The New Biotechnological Frontier: Exmovere Automotive Biosensor Technology

Specific Aim

A task in vehicle development is to configure vehicles not only according to security aspects, but also to ensure passengers feel well and enjoying their drive. The pleasure of driving a car or, more generally, "the positive emotional interaction within the product car" is vitally important for the acceptance and the success of a vehicle model today. Driving pleasure is determined particularly by the driving feeling, which arises from the complex reciprocal driver-vehicle-environment relationship. Measuring emotional reactions of drivers in close-to-reality environments opens extended views of the interaction driver-vehicle and supplies important information to design vehicles so as to better comply to and satisfy constantly increasing customer demands.

Humans are social beings that emote and their cognition is affected by their emotions. Emotions influence various cognitive processes in humans, including perception and organization of memory categorization and preference, goal generation, evaluation, and decision-making, strategic planning focus and attention motivation and performance, intention, communication, and learning.

Previous studies also suggest that people emote while they are interacting with computers. Given the involvement of emotions in human-computer interaction and the strong interface between emotions and cognition, machine perception needs to be able to capture such phenomenon and respond accordingly in order to enhance our everyday digital tools.

An important everyday activity for people is driving, and yet again research suggests that drivers do emote while they are driving in their cars and their driving is affected by their emotions. Aggressive driving in the United States results in 425,000 deaths and 35 million injuries per decade and it approximately costs $250 billion per year.

The inability to manage one's emotions while driving is often identified as one of the major causes for accidents. *Anger* is one of the emotions that negatively affect one's driving. When drivers become angry, they start feeling self-righteous about events and anger impairs their normal thinking and judgment, their perception is altered, thus leading to the misinterpretation of events.

Other states that lead to negative effects are *frustration*, *anxiety*, *fear*, and *stress*. In order to be a safer driver on the highways, a person needs to be better aware of her emotions and possess the ability to manage them effectively. Once drivers are aware of their emotional states it becomes easier for them to respond to the situation in a safe manner, but drivers can often lack in awareness.

For example, some drivers often lack the ability to calm themselves down when they are angry or frustrated. Another example is, sleepiness, which is one of the most dangerous states to be in while driving, yet when people find they are sleepy, they often force themselves to continue driving instead of stopping to rest.

This is the premise taken by Exmovere, one of the leading new companies specializing in biosensor microtechnology.

Project title: the New Biotechnological Frontier: Exmovere Automotive Biosensor Technology

Research Area: Biotechnology and psycho-physiological monitoring technology.

Broad Challenge

Most drivers are aware of the affect that things like drinking and cell phone use have on their driving, while giving little consideration to other factors that can be even more distracting. Fatigue, stress, and our emotions have a serious effect on driving, causing serious impairments that we may not even be aware of. If you are worried, upset, frightened, depressed, or even happily excited, driving skills can be as negatively impacted as they would be if you were engaged in an intense phone call or after having consumed several alcoholic drinks.

Many times we do have to drive after facing an emergency, for example, after being notified of the sudden illness or death of a loved one; or even after a confrontation with another person, such as a particularly upsetting incident at work.

Research has proven that human beings in the grip of negative (and sometimes positive) emotions have exhibited a distraction level even more serious than those experienced by cell phone users. Such emotions can cause otherwise excellent drivers to:

- Experience dimmed or otherwise impaired observation and reaction times.
- Fail to recognize situations, such as an abrupt slowing of traffic or debris in the road.
- Get to the point that they are unable to predict or to determine what the other drivers around us are doing.
- Make risky maneuvers and risky changes, such as cutting across several lanes of traffic to take an off-ramp, suddenly change lanes, or even to drive on the freeway shoulder.
- Lose the ability to perform driving skills that require precise timing or other subtle skills.
- Make a driver feel as though he or she is detached from the other drivers, vehicles, and conditions on the road.

General Effects of Emotions

- Interfere with your ability to think • Create mental distractions
- Create inattentiveness • Can cause you to act out your emotions
- Increase risk taking • Create a lack of concentration
- Interrupt your ability to process information
- Physical Effects of Emotions
- Heartbeat increases • Breathing quickens
- Digesting slows • Palms sweat • Feeling of exhaustion • Physical stress

We know these things as proven fact. They have been shown time and time again. Now, ask yourself, if the normal person can make all these mistakes by simply driving, what do public safety officials such as police and firemen feel? How do they react, considering their stress is compounded exponentially? What about airline pilots? Let’s take a moment to answer this question – with facts.

Confronted with an emergency scenario while driving, the driver's reaction time can be the difference between success and failure. Although it is an important part of driving and driver training reaction time is not easy to demonstrate. But there are exercises that can show the affect of reaction time on the decision making process.

Reaction time is the sum of the time needed for:

1. The brain to receive information from the senses. The senses we're referring to also include sensations of motion and related "seat of the pants" sensations.
2. Making decisions on what to do next. Many times, this is a reflexive reaction that carries a potential for danger with it, such as immediately smashing down on the brake pedal when we feel the car begin to skid.
3. Transmission of the messages from the brain to the muscles needed to react and move the controls.
4. The muscles to respond.

