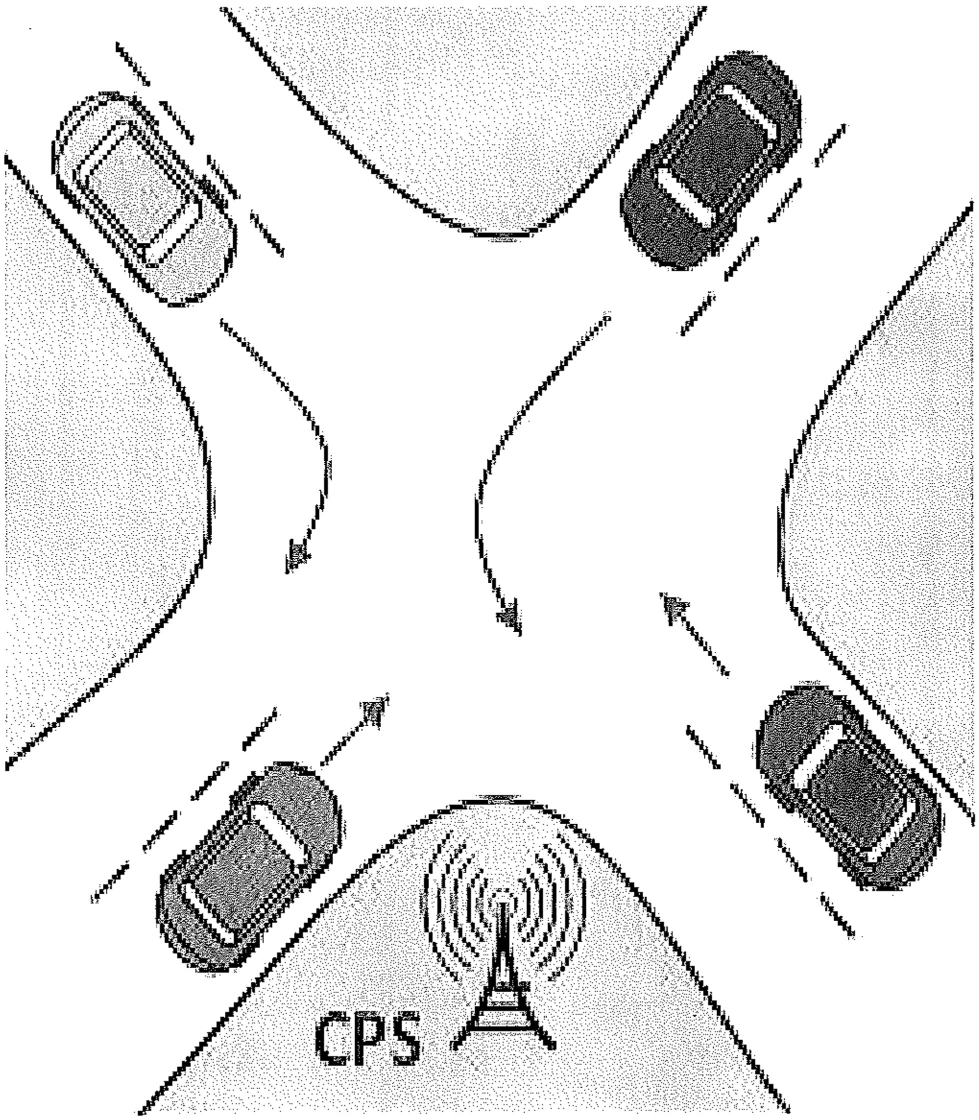

Cyber Physical Systems

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Introduction

Hello my name is Anthony Cherry and my partner is Kerry Ann Warrington. At the beginning of the 2015 spring semester we enrolled in the course CS405 (Software Development).We were paired together and presented some info about (CPS) Cyber Physical Systems which would be our main focus. The task at hand was to figure out a plausible way to implement CPS by a coding a program. In no time after a bit more research on the topic, it was decided that we would invest our time in the area of motor vehicles. Most people value their car highly so they want to keep it scratch and dent free. While there are many people who can operate a motor vehicle safely, there are still a large percentage of those who don't. The amount of accidents that occur each year is very high, but there has to be some way to decrease them. We figured that we would create a program that would simulate moving cars and use cyber physical systems to prevent them from crashing into one another. We chose to use the language Python in the compiler Pygame to create this project.

