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WIRELESS SENSOR NETWORK: ASSISTING SOLUTION FOR ACCIDENTS AVOIDANCE ON INDIAN HIGHWAYS

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Abstract: - Road transport has remained one of the important mean for long route travelling and transportation. Safety of the passengers, drivers and property is very important to discuss about when we talk about long route distance travelling. There are many issues that endangered the safety on highways. The major issues involved in occurrences of accidents could be: Vehicle driver's negligence while driving, overtaking by the vehicles, over speeding of vehicles on the highways, drunk state of the driver while driving, mechanical issues of the vehicle, Sudden arrival of cattle on highways, unfamiliar road conditions, negotiating with winding roads, roads traffic conditions, overloading of the vehicles, lane changing by the driver, road merging etc. To ensure safety it is very important to be more cautious and take proper safety measures while driving for long routes. This paper proposes the use of ICT(Information and communication technologies) to reduce or avoid the occurrences of accidents on Indian highways.

Keywords: ADC, Motes, Sensor, Transceiver, WSN

1. ACCIDENT SCENARIO IN INDIA

Road accidents are the conclusion of the relationship of various factors. It involves human population, vehicle populace, extent of road network. Road accidents results in severe fatalities, injuries, disabilities and many a times deaths. Safety of roads has become a serious issue which needs to be considered at national and international level. A report on road accidents in India 2015 published by Ministry of Road Transport and Highways, Government of India has revealed that there is increase in occurrence of number of road accidents in 2015 as compared to 2014.

Table.1 represents that there is the raise by 2.5 per cent from 4, 89,400 in year 2014 to 5.01,423 in 2015. There is also a raise in total number of deaths by 4.6 percent from 1, 39,671 in 2014 to 1,46,133 in 2015. Accidental injuries are also increased by 1.4 percent from 4, 93,474 in 2014 to 5, 00,279 in 2015. As per road accidents report 2015 it is beenfound that a total of 5, 01,423 road accidents were reported by all States/Union Territories. On an average one fatality was found per 3.4 accidents. If comparison is made on the occurrence of total number

of accidents from 2005 till 2015, it is been found that it is regularly increasing. Road accidents are increased by 14.2 percent, killing by 53.9 percent and injuries by 7.5 percent.[14]

Parameter	2014	2015	% change over previous year
Total Accidents in the country	4,89,400	5,01,423	2.5
Total number of Persons Killed in the country	1,39,671	1,46,133	4.6
Total number of Persons Killed in the country	4,93,474	5,00,279	1.4
Accident Severity	28.5	29.1	2.1

Table.1. Road accident parameters: 2014 and 2015[14]

Table. 2 represents that Tamilnadu state is at the peak with 13.8 percentage share in occurrence of total number of accidents in 2015 when compared with other twelve states. Road accidents contribute 83.6 percent of share in terms of fatalities. As per year 2015 Uttarpradesh is on top with 12.1 percent share in road accident cases followed by Tamilnadu with 10.7 percent. Tamilnadu contribute maximum in number of persons injured in road accidents with a total of 15.9 percent share.[14]

Share of 13 states	87.2	4,36,111
Tamilnadu	15.9	79,746
Karnataka	11.4	56,971
Madhya Pradesh	11.2	55,815
Kerala	8.7	43,735
Maharashtra	7.9	39,606
Andhra Pradesh	5.9	29,439
Rajasthan	5.2	26,153
Uttarpradesh	4.6	23,205
Telangana	4.6	22,948
Gujarat	4.3	21,448
Chhattishgarh	2.7	13,426
Odisha	2.4	11,825
West Bengal	2.4	11,794

Table.2 Top 13 states: Share in total number of persons injured in road accidents (in %) in 2015[14]

Table.3 represents roads can be classified as National Highways, State Highways and other roads. National Highways contribute to a percentage share that is 28.4 in road accidents. State Highways contribute to 24.0 percentage share. Other road accounted for a percentage share of 47.6. [14]

Road Classification	National Highways	State Highways	Other Roads
No. of Accidents	1,42,268 (28.4)	1,20,518 (24.0)	2,38,637
No. of Persons Killed	51,204 (35.0)	40,863 (28.0)	54,066 (37.0)
No. of Persons Injured	1,45,341 (29.1)	1,31,809 (26.3)	2,23,129 (44.6)

Table.3. Number of Accidents, Persons Killed & Injured as per Road Classification (2015)

