Safety device to prevent cell phone accidents

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With the use of cell phone for conversation and Internet have become essential in everyday life. The number of cellular subscriber has reached more than 6.8 billion subscribers around the globe (i.e., 97 phones per 100 citizens). This significant rise in use of cellular phone leads to increase in road accidents while driving. Various researches have proved that the use of Cell phone while driving plays a major contributing factor in a growing number of vehicular crashes. As the technology becomes more conventional and users become more technologically dependent, the need to reduce distraction-related risk while operating a motor vehicle also increases. This paper proposed a new innovative real time safety device based on Surface Mount Technologies (SMT) which helps in preventing the cell phone accidents. This system is also tested in roads and the effectiveness of the system by comparing with other existing system have also been discussed.

Keywords: Cell Phone Accident, Safety Device, Cell phone Accidents

Introduction

The growth in mobile phone use has brought attention to safety associated with the technology. The Major concern includes Distraction due to cell phone use while driving because many drivers have a mobile phone and use it while driving up to 974,000 at any moment during the day. According to National Highway Traffic Safety Administration (NHTSA), Drivers distraction is anything that diverts the driver’s attention from the primary tasks of navigating the vehicle and responding to critical events. To put it another way, a distraction is anything that takes your eyes off the road (visual distraction), your mind off the road (cognitive distraction), or your hands off the wheel (manual distraction). NHTSA estimate 20-25% of crashes or 1.4 million crashes per year involve some type of driver distraction1. A survey carried consisting of 1,367 drivers involved in a collision found, over 30% of drivers experienced at least one distraction at the time of collision, with distraction contributing to 13.6% of all collisions2.

Distraction was a primary factor in 28% of head-on crashes on rural, two-lane collector or arterial roads3. Similarly, the 100-Car Naturalistic Driving Study videotaped the drivers of 100 vehicles for more than one year. Analysis of the data showed, that reaching for an object (reaching a cell phone) by 3.7 times, reading by 3 times, applying makeup by 3 times, dialing a handheld device by almost 3 times, and talking or listening on a handheld device by 1.3 times4.

Drivers conversing on a cell phone were involved in more rear-end collisions, and their initial reaction to vehicles braking in front of them was slowed by 8.4%, relative to baseline. In addition, compared to baseline, it took participants who were talking on the cell phone 14.8% longer to recover the speed that was lost during braking. Drivers using a cell phone attempted to compensate for their increased reaction time by driving 3.1% slower than baseline and increasing their following distance by 4.4%5.

The risk of crash based on eye glance analysis show, the tasks with the highest risks have the longest duration of eyes off road time. The study includes light vehicle drivers and truck drivers indicate that using a cell phone can substantially increase the risk of safety-critical events such as crashes or near-crashes. An overview of different tasks and their effect on accident hazard is provided in Table 16.

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Fig. 1—Summary of Complete study
The differences in visual behavior and driving performance associated with different types of distraction was found by using different sets of sensors and algorithms\(^\text{11}\). The algorithms for distraction detection are mostly based either on eye measures or on driver performance measures (e.g., speed, lane position, and steering). The physiological measurement to detect driver cognitive distraction. Two types of physiological measurements, eye and mouth movements are obtained using the faceLab seeing machine (it’s a technology with a focus on vision based human machine interfaces which tracks human faces and certain facial features) and their relationship to each other are analyzed using Pearson-r correlation\(^\text{12}\).

A techniques based on movement of eyes for detecting drivers distraction has been carried out\(^\text{13-16}\). Based on the eye movement, a forward warning system that employs driver behavioral information is introduced. These system are capable enough to determine driver distraction when it detects that the driver was not looking straight ahead. There are few more studies which consider the position of head (driver will usually tilt the head towards left or right when they engage in conversation)\(^\text{17}\) along with eye gaze to detect distraction and some studies also considers vehicle surrounding state. In addition to this various auto companies like Toyota, Volvo, Nissan and Benz have installed driver inattention monitoring systems on their top-brand vehicles\(^\text{18}\). These systems features a camera, which uses near-IR technology, mounted on top of the steering column cover. It monitors the exact position and angle of the driver’s head while the vehicle is in motion. If the Advanced Pre-crash Safety system detects an obstacle ahead, and at the same time, the Driver Monitoring System establishes that the driver’s head has been turned away from the road for very long, the system automatically activates pre-crash warnings. If the situation persists, the system can briefly apply the brakes to alert the driver. Apart from eyes, mouth and head the research has been carried by makes use of the driver’s face vector which in principle was the detection of direction of the driver’s nose tip and consistent skin temperature changes by using physiological sensors that could be observed during cognitive and visual distractions\(^\text{19}\).