What is Cyber Physical Systems?

A cyber-physical system or (CPS) is a system of collaborating computational elements controlling physical entities.

What is the purpose of it?

Today, a precursor generation of cyber-physical systems can be found in areas as diverse as aerospace, automotive, chemical processes, civil infrastructure, energy, healthcare, manufacturing, transportation, entertainment, and consumer appliances. This generation is often referred to as embedded systems. In embedded systems the emphasis tends to be more on the computational elements, and less on an intense link between the computational and physical elements

What is the relationship between Embedded and Cyberphysical systems?

An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints.It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today

How it Works?

A CPS is the integration of abstract computations and physical processes, where sensors, actuators, and embedded devices are networked to sense, monitor, and control the physical world. In contrast to traditional embedded systems, the CPS is a network of interacting appliances with physical inputs and outputs instead of standalone devices. A typical CPS application is to connect appliances embedded with sensor nodes (which are responsible for information collection from the physical world as the source of CPS inputs) to some real-time decision making system (which represents the virtual world). Upon receiving the inputs from sensor nodes, the CPS will make a corresponding decision based on the inputs and computational processing to the actuators in the physical world by a sequence of control processes.

Mobile Cyber Physical Systems

Mobile cyber physical systems, in which the physical system in question has inherent mobility, are a prominent subcategory of cyber-physical systems. Examples of mobile physical systems include mobile robotics and electronics transported by humans or animals. The rise in popularity of smartphones has increased interest in the area of mobile cyber-physical systems. Smartphone platforms make ideal mobile cyber-physical systems for a number of reasons

