Research on Body Area Networks, Vehicular Communication Systems and their combined applications

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***Abstract*— Body Area Networks (BAN) play a vital role in health care and the Vehicular Communication Systems (VCS) are important for road safety and transportation productivity. The combination of these two will result in an application/device which will ensure better road safety, improve health care and increase standard of living. Large amount of sensors is deployed across the globe and these sensors generate humongous amount of information which is collected, processed, analyzed and used. This paper gives detailed information about, different types of sensors deployed, from which data is collected, describes in brief the different ways in which this information will be analyzed and used by the application and provides in-depth research about how, Body Area Networks and Vehicular Communication Systems collectively work together to provide multiple features to this application/device. As, there are few drawbacks and challenges with respect to BAN and VCS, they will add up and create more issues which need to be addressed with respect to this application. The paper addresses all such issues (with respect to the sensors, BAN and VCS) but, it will also consolidate the reasons for which this application/device will work efficiently once the issues are resolved and it provides future research scope.**

***Keywords*—** Sensor Networks, Body Area Networks, vehicle-to-vehicle communication, road safety, health care.

I. INTRODUCTION

A) Body Area Networks

Wireless Body Area Networks consist of intelligent, low-power, micro and Nano-technology sensors and actuators, which can be placed on the body, or implanted in the human body (even blood stream), thereby providing timely data. According to International Standards Specification, they should be low power, Short Range, Extremely Reliable and should support wide range of data rates from 75.9 Kbps to 15.6 Mbps. In order to diversify its range of applications, the technologies it must interoperate with can be ZigBee, Bluetooth, Wireless Sensor Networks, Wireless Personal Area Networks, Video Surveillance Systems and Cellular Networks. The nodes in these networks, are classified according to Functionality, Implementation and Role. Functionality, it is subdivided into three parts. Firstly, it is the Personal Device which collects all information received from sensors and actuators plus handles interactions with other users. Secondly, Sensors are present which gathers and responds to data on physical stimuli, processes data and provides wireless response to information. It can be used in wrist watches, mobiles, earphones etc. Thirdly, Actuators which interacts with user after it receives data from sensors. It also provides feedback to user after acting on sensor data. Implementation, is also subdivided into three parts. Firstly, it is the Implant Node which is planted immediately underneath skin or inside body tissue. Secondly, Body Surface Nodes are present which are either placed on human body surface or 2 cm away from it. Thirdly, External Node is present which is not in contact with human body and about 5 cm away from human body. Role is subdivided into Coordinator, End Nodes and RELAY or Intermediate Nodes. Firstly, it is the Coordinator which acts like the gateway to outside world or another body area network. Through this, all other devices communicate with each other. Secondly, it is the End Node which performs only the embedded application and is not capable of replaying messages from other nodes. Thirdly, RELAY or Intermediate Nodes which possess parent node, child node and relay messages. It is also capable of sensing data. However, if any node is present at an extremity, then the data needs to be relayed via many other nodes until it reaches the device.

One of the major application here is Patient Monitoring which is used in vital sign monitoring, as well as providing real time feedback and information on the recovery process in health monitoring applications. More specifically, they sense and wirelessly transmit vital signal measurements such as heart rate, body temperature, respiration rate, blood pressure, body implant parameters and chest sounds. WBANs are also capable of administration of drugs in hospitals, remote monitoring of human physiological data, help in rehabilitation of patients and provide an interface for diagnostics. As these networks can provide interconnection amongst various devices in or around the body such as hearing aids, digital spectacles etc. their application could go beyond patient monitoring and

also include post-treatment follow-up, pharmaceutical research, trauma care, remote assistance in accidents and further research in chronic diseases. However, WBANs do experience a path loss due to body absorption that should be reduced by heterogeneous and multi hop links consisting of sensors at various different locations. It sometimes may happen that, change in the operational conditions may cause greater number of errors and incomplete data which is relative to inherent limitations of sensors, human body postures and body movements, etc. Health Care Facilities around the world as well as humans do have specified regulations and constraints, the design of body area network devices becomes a major issue. Even more challenging issues arise in terms of antenna design due to shape, size, material and the highly corruptible Radio Frequency Environment.

