ECE4007 Project Summary

Project Title	**Early Warning System for Collision Avoidance**
Team Members (names and majors)	Graham Fletcher (EE) George Yuchi (EE) Ryan Baker (EE) Garrett Chinsomboon (EE)
Advisor / Section	Dr. Erick Maxwell / L03
Semester	2011 Fall Intermediate
Project Abstract (250-300 words)	To reduce the number of motor vehicle collisions, the team will design and build a system that detects and alerts drivers of impending collisions. 26.5% of all collisions are front-to-rear, and 64% of those are due to driver inattention. The team's design intends to reduce rear-end collisions by ensuring that the driver is alerted of potential collisions ahead of time. The system searches for conditions likely to result in a rear-end collision with a leading vehicle. It analyzes road conditions to determine headway time, and warns the driver with visual and audio alerts before the collision becomes inevitable. The design will include a laser rangefinder that allows the system to detect objects up to 300 yards away, and its output is relayed to an Arduino microcontroller. The Arduino also interfaces with temperature, humidity, and rain sensors, and reports all of the acquired data to a computer, which is responsible for estimating headway times. The system processes the input from a USB camera using computer vision algorithms to detect vehicles and better understand the rangefinder data. The driver's reaction time is estimated using the Comprehensive Optimal Velocity Model, and is taken into consideration when determining when to issue an alert. The system issues alerts via a mobile device running Android 2.3, which is connected to the vehicle's stereo system. The mobile device displays visual alerts on its screen and plays audio alerts through the vehicle's speakers. This system improves upon existing systems by taking into account road conditions and the driver's reaction time. Since each car model brakes and handles differently, the proposed design is intended to be implemented via OEM during vehicle production, taking into account the vehicle's specific performance specifications. The expected outcome of the design is a fully-functional prototype that will cost $1760.

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List **codes** and **standards** that significantly affect your project. Briefly describe how they influenced your design.	1. RS232 or Serial Port is a 25-pin serial connector which communicates data from the laser rangefinder to the rest of the system. It features ● Highly customizable pin conventions ● 8-bit data transmissions 2. USB (Universal Serial Bus) is a ubiquitous 4-pin serialized connector and handshake standard for communication between the webcam, Arduino, and computer. It features ● Self-powering connector ● Vast interoperability, library interface to Arduino ● 480 Mbit/sec transmission rate 3. I2C (Inter-Integrated Circuit or two-wire interface) interfaces the temperature/humidity sensor to the Arduino and is a popular IC-level interconnect between micro-controllers and device drivers. It features ● 400 Kbits/sec data transmission ● Configurable master/slave instances ● Supported by the Arduino "Wire" library for rapid prototyping 4. The Class 1 (eye-safe) laser standard applies to the laser emission cavity in the laser rangefinder. It specifies ● A laser wavelength of 905 nm +/- 10nm ● Low enough power output to prevent harmful exposure 5. *Manual on Uniform Traffic Control Devices*, published by the U.S. Department of Transportation, outlines: ● Normal pavement markings are "4 to 6 inches wide" ● "Broken lines should consist of 10-foot line segments and 30-foot gaps" ● Minimum highway lane width of 12 feet 6. ISO-9141-2 is an OBD-ii protocol used by Chrysler and many European and Asian vehicles. Communication occurs on a single, bidirectional line without handshake signals. ● Operates at 10.4 Kbaud ● Message length is restricted to 12 bytes, including CRC
List at least two significant **realistic design constraints** that applied to your project. Briefly describe how they affected your design.	One debilitating limitation of the Early Collision Avoidance System is the conditions necessary for adequate visibility. Both computer vision and the laser rangefinder cannot operate under low visibility conditions such as fog. The laser rangefinder is also limited by surfaces with poor reflectivity (dirty cars). Other objects that may share the road with vehicles include cyclists and pedestrians but they may not be recognized by the system. Due to monetary constraints, the laser rangefinder was chosen as the distance detector for our project. The preferred radar development kit was too expensive and the team members lacked the expertise to construct it within a semesters' time. The narrow field of view of the laser makes it difficult to detect the lead car during turns and along curvatures of the highway. The implementation of the servo for the rangefinder based on computer vision is also deemed unrealistic given the time available to complete this project.

Briefly explain two **significant trade-offs** considered in your design, including options considered and the solution chosen.	LIDAR or radar technology would have been the ideal technology to work with instead of laser but the price and the calculations required to harness the potential of either technology would have likely significantly delayed progress on other aspects of the project. Using a weather service in place of weather sensors to detect weather conditions does not only provide delayed information but also introduces the problem of reliability. The android device is reliant upon cellular data service which is in turn reliant on the availability of cellular coverage. Instead, the temperature/humidity sensor and rain sensor were integrated into the project to determine weather conditions.
Briefly describe the **computing aspects** of your projects, specifically identifying **hardware-software** tradeoffs, interfaces, and/or interactions. *Complete if applicable; required if team includes CmpE majors.*	The project makes use of several key components. In particular, a laser rangefinder, a USB camera, an Arduino Mega ADK, a rain sensor, a temperature sensor, an Android device and a laptop computer will be used. 1) Laser rangefinder. The data rate of 10Hz (calibrated) ensures that the distance measurements are constantly up to date. This rate is crucial for especially for high speeds where there may be large discrepancies between each sampling. 2) The USB camera is used for vehicle detection. It is to be mounted up behind the windshield on the inside of the vehicle. The sensor resolution provides adequate clarity of vehicles ahead of it and compensates for closer vehicles that extend behind the minimum distance of detection of the laser rangefinder. 3) The Arduino ADK allows the microcontroller to interface with an Android device and a computer through the USB protocol, the laser rangefinder through RS232 serial communication, and the temperature/humidity sensors through serial communication. 4) The rain sensor, attached to the windshield of the vehicle, uses its infrared beams to detect the presence of rain. 5) The temperature/humidity sensor is used to determine if the environmental conditions are cold enough to warrant precautions against icy roads. Auditory warnings will be produced by a mobile phone running the Android Operating System, which will be connected through the headphone jack to the automobile's auxiliary port and allow warnings to be played over the car speakers. The computer hosts the GUI that displays data on the computer screen such as sensor information or real time video stream from the USB camera. The GUI also allows for the calibration of the laser rangefinder and the camera. Since the laser rangefinder reports distance readings to anything ahead of it, not just vehicles, and we must determine whether or not the data is valid. This will be accomplished using computer vision. First, the current lane will be detected. Next, vehicles will be detected by searching for Haar-like features that match characteristics found in our training data. When a vehicle is detected, its location will be followed for several frames, and if it is determined to be in the same lane as the following vehicle, it will be classified as the lead vehicle and the method for predicting collisions will be employed. The primary function of our system is to calculate the headway time, and once that time falls beyond a certain threshold, an alert will notify the driver.