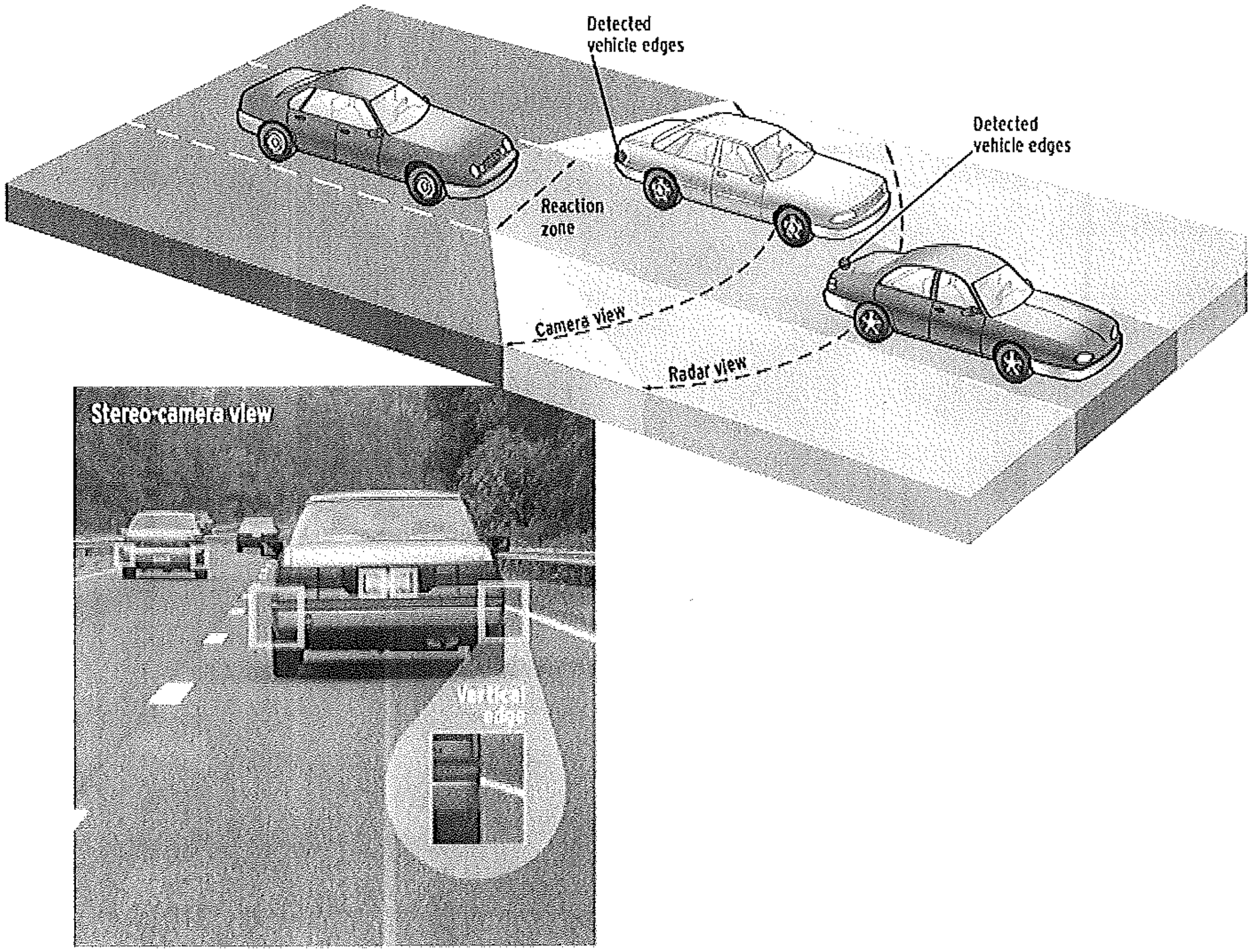
Mobile Cyber Physical Systems Use

- Significant computational resources, such as processing capability, local storage
- Multiple sensory input/output devices, such as touch screens, cameras, GPS chips, speakers, microphone, light sensors, proximity sensors
- Multiple communication mechanisms, such as WiFi, 3G, EDGE, Bluetooth for interconnecting devices to either the Internet, or to other devices
- High-level programming languages that enable rapid development of mobile CPS node software, such as Java,[13] Objective C, or C#
- Readily-available application distribution mechanisms, such as the Android Market and Apple App Store
- End-user maintenance and upkeep, including frequent re-charging of the battery

Examples

Cyber-physical systems (CPS) link cyberspace with the physical world through a network of interrelated elements, such as sensors and actuators, robotics, and computational engines. These systems are highly automated, intelligent, and collaborative. CPS examples include energy neutral buildings, zero-fatality highways, and personalized medical devices.

