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EE554 Project Proposal

Possible Project Name: "Sensing Mobile Android-assisted Real Time" CAR
(Key Terms: Vehicle, Android, Connected Device, Network, Wireless, Mobile, etc.)

Motivation:

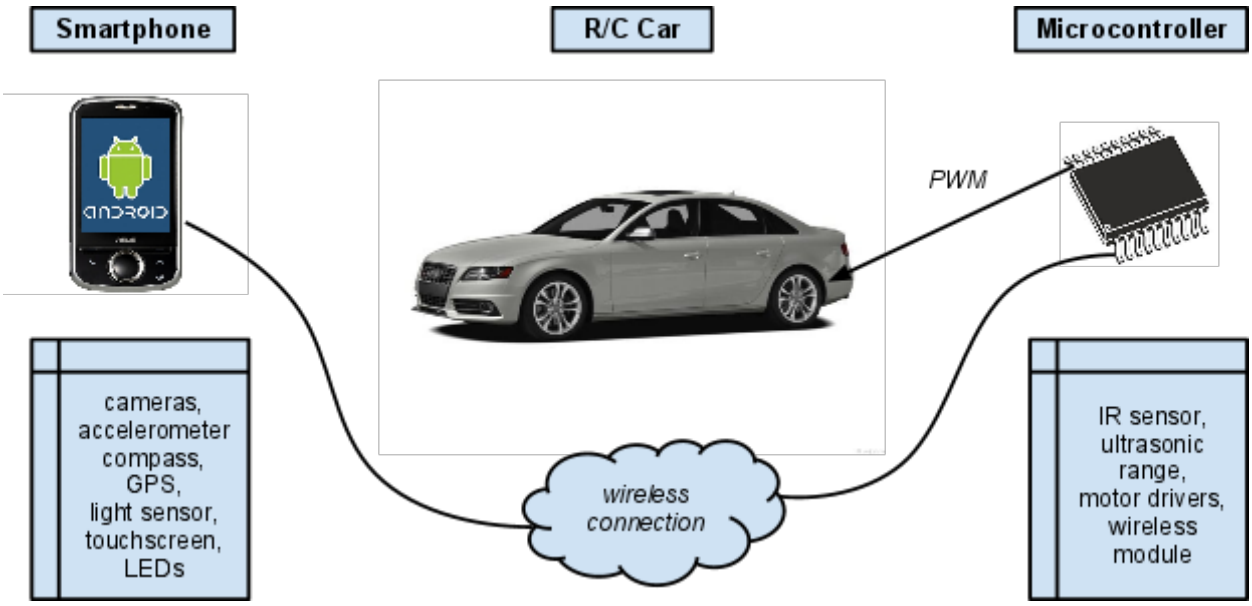
Road traffic accidents are one of the leading causes of death among humans. It is predicted that by 2020, traffic accidents will exceed HIV/AIDS as a burden of death and disability. By 2030, it will become the fifth leading cause of death.

Accidents occur because of humans' inability to react quickly in driving situations that require fast responses. Humans' reaction time is crippled as a result of drug usage such as drunk driving, physical impairment such as poor eyesight, sleep deprivation, poor road conditions caused by bad weather, inexperience, speeding, or distractions (both from inside the vehicle or from the surrounding environment). The occurrence of accidents is highly dependant on factors relating to human behavior, sensory perception, decision making, reaction speed, awareness, and alertness.

Our solution to the rising problem of road traffic accidents is to reduce the number of accidents that are caused by human error. We will build a car that can automatically avoid head-on collisions and control its speed. We also would like to enable a "lane changing assistance" feature that would let the alert the driver if there's a vehicle in their blindspot. In addition, there are many other "add-on" features that could be implemented, such as applications for the military for enemy detection and autonomous driving. We believe that in the future all cars will operate autonomously, which will greatly reduce or even prevent traffic accidents. Our car will be a step forward in achieving this vision.

HW/SW Components:

- R/C car
- ATmega328 microcontroller
- Wi-Fi shield or Bluetooth module
- Android-powered smartphone (cameras, GPS, accelerometer, compass, light)
- Infrared proximity sensor
- Ultrasonic range finder
- Lithium polymer battery
- Android SDK
- OpenCV computer vision library



Real-time Aspects:

Avoiding traffic collisions is a life-critical task that depends on a real-time system to operate reliably. This system must meet its deadlines in a predictable manner. Our project encompasses the following aspects of a real-time system:

- analog data sampling from proximity sensors and phone sensors
- analog signal processing of camera images
- motor control for R/C car
- wireless communication (synchronization, queueing)
- interrupts, scheduling, preemption, multithreading
- fault-tolerance and recovery

System Operation:

The hardware platform integrates three main devices (R/C car, microcontroller, smartphone) and interconnects their sensors/actuators through wireless communication. The ATmega328 microcontroller features analog and digital I/O, TTL serial, interrupt, and PWM pins running at 16MHz. It supports I2C and SPI communication. The microcontroller will control the R/C car motor drivers with PWM output, and read the IR and ultrasonic proximity sensors through its analog input pins. A wireless communication module will connect the microcontroller to a car-mounted Android smartphone for additional sensor input from the phone's onboard cameras, accelerometer, GPS, compass, touchscreen, and light sensors. Another mobile device (laptop or phone) can also be connected to the wireless network for additional monitoring and control.

An Android app for the smartphone will handle the wireless communication protocol, image processing, and message passing to the motor control loop running on the microcontroller. The Android SDK provides software tools and libraries for developing applications for Android-powered devices. OpenCV is a computer vision library that provides functions for real-time

computer vision, giving the vehicle the ability to “see” its environment.

Once we have this platform established, several vehicular tasks can be addressed including:

- frontal collision detection and avoidance (calculate stopping distance)
- military applications (search and destroy, remote operation, terrorist finder)
- enhanced cruise control (following another vehicle, drafting to save space/fuel)
- autopilot (autonomously drive to destination, self-parking, navigation)
- inter-vehicle communication (negotiate merges, lane changes, improving traffic flow)
- lane departure warning system
- eliminate blind spots, rear view alarm, night vision
- airbag deployment, other human safety mechanisms

Challenges:

Wireless communication
Software control
System integration
Image processing