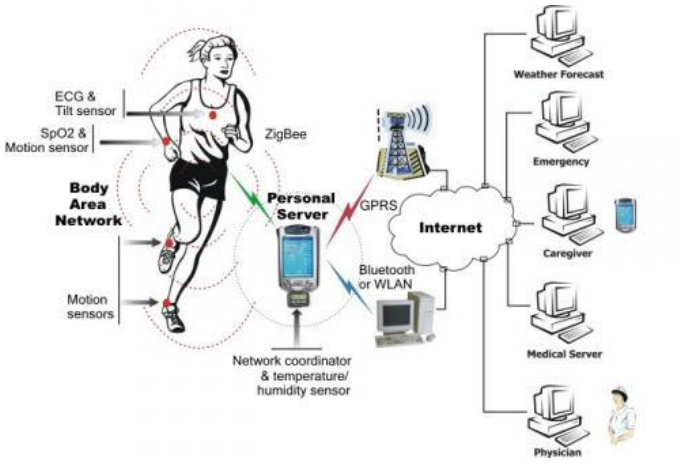

Figure: Body Area Networks

The most important factor to be taken into consideration is that the location of implant device will enlist various categories of the antenna design to be used. For example, there a certain cases wherein such kind of restrictions have limited the overall usage of these devices. There have occurred surgery cases wherein the urethra valve has to be replaced inside a human body at regular intervals but without performing surgery, having a restriction on the length of valve with a complete diameter of 4mm to 6mm only. This also means that a path antenna cannot be utilized and maintenance of a dipole or a monopole antenna which somewhat is circular in shape is quite difficult. As a result, a helical shaped antenna would best fit into a urethra valve. However, in case of body area networks, the shape is not the only criteria. It should also use a bio compatible and a non-corrosive material like titanium and platinum, which is safe for human skin, but in that case the antennas built from these metals are not strong, for example as that of a copper antenna. This illustrates the Environment challenges. The second major aspect in the implementation field is the Physical Layer Challenges. The devices should be designed in such a way that the power consumed is minimized, without compromising the reliability of the device. Current wireless technologies, have a very high peak current rate and they reduce the average current drawn by duty cycling radio between both active and sleep modes. Hence, in order to reduce the peak current drawn, reliable improvements are needed in radio hardware, sensing technologies, reduction or miniaturization in size of device is needed. Currently, the advancements in low power Radio Frequency technology is expected to achieve the above requirement. Devices should be designed to minimize power consumption, which leads to production of small, disposable devices. The problem of interference is also a major issue here. This occurs when multiple people that are using wearable WBAN come in to a range near to each other, which makes coordination impossible i.e. off-body interference. This scenario is a major cause of concern as it is estimated that by 2014, around 420 million devices will be sold, and this figure is going to rise. On-body devices deployed in one WBAN may also have interference with one another device. The third major challenge here is Security. Due to limitation of resources in terms of energy, memory, processing power, etc. the existing security mechanisms proposed for various other communication networks, do not apply here. As a result there is a pressing need to develop much more lightweight and resource-efficient protocols. For instance, an adversary can be responsible to carry out heart failure, by detecting and executing weaknesses in an Implantable Cardioverter Defibrillator (ICD).

B) Vehicular Networks

Vehicle to Vehicle Communications for Safety is actually the dynamic or spontaneous exchange of data between vehicles moving nearby which offers the opportunity for considerable safety improvements in this wireless technology. Hence, these are basically networks in which multiple vehicles and the roadside units which aid in communication of vehicles, constitute the communicating nodes. They also give each other safety warnings and important traffic related information like congestion, accidents of peer vehicles, etc. These kind of nodes are called as the Dedicated Short Range Communication devices (DSRC). They work in 5.9 GHz band having a bandwidth of around 75 MHZ, with a near about range of 1000 m. It is usually developed as a part of intelligent transportation systems. The main aim or goal behind developing this kind of communication system is safety and prevention of the excessive cost of traffic collisions.