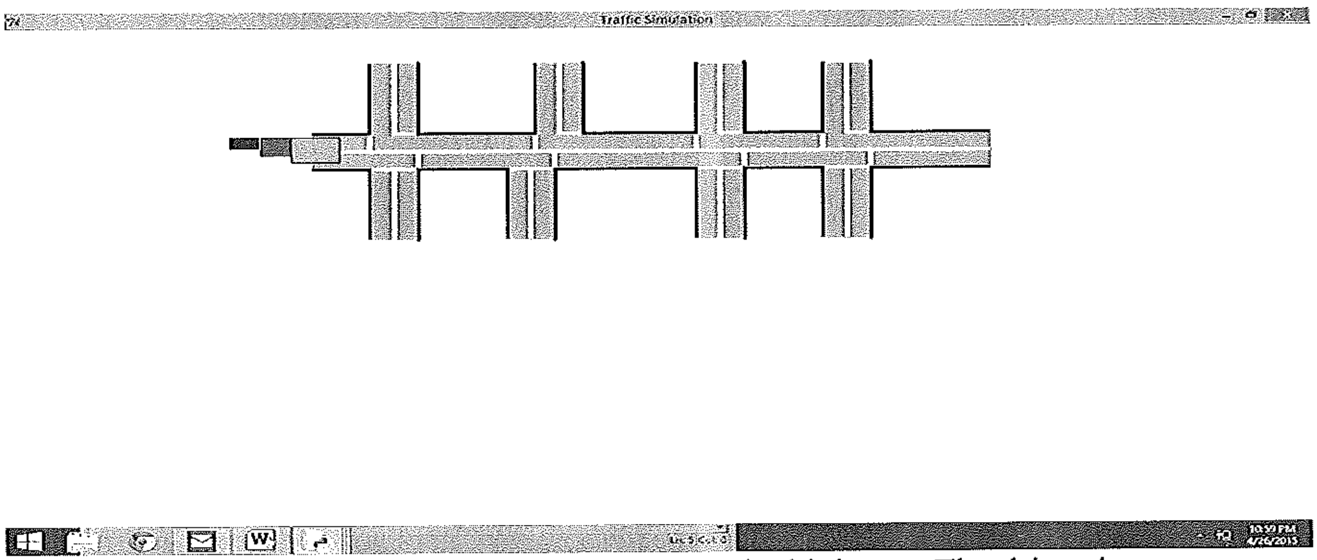
- For tasks that require more resources than are locally available, one common mechanism for rapid implementation of smartphone-based mobile cyber-physical system nodes utilizes the network connectivity to link the mobile system with either a server or a cloud environment, enabling complex processing tasks that are impossible under local resource constraints. Examples of mobile cyber-physical systems include applications to track and analyze $CO2$ emissions,detect traffic accidents and provide situational awareness services to first responders,measure traffic,and monitor cardiac patients.



