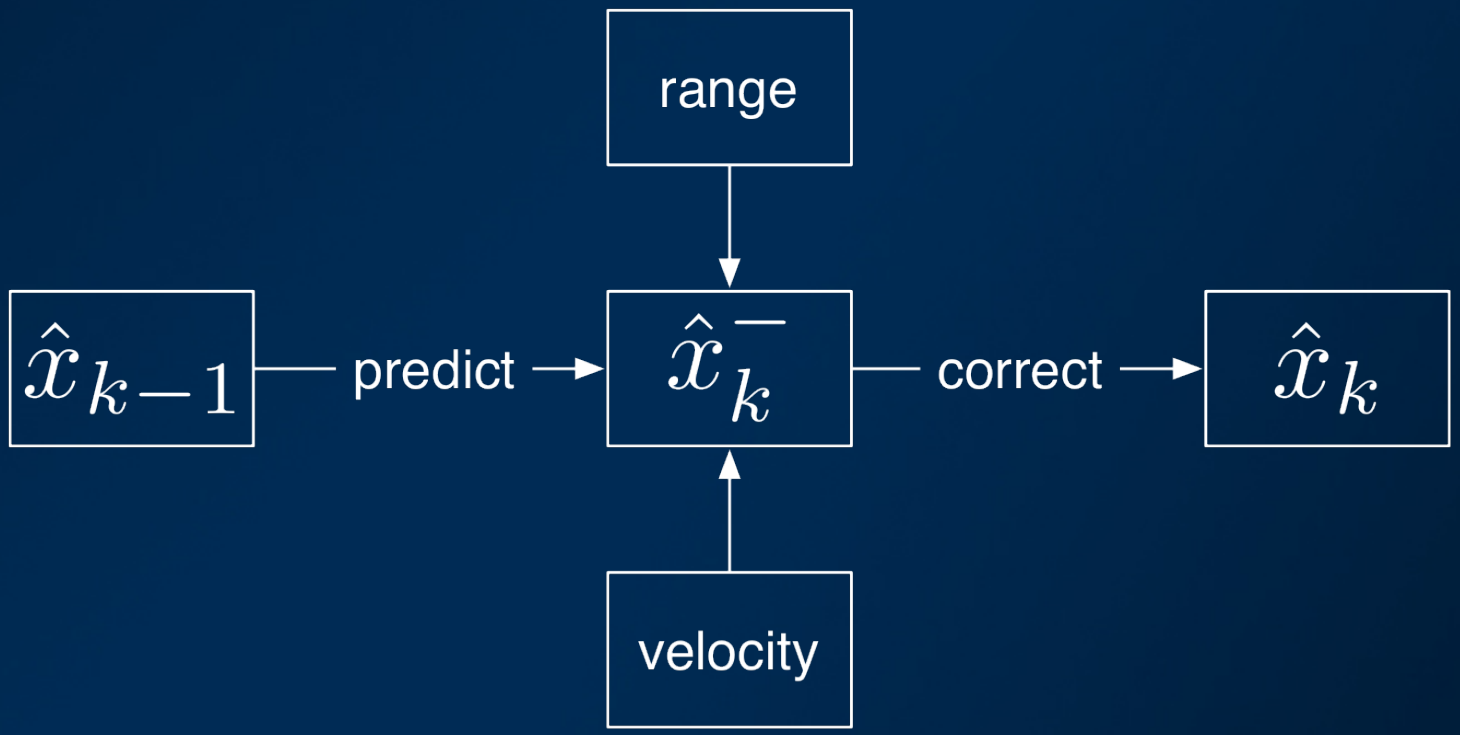
Measurement update equations:

$$K_k = P_k^- H^{\mathrm{T}}(HP_k^- H^{\mathrm{T}} + R)^{-1}$$
$$\hat{x}_k = \hat{x}_k^- + K_k(z_k - H\hat{x}_k^-)$$
$$P_k = (I - K_k H)P_k^-$$

