

A Review on In-Car Health Monitoring Systems

Sakshi Sethi

Assistant Professor

Amity University, Gurgaon, Haryana, India

Abstract- As we all know that health monitoring systems play a vital role in keeping a track on patient's physiological parameters and most of the time we spend are mostly inside our cars making it the most certain feature of our lives, looking at both the factors, a new idea of installing a compact and portable health monitoring device inside the car is proposed. This review paper aims at discussing various advantageous and valuable characteristics that can be included in a health monitoring system inside a vehicle so as to keep the driver or passenger updated about his/her health and so that necessary safety measures can be taken by the driver itself or by the car with the help of advanced technologies in emergency conditions. The device, with the help of various biomedical sensors and other processing unit systems can make it possible to detect and monitor vital physiological data like body temperature, pulse rate, respiration rate, muscle activity, breath analyzer (to detect the degree of alcohol consumption) etc. of the drivers that will ensure driver's safety as well as prevent any medical mishaps and damages on road.

Keyword: Physiological, Biomedical sensors, mishaps, processing unit.

1. INTRODUCTION

Monitoring, in medicine is the process of observing the condition of a disease or for keeping a check on patient's physiological parameters. For this purpose Medical monitors are used i.e. for continuous examination of vital parameters [1] and as we are all aware of the amount time we spend inside the car while travelling and in a world of increasing rate of chronic and acute diseases, health monitoring system in cars will be something advantageous to smartly growing human race into the future of the health and wellness.

So, the need is to provide to a safe health environment for vehicle drivers because it is required that the driver should concentrate during the entire course of the journey and, that can only be possible if the driver is healthy. Any protracted or immediate health related problems while driving can cause major mishaps. In many developing countries like India, poor health conditions are one of the major reasons that lead to road accidents and damages due to heart stroke, drowsiness or over stress etc [2]. Therefore, safety has to be ensured so that proper monitoring of the vital parameters of the vehicle drivers can be done and so appropriate measures can be taken to avoid any mishaps and damages [3]. Keeping the vehicle driver updated about his vital biological parameters will not only help to provide his/her health condition but will also ensure that the driver is aware of what action should be taken in that particular emergency situation and thereby take corrective measures or actions like informing the family member about his/her condition or parking the car safely on the side of the road [4]. These systems will be capable of tracking down the vehicle present at a particular location. These wireless devices can operate in real-time and can also be based on GPS network and GSM forming a vehicle tracking system along with working as a health monitoring system to keep the vehicle driver updated as long as the driver is behind the wheel [5].

2. LITERATURE REVIEW

2.1 Active Monitoring

In today's world of increasing rate of chronic illnesses and as more and more people are being aware of importance of health and wellness, they now prefer being updated about their vital parameters privately rather than depending on the availability and schedule of the physician. As estimated in the beginning of 2011, a tremendous increase was observed in combining the field of medical and healthcare with Smartphone applications. This type of collaboration of information technology with healthcare leading to technological innovations has helped most of the population to get an easy access and be updated about their health [6]. Various modifications are being currently going on in the Healthcare field. The industry has transitioned from discrete interactions with patients and on-going patient support into in-home, in-person and now in-vehicle patient interaction and support [7]. So, here comes the concept of introducing a personal monitoring system in vehicles which aims to collect and transfer driver's various physiological data anytime and anywhere as long as the driver or passenger is behind the wheel which in turn can prevent road accidents due to immediate odd medical conditions and the will also ensure safety while driving.

Bringing the remote healthcare monitoring system into automotive industry is nothing but an approach to offer people the best "medical device" car [8]. Various biological parameters like body temperature, heart rate, brain activity, muscle motion and other critical vital data affecting driver's health can be monitored keeping the driver regularly updated as long as the person is behind the wheel. The device can observe driver's facial expressions for example keeping driver's eye blinking rate under continuous observation, if the blinking rate exceeds the normal range then it can show that the driver is sleep deprived and hence proving his condition is not safe for carrying out a journey. Similarly, if any other variation or deviation in the driver's health information is

observed then more proactive safety measures will be provided by the car system. And for future reference, all the patients' data can be linked with cloud server so that patient is able to access previous medical records easily [9].

