CAR TO CAR COMMUNICATION

TEAM 1 SECTION 18

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ABSTRACT

Our product will use car to car communication to improve driving quality. It will be implemented in every car, allowing them to interact and give real time updates to drivers about road conditions. The system will have a state of the art monitor to display the data it collects from other vehicles. This will be combined with current technology to provide alternate routes, improving driver safety, miles per gallon and reducing time spent in traffic. The system will revolutionize the automotive industry.
INTRODUCTION

Most families in the United States have two to three cars and there are currently 254.4 million registered vehicles on the road today. With this many cars there are countless accidents were people are permanently injured and many lose their lives. This is a major issue in today’s society as kids start driving as young as fifteen years old. Also cars a huge market. Our goal is to develop a car to car communication system that will improve car safety, be economical and increase car efficiency. These are some of the fields Delphi wants to expand in and we have developed a concept that would successfully cover these goals. Our design will notify other cars in the area of hazards, traffic and current road conditions. It also cuts down on gas consumption because cars would have less time starting and stopping which helps to save gas and be more efficient. There are currently many companies attempting to produce a similar product, but all of them are still in the very early stages of development. It is an opportune time to take a stake in this market and attempt to produce our own product.
MISSION STATEMENT

To produce a system to support car communications allowing drivers to interact with the road and their surroundings. Allowing for improved driving conditions.

CUSTOMER NEEDS ANALYSIS

<table>
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<th>Customer Statement</th>
<th>Need Statement</th>
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</thead>
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<tr>
<td>I want my car to be safer.</td>
<td>The system will monitor other cars, to alert the driver of dangerous situations.</td>
</tr>
<tr>
<td>I do not want to be stuck in traffic anymore.</td>
<td>By monitoring other cars, we can predict traffic conditions and alert the driver to alternate routes.</td>
</tr>
<tr>
<td>I want more miles per gallon.</td>
<td>Avoiding traffic will help improve a cars miles per gallon. A significant amount of gas is wasted stopped in traffic.</td>
</tr>
<tr>
<td>I want it to be easy to use, a touch screen and its own display system.</td>
<td>The system will have a clear state of the art monitor that will avoid distracting users and allow for ease of use.</td>
</tr>
<tr>
<td>I do not want to pay a lot of money.</td>
<td>The system will be affordable for everyone allowing it to be implemented in all cars.</td>
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</table>
CUSTOMER NEEDS ANALYSIS

We discussed the idea of improved car to car communication with many of our friends, peers and amongst our group and found the most common needs that people addressed. We used these needs to create a chart to look at what we would focus on for our product. We decided on three major goals. Our first goal was to improve driver safety by alerting drivers of hazards on the road, so they can avoid dangerous situations. Second we wanted to improve traffic flow by notifying drivers of possible delays and providing alternate routes. Lastly by reducing traffic and alerting drivers of road hazards this will improve the cars miles per gallon, reducing pollution and saving hundreds of dollars. These three goals were the outline of our product, and what we continued to research throughout the design process. Many of the other needs we still attempted to achieve, but they were only secondary goals.

EXTERNAL RESEARCH

Overall Car to Car Communication: Car to Car Communication systems have the ability to reduce traffic by alerting drivers of possible traffic using the data collected by the cars currently stuck in the traffic. This will reduce the amount of time in stop and go situations and save fuel improving the cars miles per gallon. Not only will the system be able to alert the drivers about traffic but also dangerous hazards in the road. By avoiding these dangerous situations it is increasing driver safety. A majority of fender benders are in traffic where the individual does not even have time to break before they hit the car in front of them. This can be avoided if the driver has knowledge of their surroundings.
Car to Car Communication and Infrastructure

Many of the currently proposed car to car communications consist of cars communicating their different actions and surroundings to monitoring and control infrastructure that is located on the side of the road ranging between four to fifteen miles apart. The infrastructure then relays the information to a satellite that relays all of the information for that area to a database. The database then relays the information back to every vehicle. This type of system would be incredibly expensive costing billions of dollars. It would require that this infrastructure is spread throughout all of the country and built onto every road. The image below describes the general idea of this system.