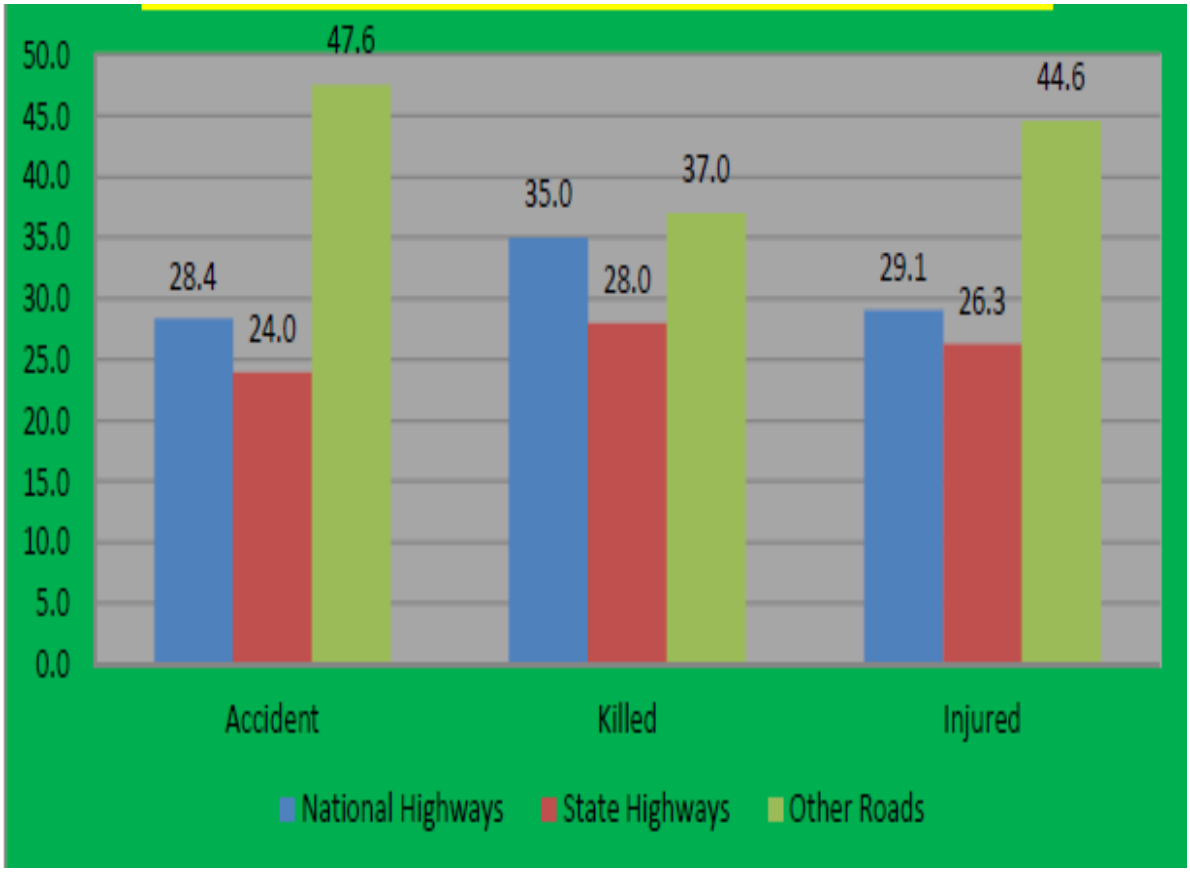

Fig.3. Percentage share of accidents, persons killed and injured as per road classification

1.1 Types of Accidents

JP Research India Pvt. Ltd.[15] Road Accident Study (2014-2015) reveals that accidents can be categorized on the basis on their types of occurrences. On the basis of analysis of 211 accidents (including 88 fatal /serious accidents) ten types of accidental cases categorized.

Fig.4 represents the types of accidents. It represents that collision with another vehicle which turns into or crosses a road contributes to 22% in all accidents and 27% in fatal accidents cases. Collision with another vehicle moving laterally in the same direction contributes to 22% in all accidents and 22% in fatal accidents cases.[15]

