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Obstacle Detection Based Collision Avoidance -A review

Meenakshi, Balwinder Singh Dhaliwal, Garima Saini

Department of ECE NITTTR, Chandigarh, Sector 26, India

ABSTRACT

In this article we analyse the causes of road accidents and their impact on both affected families and the nation's economy. We explore several techniques for preventing vehicle collisions, including sensor-based systems, camera technology, and advanced approaches such as computer vision and YOLO. Our analysis reveals that common causes of road mishaps include animal-vehicle collisions, low visibility areas, speeding, and driver error. To effectively address these challenges and reduce complexity, a machine learning system capable of processing and recognizing camera-captured image data is necessary. Timely detection and processing of potential hazards, especially on blind curves, are critical to preventing accidents.

KEYWORDS

Animal Vehicle collision; Driver Assistant system; Collision Avoidance; Computer vision; Obstacle detection; Road accidents; YOLO.

1. INTRODUCTION

Over the Indian subcontinent, street mishaps have been a significant wellspring of concern. As per Statista Research Department in 2019, the nation accounted for 151 thousand of causalities because of road accidents. Every year, around three-five % of the country's GDP is infused in street accidents. Remarkably, while India has around one percent of the world's vehicle populace, it also reckons 6% of the worldwide road traffic occurrence. In 2018, the World Road Statistics reported the number of fatalities in automobile accidents across 199 countries India ranks 1st and China second, followed by the United States. According to the Road Safety Global Report in 2018 by WHO, about 11% of all road mishap-related deaths worldwide occur in India (Road Traffic Deaths) It should be noted that in states/union territories (UTs) in 2019 4,49,002 roadway mishaps, 1,51,113 fatalities, and 4,51,361 injuries shown in Table I.

In 2019, there were 4,49,002 accidents and 1,51,113 deaths, which equates to a daily average of 1,230 accidents and 414 fatalities, and right around Fifty-one mishaps and seventeen fatalities per hour. This outcome in extensive financial misfortunes not exclusively for people, and their families, yet additionally for the countries all in all. The misfortunes are caused by the cost of medical care and also misplaced efficiency for those murdered or debilitated by their wounds, the misfortune of efficiency of family individuals who ought to take time off college or work to focus on the hurt, and so on. The state of Uttar Pradesh reported the greatest number of street mishaps in 2019 compared to 2018. Likewise, 2019 had the highest number of vehicle crashes in Tamil Nadu [1].

Accordingly, in 2019, the portion of the number of people slaughtered in the metropolitan and rustic regions was 32.9 percent and 67.1 percent. Street mischances in India slaughter nearly 1.5 lakh individuals every year.

Table. 1 Number of people killed or injured in Road accidents between 2015-19

Year	No. of Road Accidents	Change (%)	No. of Person Killed	Change (%)
2015	501423	-	14613	-
2016	480652	-4.14	150785	3.18
2017	464910	-3.28	147913	-1.90
2018	467044	0.46	151417	2.37
2019	449002	-3.86	151113	-0.20

It could be seen from the information in Figure.1 that over speeding represents the most extreme portion of street mishaps and street mishap passings (ranging from 63 to 74 percent for mishaps and from 62 to 70 percent for street mishap passings) on every one of the classifications of Expressways, and along these lines continues the trend observed across India premise. Driving in the wrong lane and driving when intoxicated are the other two traffic regulations violations that account for almost 10% to 12% of street mishaps and 9% to 10% of street mishaps passings on various National Highway categories. The class of Hit and run was trailed by "Hit from the Back" representing 18.4% of the all-out people slaughtered, trailed by "Head on impact", representing 17.7% of people executed in 2019. A hit from the back or a backside impact happens when a vehicle collides with the one before it. The number of accidents at overturning and collisions accounts for 5.2% and 19.5% of total accidents in 2019 [3].

2. CAUSES OF ROAD ACCIDENTS

Two-wheelers had the greatest contribution to deadly street mishaps in the nation in 2018. A significant segment of the mishaps that year happened at T-intersections. Over speeding has been a reason for worry all through the country paying little heed today or evening time.

Additionally, quick, and dangerous moves and unlawful road races on streets parkways not intended for the reason made critical difficulty for the police. More than 65% of the mishaps happened on straight streets. Also, public expressways had a portion of around 25% of the absolute street mishaps in 2018 [2].

