

Design of Intelligent Navigated Steering For Anti-Collision and Driver Alert System (INSFAD)

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Abstract - The main motto of automotive industries is to increase vehicle safety and design more precise active safety system to alert the occupants under pre-collision. In this paper, the designed system can analyze the drowsiness and unconsciousness of the driver by using active sensors data. The active sensors (wheel grip sensor, IR sensor) sense the wheel grip under drowsiness and infra red (IR) sensor senses the position and sitting condition of the driver. The sensors data is analyzed by the embedded system (micro-controller) algorithm which gives the condition of consciousness of the driver. GPS and GSM are interfaced with micro controller in this project to track the exact vehicle location and V2I (vehicle to infrastructure) communication gives passive safety for post collision. This implementation gives better outcome when compare to conventional drowsiness detection system like eye tracking system, lane detection with image processing.

Index Terms - Embedded system, eye tracking system, vehicle to infrastructure (V2I) communication, GSM, GPS, IR sensor and wheel grip sensor

I. INTRODUCTION

Driver unconsciousness leads to lose control on the vehicle which causes the majority of road accidents. Road Traffic Injuries (RTI) marked as 4th among the leading causes of death. According to Asia Pacific Road Accident Data (APRAD), the rate rise of road accidents in the country was raised at a compound annual growth rate (CAGR) of 2.13% in year 2011. The fatal accidents raised 18.1% to 24.3% during year 2002 to 2011. During 2011, 1.35 million accidents were noted in Asian pacific region. Only 5% of the accidents caused by the vehicle malfunctioning. Majority of accidents caused by unconsciousness and drowsiness of driver which leads to death of vulnerable pedestrians and maneuvers.

Embedded systems and Electronics plays a vital role in automotive control and safety. Such as active safety and passive safety, active safety is a driver assistance technology to prevent the sudden accidents ex: Adaptive cruise control system, anti-lock braking system (ABS), Traction control system (TRC) and vehicle stability control system (VSC).

Passive safety technology is used to reduce the extent of injuries caused by a collision ex: air bags and seat belts. Our project has enhanced new intelligent vehicle communication for collision mitigation such as V2V, V2I and ITS.

V2I (vehicle to infrastructure) is a communication between vehicle on board equipment or devices (like portable GPS receivers, hand mobile) to established infrastructure over the roads or roadside equipment (RSE). V2I is used for driver assistance in traffic updates and collision mitigation.

V2V (vehicle to vehicle) communication is to communicate one vehicle on-board equipment (OBE) to another vehicle on board equipment acts as a active safety system such as Collision Avoidance Radar Warning System (CARWS).

II. METHODOLOGY

Two types of techniques are used to analyze the drowsiness or unconsciousness of driver.

1. Intrusive method
2. Face expression recognition.

In intrusive method various instruments like Heart rate variability (HRV), a physiological signal electroencephalogram (EEG), electrooculography (EOG) connected to the driver body which monitors and check the electrical signal of brain, muscle and heart. This method more accurate to detect the drowsiness but the psychological instruments causes inconvenience to the driver and cost effective.

In face expression recognition method the expressions of the face like eye openness degree by image processing. In this method uses colour segmentation, machine learning and image differencing. Colour segmentation is to detect skin colour in an image. Image differencing is to find to face while head moments and machine learning is taken data from different frames of images of n samples predict the unknown data.

Drawbacks of face expression recognition:

- Colour segmentation is inefficient in complex background or dynamic background.
- Image differencing fails under low light or environment illumination causes adverse effect.
- This method only considers the PERCLOS (percentage of eye close).
- Ineffective in smaller eye openings, often nodding, smaller eye lid moments and longer blink duration.

To overcome the above drawbacks we come up with intelligent navigating steering (INS) which is designed by the driver performance technology. In driver performance method drowsiness is measured by bases of way of driving (ex: steering angle, steering grip, leaning aside detection) which is more accurate.

2.1 Embedded system

In INSD, embedded system plays vital role. Embedded system is a platform to take various inputs form the sensors (wheel grip and IR sensor for driver leaning aside detection) and processing data at different at condition and analyze the driver state of being drive.