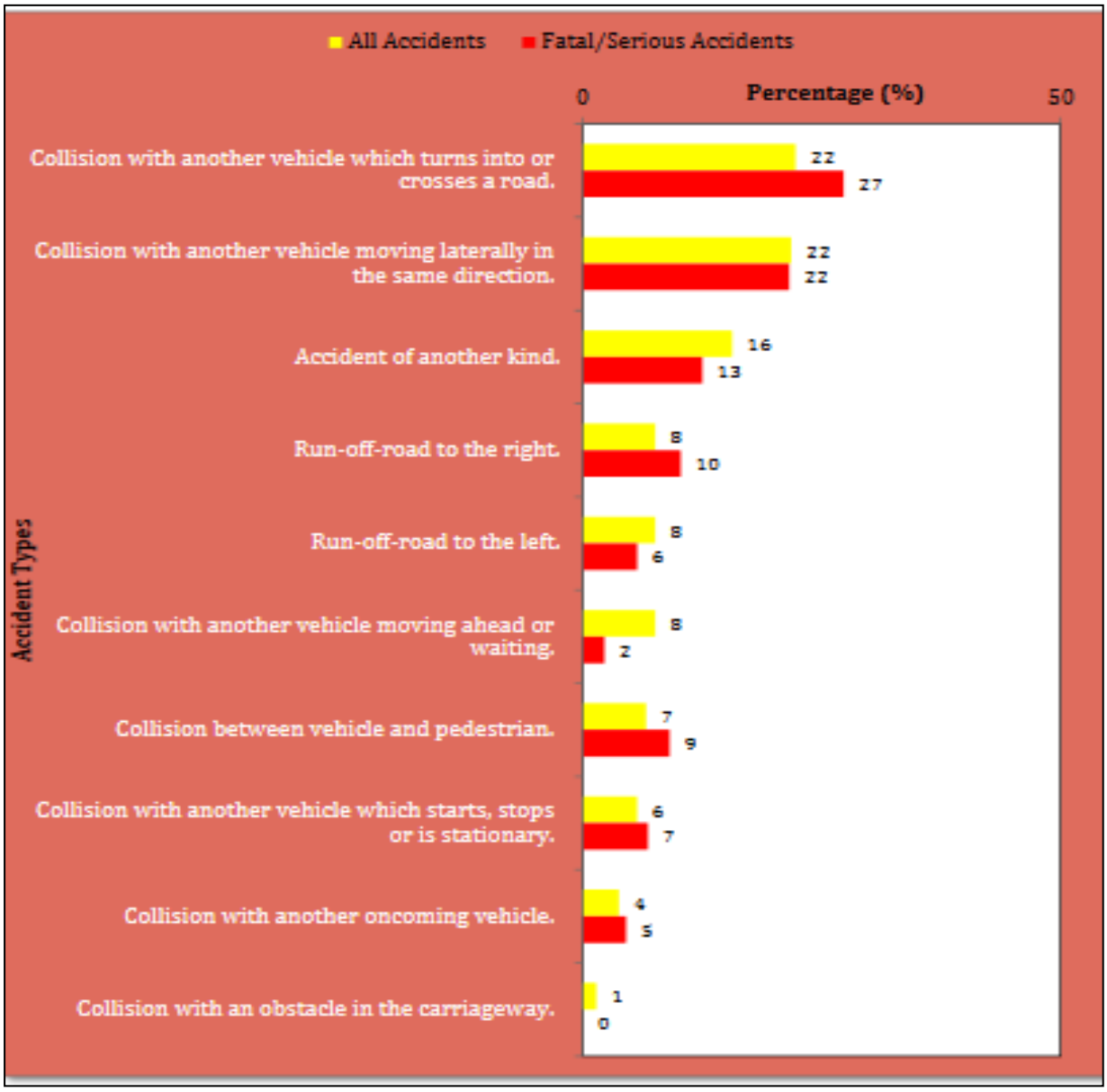

Fig.4. Percentage distribution of road accidents on the basis of accidents types [15]

Timing can also be a very important factor for frequency of accidents occurrences. Table.4 represents that maximum number of accidents occurs during 12:00 to 15:00 hour's day time with percentage share of 17.5. Percentage share of accidents occurrence during night time is 17.3. All India report 2015 reveals that accident share in rural area is more than that of urban areas. Types of vehicle involvement are also an important parameter for accidents occurrences. Four wheelers and heavy loaded vehicles contribute to highest proportion of deaths with 25.6 percent out of total number of persons killed.[14]

Time	Number of Accidents	Percent share in total Accidents
06:00 – 09:00 hrs (Day)	55,518	11.1
09:00 – 12:00 hrs (Day)	81,964	16.3
12:00 – 15:00 hrs (Day)	79,616	15.9
15:00 – 18:00 hrs (Day)	87,819	17.5
18:00 – 21:00 hrs (Night)	86,836	17.3
21:00 – 24:00 hrs (Night)	51,425	10.3
00:00 – 03:00 hrs (Night)	27,954	5.6
03:00 – 06:00 hrs (Night)	30,291	6.0
Total 24 hrs	5,01,423	100.0

Table.4. Distribution of Total No. of Road Accidents as per time of Occurrence: 2015[14]