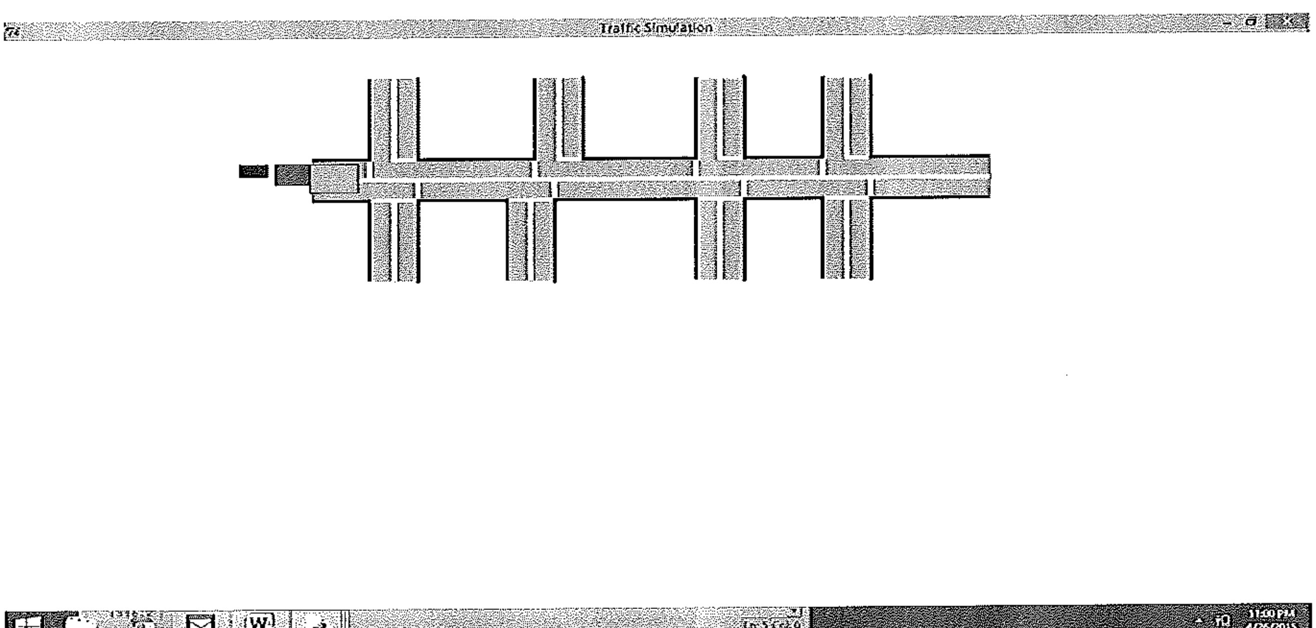
Model

Here you can see a small base model of what we did. Let's say there are three cars driving together. Assume everyone will not drive at the same speed, so what will help prevent them from crashing? Cyber Physical Systems is the answer by a longshot. By presenting embedded sensors in each corner of the cars you will create a field. As shown each sensor will have safe distance zone and a reaction zone. Once you get to close enough to another sensor a speaker inside the car will start to beep it and require you to slow down. If you fail to comply it will send a message to the cars computer system, which will de throttle the acceleration, therefore preventing the accident.