HCS 12(MC9S12XDP512) is a automotive 16-bit micro controller which was introduced by free scale semiconductors.

Features of HCS-12:

- 512 KB flash EEPROM
- 4KB EEPROM
- 32KB SRAM
- 59 GPIO lines
- LIN (local area network) and CAN (Controller area network) support.
- 8 ADC ports with 10bit resolution.
- Operating voltage 5V - 12V dc.
- Operating frequency at 4MHz.
- 6 serial communication ports.

2.2 Design of intelligence steering



Fig 2.1(a)

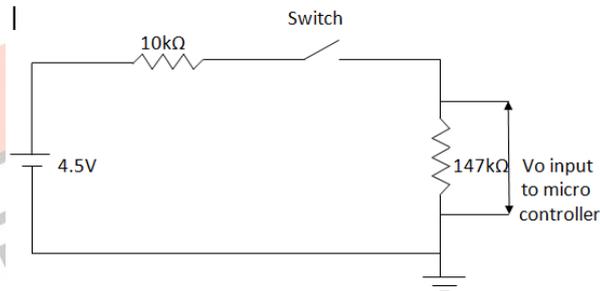


Fig 2.1(a)

Two copper strips are mounted around the steering as shown in figure 2.1(a). Top strip acts as positive conductor and bottom strip is ground. A resistance (RL) of 147kΩ is connected in series to the positive strip which is supplied by the 4.5V by 3 AA batteries connected in series as shown in figure 2.1(b).

The functioning is quite simple as whenever hold the steering two strips are short circuited because of finger acts as conducting material between two strips. When removing hand mounted strips are open circuited. Overall the design acts as a switch to detect the driver hold the steering or un-hold steering.

Current limiting resistor(R) of 10kΩ is connected in series to limit the current and protect the micro- controller. Current flowing through the circuit while holding the circuit is

$$I = V/R$$

$$I = 4.5 / (10 \times 1000) = 28.66 \times 10^{-6} \text{ A}$$

Voltage drop across load resistor $V_0 = I \times R_L$

$$= 28.66 \times 10^{-6} \times 147 \times 1000$$

$$= 4.21 \text{ V}$$

The drop across the load resistor is given input to the ADC (analog to digital converter) port of micro controller.

State of driver	Switch state	Vo voltage of RL(V)	ADC value
Holding steering	ON	4.21	216
Un-hold steering	OFF	0	0

Under driver holding steering condition two strips which are stick over the steering is short circuited and it acts as a closed switch and current passes through the load resistance of 147 KΩ the voltage drop across the resistor is 4.21V and is given input to the ADC of the micro- controller then ADC value is 216. When hands are remove from the steering strips are open circuited then current flowing the resistor is zero then the voltage drop across the resistor is 0v.



Fig 2.3(a)

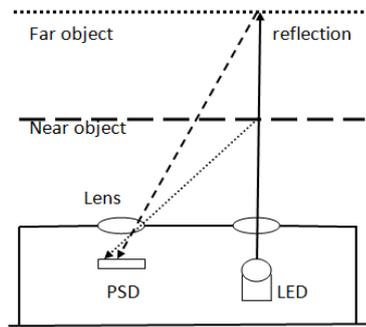


Fig 2.3(b)



Fig 2.3(c)

2.3 Leaning aside detection system

Driver leans aside under drowsiness which is detected by the infra red proximity sensor. The proximity sensor is GP2D120X model of sharp. The range of detection is 40cms working precisely under 15% luminous to 100% luminous. It detects leaning even under low light condition.

Working of proximity is electromagnetic radiation beam is transmitted by infrared LED. Radiated beam is propagated through the air strike the object and reflects towards the sensor with change in magnitude of the electromagnetic radiation. The reflected signal is scatter to the PSD (Position sensing detector) as shown in side figure 2.3(b).

PSD converts reflected electromagnetic radiation to analog electrical signal. Far distance object detected as low amplitude voltage and near object is detected as high amplitude voltage.