Street mishaps are caused by a variety of factors and the consequence of a variety of variables interacting. These are generally classified as mistakes of a human being, the traffic conditions, and the vehicle's functioning. These elements work together to produce traffic fatalities. Any methodology for creating mishap anticipation measures should in this manner be founded on a protected frameworks approach that comprehends the significance of transit regulations and guidelines for improving the well-being of street client conduct, safe street plans (vehicle plan, number of paths, path width, and so forth), and safe vehicle plan.

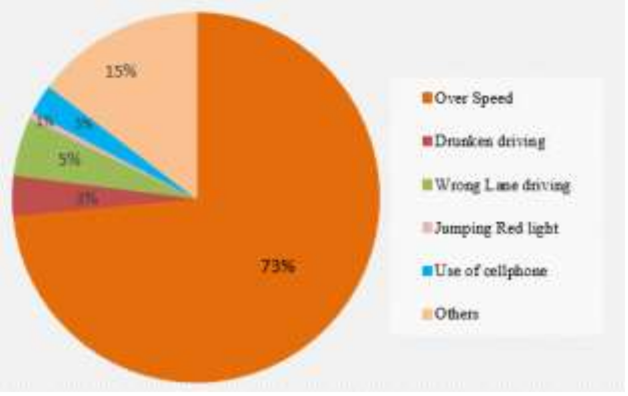

Fig.1 Street Accidents on NH under NHAI by Traffic rule infringement during 2019

1) Human Mistake: Accidents brought about by human blunders incorporate e.g., driving without a substantial driver's permit, traffic rule infractions.

2) Road Environment: accidents and incidents in a certain geographic region (Hills, planes, etc.), Horizontal lines, bends, and sharp angles are examples of road features, Different types of junctions & traffic management.

3) Driver inattention or carelessness: closely following (one after the other) at crossing points, emergency braking.

4) Traffic accidents based on road features: In 2019 number of accidents on straight roads accounts for 65.5% of total accidents and on curve roads 13.6% share of total accidents and 13.3% of total deaths.

Different types of traffic control systems are used at different types of junctions, Traffic light indicators, police-controlled signals, slow down signs, and flashing indicators are examples. In terms of geological parameters such as soil conditions, rock formations, and so on, the road layout in the hill region doesn't have substantially more space to extend the street foundation. Highways are the most important contributors to this work, as they account for most accidents in our nation. This includes the national highways that connect our country's major cities. The survey is currently underway for the curved roads in Pachamadhi (Madhya Pradesh), Chikhaldara (Maharashtra), and Dhanaulti (Uttarakhand) [4].

Road junctions are traffic joining places, they are susceptible to mishaps However, data provided by states/UTs reveal that only around 28 percent of incidents in 2019 occurred at the different sorts of intersections listed in Figure.2, with over 72 percent occurring in the "others" category. The T intersection has the highest number of accidents, fatalities, and injuries among junctions as shown in Figure.2. [3]

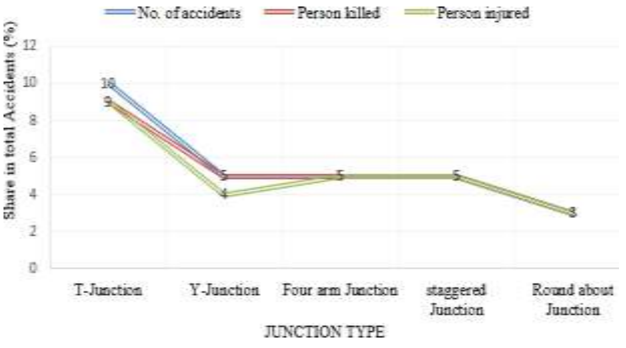

Fig.2 Accident on different type of Road junction for 2019

Power Integrity analysis has two aspects DC analysis, also known as IR, drop analysis and AC analysis, which is dynamic in nature and is also referred to as AC ripple voltage analysis. In this paper two test design cases are considered. The schematics and the board sim layout of the both the designs are used with editor tool for PI DC analysis and the performance parameters are obtained.The parameters are modified, and the impedance profile is compared for nominal values and optimised values of the design parameters.

When traveling to these locations, the existing roads have a very repetitive mix of blind curve roads (U, V-curve) and S-curve roads. As a result of such road systems, the risk of accidents is increased because exiting drivers have very little visibility in both directions as shown in Figure.3. Previously, when building roads and traffic laws in our country's curve road region, the area of the blind curves was addressed as the worst-case scenario. This is the primary cause of an increase in the number of injuries in hilly areas, as well as on roads with blind curves, T-junctions, and S-curves [5].