"According to World Health Organizations (WHO), road accidents annually cause approximately 1.2 million deaths worldwide; one fourth of all deaths caused by injury. Also about 50 million persons are injured in traffic accidents. If preventive measures are not taken road death is likely to become the third-leading cause of death in 2020 from ninth place in 1990." This type of communication makes it possible for a vehicle to detect hazards or problematic situations with other vehicle, with a 360 degrees' awareness of the position and location of other vehicles, including the threats they present, risk calculation, or even preventive measures to avoid and handle crashes. In the core of Vehicle to Vehicle

communication, is a very basic application or concept, known as “Here I Am” message. These kind of messages can also be taken or retrieved using non vehicle based technologies, e.g. Global Positioning System in order to know the location and speed of vehicle. We can also know the vehicle based sensor derived data in which the speed and location of vehicle is retrieved from the vehicle’s computer and is joined or combined with latitude, longitude or at an angle to display a much more detailed situational awareness of vehicle’s position which is travelling or traversing nearby our target vehicle.

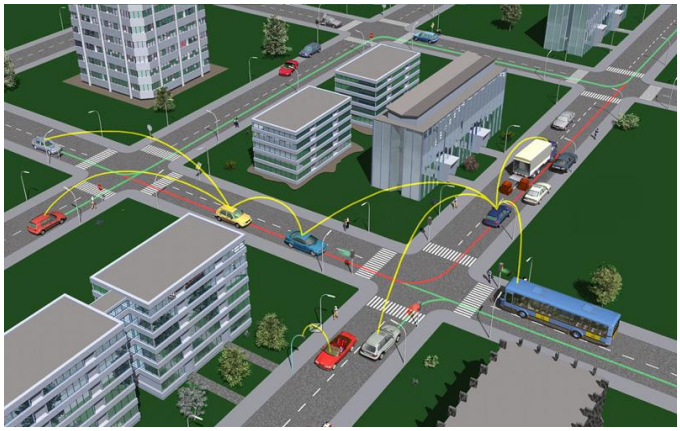

Figure: Vehicular Networks which involve vehicle-to-vehicle communication

The aim or goal of vehicle to vehicle communication is that, each and every vehicle on the roadway including trucks, buses, cars etc. will be able to communicate with other vehicles and this rich set of data will support a new generation of active safety application systems and applications. Such kind of safety systems, will help in preventing about 76 percent of crashes on roadway, hence reducing the number of accidents occurring each year. This safety mechanism is a major component in the USDOT’s Vehicle to Vehicle Communication program, and is supported by a number of research programs that improve connectivity among vehicles and infrastructure (V2I) and also among other vehicles and consumer devices (V2D) in order to give safety and mobility benefits. Some of the properties of Vehicular Networks are:

a) Sensing and Close Environment Perception: By using different kind of sensors and cameras, we can have information about weather conditions, road and vehicle conditions etc. Hence, the driver of vehicle has this information, including better visibility which will enable him/her to take appropriate action to any kind of changes in the environment.

b) Processing: With a huge amount of processing capacity present, vehicles are intelligent enough, to interpret the huge amount of data available and assist the driver in making an intelligent decision, in various vehicular applications available.

c) Storage: A large amount of storage space is needed, to store different classes and categories of information. All these data structures are continuously calculated and updated via events and decisions from the communication system present in the vehicular networks.

d) Routing and Communication: This particular property is important for the exchange of information in the network itself or with other multiple networks present. “This permits to increase the precaution perimeter with the help of an extended perception of the environment and thus give a more accurate prediction of driving problems”.

e) Processing, Energy and Communication Capacity: Here, in case of vehicle to vehicle communication, there are no restrictions in terms of energy, etc. Also they do have very large processing capabilities and have multiple communication interfaces like Wi-Fi, Bluetooth, etc.

