Accident Prevention Vitals Monitor
Circulus Inc.
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PENNSTATE
Executive summary:

This project outlined by Circulus Inc. worked to find the most effective and safest way to help a driver in a situation of distress. Four concepts were generated to determine the most accurate, practical, and safest way to help the driver; concept one was chosen to be the most useful. The Accident Prevention Vitals Monitor system will be capable of taking current and average heart rate of the driver, displaying the information on a screen for the driver to view, and determining if the driver is falling asleep, having a heart attack, stroke, etc. With this system implemented in automobiles, there will be an increase in driver’s safety, and a decline in car accidents.

Introduction:

As people are currently living longer than before, the health risks are increasing over their lifespan, and thus can impact the way they function, think, and drive. Due to the higher health risks, it is important to innovate technology and help drivers recognize the signs of a medical emergency. In the Accident Prevention Vitals Monitor, it will be capable of guiding drivers to a safer future.

At this point in time, cars are not readily equipped with devices that detect a driver’s vitals with a specific focus to occurrences that render a driver incapable of continuing his/her task. Driver safety is the driver’s responsibility, but in some cases, a driver is unable to tell when he/she has the potential to become a safety hazard.

Our project will investigate ways to identify potential safety issues in a driver’s health by monitoring vitals. These vitals can be used to determine when a person falls asleep at the wheel, has a heart attack, or is experiencing other health issues that deter from a person’s ability to drive. Our system can use this information to alert the driver, alert other drivers, and stop the vehicle.

Problem Statement:

Circulus Inc. envisions a car that improves driver safety by monitoring vitals to identify moments when driver is incapable of driving.

Research:

When a person experiences health issues that could render him/her incapable of driving, the body’s vitals can be used to notify the driver and vehicle of such occurrences. The Circulus Inc. system will look for signs that a person is having a heart attack, having a stroke, or has fallen asleep.
When a person has a heart attack, he or she experiences rapid or irregular heart beats. A person’s heart rate slows down and becomes steady when he or she falls. A brainstem stroke is accompanied by a sudden change in heartbeat, either lower or higher. By monitoring heart rate, the proposed system can detect these changes that indicate a heart attack, sleep, or a stroke.

Another indication of sleep is temperature drop. When a person falls asleep his or her temperature drops and continues to drop as they sleep. Temperature change is also an indication of a brainstem stroke. The victim loses the ability to regulate temperature. Temperature change detection can further signify dangerous situations caused by the driver’s health.

The proposed system is similar to systems that already exist. For example, a Ford Concept Car monitors the vitals of more than just the driver and is implemented in the seats instead of the driver’s wheel. It also is looking to monitor the overall health of an individual. Our system simply looks for changes that could cause immediate problems that would render the driver incapable of driving in a safe manner. A second health monitoring system described on ScienceDaily.com provides live health checks as the vehicle is in motion. This also differs from Circulus Inc.’s proposed product because this system monitors more than just immediate health problems. This means that our system will be less expensive to install and be less of a privacy issue.

**Customer Needs:**

<table>
<thead>
<tr>
<th>Need</th>
<th>Specifications</th>
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</thead>
<tbody>
<tr>
<td>Emergency Services Notifications</td>
<td>Connectivity and connection to OnStar for three years with purchase ($500)</td>
</tr>
<tr>
<td>Automatic Braking System/ Automatic Pulloff/ Hazard Lights</td>
<td>Slows and pull the cars over to the side of the road while activating the hazard lights</td>
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<tr>
<td>Ability to withstand varying temperatures (weather)</td>
<td>The monitor is able to work in all temperatures.</td>
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<tr>
<td>Ease of Installation</td>
<td>The monitor is able to be easily installed onto steering wheels.</td>
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<tr>
<td>Sensitivity Levels (if a driver is wearing gloves)</td>
<td>Appliance is able to sense heart rate when driver is wearing gloves and can continue to operate</td>
</tr>
<tr>
<td>Feature</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Aesthetically Pleasing Monitors</td>
<td>Displays that allow the maximum amount of comfort and user-friendliness will be used.</td>
</tr>
<tr>
<td>Vitals Display</td>
<td>Able to display heart rate and temperature with live updates.</td>
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<tr>
<td>Driver Memory</td>
<td>Able to remember four different driver vitals</td>
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<tr>
<td>Comfortable Monitor Covering</td>
<td>A monitor cover will be incorporated which must be comfortable and aesthetically pleasing.</td>
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<tr>
<td>Low Cost</td>
<td>Less than $400 cost for the system (excluding OnStar)</td>
</tr>
<tr>
<td>Recycled materials/ Environmentally friendly</td>
<td>Recycled material will be used when applicable and the system will use little energy.</td>
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**Concept Generation:**

Concept 1: Steering wheel heartbeat and temperature sensor with cover.
This concept will include a metal ring that will be placed on the steering wheel that will be used for detection. A covering will be incorporated with this design for comfort and vitals will be displayed on a small monitor located on the dashboard.

Concept 2: Driver seat heartbeat and temperature sensor.
This concept will include sensors positioned underneath the driver, in the driver’s seat. The seat monitors will measure vitals and display them on a small monitor located on the dashboard.

Concept 3: Armband sensor
This sensor will be strapped on to the driver when they enter the vehicle, similar to the way a blood pressure armband is initially put on. In addition, Vitals will be displayed on a small monitor on the dashboard.