Instead our new concept will work in a similar manner but will focus on only using car to car communication and no exterior infrastructure. Each car will have our system installed in it allowing it to relay information to the car in front of it and behind it. In a sense each car will constantly scan its surroundings and relay this information to other cars in its vicinity and those cars will continue passing the information to other cars. Each car’s system will only hold a certain amount of data to restrict the system from being overloaded and to keep the most up to date and relevant information. This will avoid the need for pricey infrastructure allowing the system to work anywhere, as long as all cars are implemented with it.
Radio Signals

Car to car communication has been a topic being researched as early as 2002 by the United States Department of Transportation. Many different vehicle companies have shown interest in developing such a system. But if an automotive company is successful in producing such a system it will be patented and blocked from other companies using it. This will limit the amount of people that can use it and will not allow it to reach its maximum potential. Instead a company such as Delphi could market this product to other companies allowing all vehicles to receive the technology. Our proposed system is different than others as previously described. For the system to remove the need for infrastructure we will implement the use of a wireless mesh network and radio signals.

First the radio signals are dedicated short-range communication devices (DSRC). That work in 5.9 GHz band with bandwidth of 75 MHz and at an approximate range of 1000 m. These network was set up by the United States government allowing this specific amount of bandwidth to be reserved for the use of car to car communication in an intelligent transportation system. Our proposed product will use this short range single to interact with cars that are within 1000m to avoid putting all of the strain on the mesh network. The radio signals can also be used to determine the speed of surrounding cars and the distance from collisions and other road hazards. This will be the first major part of our system and will be implemented in a protected antenna on the exterior of the car. Avoiding using the same antenna as the car’s radio for redundancy.

Mesh Network/Wireless Ad Hoc Network

Wireless mesh networks consist of mesh clients, mesh routers and gateways. The mesh clients could be any wireless device such as a phone or laptop or a computer system built into a vehicle. The mesh router would be installed in the vehicle and would relay information to the gateways. This produces a radio network that can be accessed through radio nodes and is reliable and redundant. The system does not require a central server and can be decentralized allowing for there be no major infrastructure to allow the
system to function. As seen in the picture above the signals and information will be relayed through a protected antenna separate from the radio signals antenna on the exterior of the car. The mesh network will be able to provide a cost effective and dynamic high-bandwidth network over a specific coverage area. The network is multiple routers interacting with nodes without the wiring. In our system a car will have a simple computer connected to a router that is located in the car, which will then relay the information to other cars routers. The information will travel through all of the traffic and can then be transmitted to even farther locations through a high gain omnidirectional antenna that is connected to a backbone node. The antenna will then relay the information to other cars as far away as needed.
Our products goal is to last at least eight years. In a controlled environment it could last up to twenty years, but the harsh environment of a car driving up to eighty miles per hour reduces the life expectancy dramatically. The computer system is the most delicate as it can overheat and get damaged from the constant motion. Parts can be removed without the whole system being replaced, it can also be salvaged and put in other cars.

**Benchmarking**

**Mercedes Car-to-X Technology**

Mercedes Benz introduced Car-to-X technology as a part of their Drive Kit Plus along with its Digital DriveStyle App available on mobile phones. The system uses mobile service and the Mercedes Cloud to make the car a transmitter and receiver of information. Potential hazards such as broken down vehicles and emergency personnel can be detected automatically, popping up an alert on the dashboard display with the exact location of the dangerous area. For hazards that aren't automatically detected like animals on the road or
dangerous drivers a manual alert option is available on the touch screen display which transmits the information anonymously to drivers within ten kilometers and marks an icon on the map. If the driver is travelling the purpose of the system is to make cars and drivers more aware of dangerous driving conditions and take measures to stop accidents before they happen. Car-to-X technology is similar to our design in that it transmits signals between cars in the local area to warn drivers about dangerous conditions. It differs in that it uses cell phones to transmit signals to cars and focuses more on poor driving conditions rather than mapping out highly trafficked areas.

**Cadillac Super Cruise**

Cadillac is in the process of introducing an automated cruise control system, known as Super Cruise, into vehicles in the latter half of the decade. The technology introduced will use radar, ultrasonic sensors, cameras and GPS map data to allow for the car to drive automatically controlling speed, braking, lane position, and safe following distance from other vehicles. Super Cruise is designed to even be effective in traffic jams and stop and go traffic without driver influence. The system has some limitations in areas without lane markings, in bad weather and in traffic jams currently however. If limited data is available to the system the car will prompt the driver to resume steering. John Capp, GM director of Global Active Safety Electronics and Innovation, says, “Super Cruise is designed to give the driver the ability of hands-free driving when the system determines it is safe to do so.” To insure driver focus, the car can track drover eye movement as the system is engaged. Super Cruise is similar to our design in that it takes preventative measures to eliminate human error from the roadway and creates safer driving patterns that prevent accidents.