Fig.3 S-curve Accident-prone area

The current signboard system on link roads and T-junctions is also one of the key causes of such incidents. Most of the time, such boards are not available, or if they are, they are not in a good enough condition to support the driver in the event of future road diversions as shown in Figure.4. These current signboards do not offer accurate details to the driver. This is since they are just 10-50 meters from the cliff of the curves. Because of this lack of knowledge, a driver traveling at a relatively high speed (e.g., a vehicle approaching from the top of a hill) is more likely to collide with another vehicle.

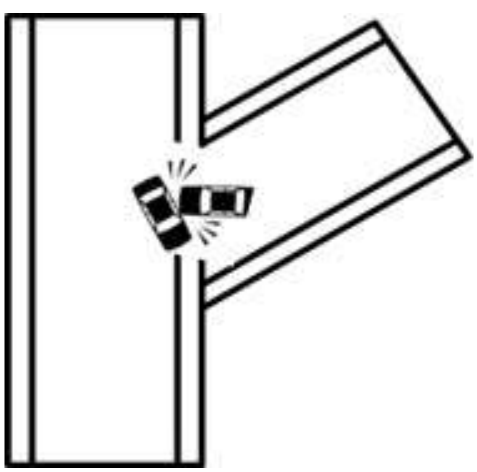

Fig.4 Accident on link road due to not availability of signboard

3. EFFECTS OF ACCIDENTS

Animal and vehicle collisions (AVCs) have a significant effect on wildlife as well as highway safety. According to environmental reports, roads trigger disturbances in wildlife's natural movement as well as physical isolation because of a lack of ecosystem connection, all of which contribute to higher animal ethics and road dangers. About 70% of AVC-related human deaths are caused by collisions and near-collisions, which have gradually increased as deer numbers and vehicle miles traveled have increased, posing increased risks to drivers, livestock, and other pedestrians. [6] According to previous studies, In the United States, about one million deer-vehicle accidents (DVCs) each year, well-outnumbering fox, wild dog, and other wildlife accidents [7]. Every hour, approximately 17 people die in India because of accidents. [8]

4. LITERATURE REVIEW

Byoung-Ki Jeon, et al. [9] presented a method for identification of the street utilizing hereditary calculation (GA). Their procedure is utilizing the spaceborne manufactured gap radar (SAR) picture to precisely identify the streets. The method is identifying the bend portions and gathering those bend fragments as an idea of locale development. Because of this gathering, the picture for the following 30 meters of the street is produced. The test results show that our strategy can precisely recognize street networks just as single-track streets and is a lot quicker than an around-the-world applied GA approach.

C.T.Chen, et al. [10] in this paper detect different types of vehicles by using real-time video on the blind road. They classified, recognized, and positioned automobiles as an item. They designed a system for both light and heavy vehicles, which has been installed at the Automotive Research and Testing Centre (ARTC, Taiwan). It was based on a minimal expense DSP platform providing blind spot and lane info. This (BDS) blind-spot detection method is 91 percent accurate and has 20 frames per second (fps) or more frame rate during day and night and in every single climate circumstance. Nowadays, the BDS is used for both ordinary automobiles and large automobiles.

P. Kedarkar et al. [11] This system is a radio frequency wave-based closest detecting device. It consists of 3 sensors. which are installed on the front, left side, and right side of the vehicle. It has an LED meter, and an audible alert. By emitting radio waves, the front sensor can distinguish the existence of any element and warns of impending threats in circumstances of temporary blind zones. Upon location, the gadget set on sound cautions & glimmers the LEDs, showing the existence of a gadget in the radio recurrence zone. After gadgets are eliminated from the radio recurrence zone, the alert and LEDs are turned off.

Patent number 201811021440 [7] This presents a discloses a simple, rugged system for preventing collisions of vehicles on blind curves. When a vehicle crosses one side of the blind curve, the paired sensors (Inductive loop sensors) are activated in a sequential manner, and data is processed and communicated to a microcontroller that controls the LED lights on the other side of the blind curve. As per the signal received, the LED lights glow red or yellow, thus warning a driver on the opposite side of the curve, of a vehicle coming from another side of the curve. The driver can thus slow down or stop, due to which collision/accident is prevented. A critical feature of the invention is the use of paired but widely separated (40 feet) sensors linked to the suitable microcontroller which can process the data as per the coded set of instructions (software), to distinguish between incoming and outgoing.