Operating specifications of GP2D120X

S.No	Parameter	Rating
1.	Supply voltage (V _{CC})	-0.3 V to 7V
2.	Operating voltage (V _{CC})	4.5V
3.	Operating temperature (T _{op})	-10°C to +60°C
4.	Output terminal voltage(V _o)	-0.3V to 3.2V
5.	Storage temperature (T _{ST})	-40 to +70

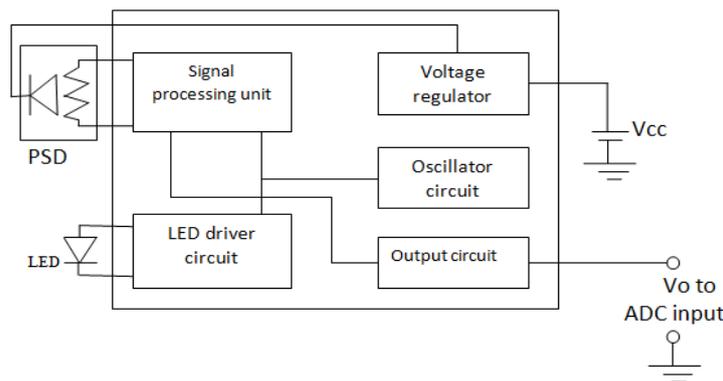


Fig 2.3 (d) Blok diagram of proximity sensor

Block diagram of proximity sensor

Proximity sensor is energized by the supply of 5v which is stabilized by voltage regulator. Infrared LED is to transmit electromagnetic radiation which is driven LED driver circuit. Position sensing detector (PSD) receives the reflecting beam from the object.PSD converts electromagnetic radiation to electrical signals.

Electrical signal which undergoes to signal conditioning gives bounded analog output signal (0.2v- 3v). Analog output signal is given input to the ADC of the micro-controller.