As per 2015 report various caused of road accidents were analyzed. Fig.5 represents that driver's negligence while driving is the most responsible factor of accidents occurrence Driver's fault report about 77.1 percent of the total accidents. Other analyzed factors are: Overloading of vehicles, unfavourable weather conditions, hit and run cases, head on collision, path holes, speed breakers and poor vehicle maintenance.[14]

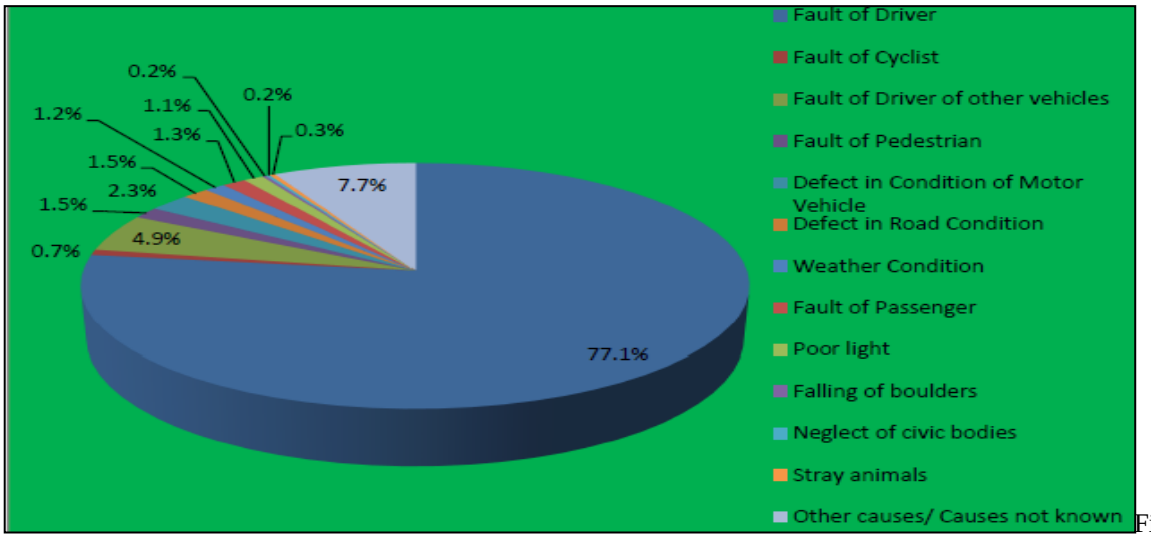

Fig.5. Causes of road accidents 2015[14]

1.2 Safety initiative on highways by Government of India

Road Accidents in India-2015 report published by Transport Research Wing has mentioned about initiatives taken by Government of India road safety. National Road Safety Policy focuses on encouraging safer road infrastructure, enforcement of safety laws and promoting awareness. State road safety councils and District road safety councils are set up. Frequent road safety audit for National highways is being done. Identification and rectification of accident prone spots on the highways is a measure issue of concern. Driver training institutes in state are opened up and also there are refresher training is given to the drivers of heavy motor vehicles. Road safety Road Accidents in India-2015 report published by Transport Research Wing has mentioned about initiatives taken by Government of India road safety. National Road Safety Policy focuses on encouraging safer road infrastructure, enforcement of safety laws and promoting awareness. State road safety councils and District road safety councils are set up. Frequent road safety audit for National highways is being done. Identification and rectification of accident prone spots on the highways is a measure issue of concern. Driver training institutes in state are opened up and also there are refresher training is given to the drivers of heavy motor vehicles. Road safety Road Accidents in India-2015 report published by Transport Research Wing has mentioned about initiatives taken by Government of India road safety. National Road Safety Policy focuses on encouraging safer road infrastructure, enforcement of safety laws and promoting awareness. State road safety councils and District road safety councils are set up. Frequent road safety audit for National highways is being done. Identification and rectification of accident prone spots on the highways is a measure issue of concern. Driver training institutes in state are opened up and also there are refresher training is given to the drivers of heavy motor vehicles. Road safety Government to provide cashless treatments to the victims of road accidents on highways.[14]

It also involves providing safe and proper marking lanes for guiding the road users.[16] Adequate actions are been taken to control driver's behaviour through construction zones, as they have higher accident rate.[16] Sign boards are deployed on the highways to face the ongoing traffic. Traffic cones are interchangeable with Drums/Traffic Cylinders.[16] Precautions are been taken to warn the road users in advance about the approaching hazard in advance.[16] The advance warn zone are provided with the information through a series of traffic signs along the length of the zone. [16]

2. RELATED WORK

Adnan K. Shaout et.al.[1] "A Mobile Application for Monitoring Inefficient and Unsafe Driving Behaviour" has proposed a practical and economical way to capture, measure, and alert drivers of inefficient and unsafe driving. The proposed solution consists of a mobile application, running on a modern smart phone device, paired with a compatible OBD-II (On-board diagnostics II) reader.