3. TECHNOLOGY USED FOR MONITORING VITAL PARAMETERS

3.1 ECG MONITORING

Innovations leading to the development of new and smart sensors are leading to easy acquisition of bio-signals. New sensors consisting of conducting fabric and capacitive electrodes are found to be capable to get ECG measurements from the driver. Research done in the Philips Chair of Medical Information Technology at Aachen University as a joint project with European Ford Research Center has acquired interesting results for monitoring vital parameters. It has been observed that driver's ECG can be acquired in a non-contact manner without compromising with the driver's comfort. EPIC sensor technology has been created considerable interest with automobile manufacturers as it can provide low cost and reliable detection for many automotive applications [10].

3.2 BP MONITORING

For monitoring driver's blood pressure efficiently a compact BP monitor can be used and installed in the cockpit of the car. BP monitoring can also be possible if the monitoring part of the system is integrated in the form of wristwatch. This form of the system will be compact that is it will be small and simply placed around the wrist. The system will make use of high pass filter that will control the cuff pressure so that the oscillations or variations can be observed in a function of time.[11]

3.3 DROWSING DETECTION

For drowsing detection the system can make use of infrared cameras or retina sensors that will scan driver's face in order to detect the situation in case the driver goes through drowsing condition. And, so this feature will enable the car system to take possible safety measures like slowing down of the car, inflate safety airbags quickly in the case of instant collision or be able to warn the driver through an alarm system.[12]

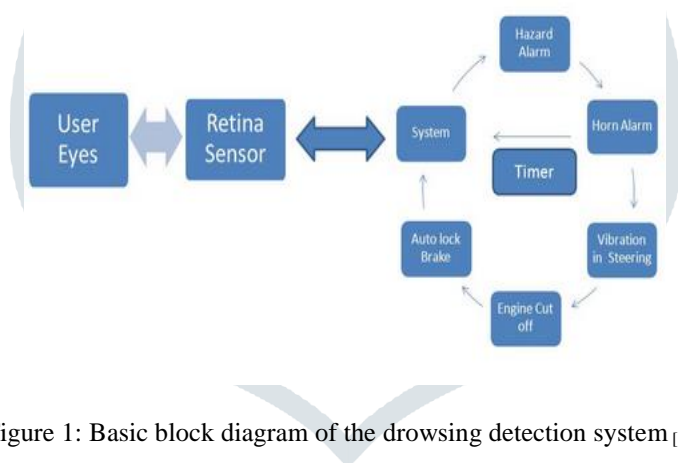


Figure 1: Basic block diagram of the drowsing detection system [15]

3.4 RESPIRATION RATE

Several methods and techniques have been developed for the measurement of respiratory activities so that certain life threatening respiratory conditions like COPD(chronic obstructive pulmonary diseases) can be diagnosed at early condition. A device known as 'capnograph' had been routinely in use in departments and organizations like hospitals and centers for critical care to monitor the respiratory status of the patients. Other well adapted respiratory monitoring devices include Respiratory Inductive Plethysmograph (RIP), electrical impedance tomography, thermistors for measuring airflow measurements, piezoelectric transducers, and Micro-Electromechanical Systems (MEMS) accelerometers. By integrating the body sensor network technology with the above discussed methods and techniques so that it can be easily deployed while being less obtrusive to patients. Accelerometers have been increasingly used in recently years to derive respiration rate. Accelerometers worn on the torso are capable of measuring inclination and angular changes during breathing and then respiration rate can be estimated using digital signal processing technology. [16] Integrating this type of technology into the portable health monitoring system for cars would be very beneficial.

3.5 HYDRATION DETECTION

These sensors can be used to keep a check on chemical activity taking place like various electrolyte levels in real time, and simultaneously monitors the production of sweat in order to determine the status regarding hydration. And, this system can be designed to get fitted in palm or to be worn on a wrist. This sensor can be calibrated to be used for a specific person or a group of people and thereafter transmitting the data to the monitor screen and then get stored in the cloud. [9] Researchers from North Carolina State University has developed a sensor that consist of two elastic polymer having conducting silver nanowires that are capable of monitoring electrical properties of the skin and then finally detect a person's hydration level. And, these sensors are relatively inexpensive, light weighted, flexible and stretchable and can be incorporated with other prototyping devices so that these can be worn on the wrist or as a chest patch and be simultaneously be transmitted to the display and to the cloud .[13]

