

# A SMART SEAT BELT

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## 1. ABSTRACT

The main idea of writing this paper is to introduce the concept of smart seat belts which includes detailed description of how the concept of the smart seat belt arrived, how it work, pros and cons etc. does. Road accidents are unavoidable. Failure to wear a seat belt is one of the leading causes of road crash death.

## 2. INTRODUCTION

Smart Seat Belts includes various sensors present inside the vehicle which can detect the objects nearby. Sensors continuously calculates the distance from current vehicle to external object and relates their speeds. Depending on decelerating speed and distance between vehicle and object, sensors detect the probability of collision with collision speed and possible damage and then sends signal to seat belt which alerts the driver. The seat belt instantaneously reacts to the signal and tightens.

Smart Seat belt can spot when breathing and heart rate slows and issue a warning alarm to pull over to prevent motorists from causing accidents through nodding off. This is the concept of a Smart Seat Belt.

## 3. BACKGROUND

A European project called HARKEN (Heart and Respiration In-Car Embedded Non-Intrusive Sensors) created a sensor system. It is built into the safety belt and seat cover that can detect fatigue or drowsiness even before the appearance of more obvious symptoms such as yawning or bad driving patterns. This system could potentially lead to driver warning system. Driver Warning System is capable of helping to chip away at the annual death toll from road accidents - 33,561 fatalities in US and 28,100 fatalities in European Union in 2012. Accidents occurred in driving may represent the 3<sup>rd</sup> most common cause of disability and death worldwide by 2020<sup>[1]</sup>.

The proposed solution in this project is to address the stated need is a non-intrusive sensing system of driver's respiration and heart embedded in safety belt and seat cover of a car. It will detect the mechanical effect of respiration and heart activity, filter and cancel the noise and artefacts expected in a moving vehicle (vibration and body movements), and calculates required parameters, which are delivered in a readable format to integrate it in fatigue detector.

Seat belts not only save the lives of drivers, but also the pedestrians on road. As per the statistics in 2012, seat belts saved an estimated 12,174 lives. It is the responsibility of both the pedestrians and drivers to follow the seat belt rule in order to save lives of people. As per National Highway Traffic Safety Administration statistics in United States, Seat belts not only save as per the statistics in 2012, seat belts saved an estimated 12,174 lives. It is the responsibility of both the pedestrians and drivers to

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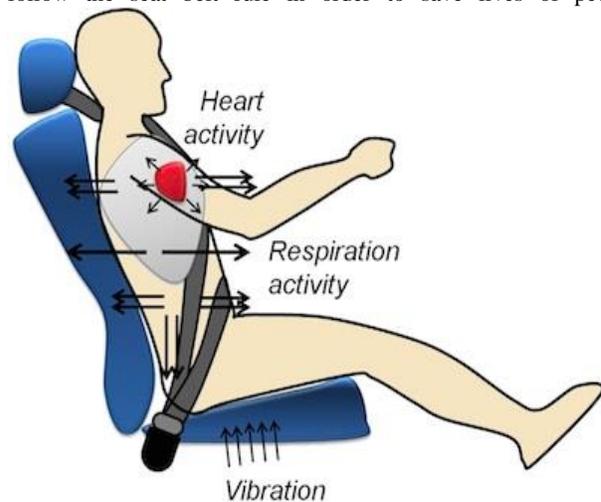


Figure 1: Concept of Smart seat belt.

As per National Highway Traffic Safety Administration statistics in United States, states with primary enforcement laws averaged 90 percent safety belt use while states with secondary enforcement laws averaged about 78% use. Certain high-risk groups (such as teens and impaired drivers) may have lower usage rates<sup>[3]</sup>.

## 4. CONCEPT OF SEAT BELT

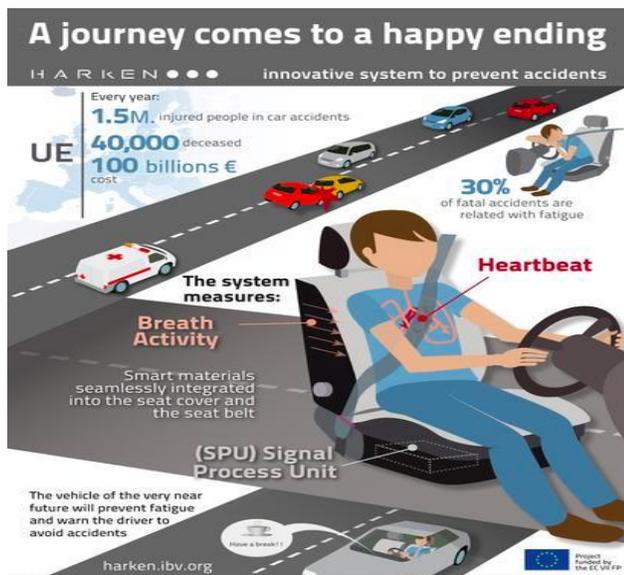
### 4.1 Working of a Seat Belt

Road trips volume involve more than 200 million in Europe, 254 million in United States (As per statistics). Among which, 1.5 million people are involved in car accidents.30% of these accidents are caused by fatigue. By 2020, these kind of accidents will represent the 3<sup>rd</sup> most common cause of death and disabilities swelled by. Moreover they represent an economic issue to social, medical and human cost of car accidents is estimated at 100 billion euros yearly.10-25% of these costs are caused by fatigue.