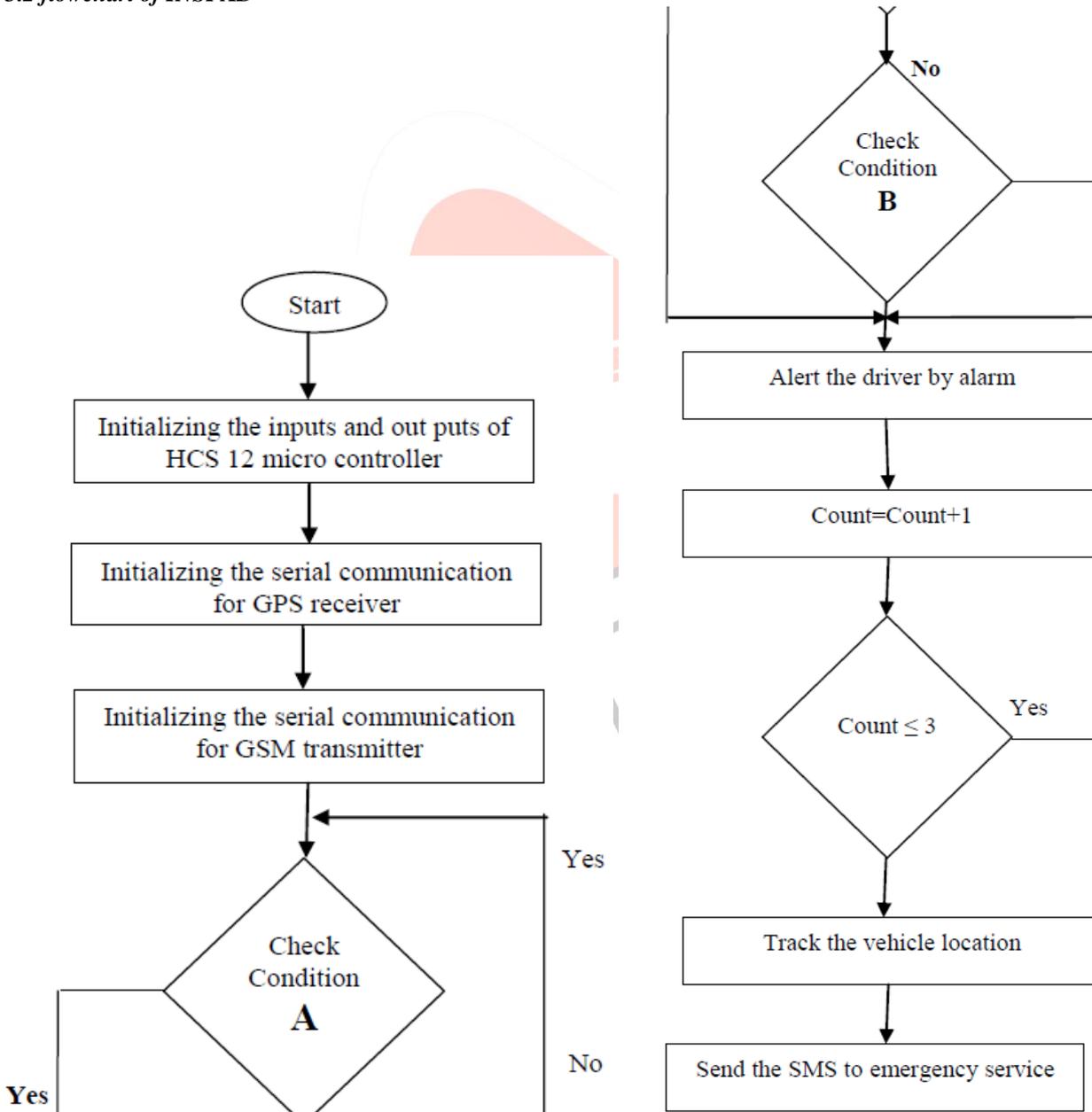
III. SOFTWARE IMPLEMENTATION

3.1 Algorithm description

- Step1: Start the INSFAD.
- Step2: Initialize the inputs (wheel grip sensor and IR sensor)
- Step3: Initialize the outputs (buzzers) to HCS-12 micro-controller.

- Step4: Initialize the tracking device (GPS receiver) to HCS-12 micro-controller.
- Step5: Initialize the communication device (GSM module) to HCS-12 micro-controller.
- Step6: Check the steering wheel grip condition. If driver removes hands from the steering then go to step8 else go to step7.
- Step7: Check driver leaning aside condition. If driver leaning towards any side then go to Step8 else go to step6.
- Step9: Alert the driver through buzzer.
- Step10: Count the alarms and increment the count by 1.
- Step11: If count is less than 3 repeat alarms with 10 seconds delay between any 2 alarms else go to step11.
- Step12: Track the vehicle exact location through GPS.
- Step 13: Load the values of latitude and longitude.
- Step14: Send SMS to emergency services.
- Step 15: Go to step1.
- Step 16: If any error.
- Step 17: Stop.

3.2 flowchart of INSFAD



Conditions:

A = If driver removing hands from Steering.

B= If driver leaning aside.

IV. HARDWARE IMPLEMENTATION

4.1 Wheel grip sensor

Wheel grip sensor works on the principal ohm's law. The primary function is to detect whether the driver holding steering or not. Whenever holding steering the voltage drop across the resistor (RL) is 4.21V. The load resistor is connected in series to the copper strips which is laid on the steering wheel. This analog voltage is fed to ADC channel of the micro controller.

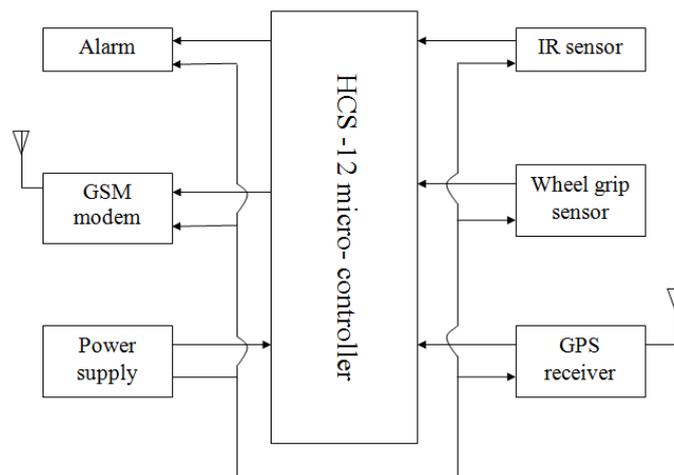


Fig 4.1 Block diagram of INSFAD.