States: $x = \begin{vmatrix} \mathrm{range}_k \\ \mathrm{range}_{k-1} \\ \mathrm{velocity}_k \\ \mathrm{velocity}_{k-1} \end{vmatrix}$ Transition Matrix: $A = \begin{vmatrix} 2 & -1 & -dt & dt \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 2 & -1 \\ 0 & 0 & 1 & 0 \end{vmatrix}$

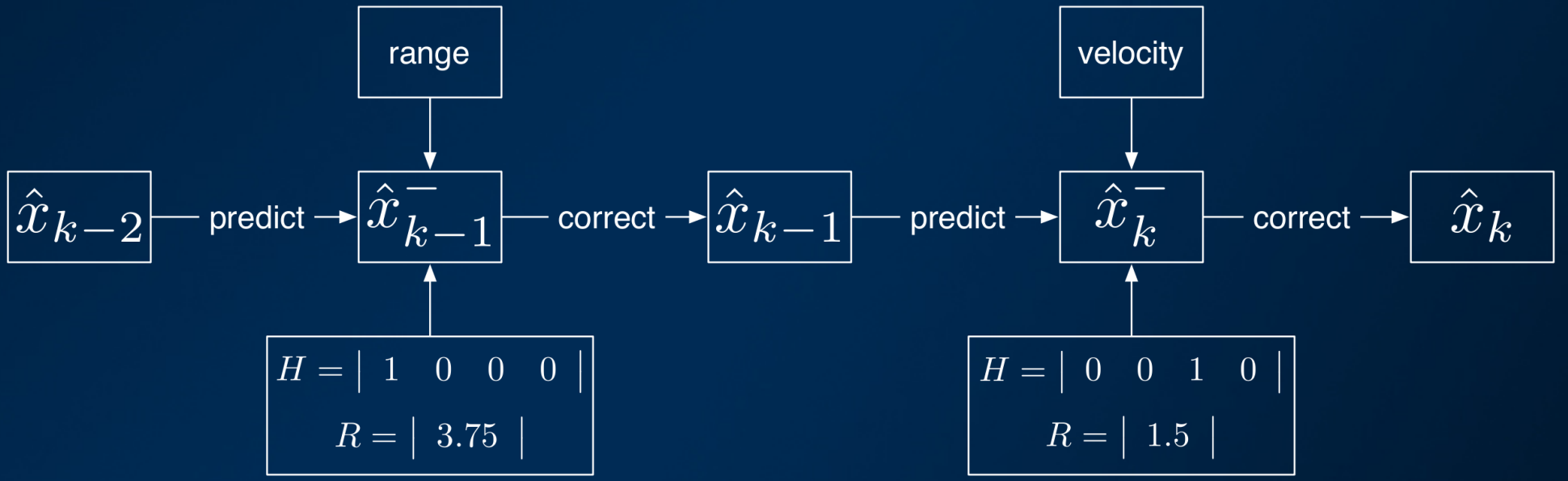
Asynchronous Fused Kalman Filter

General Kalman filter update procedure:

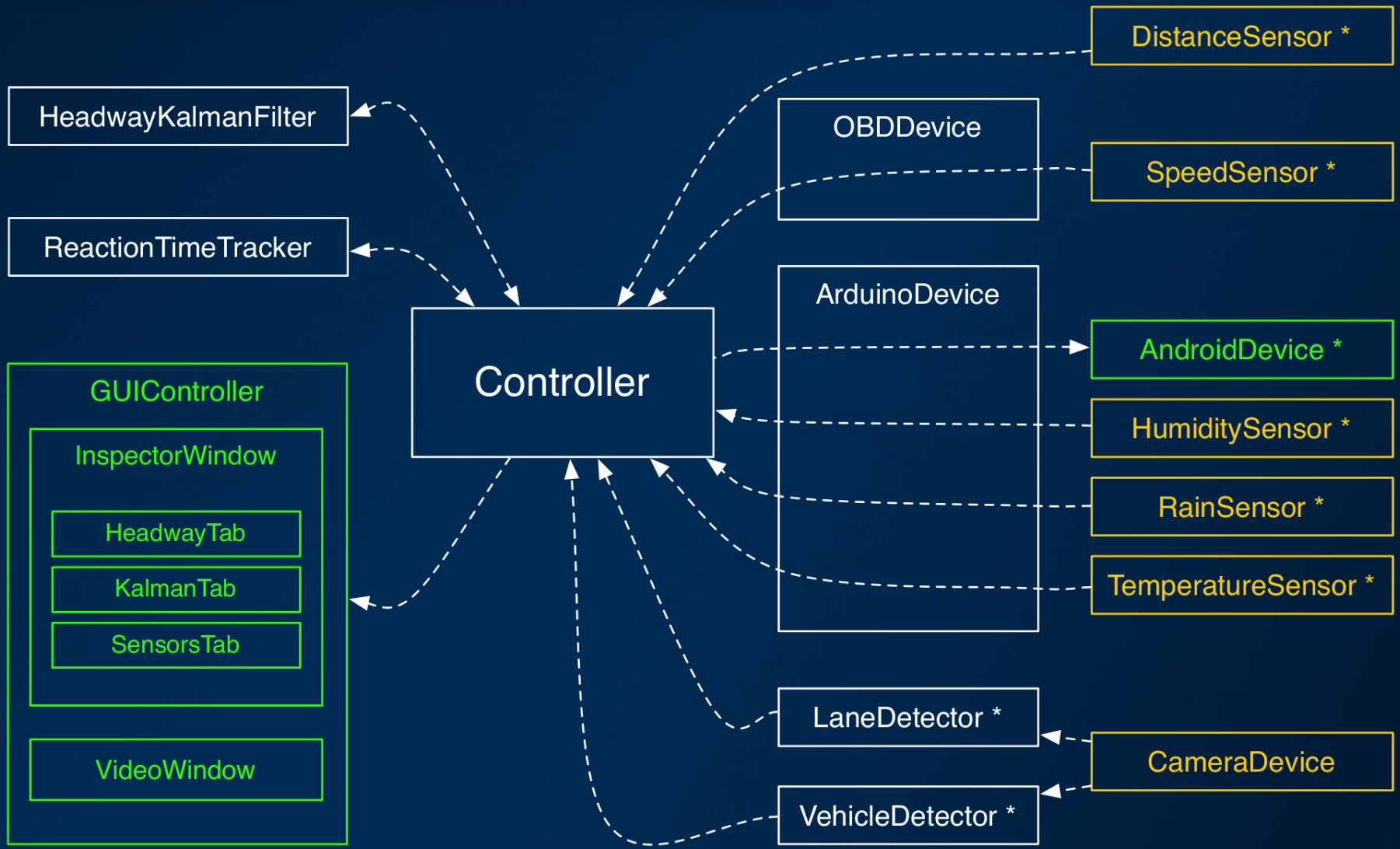


Asynchronous Fused Kalman Filter

Asynchronous Kalman filter update procedure:



Software Overview



Original Objectives

Method of predicting impending collisions

Auditory/visual warnings

Weather/environmental factors

Weather-proof enclosure to protect external parts

Completed Objectives

Method of predicting impending collisions ✓
- Mathematical algorithms

Auditory/visual warnings ✓
- Android displays pertinent data and emits alerts

Weather/environmental factors ✓
- Implementation of environmental sensors
- Role of environmental sensor data in reaction time calculations

Weather-proof enclosure to protect external parts ✓
- Sensors physically insulated
- Laser insulated with weather proof materials

Final Cost

Previous Expenses	Cost
Senior Design Budget Total	$495
Parts contributed by members	$1250
Additional Expenses	**Cost**
Wires, Misc. Cables and Connectors	$14
USB Hub	$24
Waterproofing Materials	$10
Phone Mount	$15
Final Project Total	**$1808**

Future Work

Adaptive cruise control abilities
- Engage the car system to automatically brake
- Regulate vehicle velocity

Servo installation
- Adjust the laser based on computer vision

Radar rangefinder application
- Wider field of view for vehicle detection

Accurate road condition detection
- Real-time ice detection using radar