f) Environment and Mobility Model: The environment property in normal context are often restricted to open spaces or indoors. The movements of the vehicles are connected to road infrastructures, to the highways or freeways or within a metropolitan area. The restrictions created by this type of environment e.g. the radio obstacles and multipath fading effects, they affect the mobility model and radio transmission quality to be considered in proposed rules and regulations, as well as solutions. This is also linked to the behavior of the driver present inside the vehicle.

g) Type of Information and diffusion: Vehicular safety being one of the most important concerns here, this property will focus on broadcast of messages from a source point to several recipients present inside the network. However, the vehicles which are affected by this kind of diffusion property, depend on their geographical location in the occurred event. Hence, the communication is mainly unidirectional.

h) Network Topology: In Vehicular Ad Hoc Networks, any node or a vehicle in our case, can quickly join or leave the network, in a very short period of time, which does cause a lot of regular changes in the network topology. Also, problems such as network clustering can occur multiple times, especially when the vehicular communication is not properly setup.

Hence, all the solutions proposed can be setup in majority of the vehicles. There are various regulations and restrictions which must be imposed on vehicular networks in order to function properly. Some of most important security requirements are:

a) Data Authentication and Integrity*:* Here, authentication implies that the transferred data should be crosschecked by allowed vehicles, and also their identities have to be checked. Integrity means that the originally transmitted messages will be sent to the recipient without any error.

b) Data Confidentiality: Here, a number of encryption schemes will have to be used to make sure that the data transmitted between vehicles and remote stations is encrypted and secure.

c) Vehicle Privacy and Anonymity: Here, the messages which have to be accessed by the authenticated vehicles etc. should not be exposed to those kind of vehicles who drive dangerously on the road. Hence, the identities of such vehicles should be documented in such a way that later on any action can be taken towards them.
d) Access Control: Here, all the vehicles present in the network should have the capability of accessing the available services given by the remote node.
e) Data Non-Repudiation: Here, the senders of the data should not be able to deny their identity, as it may mislead other vehicles and eventually give them incorrect location or position of events and reduce the cooperation between them
f) Vehicle ID Traceability: Here, this basically means the ability to get real identities or the addresses of vehicles which have sent messages to one another.
g) Availability: Here, this basically means the guaranty that the communication between vehicles and or nodes will take place even when the conditions are unfavourable. Also, the network should be such that it is able to face different types of attacks and still continue to provide services.
h) Anti-Jamming: Here, in this case, the malicious nodes or vehicles may continue to send multiple interfering messages to make the communication between legal vehicles as impossible.
i) Impersonation: Here, certain vehicles may try to acquire a false identity and then communicate with other vehicles and alter their behaviour.

Challenges in Vehicular Networks

Vehicular networks are presented with a number of challenges to function properly. Some of the most common challenges are:
a) *Network Volatility:* This means that the communication between two vehicles, may last for a shorter period of time, due to the acceleration or speed between them. Hence, the possibility of having "long-lived context" is quite less.
b) *Liability vs. Privacy:* This means that the information about vehicles should be accessible, which can be utilized in conducting investigations later on in case of any mishap, etc. Also, privacy is an important issue here, in order to make sure that the information reflected by a vehicle, rightly belongs to it.
c) *Infrastructure-less:* Here, most of the possible architectures in the case of VANETs, rely only on communication. Hence, no centralized architectures or routers, etc. are used. So to compensate in this case, a kind of "trust relationship" should be established between vehicles, by utilizing "reputation management systems".
d) *Wireless Link Use:* Here, this technology depends entirely on wireless channels, and it requires the very strong security mechanisms to establish channels between nodes or vehicles, which are confidential, and possess network integrity.
e) *Multi-hop Connection:* Here, the VANETs sometimes utilize the concept in which if one vehicle, sends some kind of information then that message must pass through all the possible neighbours in its range. Also, any kind of vehicle which exercises or displays incorrect behaviour should be penalized accordingly.