A. Mounika et.al.[2] "Driver Behaviour Monitoring and Alerting System For Safer Navigation" has proposed a non-intrusive bio-potential measurement system for driver's health monitoring and fatigue detection. The entire system composed of ARM7TDMI microcontroller, LCD display, alcohol sensor, eye blink sensor, ECG sensors, GPS system, GSM, Motor drive.

I.G. Daza et.al.[3] "Drowsiness Monitoring Based on Driver and Driving Data Fusion" has proposed a non-intrusive approach to monitor driver's level of drowsiness and fatigue. The proposed approach will include calculation of PERCLOS(Percentage of eye closure in a time frame of 30s) using stereo vision system, Steering wheel angle, Lateral position of the vehicle and the aggregated results obtained from CAN(Controller Area Network is a vehicle standard that is designed to allow microcontrollers to communicate with each other without host computer).

Joel C. McCall et.al.[4] "Visual Context Capture and Analysis for Driver Attention Monitoring" has proposed Driver Attention Monitoring System. Aggregated outcomes from LISA-Q test bed that capture video, audio and vehicle information, Laser Radar information and information gathered from GPS system were considered as input to the system for evaluating driver's behavioural state.

Kelvin C. Baldwin et.al.[5] "The Driver Monitor System: A Means Of Assessing Driver Performance" has proposed a driver monitoring system which is composed of a GPS receiver, a two axis accelerometer and three video cameras. The Driver Monitoring System is installed in the car. The driver monitoring system composed of two web cameras one for the driver and other for forward view, two axis accelerometer is used for axial and traverse acceleration of the vehicle. The system proposed by the receiver can be extended to stress more on monitoring driver's health and behaviour in more precise way.

Luis M. Bergasa et.al.[6] "Real-Time System for Monitoring Driver's Vigilance" has proposed a non-intrusive prototype computer vision system for determining driver's level of vigilance. The prototype has focused on calculating six parameters like PERCLOS (percentage of eye closure), eye closure duration, blink frequency, nodding frequency, face position and fixed gaze. The architecture of the proposed system consists of modules such as image acquisition, pupil detection and tracking, visual behaviours and driver vigilance.

Mohamad-Hoseyn Sigari et.al.[7] "A Review on Driver Face Monitoring Systems for Fatigue and Distraction Detection" has proposed driver face monitoring system that includes capturing of images from driver face and extract the symptoms of fatigue and distraction from eyes, mouth and head. These symptoms usually includes percentage of eyelid closure over time (PERCLOS), eyelid distance, eye blink rate, blink speed, gaze direction, eye saccadic movement, yawning, head nodding and head orientation. The Driver face monitoring system composed of major components such as: Imaging, Hardware platform and the processor and the intelligent software. The alertness level of driver's is detected and if inattentiveness from the driver's side is noticed the alarm system get activated..

Amardeep Sathyanarayana et.al.[8] "Driver Behaviour Analysis and Route Recognition by Hidden Markov Models" proposes ability to respond to different driving contexts and system reliability under varying road and environmental conditions and driver reliability. The research involves bridging of inexpensive and non-intrusive sensors with artificial intelligence for the purpose of signal analysis and modelling.

Prasant Roy et.al.[9] "Driver Assistance System" has proposed a system that will predict and analyze the road environment that will assist drivers to have better experience while driving. The system has focused basically on two modes that include: City mode and Highway mode. For city mode the system has tried to solve the problem of noise pollution by having an IR transceivers to be used among the vehicles to transmit the signal. A buzzer in the frontal vehicle will indicate the driver that some vehicle at the back asking for the side, this will help the driver's to escape from accidents and collisions in narrow passages. The ultraviolet sensors will help in finding the distance from the obstacle vehicle. All the sensors are connected to UART port of Nuvoton board.

QiangJi et.al.[10] "Real-Time Eye, Gaze, and Face Pose Tracking For Monitoring Driver's Vigilance" has proposed a real time computer vision system for monitoring driver's level of vigilance. The prototype focuses on monitoring various visual clues which include eyelid movement, face orientation, pupil movement. The main components of the system consists of hardware for real time acquisition of video images of the driver and various software implementations for real time eye tracking, eyelid movement parameters computations, face pose discrimination and gaze estimation.