HARKEN (heart and respiration and Kat embedded non-intrusive senses) is born to use this problem. The idea comes up from the fact that heart rate and respiratory pace change when people get into fatigue state. Up to now, no system was capable of measuring despite a constant in a car on a non-invasive way. This device developed by the companies, universities and technology centers of two consortium is based on the set of components based on the set of components capable of performing and non-invasive measurement of the heart rate and respiratory pace desist innovation that harken brings. It measures both their rivals on a

scenario affected by vibrations and use a movements by means of intelligent materials embedded into the seat cover and to seat belt. The system detects the mechanical effect of the heartbeat and respiratory activity. Filtering and cancelling denies cost but a moving vehicle elements vibrations and body movements calculating the relevant parameters that will be integrated into future fatigue. A Sunderland's detectors dissolution has been tested by users and close track tests. In order to prove its effectiveness under real-life conditions [6].

Harken is based on 3 main components: Seat sensor, Seat belt sensor and Signal processing unit (SPU). SPU processes the sensor data on real time. It captures the physiological signals from the sensors. This integrations are not visible to the user. The final outcome is a fully functional prototype that monitors to fatigue related physiologic activity and to anticipate and prevent car accidents [4].



**Figure 2: Working of seat belt**

The Preliminary test of this device have led to positive and reliable results. This way, in the very near future it will reduce the car accidents enabling a much safe and comfortable driving experience.

It is mandatory to implement seat belt as the primary rule in every state. Government should put the fasten seat belt sign in every signal. Wearing seat belt is best defense against injury or death in the event of a crash. A seat belt increases chances of surviving a crash by up to 60%. Despite this, far too many motorists still refuse to buckle up for a variety of reasons.

Not only the government, awareness of this concept should be spread by organizations. NOYS (National organization for youth safety) is one of the organization established with a mission to build partnerships that save lives, prevent injuries, and promote safe and healthy lifestyles among all youth and encourage youth leadership and empowerment.



**Figure 3: Seat Belt Rule**

## 4.2 Functionality of Seat Belt

This system monitors the mechanical, physiological activity related to respiration and the cardiac cycle. The proposed solution is a nonintrusive sensing system of driver's respiration and heart activity, embedded in the seat cover and the safety belt of a car. The rhythm of heart beat, specially heart rate (HR) and heart rate variability (HRV), are good indicators of concentration and wakefulness (Lal and Craig, 2001), where in the decrement of respiration rate has been also been proved to be correlated with increasing fatigue in monotonous driving (Milosevic, 2010), such that slow and deep breathing can indicate a relaxed resting state.

The HARKEN system will detect the mechanical effect such physiological activity, filter and cancel the noise and artifacts expected in a moving vehicle (vibration and body movements), and calculate parameters like the intervals between heart beats, or the amplitude and frequency of the respiration signal, which will be delivered in a readable format to integrate it in a fatigue detector (see figure 2).

This system introduces some innovations, which solve important limitations of current systems. First, this replaces the conventional electrodes to monitor physiological signals by smart textile materials, composed by a combination of fibers and yarns with electrical properties, supported by standard textile of seat and belt, although this imposes some conditions on the type of signals that will be gathered.

The solution concept of the safety belt is technologically similar to the plethysmography monitors that are usually employed to measure respiration, through strain of a couple of thoracic and abdominal strips. On the other hand, placement of safety belt strap on the chest and abdomen on the driver, and pressure exerted on body, are usually inadequate for physiological monitoring purposes. Thus, besides integration of sensitive material in the strap, there is the challenge of adapting structure of the safety belt and its anchorages to improve these conditions. A study of driver anthropometry is currently being conducted, in order to determine the optimal location of the sensors, and design a system of tensors that will help get a better control of the placement and pressure of the sensor.