S. Dhalwar et al. [12] In this paper, a computer vision-based solution is provided for the recognition of these mirrors, and earlier notification to the driver will be important in the Advance Driver Assistance System (ADAS). The front camera placed on the vehicle will capture image frames in succession with a specified time interval. This convex mirror gives information about coming vehicles or hurdles on the blind curves. The traffic mirror identification and categorization of traffic mirrors utilizing the YOLO (You only look once) convolution neural network. After Mirror analysis the information helps to assist the driver in safe driving.

S. U. Sharma et al. [13] The suggested framework is based on over 2200 images and has been validated on several video clips of creatures on interstates with varying car speeds. Our proposed strategy will caution the driver if the speed limit exceeds 35 km/hr. If the speed exceeds 35 km/hr. even though the creature gets identified accurately, the pilot will not have enough time to escape a crash.

A. Mammeri et al. [14] Authors propose a two-stage framework, In the first stage, LBP- Adaboost detector is used to identify areas of interest that may include big animals. The second step, a framework built on (SVM) Support vector machine classifier trained using HOG [30], improves detection performance, especially during the day. The training data are derived from the big dataset of different animals, which comprises common and thermographic photos of large animals.

C. Druta et al. [6] discussed a major safety concern with animal-vehicle accidents (AVCs) in Virginia, United States, specifically Deer and vehicle collisions (DVCs). The authors established and evaluated the functioning of the most effective mitigation strategy is a Buried cable animal detection system (BCADS) to notify coming vehicles with roadside or in vehicle alerts depending on the active presence of a creature on or around the road. At the same time, the ‘Deer Crossing’ warning indication was put at the spot and connected to the BCADS to inform oncoming cars when a creature crossing was spotted.

A. M. Ibrahim et al. [15] The forward collision warning system is broken down into four primary goals: recognizing automobiles, calculating depth, allocating cars to lanes (lane assign), and tracking methodology. The proposed study focuses on the software approach by employing YOLO [28], a deep learning object detection network that can recognize automobiles with an efficiency of close to 93%.

P. Chakraborty et al. [16] To predict traffic jams from camera photos, authors employed two separate deep learning approaches, deep convolution neural network, and YOLO [29]. To analyze the improvements gained utilizing deep learning methods, the support vector machine (SVM), a shallow technique, was additionally used as a correlation. There are two basic approaches to detecting traffic jams using camera photos. The first solution involves feeding the input image through an object detection method to evaluate the number of vehicles in the picture, when the numbers of vehicles reach a certain threshold, the picture is marked as crowded. The second technique categorizes the complete picture as crowded or non-congested.

M. H. A. Hassan et al. [17] This study aims to measure the driver’s field of view through side mirrors with and without a circular convex blind spot mirror. Hassan et al. have proposed a new way to measure the field of view using headlamps. The captured image was traced in Adobe Photoshop before being imported into MATLAB to calculate the area of reflection. The global threshold was calculated from the imported grey level using Otsu’s method. The grayscale image was then converted to a binary image based on a previously calculated threshold. Experiments have shown that a circular convex mirror attached to the lower right-side mirror expands the driver’s field of view by up to 211%.

Patent number US6483443B1 [18] presents a loop sensing device for recognizing automobiles driving along a road lane, consisting of an outer loop creating a zone of a magnetic field having the same polarity as the outer loop and an inner loop scaled to fit inside this zone of constant polarity. The sensing circuitry energizes both the outer and inner loops separately to detect cars going through the loops. The outer loop will be used to detect a vehicle’s chassis, whilst the inner loop may be utilized to detect a vehicle’s wheel or axle.

Patent number US 9,260,095 B2 [19] A picture handling framework is operable to deal with picture information caught by the camera to decide the presence of the main vehicle in front of the prepared vehicle and to decide the light level of the taillight of the main vehicle. Receptive to an assurance of the relative speed and acceleration of the main vehicle compared with the vehicle ahead, the vision framework decides on a slowing down level of the equipped car in order to avoid colliding with the vehicle ahead.

T. S. Ajay et al. [20] Four ultrasonic sensors have been installed in the car to inspect the front, rear, and two sides. When an obstruction in the vulnerable side zone is detected, the distance between the obstacle and the sensor is computed and communicated to the Arduino Mega Board, then data is used to control the motor and to decrease the speed of the motor.

Din-Chang Tseng et al. [21] Authors proposed a lane change assist system with aiding developing ways. Two cameras are placed behind the host vehicle's side mirrors to collect back pictures for identifying moving toward vehicles. The suggested framework can differentiate between side vehicles with varying speeds.