T. Brandt et.al.[11] "Affordable Visual Driver Monitoring System for Fatigue and Monotony" has proposed a visual driver surveillance system to measure driver's head motion and eye blink patterns. Driver's face is detected using cascade Haar wavelets. Eyes are detected in the upper region of the face on the basis that eyes are considered as the darkest region of the face. Optical flow in each eye region is detected and an alarm is raised if there is no eye blink after a certain period of time. Webcams are sensitive to infrared sensors so to protect the video images obtained from webcam infrared blocking filter is used.

3. ACCIDENTS AVOIDANCE USING ICT (INFORMATION AND COMMUNICATION TECHNOLOGY) ON INDIAN HIGHWAYS

Indian road network is second largest in the world. It is 33 lakh km.[16] Expressway contributes 200 km in length. National highways involves 96,260.72 km. State highways contributes 1,31,899 km.[16]National Highways constitute about 1.7% of the road network. It carries about 40% of the total road traffic. Increase in vehicles has been growing at an average pace of 10.16% per annum.[16] India is a developing country, there is increase in vehicles on roads day by day. Road safety is the major issue of concern for the Government of India.

We propose the use of ICT (Information and communication technologies) for making journey by roads safer. The latest inventions in ICT and electronic engineering will help in providing smart safety system for accidents avoidance. Smart sensing devices will be used for communication and monitoring purpose. WSN (Wireless sensor network) and ICT(Information and communication technologies) can possibly be helpful in reducing the accident scenario on Indian highways. Wireless sensor network is one kind of prominent communication technology which could be helpful in monitoring Indian highways in 24x7x365.

3.1 Wireless Sensor Network (WSN)

A Wireless Sensor Network is one kind of wireless network includes a large number of circulating, self-directed, minute, low powered devices named sensor nodes called motes. These networks certainly cover a huge number of spatially distributed, little, battery-operated, embedded devices that are networked to caringly collect, process, and transfer data to the operators and it has controlled the capabilities of computing & processing. Nodes are the tiny computers, which work jointly to form the networks. [12].

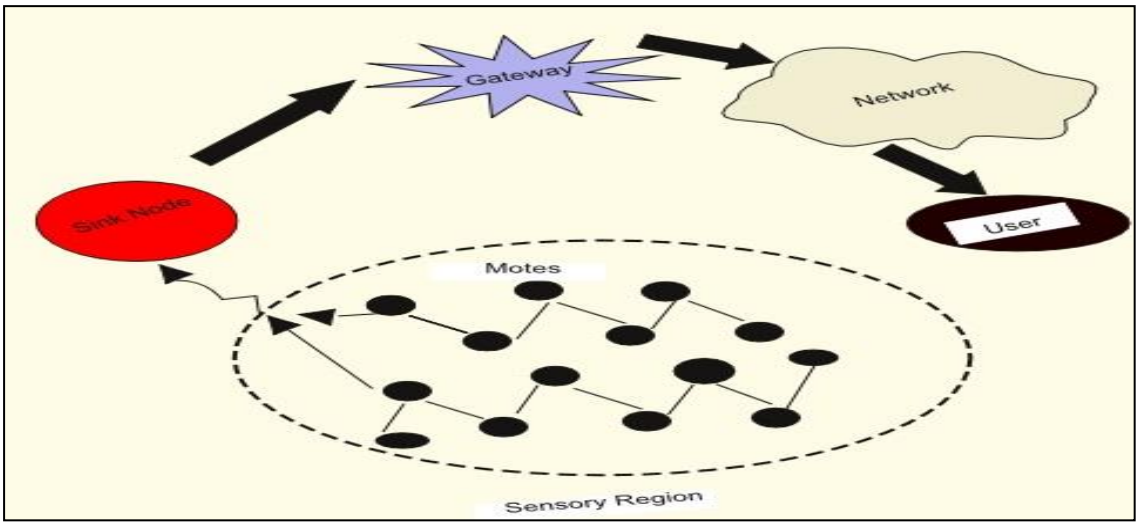

Fig.6. Block Diagram of Wireless Sensor Network

The sensor node is a multi-functional, energy efficient wireless device. The applications of motes in industrial are widespread. A collection of sensor nodes collects the data from the surroundings to achieve specific application objectives. [12] The communication between motes can be done with each other using transceivers. In a wireless sensor network, the number of motes can be in the order of hundreds or even in thousands. [12].