Going in more depth to understand the possible attacks on the vehicular ad hoc system, they are classified as:
a) *Insider Attacks:* These kind of attacks are caused by those vehicles which exhibit malicious behavior but are present inside the VANET.
b) *Outsider Attacks:* These kind of attacks are caused by those vehicles which exhibit malicious behavior but are present outside the VANET, and may also not belong to a specific VANET.
c) *Passive Attacks:* In these kind of attacks, the eavesdropper does not communicate directly with legitimate vehicles, but can capture the information transferred or sent from one vehicle to the other, and execute malicious behavior.
d) *Active Attacks:* In these kind of attacks, the eavesdropper tries to disguise himself as an authorized vehicle, in order to redirect the path of data transmitted between vehicles, and sometimes also cause a disruption or breakdown between the authorized vehicles.

List of Attacks are as follows:
a) *Message Spoofing Attack:* Here, the malicious vehicle sends incorrect information in the form of messages to other vehicles.
b) *Message Replay Attack:* Here, the malicious vehicle keeps on replaying previously sent messages to cause network traffic congestion.
c) *Impersonation Attack:* Here, the malicious vehicle claims that it is an authorized vehicle, i.e. tries to alter its true identity and send incorrect messages to other vehicles.
d) *Denial of Service Attack:* Here, the malicious vehicles continue to send unnecessary information or messages to occupy large bandwidth of the communication channel and utilize maximum resources of other vehicles.

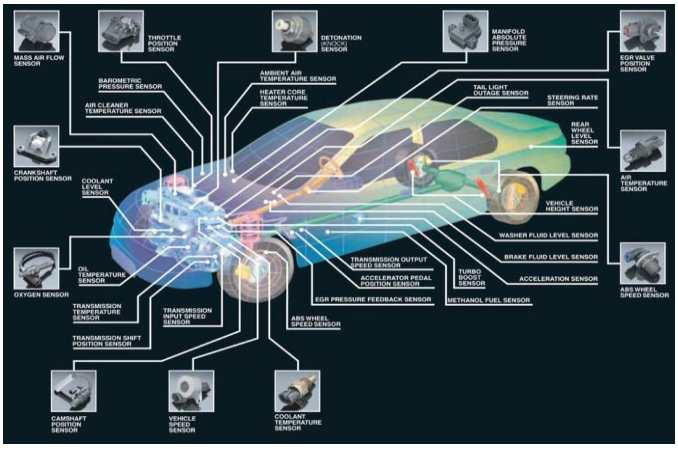

Figure: Car Sensors

Below, a broad classification of sensors is given which are utilized inside a vehicle. Also, the information generated by them are utilized by control module within a car.

a) Throttle Position Sensor (TPS) is a variable resistor which changes or alters value based on throttle movement of throttle inside the vehicle. The information from these sensors are used to adjust the fuel delivery. Also, here the "vehicles equipped with electronically shifted transmissions use information from the TPS to control transmission shifting as well".

b) Manifold Absolute Pressure Sensor (MAP) sends the load information of the engine to control module. Then this information is used to calculate fuel delivery, spark timing, etc.

c) Camshaft Position Sensor (CPS) is used to find out the position of the number one cylinder. The information thus generated is utilized by control module as a reference point to initiate or start the sequential fuel injection operation inside the engine.

d) Oxygen Sensor (OS) generates a very large voltage signal based on the amount of oxygen in engine exhaust. This voltage signal is then used to provide air and/or fuel mixture information for delivery of the fuel and emission control inside the engine.

e) EGR Temperature Sensor (ETS) is a thermistor used to verify EGR flow. "The information obtained from this sensor is used to provide diagnostic and troubleshooting information to the control module."

