

Delphi Design Project

Emergency Vehicle Intersection
Sensor Technology

E.V.I.S.T

DELPHI

Innovation for the Real World

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EDSGN 100 FALL 2014

Introduction and Problem Statement:

All emergency vehicles are equipped with appropriate lights and sirens to alert other vehicles of their presence. Even with these precautions set forth, not all drivers are aware of incoming emergency vehicles because of distractions like cell phones, passengers, loud music, etc.. Busy intersections are where these numerous accidents occur. In fact, the Pennsylvania Department of Health for 2007 stated that 190 motor vehicle accidents involving ambulances were reported. 87 (46%) of these accidents occurred at intersections. Data found in other states also supports that accidents at intersections is a national problem, even when lights and sirens are running (1). This is not only an issue with ambulances, but also other dispatch vehicles like police cars and firetrucks. The US Department of Transportation states that in 2012, 16 fatalities occurred from ambulances, 9 fatalities from firetrucks, and 35 from police vehicles in emergency use (2). Many lives and money taken from accidents can be saved if a new form of communication between dispatched vehicles and motorists is put forth.

Executive Summary:

The design team worked to create an effective sensor system which allows emergency vehicles to safely pass through intersections without accidents occurring with other vehicles. Global Position Systems (GPS) combined with Collision Warning Systems are utilized to notify and potentially stop drivers when incoming emergency vehicles are at intersections. Since the team is using a combination of previously added vehicle accessories, only new programming needs to be installed for communication between vehicles to occur. Because our design uses technology already built into the vehicle, very minimal costs are needed to create the product.

Research and Calculations:

Of all reported accidents in the United States, approximately 40% each year occur at intersections(3). This is a major issue as these very small sections of roads are becoming more and more dangerous. The first issue is when a township or state should decide that a particular intersection is too dangerous. The second is how it should be dealt with. The current solution is to just close the intersection from one direction so that there is no cross traffic, but this then creates many logistical issues as new routes are needed to get through those areas. Of the massive number of intersection accidents, almost all of them are related directly to driver fault(3). This shows that while many accidents occur because of weather or vehicle failure, accidents at intersections are primarily the fault of humans making these areas significantly more dangerous than any other stretch of road as a deadly accident could occur at any time regardless of outside factors.

Customer Needs:

Various customer statements were put forth in class and discussed to find the customer needs in the market. The customer needs were then applied in our concept generation to so that our designs met the highest amount of the stated needs.

Concept Generation:

Three project ideas were put forth from our design team through research on the internet and other available resources. They were: temperature based sensors in cars, stoplight sensors at intersections, and emergency extinguishers within the engines. Individual surveys were created and sent to various audiences to gather feedback on the three ideas to narrow down our concept to one single idea. Brief summaries of the designs are given below with survey analysis.

1. Temperature based sensor inside the car for the protection of children and pets. If children and pets were left in the car by accident, the car windows will open to lower the temperature as certain level of temperature is detected. Alarm system will be connected with the sensors to send out signals to notify nearby people that pets and children are in danger. The team planned to use the technology of hypersonic sound invented by Woody Norris for the alarm system for the purpose of reducing amount of noise of the product.

Survey results analysis : a large portion of people did not think the product is necessary because they believe they will not leave their children and pets alone in the car. No one wanted to pay for the technology that they felt was unnecessary and possibly quite risky if a failure occurred

2. Sensors on stop light to slow down over speeding vehicle. Since accidents usually occurs on intersections, the group came up with this concept which forces drivers to slow down near intersections. Stop lights sends out signals which correspond to the car's braking system. Specific wave frequency will be developed for the concept.

Survey analysis: people tends not to disagree this concept because saying that it is incomplete and unnecessary at some point. Many responses stated that this concept may cause more accident and other serious negative influence on drivers. For example, one of the response states: "People will disable them and other people will assume they do not have to pay as much attention since the system should save them. Additionally, speeds at or below the speed limit are more than deadly for a T-bone, unless the sensors can completely stop a car from running a red they are next to useless."

3. Emergency fire extinguisher within the fuel tank. Chemical fire extinguisher in the fuel tank to prevent explosion and fire caused by the fuel. The technology and material for the fire extinguisher are very hard to find, there shows no results which can be used in the research process.

Survey Results: we had a difficult time compiling data for this design idea. Some survey takers found the idea confusing and unrefined. The uses of the product had a small window which made the desirability of the product quite low. Most people felt that the cost of the product outweighed the possible benefits leading to an uninterested buying audience.