Concept 4: Defibrillation Electrodes
These monitoring devices are sticky plastic circles attached to wires that are placed on the body to detect vitals. Vitals will be displayed on a small monitor on the dashboard.
### Concept Selection:

<table>
<thead>
<tr>
<th>Concept</th>
<th>Aesthetics: Weight 10%</th>
<th>Comfort Level: Weight 25%</th>
<th>Accuracy: Weight 50%</th>
<th>Practicality: Weight 15%</th>
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<td>.15</td>
<td>1.75</td>
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*Ranked 1-5, 5 being the best

### Final description:

Concept One was the most plausible. This concept would seemingly fit into the driver’s usual routine; this concept adds no additional discomfort or annoyance for the driver. By putting the detection system on the steering wheel with a cover, a car that incorporates this concept would be indistinguishable from one that does not. Our concept would also have accurate monitoring compared to the other concepts.

In order to deliver on the proposed system, the design will include a similar detection system as the PASPORT Hand Grip Heart Rate Sensor. This sensor utilizing metal hand sensors to monitor heart rate^1.
**Cost Analysis:**

The calculated approximate cost to cover the entire steering with heart rate sensors is $200. The system for data collection and monitoring the heart rate costs about $75. Lastly, OnStar connectivity costs $20 per month or $500 for three years. The cost to implement the proposed design onto cars would be less than $5. People would be willing to pay around $250 for the system itself based on previous research. In addition, they would be willing to pay for OnStar connectivity it is true that many people are already paying for OnStar.

**Scenarios:**

**Scenario 1:**

The driver turns on the car and prepares to drive. Immediately when the driver puts his or her hands on the steering wheel, the Accident Prevention Vitals Monitor will detect a heart rate through the driver’s temperature. In the beginning, the system will take the initial heart rate and start to analyze it. The driver is able to then start monitoring his or her heart rate visibly if he/she wishes to, by switching the screen from GPS/ audio/ menu/ etc. to the vital screen. The screen will display the heart rate as a large number so the driver can easily glance at it. Within a few minutes, the system will pick up a average heart rate, which would also be displayed. The driver has no accident, and arrives at the destination safely.

**Scenario 2:**

The driver gets in the car and has had a normal heart rate of anything between 60-100 beats per minute. The journey has been incident-free so far, but the driver has been driving for a few hours and it is now starting to get dark. As it becomes night time, the driver starts to fall asleep and the system starts to recognize a decrease in heart rate. If the system detects a decrease in heart rate, it will alert the driver or take control of the vehicle to prevent an accident.
rate. The Accident Prevention Vitals Monitor then will alert the driver by asking if the driver is ok a few times. The driver becomes aware that he/she is falling asleep, and pushes a button which lets the system know that the driver is awake and aware of the scenario.  

Scenario 3:

The driver gets in the car and starts to have a normal heart rate. The system takes the driver’s vitals and analyzes his/her average and current heart rate, which the driver can now see on the monitor. It is midday and the driver is driving on a local two lane road, in the right lane. Soon the driver starts to feel a few chest pains and pain in the shoulders, and then determines it is probably nothing to worry about. However, the driver does not remember that he/she experienced these same symptoms a few days ago. Suddenly the driver has a heart-attack, and the system picks up the change in heart rate. The system asks if the driver is ok a few times, and detects no response. The Accident Prevention Vitals Monitor then slowly brakes the car to a stop, turns on hazard lights, and calls OnStar, State Farm, or another road-side help system.

Feasibility Analysis:

The automobile company pays for the materials and installation of the system. The calculated cost is about $200. The consumer pays a fee for OnStar, a fee which is set at $20 a month or $500 for three years. Considering all aspects, the implementation of the system would pose no legal or privacy issues. Circulus Inc.'s system operates by means of live monitoring and does not retain records of the user. Given that the system applies to every car with OnStar capability and the fact that OnStar is currently available in over forty different car models, regulation by the government would be possible.

Life Cycle Analysis:

This design incorporates recycled aluminum and recycled copper wiring as the materials for the bulk of the system. This reduces the amount of energy use for production by 90% for the recycled aluminum and by 15% for the recycled copper wiring. These materials would then be sent to be made into the heart rate system and incorporated in cars. After enough use, the entire system will be able to be recycled and reused.

The design will go through a considerable amount of on-off cycles so it must be robust. The average number of on-off cycles in one day is 4 with a total of 14600 on-off cycles in a ten year period. In addition, the concept will go through about 3 hours of use
per day, which amounts to 10,950 hours of use over a ten year period. The proposed design should be able to handle this level of usage as long as the steering wheel remains undamaged if the car were to be involved in any accidents. With all of this usage, the problem of the system no sensing a heart rate could be a problem. To prevent this, the design’s sensitivity could be increased, which can be done by the dealership for the lowest cost.

Dealing with Circulus Inc.’s design’s use of supporting infrastructure, Onstar is a system that remains in cars and can keep them connected well over a decade. The only condition is that the vehicle owner must pay for Onstar connectivity every few years. Thus, the short lifespan of supporting consumer electronics is not a major concern.

Conclusions:

Ultimately, the heart rate and temperature system will help prevent accidents that occur when a person experiences drowsiness, a heart attack, or a stroke. Although the system focuses on safety, the concept does not compromise on green or connectivity. The proposed system will incorporate green ideals by using as much recycled material as possible; the consumers could also add additional green features to their vehicles if they chose to do so. The chosen concept does not compromise connectivity because the car companies are simply adding a feature to the car. This would not prevent the consumer from implementing additional connection features. Additionally, even though the system is not connected to surrounding cars, the system is connected to OnStar, the implementation of which is becoming more and more popular among carmakers.

References:

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2 http://www.webmd.com/heart-disease/guide/heart-disease-heart-attacks
3 http://sleepfoundation.org/how-sleep-works/what-happens-when-you-sleep
4 http://www.psfk.com/2013/08/ford-seats-monitor-vital-signs.html
6 http://sleepfoundation.org/how-sleep-works/what-happens-when-you-sleep
7 https://www.onstar.com/web/portal/equippedvehicles?q=1