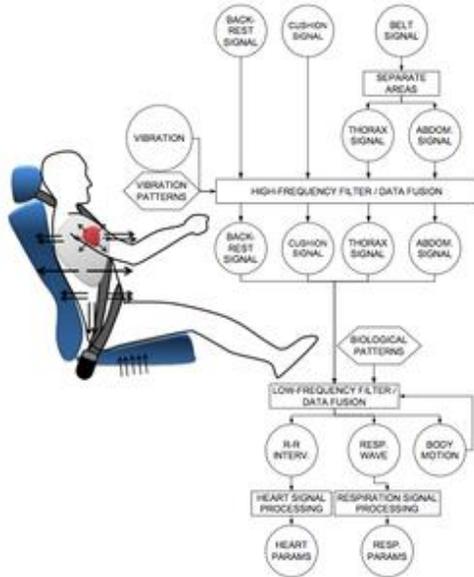


Figure 4 Scheme of the HARKEN concept

### 4.3 Configuration and results:

The sensors of the smart seat belt system have been produced with a textile that is sensitive to the pressure exerted by the driver's body. This can detect the small differences of pressure caused by the cardio-respiratory activity, which can be smaller than 1 g/cm<sup>2</sup> in the case of the heart rhythm.

To detect these signals reliably, sensing areas of interest were defined in a safety belt and a car seat based on the levels and homogeneity of the pressure sustained in driving experiments.

#### 4.3.1 Test Results of Sensors and Real time functionality:

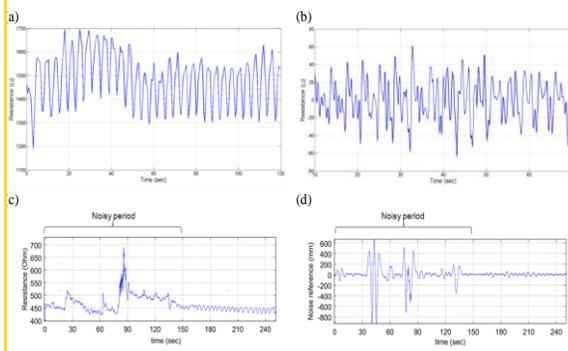


Figure 5: Signals of Sensors in test and real time scenario

Figure a: Shows a fragment of signal in sensors without noise.

Figure b: Shows a noiseless signal transformation by high pass filter that presents a greater frequencies of heartbeat.

Figure c: Shows noisy signal of sensor in fragments which includes distortions due to user's movements.

Figure d: Shows the accelerated measure reference noise on the seat belt after the integration of signal, to estimate motions of users trunk.

## 5. STATISTICS

According to national statistics, there are several demographic groups who have a lower seat belt rate than others. These groups include 16-24 year olds, males and drivers who are alone in the vehicle. In addition to this, research has shown that 67% of the pickup truck drivers are killed in traffic crashes for neglecting the seat belt [7].

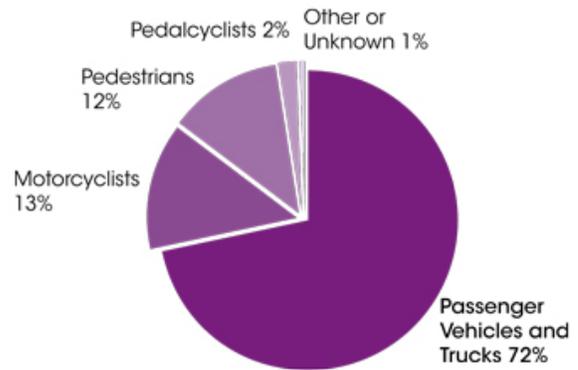


Figure 6:

### 5.1 Road Accidents Statistics

About 1.24 million people die each year as a result of road traffic crashes.

Road traffic injuries are the leading cause of death among young people, aged 15–29 years. 91% of the world's fatalities on the roads occur in middle-income and low-income countries, even though these countries have nearly half of the world's vehicles. Half of those dying in these accidents are pedestrians, cyclists and motorcyclists. Without action, road traffic crashes have been resulted in deaths of almost 1.9 million people annually by 2020.

Only 28 countries, representing 416 million people (7% of the world's population), have adequate laws which address all five risk factors i.e., drink-driving, speed, helmets, seat-belts restraints and child [8].

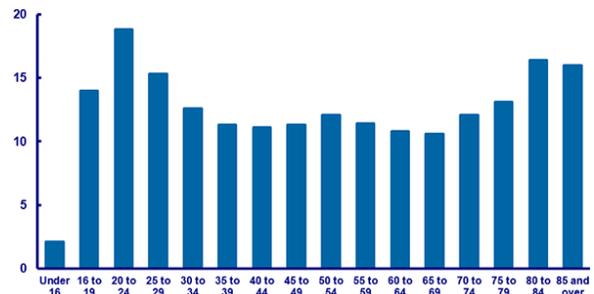


Figure 7: Accidents statistics of different age groups without seat belts

### 5.2. Seat Belt Statistics

Seat belt statistics show that wearing a seatbelt can save your life or reduce injury if you are involved in a car accident. In United States only 75% of Americans buckle up. It is estimated that nearly 1/3 of all accident fatalities can be prevented if everyone wore a seat belt.