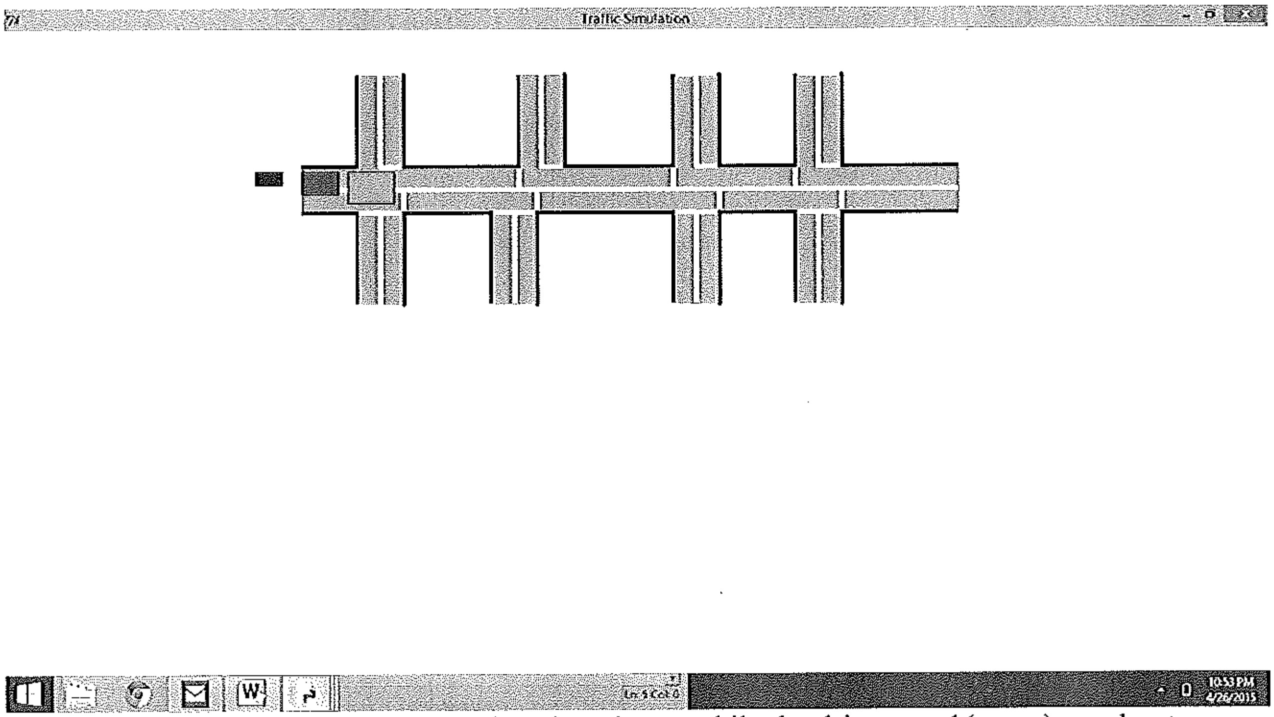
Screenshots and Code Explanation



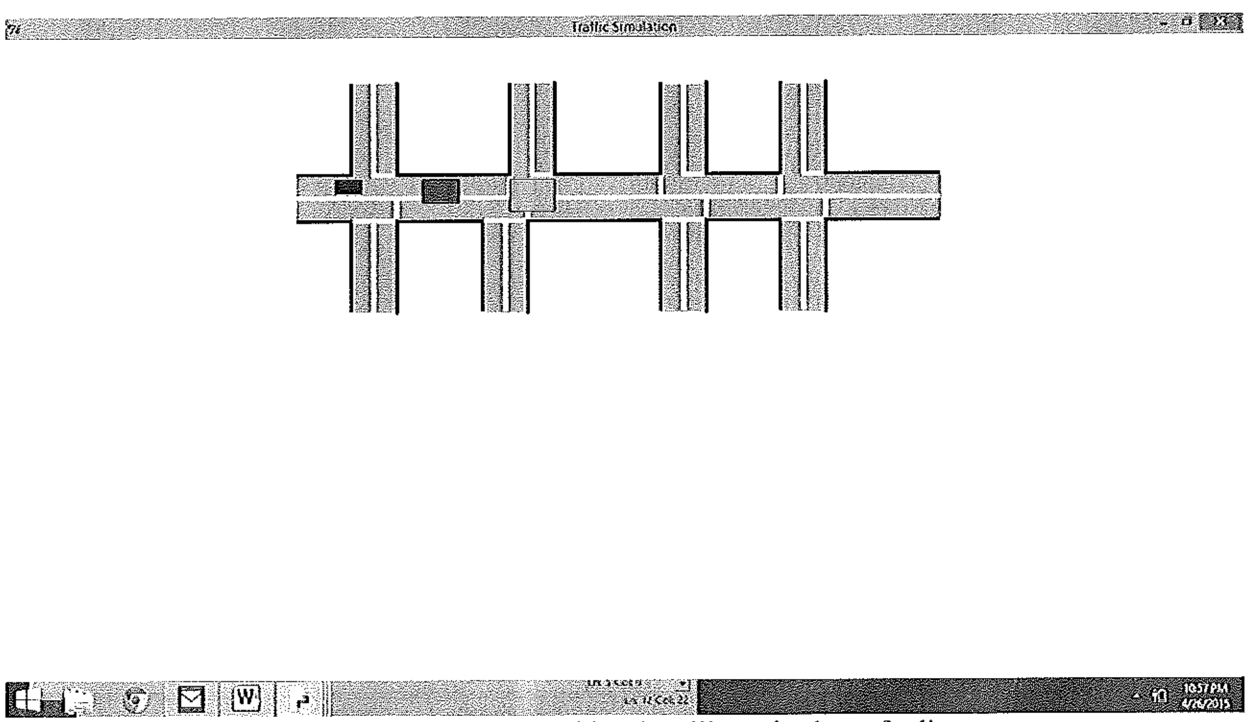
Here you see 3 cars about to go down ramp onto the highway. The driver in car 1(green) has slowed down too swiftly to make the transition. This causes the drivers behind to do the same but they almost run into each other. Here's where Mobile Cyber Physical Systems kick in.