<table>
<thead>
<tr>
<th>Event</th>
<th>Light Vehicle/cars</th>
<th>Heavy Vehicle/Trucks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dialing a Cell Phone</td>
<td>2.8 times as high as non-distracted driving</td>
<td>5.9 times as high as non-distracted driving</td>
</tr>
<tr>
<td>Talking and Listening to Cell Phone</td>
<td>1.3 times as high as non-distracted driving</td>
<td>1.0 times as high as non-distracted driving</td>
</tr>
<tr>
<td>Reaching for a Cell Phone</td>
<td>1.4 times as high as non-distracted driving</td>
<td>6.7 times as high as non-distracted driving</td>
</tr>
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**Table 1—Cell Phone Task Vs Risk Crash**
There was also distraction or inattention detection system based on the measurement of brain-waves, heart rate and pulse. The study found that, the average heart rate was increased by approximately 8 beats per minute when conversation happens, based on the finding, a warning or alarm will get triggered to prevent distraction. Similarly the research collects and analyzes physiological data such as electrocardiogram (ECG), electromyogram (EMG), skin conductance and respiration during real world driving tasks to determine a driver's relative stress level. During high stress situations incoming cell phone calls was diverted to voice mail and navigation systems were programmed to present the driver with only the most critical information.

Methods
To study the risk associated with the usage of the mobile phones while driving, a set of questionnaires were asked to the drivers by interview or through an online survey containing the same set of questionnaires. Participants in the study were from a purposive sample of college students drawn from various colleges and working professionals with their age between 21 and 30 and all of them having driving license of their own. At the time of creating this report, from the total sample of 950 targeted, and received a complete response from 843 participants, giving a response rate of 88.7% by the motor vehicle drivers. Nearly, 107 responses are excluded due to inconsistent or half filled.

The results show that there is an exceptionally high level of a mobile phone use by the drivers while driving. Overall, about 784 (93%) drivers agreed to the use of mobile phone while driving, whereas only 59 (7%) reported they never use their mobile phones while driving for any other purposes. In this study, almost all the users i.e., 784 (93%) of drivers who use a cell phone while driving say that they attend incoming calls assuming that it could be an emergency call. Though 750 (89%) of drivers know the risk of using cell phones while driving. Only 219(26%) recommends for banning the cell phone from use. While, 624(74%) drivers indicated that instead of banning cell phones which some time include life-saving emergency calls, advanced technology should be developed to restrict the driver from using a mobile phone with provision provided to make or a receive call only when the vehicle is stopped. Nearly 599(71%) drivers admitted that they would drive fast (Rash Drive) if mobile communication are entirely blocked inside the vehicle by using technologies like mobile jammers or the mobile applications which will block the cell phone when vehicle’s in motion is detected.

Methodology
An automatic electronic circuit of size 5cm x 4cm was designed based on System mount device technologies which helps in detecting whether the cell phone use inside the vehicle is either the driver or the passenger. Though various systems do exists for detecting the use of a cell phone. The trouble is that, these commercial systems do not have the ability to differentiate between cell phone user was either the passenger or the driver. Even under extreme condition i.e., when all passengers use the cell phone except the driver, this circuit is able to distinguish that it is not the driver who use the mobile phone. The figure 2 shows the microelectronic safety system.