Wireless sensor networks may comprise of numerous different types of sensors like low sampling rate, seismic, magnetic, thermal, visual, infrared, radar, and acoustic, which are clever to monitor a wide range of ambient situations. Sensor nodes are used for constant sensing, event ID, event detection & local control of actuators. [13] The applications of wireless sensor network mainly include health, military, environmental, home, & other commercial areas.[13]

WSN can be of two types: Structured WSN and Unstructured WSN. Structured WSN is collection of few distributed nodes that are deployed in pre-planned region and it possesses lower network maintenance. Unstructured WSN will be collection of densely distributed nodes; it includes Ad-hoc distribution of nodes and has difficult network maintenance. [13]

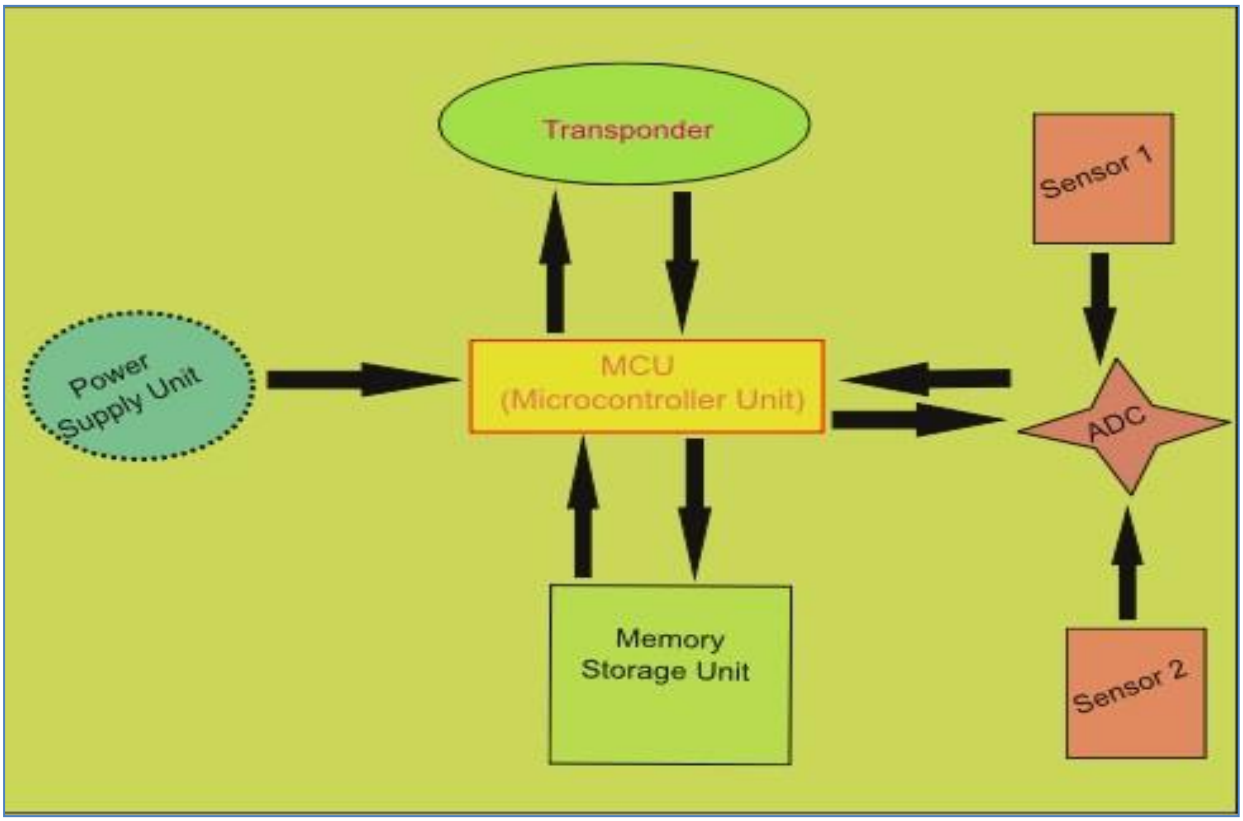

Fig.7. Architecture of Sensor Node

A sensor node, also known as a mote, is a node in a sensor network that is capable of performing some processing, gathering sensory information and communicating with other connected nodes in the network.[17] Fig.7 represent that sensors are used by wireless sensor nodes to capture data from their environment.They are hardware devices that produce a measurable response to a change in a physical condition like temperature or pressure. Sensors measure physical data of the parameter to be monitored and have specific characteristics such as accuracy, sensitivity etc. The continual analog signal produced by the sensors is digitized by an analog-to-digital converter and sent to controllers for further processing.A wireless sensor node is a popular solution when it is difficult or impossible to run a mains supply to the sensor node. However,since the wireless sensor node is often placed in a hard-to-reach location, changing the battery regularly can be costly and inconvenient. An important aspect in the development of a wireless sensor node is ensuring that there is always adequate energy available to power the system. The sensor node consumes power for sensing, communicating and data processing. More energy is required for data communication than any other process.