4.2 IR position sensor

IR position sensor works on electromagnetic emission and absorbs the reflected signal from the object. Change in magnitude of reflected signal means the leaning aside of the driver. This method detects the drowsiness of the driver by driver performance technology. This method overcome the drawbacks of face expression recognition like colour segmentation and image differentiation under low under interior light of vehicle.

4.3 GPS receiver:

NMEA is an American organization which operates 24 satellites to navigate and track a vehicle. At a time 6 satellites monitor any particular location in the globe. Using GPS receiver we can track the location, date and time etc.

4.4 GSM modem

GSM modem is a device which is interface with micro controller to communicate mobile. Using attention commands micro controller can communicate via SMS or call. Modem is interface micro controller through serial communication.

4.5 Alarm

Piezo electrical buzzer works on the principle of reversal piezo effect. The operating frequency is 2 to 4 kHz. The operating voltage is 5V and it is supplied by port pins of the micro controller. Buzzer is used for alert the driver under the drowsiness.

V. WORKING

In performance based drowsiness detection, various sensors are used to sense the drowsiness or unconsciousness. In this project the overall theme is to detect the drowsiness and alert the driver under unconsciousness and track the vehicle and send the information to the emergency services through SMS under abnormal conditions.

Wheel grip sensor is to sense the whether the driver is hold the steering or removes the hand away from the steering. Wheel grip sensor is designed by two copper strips mounted upon the steering and it is energized by the supply of VCC. A load resistor RL is connected to in series to the supply whenever hold the steering current flows the resistor, if removes hands from the steering current flow the resistor is zero. The voltage drop across the resistor is taken as the input to ADC of the micro controller.

IR proximity sensor is to sense when the driver in nodding or leaning aside condition. The IR sensor works on electromagnetic radiation which is emitted from the infrared LED. After striking the driver it reflects back to the receiver. Angle of leaning aside causes change in magnitude the change in magnitude of electromagnetic radiation can be detected by PSD. The change in

magnitude of radiation causes change in analog output voltage of the sensor. The output voltage is given to ADC of micro-controller. Micro-controller estimates drowsiness state of driver by performance technique.

Whenever the driver removes the hands or leaning aside, the alarm alerts the driver by giving automatic buzzer. Alarm strikes with an interval of 10 seconds.

A GPS receiver always tracks the location vehicle with reference to latitude and longitude and these data is taken by the micro controller through serial communication. GPS receiver also gives the information about time and vehicle speed.

A GSM module is interface with the micro controller to communicate vehicle to infrastructure for emergency services such as ambulance police etc. whenever driver drives the improper driving gives thrice alarm. Driver should reset the alarm otherwise micro controller sends the SMS to the emergency services to rescue the occupants in the vehicle.

VI. RESULT

The system robustness has tested on electro optical test at temperature range of -40°C to 70°C and the humidity of 90%RH at range of operation of IR proximity sensor 4cm to 40cm.

No	Test equipment	Test condition	No of samples (N)	No of defective (d)
1.	Temperature cycling	1 cycle -40° to $+70^{\circ}\text{C}$, 30 min, 25 cycles test	10	0
2.	High humidity storage and high temp.	90% RH, $+40^{\circ}\text{C}$, 500h	10	0
3.	Low temp. storage	-40°C , 500h	10	0
4.	High temp. storage	$+70^{\circ}\text{C}$, 500h	10	0
5.	Operating life	$+60^{\circ}\text{C}$, $V_{\text{CC}}=5\text{V}$, 500H	10	0
6.	Variable frequency vibration	10 to 50 to 10 HZ/1min. 2h/X, y, Z direction overall amplitude: 1.5mm	8	0
7.	Mechanical shock	1000m/s^2 , 6.0ms 3 times $\pm X, \pm Y, \pm Z$ direction	8	0

The equipment is tested under low luminous light of 15% to 80 % luminous and test results are quite linear at $\pm 0.02\%$ marginal error.