An RF power amplifier is a type of electronic amplifier used to convert a low-power radio-frequency signal into a larger signal of significant power, typically for driving the antenna of a transmitter. It is usually optimized to have high efficiency, high output Power (P1dB) compression, good return loss on the input and output, good gain, and optimum heat dissipation. The circuit can detect the incoming and outgoing calls, usage of Internet from driver seat, even if the mobile phone is kept in the silent mode. The moment the bug detects RF

![Fig. 2—Safety System for Cell Phone Detection of Size 5cm x 4cm using SMT](image-url)
transmission signal from an activated mobile phone, it starts sounding a beep alarm and the LED blinks. The alarm continues until the signal transmission ceases. An ordinary RF detector using tuned LC circuits is not suitable for detecting signals in the GHz frequency band used in mobile phones. The transmission frequency of mobile phones ranges from 0.9 to 3 GHz with a wavelength of 3.3 to 10 cm. So a circuit detecting gigahertz signals is required for a mobile bug.

Op-amp IC CA3130 is used in the circuit as a current-to-voltage converter with capacitor connected between its inverting and non-inverting inputs. It is a CMOS version using gate-protected p-channel MOSFET transistors in the input to provide very high input impedance, very low input current and very high speed of performance. The output CMOS transistor is capable of swinging the output voltage to within 10 mV of either supply voltage terminal.

Capacitor in conjunction with the lead inductance acts as a transmission line that intercepts the signals from the mobile phone. This capacitor creates a field, stores energy and transfers the stored energy in the form of minute current to the inputs of IC. This will upset the balanced input of IC and convert the current into the corresponding output voltage. Capacitor 100mf along with high-value resistor 2.2M keeps the non-inverting input stable for easy swing of the output to high state. Resistor 100K provides the discharge path for capacitor 100mf. Feedback resistor 2.2M makes the inverting input high when the output becomes high. Capacitor 47pF is connected across ‘strobe’ (pin and ‘null’ inputs (pin 1) of IC for phase compensation and gain control to optimize the frequency response. When the system detects the signal it will automatically ON the mobile jammer.

**Results and Discussion**

The microcontroller is programmed in such a way that, once the voltage level obtained from the RF amplifier stage is greater than the value of the voltage stored in EPROM of microcontroller, it identifies that the driver is using the cell phone and not the passenger. The system has been tested in a Maruti Omni on the roads, and used Blackberry 8520 hand held phone with GSM connection to carry out the experiments as shown in figure 3.

The mobile detection circuit is placed on the top of the driver seat such that antenna pointing towards the drivers head. Even, when the driver adjusts the seat by moving forward or backward, the system is able to identify the usage of mobile phone. The detection unit is installed such that, the distance between detection unit and the head of the driver was (22 +/- 2cm). This device can be installed on all types of vehicles by maintaining this distance.

The practical experiment has been carried out to identify the effective operation of the system. The experiment has been performed by 5 volunteers of different heights (168 +/- 7cm) and the vehicle is driven in a speed between 40-50 Km/h. The first experiment has been carried out by making a call to

![Fig. 3—Real Time Hardware setup of the Device on the Vehicle](image-url)
the driver when the vehicle is moving and the call is maintained for few seconds. An antenna placed above the driver’s seat will start capturing energy from a mobile phone and it is recorded in a laptop for analysis. The experiment is further carried out by calling to the front-seat passenger, then to the rear-seat passenger behind the driver and finally to the rear-seat passenger behind the front-seat passenger. The energy captured during each experiment is depicted as in Figures 4 (a)-(e) and it is also transferred to laptop for analysis. When the mobile phone is not in use, (i.e., When the driver kept this cell phone in shirt pocket) the energy captured is minimal and it ranges from 3mV-5mV as shown in figure 4(a).