Using biosensor technology drivers get a more luxurious and personalized experience. To make cars sensitive to the moods, feelings and emotions of the driver and occupants is to prevent road rage, sleepy driving and other physiology-related dangers.

Exmovere Automotive Biosensor technology can help provide a more fulfilling, safer option to the current vehicles on the market.

Specific Challenge

The immediate benefit to car makers of using emotion algorithms and biosensors is the creation of an artificially intelligent and sensitive vehicle interface or “persona.” Vehicles may now be equipped with voice prompts, comments and messages which are directly related to the user’s state of mind, moods and emotions. These signals may be selectable and/or randomly alternating between half a dozen characters, accents, male/female, etc. Voice announcements may be made with simulated emotional and idiosyncratic behavior, selected by the computer based on the actual reading of - and in reaction to - the psychological makeup of the driver and occupants at any given time. Exmovere has created video game controllers that feature ECG sensors, along with games that get kids to settle down while they’re entertained. Given the explosion in backseat video use, Exmovere’s game applications would make a fun, simple complement to the luxury and safety features offered elsewhere in the car. This also taps into a growing trend in automotive research: adding more “virtual” or gaming-borne cues to vehicles oriented to young people.

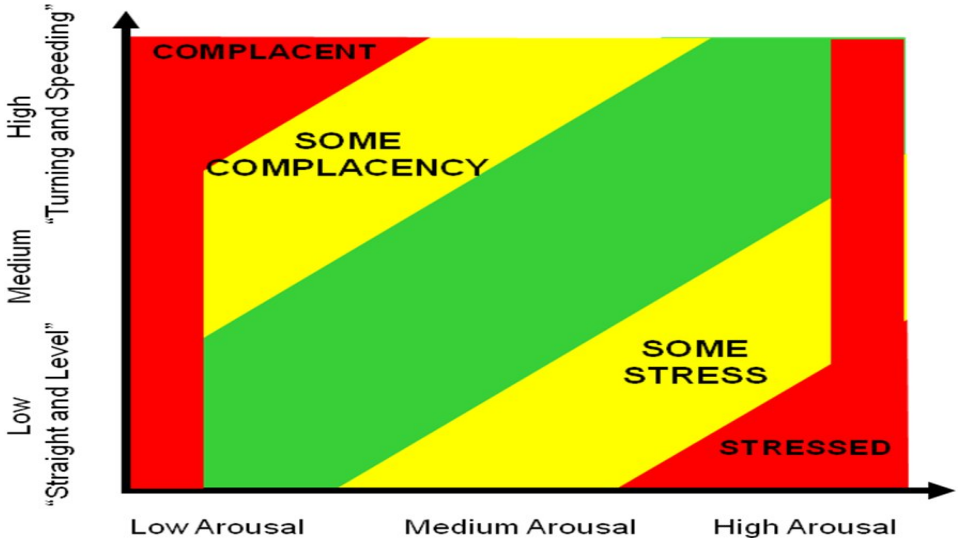
Research Design and Methods

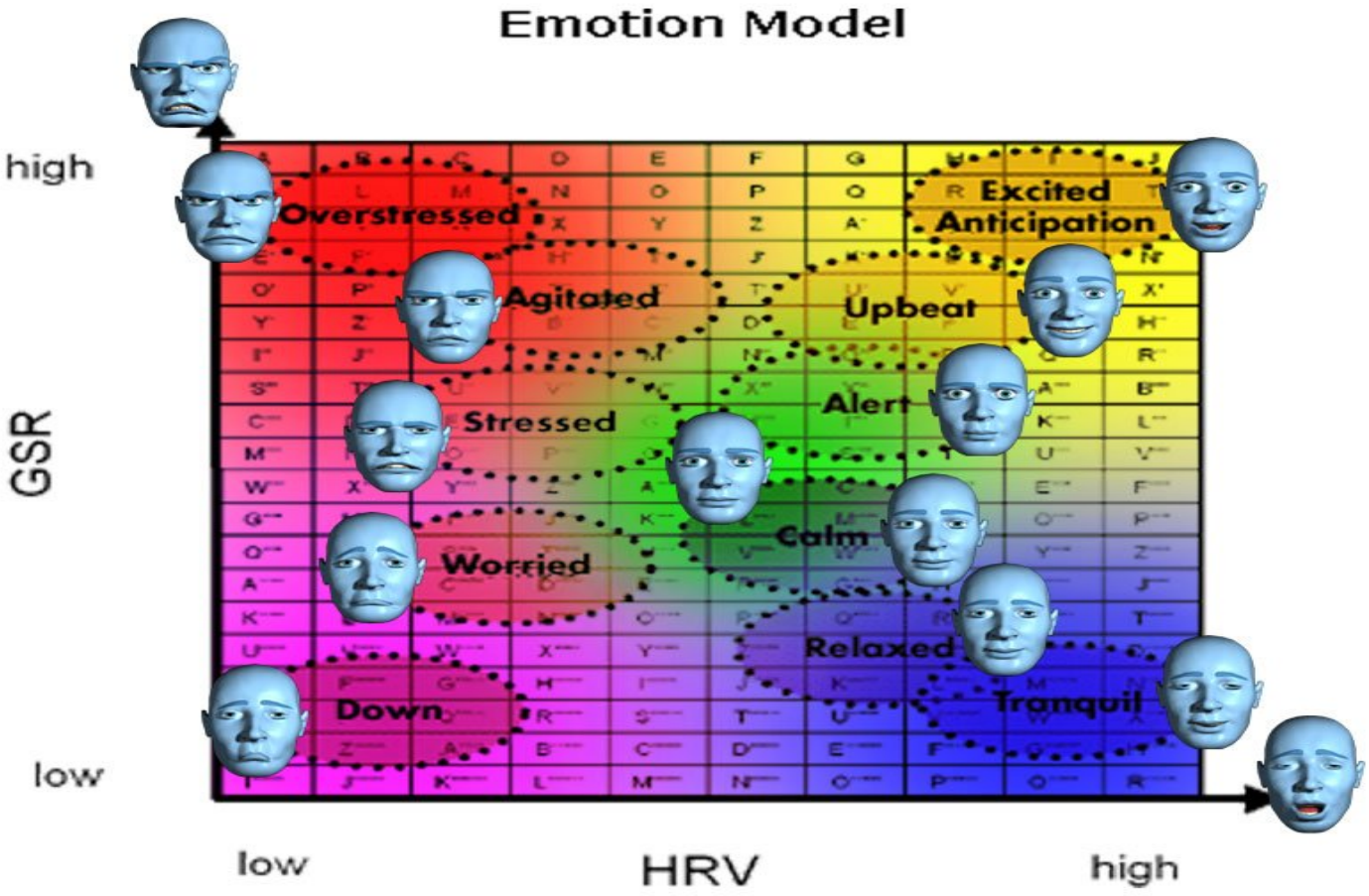
State of the art biotechnology is used in the following methods:

- Exmovere's current technology is centered on the driver's cockpit, and specifically the steering wheel.
- Exmovere's patent-pending steering wheel sensor system can pick up galvanic skin response and dynamometry data simultaneously.
- The sensors do not require two-handed use of the steering wheel, and can determine the driver's state of mind by comparing his/her physical data to data related to the vehicle's activity.
- The sensors may be shaped in the form of a logo, and come in the form of stainless steel, gold or other metals.
- To use steering wheel embedded biosensors to identify driver physiological state
- To determine driver activity with the steering wheel itself
- To use emoticons to show the driver his level of engagement at the wheel at any given moment
- To use voice prompts to guide the driver back to his ideal driving state, defined by Exmovere's car-driver algorithm.

How We Built It

- Complete steering column removed from Lexus ES300 and mounted to a base-plate and enclosure.
- Steering wheel retrofitted with peripheral galvanic skin response electrodes and coupled to dynamometer which is interfaced via a data acquisition card and biasing network to PC.
- Software written to continuously display signals while interpreting emotional state, and providing audio/visual feedback to help reach ideal state.
- Bar graphs and color coded visual of steering wheel show perceptual changes in dynamometer and GSR, limited at 100%.
- Emoticons display user emotional state in real-time.
- Voice prompts attempt to guide user back to ideal emotional state at a maximum of once each 15 seconds (for demo purposes only…actual car can be made less or more intrusive).





Additional Goals

- Creating an all-in-one installable system for trucks, including steering wheel or steering wheel wrap featuring all electronics, sensors, etc.
- Enabling that system to communicate with external vehicle devices and accessories: navigation system, driver wristwatch, key-fob, cell phone, PDA, etc.
- Enabling more sophisticated emotion data based biometric ID functions for drivers: fingerprint/GSR/HR key-fob, ignition, etc.

Benefits:

- Exmovere embedded steering wheel sensors can monitor driver emotional states and signal a need to relax or pay more attention.
- Exmovere technology is based on proven methods, and requires minimal development for installation in cars.
- This system can be tuned to offer safety and luxury benefits to drivers and occupants alike.

Exmovere is able to integrate these sensor applications into a virtual butler, a persona for the car that is sensitive to the vehicle occupants' needs, desires and tendencies.

Challenge and Potential Impact

Safety, security and driver comfort are major considerations when buying a vehicle, and these demands will result in major leaps forward by car manufacturers and component engineers. The immediate benefit to car makers of using emotion algorithms and biosensors is the creation of an artificially intelligent and sensitive vehicle interface or “persona”. The ability of the vehicle to “sense” the emotion of the driver will become the new demand of the next decade. While safety and security come to the forefront, the innate conditioning that can be provided by a vehicle equipped with Exmovere Automotive Biosensor Technology can provide a much faster reaction time by helping assure the right frame of mind is developed and maintained.

Combined with other products such as the Exmovere Empath Watch, all vital signs can be monitored as well. This advancement in personal biotechnology will prove invaluable when applied to the public safety venue, as well as airline pilots.

Conclusion

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The Exmovere Automotive Biosensor Technology has broad implications for the next generational development in comfort, safety, and in micro-biotechnological advances that have broad-spectrum application.