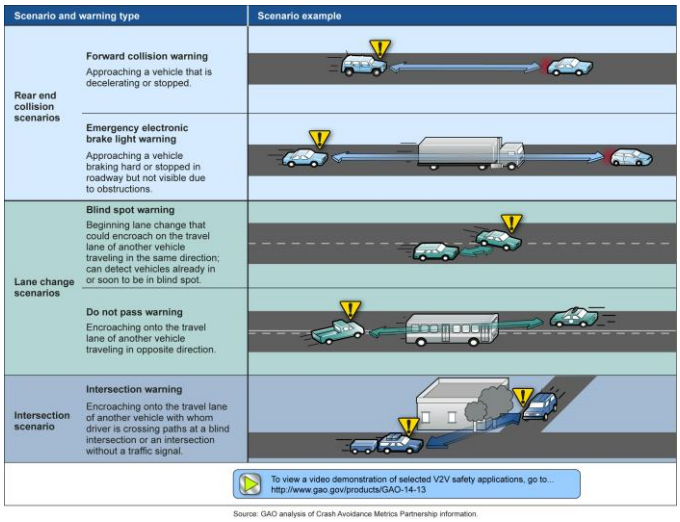

Figure: Collision avoidance using vehicle-to-vehicle communication

Applications of Vehicular Networks

The main applications of Vehicle to Vehicle Communication can be categorized into three parts:

a) Road Safety Applications: This application is considered of utmost importance, due to the increasing number of accidents on roads due to the presence of millions of vehicles on road. To improve safety in such scenario, and to counter road accidents, these kind of applications give the possibility of avoiding accidents, stationary and mobile obstacles and giving out weather information.

b) Driver Assistance Applications: This application helps to carry out autonomous driving and give support to the driver in certain situations, prevention of straight or curved lane exits, etc. Also, a number of trucking companies these days, use this technology for productivity, to reduce consumption of gasoline.

c)Comfort Applications for drivers and passengers: This includes user information and communication services like access to internet, inter-vehicle chat, network games, etc.

Below is a list of multiple services offered by vehicle to vehicle communication networks:

a) Alert in case of accidents: This kind of service alerts the vehicles, in case of an accident that the traffic conditions have been changed and it may be necessary to exercise more caution while driving. It is also required in case of reduced vehicle density to store the messages so that it can be retransmitted if some other vehicle enters the retransmission zone. Also, in this case the safety messages are transmitted at regular intervals of time. Thus the nodes which are designed to carry out message retransmission will keep on sending alert messages. However, in order to carry out faster message transmission, the length should be less.

b) Alert in case of Abnormally Slow Traffic: This kind of service alerts the drivers of certain traffic conditions. The driver is indicated to slow down car irrespective of nature of traffic problem. Here, an official vehicle, doing the road work, can also initiate sending of alert message. However, if this kind of message is transmitted in case of an accident, it should be sent quickly, effectively and efficiently.

c) Highway Hot Spot: This service includes the proposal to access the Internet from a station or from the highway by making a valid payment. Passengers, will be able to play network games, download MP3 files, etc.

d) Parking Management: This kind of service collaborates information on space availability present in car parking lots and coordinates between multiple cars to help them find free spaces to enable a hassle free parking scenario.

II. PROPOSED SYSTEM

As we have discussed about Body Area Networks and Vehicular networks, we have mentioned their characteristics, their properties, their applications and challenges, so, we have set the base for our actual research that involves the combination of these two concepts. In this section, we have listed couple of applications which will be as follows:

A) If the speed of the car which the user is driving increases than what it should be, he will be notified by the device OR Speed limit boards will be identified and before

they are crossed users will be notified so that, they can limit their speed accordingly.

The system is called the Intelligent Speed Limiter and it combines two existing technologies already fitted to many cars:

i) Adjustable speed limiters - these use sensors mounted in a car's wheels to detect how fast it is going. Once software understands that the vehicle is at a maximum preset speed, rather than applying the brakes, it limits the amount of fuel that reaches the engine. The system does, however, allow the driver to quickly suspend the restriction by pressing the accelerator pedal to the floor, letting them overtake another vehicle or avoid a collision.

ii) Traffic sign recognition- a forward-facing windscreen-mounted video camera scans the environment for road signs and alerts the driver to their presence. Using this system, the user will not miss any sign boards and this will ensure full personal safety as well as road safety. This system can be integrated with a wearable device so as to provide a better way to notify the user about the speed limits and the road signs.

Figure: Different Alerts

B) Parking assistance: Users can enable their device to communicate with their car in a parking lot, then, the device can provide information about the location of their car.