The surveys revealed that the most appealing, even though none seemed very appealing, was the technology of sensors in traffic lights. Our group decided to refine the design to give the consumers a better idea of what the actual technology is and the uses of it.

All questions asked on this particular survey can be found on the following link:
<https://www.surveymonkey.com/results/SM-KJL856LV/>

Concept Selection:

An AHP matrix was developed to help ranked all features/requirements of the design. Table 1 can be seen below including the definitions of the features.

Table 1:AHP Matrix for Design Requirements								
	Safe	Fail-Safe	Connected	Builds off old tech.	Maintain able	Cost-effective	Total	Weight
Safe	1	1	1	3	3	3	12	.25
Fail-Safe	1	1	.5	2	2	3	9.5	.20
Connected	1	2	1	3	2.5	2	11.5	.24
Builds off old tech.	.33	.5	.33	1	.5	.33	2.99	.06
Maintainable	.33	.5	.4	2	1	1	5.23	.11
Cost-effective	.33	.33	.5	3	1	1	6.16	.13
							47.38	

Safe: does the product increase the safety of motor vehiclists?

Fail-Safe: does the product have a fail-safe that can be easily used quickly and effectively?

Connected: does the product increase the connectivity of vehicles on the road not only internally but with other vehicles?

Builds off old tech.: can the product be created with existing technology?

Maintainable: is the product easy to maintain without large quantities of money/work?

Cost-effective: is the products cost effectively lower than its benefits?

Our team had three major designs put forth which were referred to as Emergency use, Commercial use, or Hybrid use of sensors in traffic lights.

Once the weight of each requirement is found, it can then be used to determine which of our three design concepts should be used. A Design Selection matrix was created to compare each design with weighted and unweighted values which is shown in Table 2.

Table 2: Design Selection Matrix				
	<i>Weighting</i>	Emergency	Commercial	Hybrid
Safe	.25	4	3	4
Fail-Safe	.20	4	3	4
Connected	.24	4	3	3
Builds off older tech.	.06	3	3	3
Maintainable	.11	3	2	2.5
Cost-effective	.13	2	3	3
Unweighted Total		20	17	19.5
Weighted Total		3.567	2.89	3.399

Based off the design selection matrix, the weighted total followed the order of:

- 1st: Emergency
- 2nd: Hybrid
- 3rd: Commercial

Final Description:

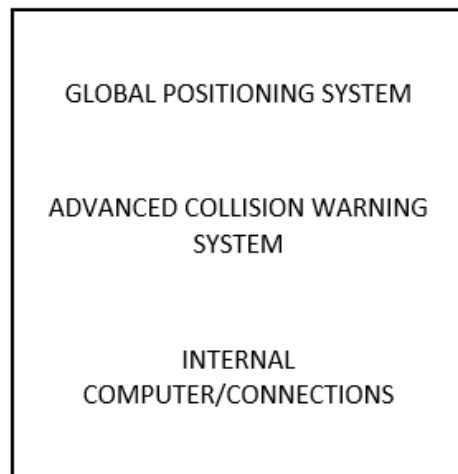
E.V.I.S.T. is a link between global positioning systems and advanced collision warning systems. Using signals sent from emergency response vehicles, drivers will be notified both visually and audibly that such a vehicle is approaching the upcoming intersection. The main intention of the system is to warn the driver so that he/she will slow down at that time. If this is not enough, once the car gets too close to the intersection at too high a speed, the collision warning system will step in and slow the car down automatically keeping all persons in the vicinity of the intersection free of harm.

Systems Diagram:

INPUTS

INTERSECTION
LOCATION VIA
GPS SIGNAL

ELECTRICITY



OUTPUTS

VISUAL WARNING

AUDIBLE WARNING

AUTOMATIC
BRAKING



Scenarios:

While driving to work on a typical day, Roger receives a notification from his car's GPS that an emergency vehicle is approaching the intersection ahead of him and that he should slow down. Roger sees that he is speeding and slows down until the ambulance goes by and the notification goes away. He then safely drives the rest of the way to work and carries on with his day. After work Roger is tired and a little groggy when another notification comes from his GPS. This time he doesn't notice it and continues to go slightly above the speed limit. Once he gets too close to the intersection where a racing police cruiser is headed, the notification relays a signal to his car's assisted braking system and the car slows down automatically bringing Roger back from his daydream and allowing him to stay safe as the cruiser flies by. E.V.I.S.T. effectively notifies drivers of potentially dangerous situations at the most dangerous sections of roadways anywhere. When notification is not enough, physical action is taken to keep the driver and other motorists safe. Because this technology is built off of GPS units, it could eventually be expanded for use on all sections of roadways without incorporating any new tools or programming. Also, because it all comes from the GPS units, a system failure will not damage the car in any way, and all functions will simply revert to the driver, which is how things currently work.