3.2 Benefits of use of WSN for Indian Highways

- Analyze driver's behavior in real time.
- Monitoring of mechanical condition, load condition, road condition, lane changing by the drivers, speed monitoring of the vehicle at the junctions where highways connecting the villages.
- Analysis of Climatic conditions that affects driving behavior.
- Monitor driver's physiological parameters like visual distractions, manual distractions and other vehicular parameters.
- Receive alerts to take intimated actions in real time.
- Reduce risk for the safety of drivers and passengers.
- Highlights areas for drivers re-training
- To give intimation signal to surrounding vehicles also in emergency situation like if driver is drunk,

- mechanical system of the vehicle is not working properly etc.
- To avoid any kind of emergency accidental situation that could arise due to inattentiveness of the driver while driving.
- To have restriction on vehicular speed system so as to restrict the speed of the vehicle in case the driver is not driving recklessly.
- To have full control on vehicle location in real time.
- Highlights areas for drivers re-training.

3.3 WSN based architecture overview

Fig. 8 represents that WSN based architecture will have sensors as key components. Sensors will be helpful in monitoring Highways, Driver's behaviour and Environment. Sensors will be helpful in retrieving real time data from mentioned parameters. WSN based intelligent system will be helpful in generating alert for nearby driver's vehicle for safer driving and notification to the control room. Control room on the basis of accident situation arises will communicate with safety agency like police and ambulance in case of emergency.

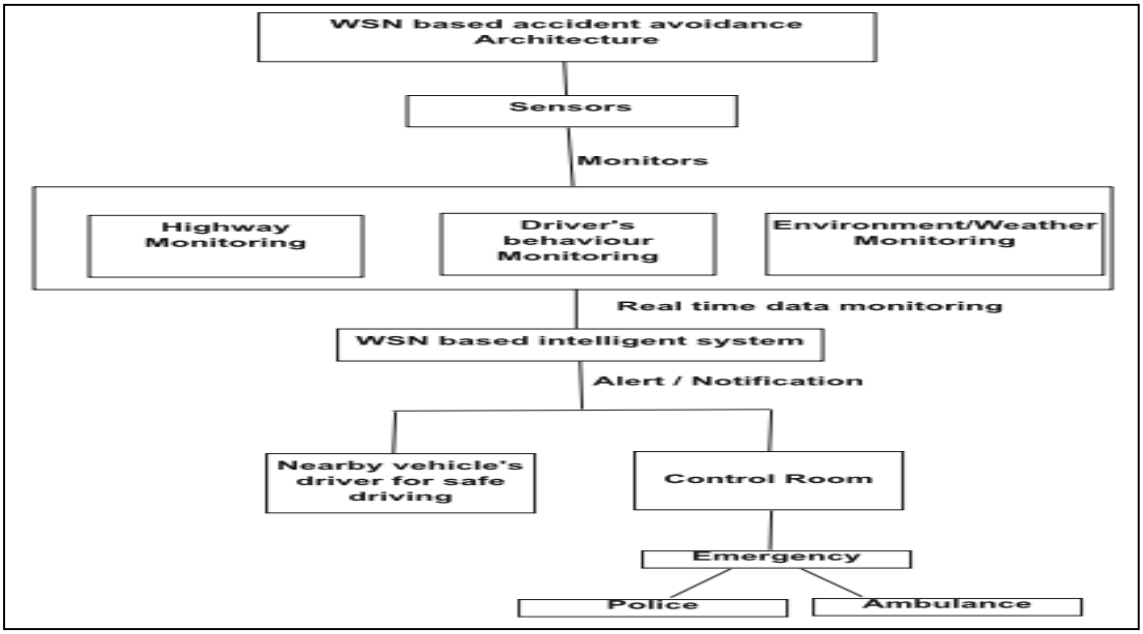

Fig.8. WSN based Architecture overview

4. CONCLUSION

In this paper involves the analysis of road accidents on highways in India. Deaths and injuries due to road accidents are increasing day by day. It's a serious issue of concern nationwide. The factors responsible for such fatalities are many. WSN could be a possible approach that could be helpful in finding a proper solution for at least reducing occurrences of accidents on highways. WSN could be helpful in generating notification or alert before accidents occurs. It will be helpful in monitoring parameters of driver's behavior, vehicle condition and road condition in real time. We can say that WSN could reduce the accidents on highways upto a greater extent.

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