GPS tracking device (it's a device that uses the GPS to determine and track precise location of a vehicle and the recorded location data is stored within the tracking unit, or it may be transmitted to a central location data base or Internet enabled computer which is then used to analyze the vehicle's track), can be installed in the vehicle which will save the vehicle's current location and also be connected to the wearable device so as to help the user find its car in a crowded parking lot as he will be notified about the location of the car.

C) Device will beep if the user is outside the car and someone tries to access or damage the car.

There is a list of sensors mentioned below which are enabled inside a car so as to protect the car from theft.

Door/Pin switch: Pin switches are installed in any door, hood, lid, or cargo area in order to cause an alert when the door is opened.

ii) Pressure sensor: Pressure inside of a vehicle changes when a window is broken or a door is opened, and the pressure sensor is able to detect this change.

iii) Motion/Tilt sensor: Motion/Tilt sensor is an external element of the car alarm system that acts to monitor the position of a vehicle and respond when there is motion or movement deviating from that position.

iv) Shock sensor: It works in a similar fashion like the motion sensor or pressure sensor but, it detects various degrees of impact to a vehicle from the outside, such as when someone bumps the vehicle or hits it.

v) Closed loop sensor: It is connected to the vehicle's electrical system in order to monitor the wiring to all the components of the vehicle so, if a wire gets cut, then the close loop sensor will detect it.

When these sensors communicate with the wearable device i.e. the device worn by the user, he will get updated in case of an emergency as the above sensors will react appropriately and communicate the information to this device and since, vehicle-to-vehicle communication is possible, same information can also be broadcasted to other vehicles so as to seek help.

D) In built vehicle sensors will update different information to the device like if the car needs maintenance or it needs petrol/diesel/water refill OR these sensors can notify about any internal problems or failures.

Each of the above mentioned vehicles warning indicator are connected to some sensors enabled inside the vehicle and based on the performance of those sensors, these indicator lights are switched on, in order to indicate the driver about some issue/problem. But, since it is not directly notified to the user, the user might not notice the indicator and lead into a problem. So, in order to avoid this, these indications will be provided by the device used by the user so that, he will not have to continuously monitor the vehicle warning indicators and he will be directly notified.

One of the drawbacks experienced in this is a failure experienced in of one of the devices Ex. the Malfunction Indicator Light or the Check Engine Light which is to indicate a detected problem with the vehicle's engine, transmission or emission control system and alert the driver about the issue. So, if there is a failure in this device it will not give the user any indication which might lead him into a catastrophic situation.

E) Use of body sensors/Brain-Computer-Interface to know what the user in thinking or to know his mental/physical condition" (i.e. if he is drunk, sleepy, hungry, etc).

There are body sensors which can be implanted inside a user's body or the BCI (Brain-Computer-Interface) can be used, which will identify a user's need like the person is hungry as well as it will also understand the mental health of a person i.e. if the person is feeling sleepy or he is feeling dizzy or he is drunk and then communicate this information with car