Total Cost Analysis:

Taking full advantage of existing technology E.V.I.S.T. takes current GPS technology and connects them together as well as using current collision warning systems to slow down speeding vehicles. This means that the cost to integrate this system into the current market is significantly cheaper than most new high tech designs. Many modern cars come with a gps integrated into the dash, or at least have a gps tracker installed. Also, many people own a separate GPS that they use in their vehicles. The only cost to upgrade these systems would

be to add the programming and connection to the vehicle so that the GPS can link to the brakes. Much of this falls under Non-Recurring Engineering (NRE) costs, while for upgrades the only consistent cost is the wire that would link the GPS to the car. External GPS systems cost on average \$250-\$300 for a reliable and up to date system. For new cars without an included collision warning system, the vehicle upgrade package runs on average around \$3,000 which includes many safety systems on top of assisted braking. All in all, the highest an upgrade would cost would be around \$3,500, but the average would be significantly lower as most cars come with this technology already installed(4). This makes it more appealing to consumers, and attractive to car manufacturers.

Life Cycle Analysis:

According to the life cycle assessment done by Audi, life cycle assessment analyses the effect of a product on the environment during its entire existence by evaluating the following steps.

Development Phase: the development of the product requires the creation of the software as well installing software. There will not be any raw material used except for electricity used by computer and GPS. The testing phase which the product must have requires raw material. Ambulance, police vehicles or other emergency vehicles are needed, testing also needs a regular vehicle and any Global Positioning System. The effect on environment caused by the progress of testing is extremely low because there only requires tiny amount of driving distances.

Production Phase: the progress of producing requires existing GPS and collision warning system. There will not be any effect on environment.

Use Phase: The product functions with the GPS and collision warning system. The only cost of functioning will be electricity.

Recycling Phase: The recycling of the product will be replacing updated product to the old version. The old version of the software can be deleted completely. There is no effect on environment.

Conclusions:

During the process of generating concept of the product, many problems were solved and significant lessons were learned by the team. although great amount of original ideas was brainstormed by the team members. but factors such that customer needs, selection of technologies and social acceptance was expected to be considered. Through detailed research and proper methods/skills of engineering designed, various concepts provided by the team members was narrowed and eliminated to generate the final concepts.

The E.V.I.S.T was selected for the final product concepts because delphi's requirements of safety and connected were well satisfied and the product's connection with existing technology increases the easiness of applying concept into real life. This concept will efficiently reduces the chance of car accidents since the product can enter the market in a extremely short amount of time due to its ability of combining with old technologies. Although practical and efficient, the product tends to be influenced by existing problems in Global positioning system. The the results which comes from inconsistency of signals with errors and miscommunication between drivers and GPS might set the roads in chaos. There are still performance tests that needs to be done in various conditions.

The team's purpose of the E.V.I.S.T was to make the intersection traffic safer and more organized. Therefore, the progress of improving Global Positioning System should be developed as the product being installed. Although the consistent performance of E.V.I.S.T

needs to be considered in long run, the welfare brought by this product definitely worth the costs and time spend on it.

Works Cited

1. "Motor Vehicle Accidents Involving Ambulances." (2013): 1-2. Zurich Services Corporation. Web. <www.zurichna.com>.
2. National Highway Traffic Safety Administration (Nhtsa), National Center For Statistics And Analysis (Ncsa). "Traffic Safety Facts 2012." *A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System* (2012): 112. Print.
3. U.S. Department of Transportation. (2010). *Crash Factors in Intersection-Related Crashes: An On-Scene Perspective* (DOT HS 811 366). National Highway Traffic Safety Administration. Web. <<http://www-nrd.nhtsa.dot.gov/Pubs/811366.pdf>>
4. Chevrolet. (2014). *Build Your Own Small Trucks: 2015 Colorado* | Chevrolet. <http://www.chevrolet.com/colorado-small-truck/build-your-own.html?x-zipcode=16802&x-series=12V43_4Z7>
5. (<http://www.woodynorris.com/articles/TechnologyReview.htm>)
6. <https://www.surveymonkey.com/results/SM-KJL856LV/>