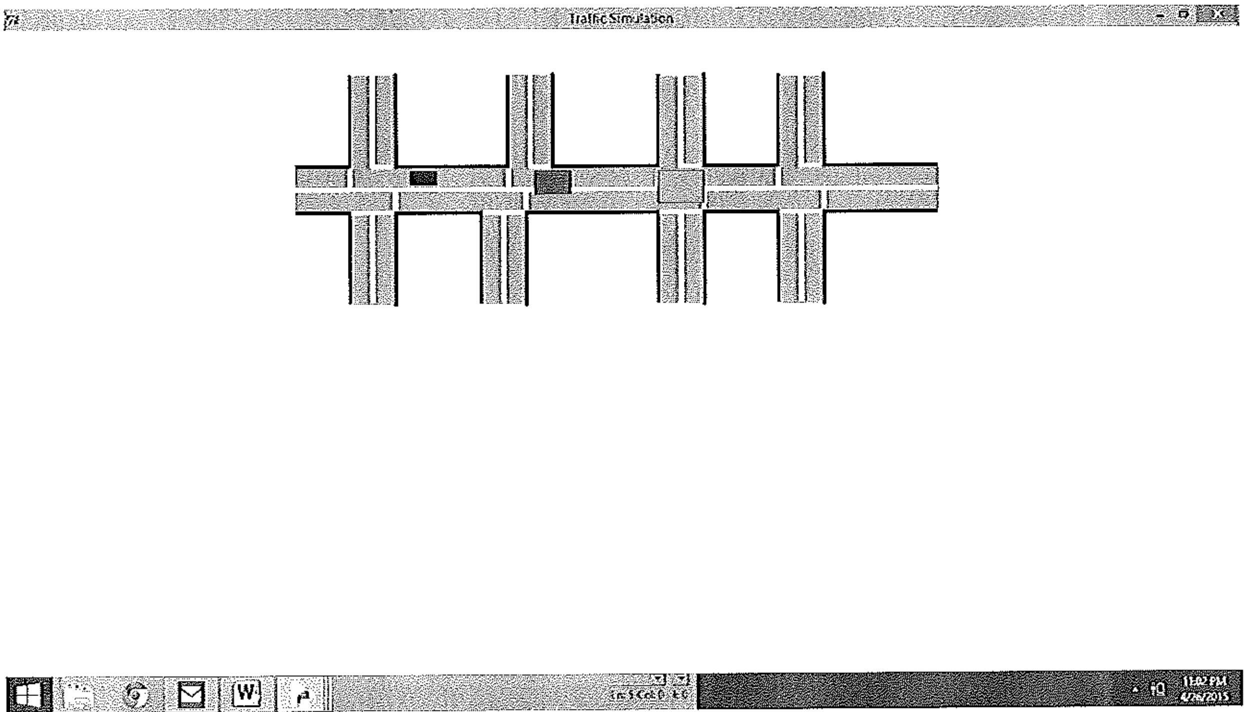
Next you see where the radars and sensors have alerted saying the red/blue vehicle has a breach in the reaction zone, which tells the car 3(blue) to slow down first.