Distance from driver to IR sensor in cms	At 80% luminous output analog voltage of IR sensor	At 15% luminous output analog voltage of IR sensor
1	1.38	1.36
2	2.2	2.2
3	3.08	3.1
8	1.56	1.5
14	0.92	0.9
18	0.74	0.72
25	0.5	0.47
30	0.41	0.39
35	0.38	0.28

The graphical representation of luminous verses distance as shown below

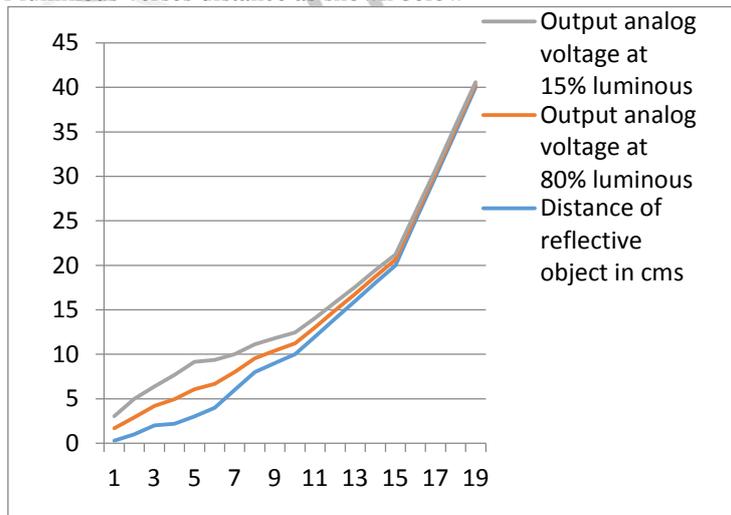


Fig Luminous intensity verses distance.

GPS tracks the vehicle location as latitude of 1258.2619,N and longitude of 7909.5555,E is shown in code warrior simulator for the HCS-12 micro-controller.

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True-Time Simulator & Real-Time Debugger C:\Documents and Settings\admin\My Documents\surbhi\Project_73\PE_Multilink_C
File View Run MultilinkCyclonePro Component Data Window Help
HCI2 Addr: 0x21741 Size: 13 (man.c)
result <4> array[2] of unsigned int
data <100> array[100] of unsigned char
lat <12> array[12] of unsigned char
[0] '1' 49 unsigned char
[1] '2' 50 unsigned char
[2] '5' 53 unsigned char
[3] '8' 56 unsigned char
[4] '.' 46 unsigned char
[5] '2' 50 unsigned char
[6] '6' 54 unsigned char
[7] '1' 49 unsigned char
[8] '9' 57 unsigned char
[9] '.' 44 unsigned char
[10] '1' 78 unsigned char
[11] '0' unsigned char
lon <15> array[15] of unsigned char
[0] '10' 48 unsigned char
[1] '7' 55 unsigned char
[2] '9' 57 unsigned char
[3] '10' 48 unsigned char
[4] '9' 57 unsigned char
[5] '.' 46 unsigned char
[6] '5' 53 unsigned char
[7] '5' 53 unsigned char
[8] '5' 53 unsigned char
[9] '5' 53 unsigned char
[10] '1' 46 unsigned char
[11] '1' 46 unsigned char
[12] '1' 46 unsigned char
[13] '1' 46 unsigned char
[14] '1' 46 unsigned char
[15] '1' 46 unsigned char
Automatic (breakpoints, watchpoints, and trace possible) MCR512HDS12 RUNNING
SCI0DB1=0x00
SCI0DB2=0x00
for(i=0; i<2; i++)
{
SCI0DB1=SCI0DB1+1;
while(!SCI0DB1_DONE); //checking Transmission completed
}
SCI0DB2=0x0D;
while(!SCI0DB2_DONE);
for(i=0; i<9; i++)

```

Fig Result of Simulator GPS tracking latitude and longitude.



Fig 6.1(a)

GPS transmitter transmits the SMS to the emergency services when the INSFAD system detects the drowsiness of driver and given alarm. If the driver didn't reset the alarm, it sends the SMS to emergency services such as ambulance and police etc. GPS sends the tracking vehicle location (1258.2619N, 07909.5555E) to particular location shown in right side fig 6.1(a)

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