When a call is made to the driver, and during the conversation on the phone, an antenna placed above the driver’s seat has been started to capture the energy from a mobile phone and it ranges from 75mV-150mV as shown in Figure 4(b). When a call is made to the front-seat, rear-seat passenger behind the driver behind front seat passenger

Fig. 4—(a-e) Energy Absorbed by Safety Detection system (a) Phone in Driver’s Pocket , (b) Drivers Phone Conversation, (c) Front-Seat Passenger, (d) Rear-Seat Behind Driver Seat, (e) Rear-Seat behind Front Seat Passenger
and to the rear-seat passenger behind the front-seat passenger in all these cases the voltage obtained during the call is below 75mV as shown in Figure 4(c)-(e) respectively. Therefore, the voltage obtained by the antenna will be above the threshold voltage of 75mV, only when an incoming/outgoing call is made from the driver seat, since the distance between the cell phone and antenna is small. In all other cases, voltage captured by the antenna would be low since the distance between antenna and their cell phone is too far.

When the signal received by the antenna exceeds a threshold value of 75mV it indicates that the cell phone is used by the driver, not the passenger. Further, one more experiment has been carried out, where all the passengers make use of the cell phone except the driver, and captured the voltage obtained during this activity. Even in this situation, an antenna captured a voltage of less than 75mV which is great enough to identify that the mobile phone was operated by the passengers, not the driver. Figure 5 shows the voltage absorbed by the detection unit when the driver and passengers received the calls.

Furthermore, to avoid transitory situations that might trigger false alarms, a low-pass filter is programmed to eliminate voltage peaks and smooth out the input signal. A factor which has been considered during implementation of the algorithm is, it ignored the voltage captured by the detection circuit during first 3 seconds in order to avoid false activation of the system because there is a chance that the driver’s cell phone can emit more voltage (i.e., above 75 mV) while performing hand-off, which normally completes its operation within 2-3 seconds. In general, hand off occurs when mobile was moved from one cell to another.

The detection unit is developed to identify whether the driver if he/she was talking on the phone, and when there is a phone call, a microcontroller detects whether the vehicle is in motion or not based on RPM values captured using a photo interrupter sensor. If a vehicle in motion is detected, then the microcontroller activate a voice chip and incase if the driver stops the vehicle within 8sec., then microcontroller allows the call else, a low range mobile jammer is used which will prevent the driver from receiving or making a call. From the time of incoming call to the activation of mobile phone jammer takes approx. 20-25 sec. Even this timeframe is sufficient for driver distraction. In order to prevent the user from talking on cell phone during this timeframe, the PIC microcontroller along with a micro camera mounted in front of driver and a transmitter is used which transmit the driver face along with vehicle number plate information to the receiver which is placed on a signal post. The experimental setup of the detection circuit along with other hardware setup is shown in figure.

The experiment is carried out by installing the hardware setup with slight modification from the real hardware kit (Here, counter is used which start counting when both the jammer and vehicle in motion is detected, while, removing transmitter part which is used to send the vehicle number plate information to the police) in 18 cars. The complete operation of the system is explained to all the drivers. Exactly 3 months after the installation of the system, the details have been collected from the drivers and also from the counter attached on the hardware kit placed on the car, and found, out of 18 drivers only 2 of them use a cell phone while driving, while the rest of the 16 drivers also got the call but this time the driver stops the vehicle in a safe place, once the system notifies the driver that there is an call via voice chip, and before the activation of mobile jammer. Since, the drivers knew well in advance that mobile jammer placed near driver seat will block the communication soon, which will force the drivers not to speak more.

**Comparison with Other System**

The table 2 shows how far the hardware system is effective when compared with other techniques which are used to prevent distraction due to usage of cell phone. The proposed hardware system is capable of differentiating whether the cell phone used is either by the driver or the passenger. Though, the proposed system requires hardware unit to be attached above the driver seat it is not intrusive because it does not require any equipment or device attached to the driver.
In this paper, an innovative safety system to prevent the occurrence of accident due to mobile phone use by drivers an attempt has been made to provide a low-cost, non-invasive, small-size safety system which is capable of differentiating the use of cell phone is either by the driver or the passengers. This small-size hardware system along with low range mobile jammer is used to detect the driver’s use of mobile phone, while ignoring the phone used by the fellow passenger in the vehicle and possessing the ability to block the mobile communication only in the driver seating area while providing an option for the driver to attend an call only if the driver stops a vehicle at a safe place. The implementation of this system in all vehicle will helps in reduction of accidents to great extent and it will also acts as a life saving equipment.

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