David P. Racine et al. [22] work outcomes show that incorporating an active blind spot accident-avoidance framework with a power input pedal and a controlling wheel into a vehicle can assist to decrease blind spot crashes.

Rene Sosa et al. [23] The framework cautions the driver at a safe enough distance to prevent an accident. After comparing the distance and relative speed of both the obstacle and host vehicle, the system gets the alert and brakes. Because the framework does not depend on the utilization of specific sensor innovation, it tends to be utilized with LIDAR, IR, and RIDAR.

Babu Varghese et al. [24] The suggested system employs eight distinct detecting locations of the ultrasonic sensors for both crash and blind spot identification. The sensor detects objects within a predefined range and sends them to the Arduino platform for manipulating the information. A buzzer has been installed to provide an audio alarm, and an LED may be utilized to provide visual notification.

R. P. Mahapatra et al. [25] This framework is a closeness recognition gadget that uses radio recurrence waves. The front sensor recognizes the presence of any entity and cautions about the forthcoming threats in instances of impermanent blind spots by transmitting radio waves. When a device is detected, the gadget emits loud alerts and flashes the LEDs, indicating the existence of an obstacle in the radio recurrence zone.

Faiz. A. B. et al. [26] in this framework created an Android application that detects and sends an immediate alert message to the closest police headquarters & medical services place about an accident. This application is incorporated with an exterior pressure sensor to retrieve the car body's outward force. It has GPS Tracking and a gyroscope sensor on an Android device to monitor pace and inclination angle variation when the pressure rate or inclination angle change exceeds the set specified threshold and the pace of the automobile fault is equal to or flaw equivalent or under 33% really at that time application distinguishes the circumstance as a mishap to receive pressure sensor information, the Android phone's Bluetooth connection must be turned on. From that point onward, the application takes a crisis number to send a message following recognizing the mishap.Patent No. US 20110066325A1 [27] The framework likewise incorporates at least one curve detector, which recognizes the curves of a roadway and controls the overspeed gadgets which cause slowing down to vehicle tires and additionally decrease motor force to keep a vehicle precisely arranging the bent street.

5. DISCUSSION

C.T.Chen, et al. [10] This (BDS) blind-spot detection method is 91 percent accurate and has 20 frames per second (fps) or more frame rate during day and night and in every single climate circumstance. S. U. Sharma et al. [13] this proposed strategy will caution the driver if the speed limit exceeds 35 km/hr. Shown in Table 2 if the speed exceeds 35 km/hr. even though the creature gets identified accurately, the pilot will not have enough time to escape a crash. A general precision of nearly 82.5% is accomplished with respect to discovery utilizing computer vision technology in which the camera is mounted on the vehicle. A. Mammeri et al. [14] This two-stage system has shown great results during the day but has shown limited capability during the night. Other situations, such as posterior, front viewpoints, and postures at different angles will be addressed in the future. C. Druta et al. [6] the BCADS can identify bigger creatures such as deer, as well as smaller creatures such as foxes, with about 99 percent accuracy.During the first year following system implementation, there was a 75% decrease in deer-vehicle collisions. Data acquired during caution sign illumination revealed that nearly 80 percent of cars eventually stop or slow down their speed in reaction. A. M. Ibrahim et al. [15] A deep learning object detection network that can recognize automobiles with an efficiency of close to 93%. As a result, employ a depth estimate approach that makes use of the measurements (width and height) of the output border box from YOLO. These measurements were utilized to determine the distance with 80.4 percent accuracy. M. H. A. Hassan et al. [17] Experiments have shown that a circular convex mirror attached to the lower right-side mirror expands the driver's field of view by up to 211%. T. S. Ajay et al. [20] ultrasonic sensors can identify blind spots but the HC-SR04 Ultrasonic sensor has a limited assessment range of 2-400cm. It can be concluded that the Buried Cable Animal Detection System (BCADS) proposed by C. Druta et al. [6] stands out as a robust method for obstacle detection in blind spots. BCADS achieved high accuracy, significantly reducing animal-vehicle collisions, and successfully engaged drivers' responses.