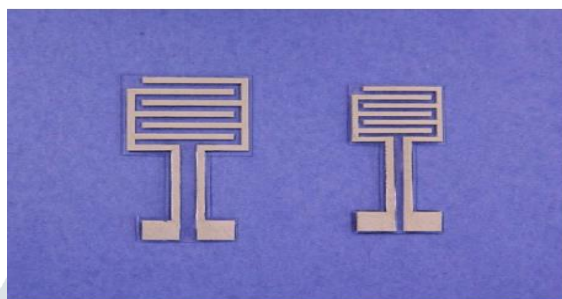


Figure 2: Electrodes used for hydration sensors [13]

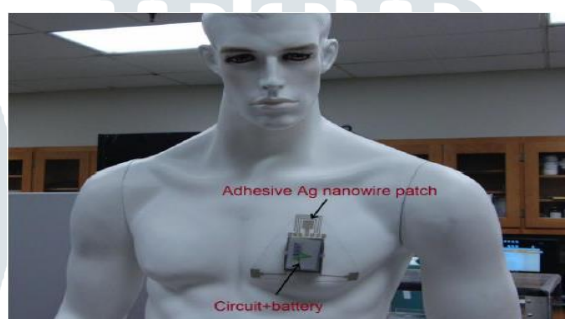


Figure 3: Installation of Hydration Sensor for measuring the hydration level of the person. [13]

3.6 ROAD RAGE DETECTION

Special camera based systems has been developed by European Car Safety Researchers that maps facial expressions of the drivers while they are behind the wheel and then with special emotion detection coding it will be able to detect whether the driver is suffering from road rage or not. The thought behind this system is, when a person gets aggressive because of irritation which leads to less attention while driving eventually results in more number of accidents. These systems can warn the driver to take rest and getting the car slowed down or getting the car parked on the side of the road until the driver feels alright again if the driver is expected to be suffering from tiredness or fatigue and that is measured by calculating the percentage blinking rate of the persons' eyelid. Researchers have developed a device " EPFL's Signal Processing 5 Laboratory(LTS5) in association PSA Peugeot Citroen, that makes the use of an infrared camera installed behind the steering wheel of the car to scan the seven universal hard-coded emotions that a human face can show. If the face under observation is showing the emotion of anger and irritation for a long time then with the help of software it will warn the system that the person is suffering from road rage but in future, this system is expected to do a lot more. [12]

4. INTERNET OF THINGS (IOT)

As Internet of Things (IOT) can provide a wide range of applications in almost every field such as health, traffic congestion and security, Introducing the concept of Internet of Things (IOT) provides connection between almost everything and so they also play an important role in providing a bridge for the network of sensors and internet so that the acquired data can be stored in the cloud for drivers' future references. The approach basically involves translating information between internet protocols and the network of sensors and the advantage of using this pathway that already have valuable information and building control over both sides i.e. from the sensor network and the information to be transferred through the cloud along with displaying the data on the screen. With the help of IOT, it will not benefit the drivers but will also promote the concept of tele-health. [11]



Figure 4: Data Flow [13]

5. DISCUSSION

Healthcare technologies inside a car can give rise to many safety features by monitoring vital parameters. Most of the accidents mishaps are due to tiredness, distraction, over-stress and drowsy vehicle drivers. All these human factors should be taken under consideration and should be taken note for making the monitoring of vital parameters possible. Today, cars and motors have become a certain characteristic of our lives that most of the people spend half of their entire life travelling in cars. So, by managing or keeping a check on passenger's health by continuously collecting the physiological data will ensure safe driving and can prevent many mishaps to happen. This approach is important for people who are already at risk of sudden chronic illnesses to take place that can lead to unsafe driving. The development of this device is not only to improve the life quality but also to bring peace of mind to the family of the driver or passenger. Medical sensors embedded in a car system could be capable of detecting many critical data that can lead to certain appropriate steps ranging from auto pilot to providing emergency services. Though the concept of In-Vehicle Health Monitoring System is fresh and interesting but still there are many challenges that have to be overcome to create this idea into reality. If the collected data can be stored in the cloud or server then it would be very valuable for the drivers to get an easy access to their previous reports. The system should be designed as such that the power consumed should be less as compared to the other system. The device should be reliable, user-friendly and should have been easily accessible by the drivers. The sensors systems that will be used are pretty much expensive thereby increasing the cost of the system and the accurate results that is also a challenging part.

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