sensors which can then communicate with the GPS unit in order to

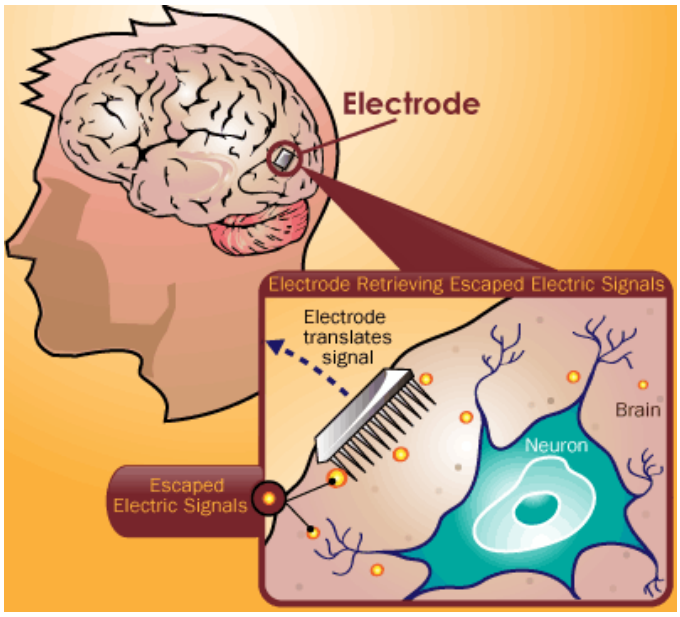

Figure: How Brain-Computer-Interface works

locate or suggest some places nearby for refreshments and it will also communicate with the other vehicle sensors so that, the car in slowed down in order to avoid and collision or accident (since the person is sleepy/drunk and unable to control the vehicle) respectively. These body sensors will also notify the car sensors in case of emergency (that has already occurred) so that, it can broadcast the information (that, it is an emergency) to the surrounding cars as well as to the hospitals/ambulances nearby.

III. FUTURE RESEARCH

The proposed system is very powerful and efficient. It has strong potential to address some of the challenges or problems faced in day-to-day life. Before these challenges are actually taken care of, there are certain challenges with respect to both Body Area Networks and Vehicular Communication Systems using which the vehicles communicate, which needs to be addressed in order to move on with the proposed system.

The major issues faced by Body Area Networks are as follows: **Security**: Considerable effort would be required to make WBAN transmission secure and accurate. Confidentiality, authentication, integrity, and freshness of data together with availability and secure management are the security requirements in WBAN. **Interoperability**: In order to promote information exchange, plug and play device interaction, WBAN systems have to ensure seamless data transfer across standards and they must be scalable, ensure efficient migration across networks and offer uninterrupted connectivity. **Sensor validation**: Pervasive sensing devices are subject to inherent communication and hardware constraints including unreliable wired/wireless network links, interference and limited power reserves which results into erroneous datasets. **Data consistency**: Data residing on multiple mobile needs to be collected and analyzed in a seamless fashion. **Interference**: Interference can be reduced and increase in the coexistence of sensor node devices with other network devices can be achieved using wireless link. **Data Management**: It is important to manage and maintain these datasets.

Besides hardware-centric challenges, the human-centric challenges like cost, constant monitoring, constrained deployment and consistence performance should also be addressed for practical BAN development.

There are various issues faced by vehicular communication systems which are Addressing and Geographical addressing, Risk analysis and management, Anonymity, Privacy and Liability, Secure Localization, technology development constrain, vehicle communication fully depends on robust data collection and accurate sensor detection, implementing accurate sensors and proper mounting and Prioritization of data packets and congestion control.

Based on the analysis we have dealt so far, we can conclude that, despite of the fact that both, Body Area Networks and Vehicular Networks are well studied in literature from several aspects, their combination or integration is interesting and opens research directions that needs to be addressed. Moreover, many aspects need an interdisciplinary analysis in order to take into account their specific features and their implications.

IV. CONCLUSION

Through the medium of this research paper, we conclude that Body Area Networks play a vital role in health care monitoring of patients, via implantable or wearable sensors. Also, vehicle to vehicle communication are very important to enable safety on roads, give internet access to passengers, assist in parking, etc. We also classified the sensors utilized in this technology, according to Role, Functionality and Implementation. Also, it's individual application areas and challenges due to its shape, size and material is described. In case of vehicular networks also, its basic concept i.e. it's implementation and applications, etc. are described. Also, the challenges associated with from security point of view are discussed. The future research was also taken into consideration in which challenges related to Security, interoperability, sensor validation, etc. are discussed. Hence, in order to move forward, certain issues will have to be resolved. Also, it is made sure that besides the software centric challenges, hardware centric challenges are also resolved as far as wireless body area networks are concerned. Also, various issues in case of vehicular networks also will have to be resolved like Risk Analysis management, Privacy, Liability, etc. will have to be resolved. However, it is clear

that until & unless. these issues are addressed; the implementation of the research topic might pose certain problems.

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