Table 2. Comparison table of all technology used for Obstacle detection in blind spots

Particulars	Reason of Accidents	Sensor used	Technology used	Enforcement's limitations	Speed & Accuracy	Obstacle Detected by system
A Practical Animal Detection and [13]	Animal-Vehicle collision	Camera mounted on vehicle	Computer Vision Technique	The proposed method can be readily expanded to identify other animals and pedestrians.	100ms (10 frames per second) & 82.5%	Animal (Cow)
IOT Based Smart Anti-Collision System [7]	Blind Curves	Inductive loop sensors	Embedded System	Capable of detecting all types of vehicles crossing on road but not able to detect animals and pedestrians. Sensors are installed on the road, so the cost and complexity of the system is high	90%	Vehicles
Preventing Animal-Vehicle Crashes [6]	Animal-Vehicle Crashes	Buried cable animal detection system (BCADS)	Radio frequency signals	Before the system installation, a site survey was needed, System is costly and very complex to install.	99% (Reliability)	Only Animals (Deer)
Blind-Spot Vehicle Detection [21]	Vehicle accidents during lane change	Two cameras are mounted under side mirrors	Multi-resolution optical flow detection, static feature detection .	The road surface can appear dusky and unclear during heavily rainy days and at night, making it difficult to detect important features such as optical flow, edges, and underlying shadows. As a result, the accuracy of detection may not be optimal	28 milliseconds 95.67%	Vehicle
Animal-Vehicle Collision [14]	Animal-Vehicle Collision	Visible range cameras	Two-stage architecture LBP-AdaBoost/ HOG-SVM	Observed that the combined use of LBP-AdaBoost and HOG-SVM for object detection exhibits limited capabilities during night-time.	167ms	Large Animals (Horse, Cow, Deer)
Real-Time Collision Warning System [15]	Vehicle crash avoidance	Mono camera.	YOLO, computer vision technique	To improve the accuracy of object detection, it is possible to fine tune a CNN by training it with more images that closely resemble the environmental condition in which the system will operate.	streaming speed 23 FPS & 93%	Cars

6. CONCLUSION

Mostly all the above system sensors are installed on the vehicle, so its benefits are only restricted to the vehicle owner. Inductive loops and buried cable sensors for vehicle detection are installed on the road and which is very crucial to implement in every blind spot. Some systems use an ultrasonic and infrared sensor. These systems is a limited range of sensors. Convex mirrors are not enough to identify the type of obstacles at the blind curve. Methods in the literature survey do not detect animals, road neural network-based system that helps to recognize all types of obstacles, landslides, and pedestrian combinedly in blind spots and low visibility areas. This required a convolutional of obstacles by doing image processing and object identification. Sensor-based systems have been wired, so it is very difficult to manage and dig the road but using camera-based systems to capture real-time images reduces the complexity and cost. To fulfill all requirements such as detecting all types of road obstacles and reducing complexity, there is a need for a machine learning system that can process and recognize the data of captured images by camera. Time required for detection and processing plays an important role in avoiding accidents on blind curves, so there is a need for a convolutional neural network algorithm for greater accuracy in object detection with less time. In conclusion, the YOLO-based deep learning approach introduced by A. M. Ibrahim et al. [15] presents itself as a strong contender for obstacle detection in blind spots due to its recognition efficiency, deep learning advantages, and depth estimation. However, a comprehensive evaluation involving a diverse set of obstacle types, real-world testing, depth estimation accuracy, training data quality, and consideration of cost-effectiveness is necessary to determine its full potential and suitability for deployment in practical scenarios.

REFERENCES

1. N. Anjum, V. K. Singh Yadav, and V. Nath. (2023). Design and Analysis of a Low Power Current Starved VCO for ISM band Application. International Journal of Microsystems and IoT, 82–98. (Vol. 1) https://doi.org/10.5281/zenodo.8288193

2. P. Mishra, P. Mishra , (2017).Vital Stats Overview of Road Accident in India, PRS Legislative Research Institute for Policy Research Studies, no. 011, pp. 4801–2, (Vol. 4343), http://www.prsindia.org.

3. Dinesh, Mohan (2009). Road Accidents in India, International Association of Traffic and SafetySciences, pp. 75-79,(Vol. 33), doi:10.1016/s0386-1112(14)60239-9

4. P. D. Saraf and N. A. Chavan (2013). Pre-crash Sensing and Warning on Curves: A Review, International Journal of Latest Trends in Engineering and Technology (IJLTET), (Vol. 2), Issue 1, pp. 80-83,

5. A. K. Joshi, C. Joshi, M. Singh, and V. Singh(2014). Road traffic accidents in hilly regions of northern India: What has to be done?, World Journal of Emergency Medicine, (Vol. 5), no. 2, pp.112-115, doi: 10.5847/wjem.j.issn.1920-8642.2014.02.006