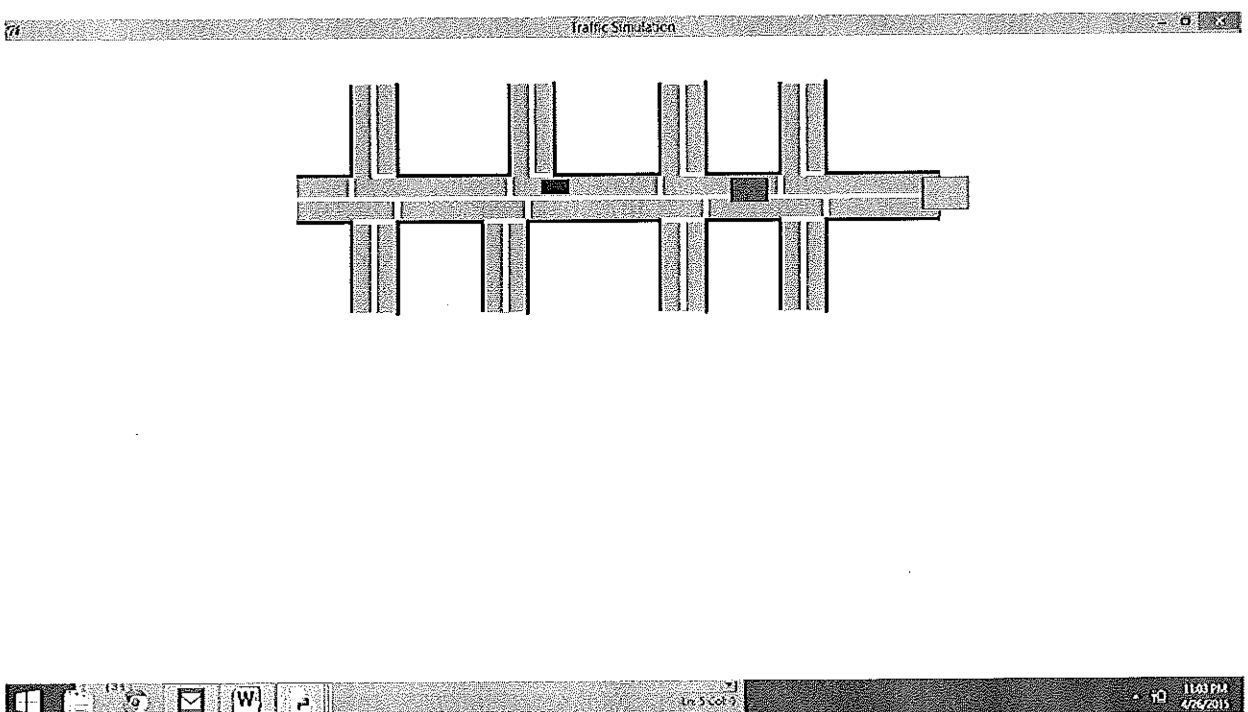
Next you see car 2 (red) is informed to slow down, while the driver car 1(green) accelerates.



Now here's where each vehicle has separated but is still not in the safe distance zone



Cars 1(Green) and Car2(Red) will accelerate to the safe zone distance



Once the safe distance zone has been reached each car will cruise at an equal distance, therefore preventing an accident from happening all while making it safer to drive on the highway

```
import Tkinter as tk
import time
root=tk.Tk()
root.title("Traffic Simulation")
canvas = tk.Canvas(root, width=1000, height=400, bg="#FFFFFF")
canvas.pack()
# make roads
road_data = [
 (140,150,200,150,200,150,200,50),
 (250,150,250,50,250,150,374,150,374,150,374,50),
 (424,150,424,50,424,150,542,150,542,150,542,50),
 (592,150,592,50,592,150,674,150,674,150,674,50),
 (724,150,724,50,724,150,850,150),
 (140,200,200,200,200,200,200,300),
 (250,200,250,300,250,200,344,200,344,200,344,300),
 (394,200,394,300,394,200,542,200,542,200,542,300),
 (592,200,592,300,592,200,674,200,674,200,674,300),
 (724,200,724,300,724,200,850,200),
 ]
for t in road_data:
 canvas.create_line(t, width=5)
# color roads
road_color_data = [
 (140,152,850,198),
 (202,50,248,300),
 (376,50,422,152),
 (346,198,392,300),
 (544,52,590,300),
 (676,52,722,300),
 ]
for t in road_color_data:
 canvas.create_rectangle(t, fill="#999999", outline='#999999')
# lines on road
road_lines_data = [
 (140,175,850,175),
 (225,50,225,150,248,150),
 (202,200,248,200),
 (225,200,225,300),
 (399,50,399,150,422,150),
 (346,200,392,200),
 (369,200,369,300),
 (567,50,567,150,590,150),
 (699,50,699,150,722,150),
 (544,200,590,200),
 (567,200,567,300),
 (676,200,722,200),
```

Conclusion

The creation of this project went very well. As we learned more about Cyber Physical Systems it propelled our vision to use it in automobiles. Through trial and error we were able to create a highway model and get the cars moving across the platform. We were successful in implementing the idea of sensor/radars embedded on the edges of each vehicle to calculate the speed and distance the cars moved, thus making sure they would not collide. This has proved that Cyber Physical systems should start to be commonly used in modern vehicles because not only will it save your car but it can also save a life