**Volvo City Safety System**

Volvo developed an automatic braking system at speeds of 19 miles per hour or less. Using infrared and radar sensors Volvo’s system can assist in braking and even apply full braking force to prevent a dangerous collision. This technology is designed for high traffic, slow moving areas, such as a city. It is similar to our design in that it takes preventative measures against accidents and is designed for highly trafficked areas. Our design differs because it can work at any speed and uses mesh networking to relay traffic conditions to other cars. Our system is designed to ease the flow of traffic while Volvo aims to eliminate driver error in high traffic, slow moving zones.
Concept Generation

<table>
<thead>
<tr>
<th>Smart City Needs</th>
<th>Topic</th>
<th>Need</th>
<th>Importance 0-10</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Safety</td>
<td>Improved car safety</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Life Cycle</td>
<td>Sustainability</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Life Cycle</td>
<td>Extended life expectancy</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>Energy</td>
<td>Improved miles per gallon</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Safety</td>
<td>Accident prevention</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>Safety/Energy</td>
<td>Reduced traffic</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>Cost</td>
<td>Affordability</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>Energy</td>
<td>Minimal use of limited resources</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>Life Cycle</td>
<td>Utilize current car technology</td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td>Appearance</td>
<td>Convenient display and ease of use</td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td>Appearance</td>
<td>Easy installation</td>
<td>5</td>
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<tr>
<td>12</td>
<td>Life Cycle</td>
<td>Implemented in all cars</td>
<td>10</td>
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Based on the three major concepts that Delphi is looking to move forward in, Green Energy, Safety and Connectivity, we began to brainstorm and research different concepts that fell under these categories. The chart ranks the needs we discovered from our customer analysis and research, based on their practicality and functionality. We determined their rankings from our external research. Our different concepts for the final product will be based on the highest rankings. Based on the chart we concluded that our product will improve car safety and avoid dangerous situations by reducing traffic and allowing cars to communicate with their surroundings. For this to work successfully our final product will need to be implemented in all cars and have a long life expectancy.
OUR CONCEPT

Concept Selection

[Hand-drawn diagram with various criteria and ratings]
After creating our concepts, we compared them in multiple ways. First we compared each concept to the other concepts and determined which would be better a match compared to what customer needs we originally set out to achieve. When we had selected our final idea we benchmarked it to other ideas that were already out or in the process to see where ours would stand. We decided on our final idea being a system that allows cars to communicate through wireless signal to give another car a heads up about traffic they may encounter ahead. Our system would have a few main components and two types or wireless signals. The system would be installed in a car under the hood as a little black box. It would then be connected, via wiring, to a GPS/navigator or a new device would be provided in the car. This is necessary so the driver is not getting the alerts through his phone and does not have to take his focus off of the road, thus keeping the driver and passengers safer.

The black box will have a signal receptor and a signal sender. Both will use radar signals based more for short distances. The short distance signal will be for about 1000m. The reason we settle with this radar signal is because it does not interfere with other signals, especially things such as police scanner, and is not restricted in any areas. This is what the car will send and receive periodically as driving. It will receive other signals from cars within that distance as well to let it know where there is traffic or congestion. The driver is then alerted by the monitor that there is traffic ahead and where it is. This will allow the driver to take a different route before he/she gets into the traffic, thus putting them in a safer situations and saving them gas.

We have to idea of how the system will be installed. The first is the system can become standard in the newer cars in production and therefor is included in the purchase of a new car. The next way is the system can be installed during an annual inspection if a person chooses they want the system but don't want or can't afford a new car. The system does not require all cars to have it for it to work but it becomes more effective when more cars have it. The system is reusable and is very efficient causing it to benefit those who use it.
Our concept was formed and molded using the design process. We started by creating multiple concepts using brainstorming that satisfied the customer needs. We compared which concept best fit the needs and covered the most and most important. We also believe this will be the most beneficial to its users. The final concept we selected was a car to car communication system. The system will be pretty simple using radar signals to communicate with other cars in the area and determine if there is traffic. A monitor the displays and alerts the driver of the traffic. The limited bandwidth and distance of the signals will make it so the driver only gets information for the area he/she is close to and not from other far areas. We then benchmarked our system with the Mercedes Car to X, Cadillac Super Cruise, and Volvo’s outbreak system since they are similar concepts or products. We did this in our house of quality. We also determined the lifecycle and its sustainability. Using the whole design process we think we have created modified our concept to be the best concept for the needs we were looking to satisfy.