6. C. Druta and A. S. Alden (2020). Preventing Animal- Vehicle Crashes using a Smart DetectionTechnology and Warning System, Transportation Research Record , (Vol. 2674), no. 10, pp. 680–689, doi: 10.1177/0361198120936651

7. Meenakshi, B. Nishant and P. Bansal (2019). IOT Based Smart Anti-Collision System for Blind Curves, Patent Application No. 201811021440,

8. I. Mohammad, R. Pandey (2015). Providing Vehicle Safety and Fastest Accidental Aid using Wireless Sensor Network, International Journal of Engineering and Management Research, (Vol. 5) , pp. 705–710,

9. B. K. Jeon, J. H. Jang, and K. S. Hong (2002). Road detection in spaceborne SAR images using a genetic algorithm, IEEE Transactions on Geoscience and Remote Sensing, (Vol. 40), no. 1, pp. 22–29, doi: 10.1109/36.981346

10. C. T. Chen and Y. S. Chen, 2009, Real-time approaching vehicle detection in blind-spotarea, 12TH International IEEE Conference on Intelligent Transportation, 3-7, pp. 24–29, doi: 10.1109/ITSC.2009.5309876

11. P. Kedarkar, M. Chaudhari, C. Dasarwar, and P. B. Domakondwar (2019), Prevention Device for Blind Spot Accident Detection and Protection, International Research Journal of Engineering and Technology, 624–627 (Vol. 6).

12. S. Dhalwar, S. Ruby, S. Salgar, B. Padiri (2019), Detection Image Processing based Traffic Convex Mirror Detection, 5TH International Conference on Image Information Processing (ICIIP), JP University of Information Technology, Himachal Pradesh, India, 41–45.

13. S. U. Sharma and D. J. Shah (2017), A Practical Animal Detection and Collision Avoidance System Using Computer Vision Technique, Special Section on Innovations in Electrical and Computer Engineering Education IEEE access, 347–358. doi:10.1109/ACCESS.2016.2642981

14. A. Mammeri, D. Zhou, and A. Boukerche (2016), Animal-Vehicle Collision Mitigation System for Automated Vehicles, IEEE Transection on System, Man and Cybernetics, 1287–1299 (Vol. 46). doi:10.1109/TSMC.2015.2497235

15. A. M. Ibrahim, R. M. Hassan, A. E. Tawfiles, T. Ismail, and M. S. Darweesh (2020), Real-Time Collision Warning System Based on Computer Vision Using Mono Camera, 2nd Novel Conference on Intelligent and leading Emerging, Giza, Egypt, 60–64. doi:10.1109/NILES50944.2020.9257941

16. P. Chakraborty, Y. O. Adu-gyamfi, and S. Poddar (2018), Traffic Congestion Detection from Camera Images using Deep Convolution Neural Networks, Transportation Research Record, 222-231, (Vol. 2672).

17. M. H. A. Hassan, F. Y. Tan, M. A. Abdullah, N. Q. Radzuan, and K. A. A. Kassim (2020), Does a Circular Convex Blind Spot Mirror Increase the Driver' s Field of View, Journal of the Society of Automotive Engineers Malaysia, 44–49, (Vol. 4).

18. R. H. Lees, R. A. Lees (2002), Loop Sensing apparatus For Traffic Detection, Patent No.:US 6,483,443 B1.

19. W. J. Chundrlik, D. Raudszus (2016), Vehicle Vision System with Collision Mitigation, U.S. Patent No. US 9.260,095 B2.

20. T. S. Ajay, R. Ezhil (2016), Detecting Blind Spot by Using Ultrasonic Sensor, International Journal of Scientific and Technology Research, 195-196, (Vol. 5).

21. D. C. Tseng, C.T.Hsu and W. S. Chen (2014), Blind-Spot Vehicle Detection Using Motion and Static Features, International Journal of Machine Learning and Computing, 516-521, (Vol. 4).

22. D. P. Racine, N. B. Cramer, and M. H. Zadeh (2010), Active blind spot crash avoidance system: A haptic solution to blind spot collisions, 2010 IEEE International Symposium on Haptic Audio-Visual Environments and Games, Phoenix, AZ, USA, 1-5, https://doi.org/10.1109/HAVE.2010.5623977

23. R, Sosa, G, Velazquez (2007), Obstacles detection and collision avoidance system developed with virtual models, 2007 IEEE International Conference on Vehicular Electronics and Safety (ICVES), Vienna, Austria, 1-8, https://doi.org/10.1109/ICVES.2007.4456397

24. V. Babu, R. T. Jacob, F. Kamar and A. S. Rizwan (2014), Collision Avoidance System in Heavy Traffic and Blind Spot Assist Using Ultrasonic Sensor, International Journal of Computer Science and Engineering Communication (IJCSEC), 93-96, (Vol. 2).

25. R. P. Mahapatra, K. Vimal Kumar, G. Khurana and Roopam Mahajan (2009), Ultra Sonic Sensor Based Blind Spot Accident Prevention System, 2008 International Conference on Advanced Computer Theory and Engineering, Phuket, Thailand, 992-995 https://doi.org/10.1109/ICACTE.2008.165

26. A. B. Faiz., A. Imteaj., M. Chowdhury (2015), Smart Vehicle accident Detection and Alarming System using a Smartphone, 2015 International Conference on Computer and Information Engineering (ICCIE), Rajshahi, Bangladesh, 66-69, https://doi.10.1109/ccie.2015.7399319

27. J. Lu, D. D. Eisele, T. E. P. Christopher Nave, L. Tellis, J. D. Rupp (2011), Curve-Related Accident Mitigation, United States Patent - US20110066325A1, 2011

28. J. Redmon and A. Farhadi (2018), Yolov3: An incremental improvement, arXivpreprintarXiv:1804.02767, 2018.

29. Redmon, Joseph, et.al., (2016) You only look once: Unified, real-time object detection, In Proceedings of the IEEE conference on computer vision and pattern recognition, 779-788.

30. Y. Zhang, K. Guo, W. Guo, J. Zhang and Y. Li, (2012), Pedestrian crossing detection based on HOG and SVM, Journal of Cyber Security, 79–88, (vol. 3). DOI:10.32604/jcs.2021.017082R.

31. T. S Reddy, K.A. M Junaid, Y. Sukhi and Y. Jeyashree and P. Kavitha and V. Nath (2023), Analysis and design of wind energy conversion with storage system. e-Prime - Advances in Electrical Engineering, Electronics and Energy 100206 (Vol. 17). https://doi.org/10.1016/j.prime.2023.100206

32. D. Sharma, A. Rai, S. Debbarma, O. Prakash, M K Ojha and V. Nath (2023), Design and Optimization of 4-Bit Array Multiplier with Adiabatic Logic Using 65 nm CMOS Technologies, IETE Journal of Research, 1-14. https://doi.org/10.1080/03772063.2023.2204857

33. J. Tirkey, S. Dwivedi, S. K. Surshetty, T. S. Reddy, M. Kumar, and V. Nath. (2023), An Ultra Low Power CMOS Sigma Delta ADC Modulator for System-On-Chip (SoC) Micro-Electromechanical Systems (MEMS) Sensors for Aerospace Applications. International Journal of Microsystems and Iot, 26–34(Vol.1). https://doi.org/10.5281/zenodo.8186894

34. D. Sharma, N. Shylashree, R. Prasad, and V. Nath. (2023), Analysis of Programmable Gain Instrumentation Amplifier. International Journal of Microsystems and Iot, 41–47(Vol. 1). https://doi.org/10.5281/zenodo.8191366

AUTHORS

Meenakshi received her B.Tech degree in electronics and communication engineering from Baddi University of Emerging Science and Technology ,Solan, India in 2017. She is currently pursuing M.E. in electronics and communication from NITTTR, Chandigarh, India. Her areas of interest are embedded systems, artificial intelligence, machine learning and human computer interaction.

Corresponding Author E-mail: meenakshiverma415@gmail.com

Balwinder Singh Dhaliwal is Currently Associate Professor in NITTTR, Chandigarh, India. He has Received Ph.D. and M.Tech. in Electronics and Comm Engineering from Punjab Technical University Jalandhar. His areas of interest are Antenna (Fractal, MIMO), ANN, Digital Signal Processing, Soft Computing.

E-mail: balwindersdhaliwal@nitttrchd.ac.in

Garima Saini is Currently Assistant Professor in NITTTR, Chandigarh, India. She has Received Ph.D. and M.Tech. in Electronics and Comm. Engineering from Punjab Technical University Jalandhar. Her B.Tech degree in electronics and communication engineering from Kurukshtera University, Kurukshetra. Her areas of interest are Advanced Digital Communication, Antenna Design Simulations & Optimization, Wireless & Mobile Communication.

E-mail: garima@nitttrchd.ac.in .