Project Name: **Smart Vehicle System**
Team Name: **CECAI**

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1. Introduction:

With the increase in the number of automobiles around the world, vehicle protection has become a major concern. Chained accidents with numerous fatalities and property damage result from the fact that following drivers are blind to fate. Although there is an autonomous vehicle, when comes to accident safety system, more accurate and reliable prevention technique is needed. Vehicle accidents may happen due to the following reasons:

-Obstacles crashing | *- Glare of high beam* | *-Sideway accidents* | *-Brake failure* | *-Red Light Jumping* | *-Over Speed Limit*

To prevent accidents from most of the problems, and even to make the vehicle semi-autonomous, the proposed solution here incorporates real-time semi-autonomous vehicle safety system. This system's accident prevention controller can be mainly divided into the following modules:

-Obstacle detection
(stereo vision + ultrasonic + V2V)

-Automatic Headlight Dimming
(dimmer circuit with light vision)

-Side Speed Measure with Instant air bag
(side- speed measurement)

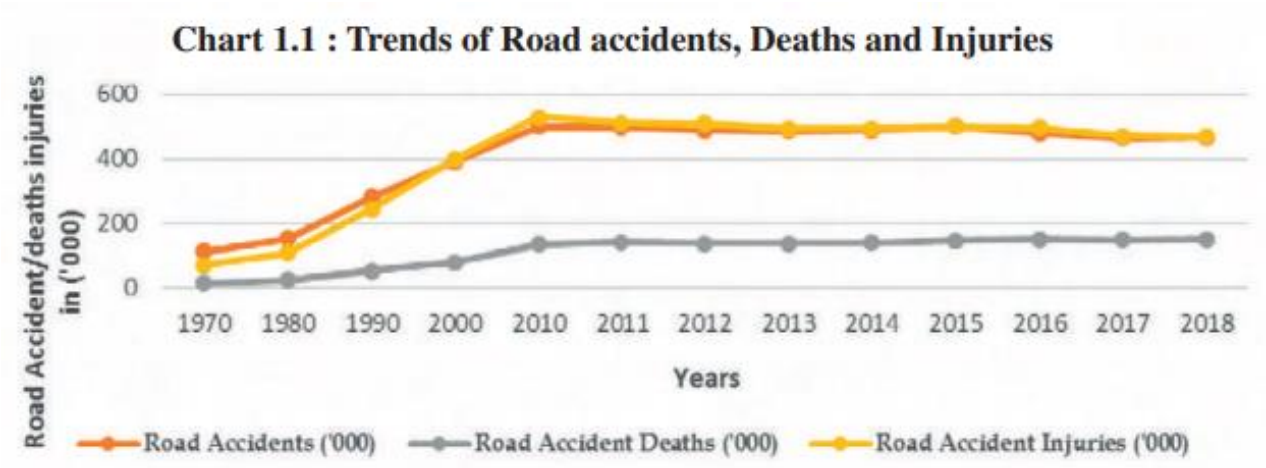
-Smart braking system
(GPS + GSM integrated)

-Auto traffic controller
(vision based)

-Location based Speed Limiter
(speed limiter based on location data)

2. Detailed Problem Statement:

In recent years, the road accident has become a global problem and marked as the ninth prominent cause of death in the world. Due to the enormous number of road accidents every year, it has become a major problem. It is entirely inadmissible and saddening to allow its citizen to kill by road accidents. Even there is a lack of accurate accident safety system in autonomous vehicles too.



The above graph reveals a consistent increase in road accidents, accident-related deaths and road injuries up to 2010 after which all three categories of accidents, deaths and injuries have stabilised with marginal fluctuations. As per the survey of The Insurance Institute for Highway Safety (IIHS), only about a third of crashes were the result of mistakes that automated vehicles would be expected to avoid simply because they have more accurate perception than human drivers and aren't vulnerable to incapacitation. To avoid the other two-thirds, they would need to be specifically programmed to prioritize safety over speed and convenience. So, there is a more need for designing an accident control safety system to minimise these kinds of accidents in both autonomous and non-autonomous vehicles.

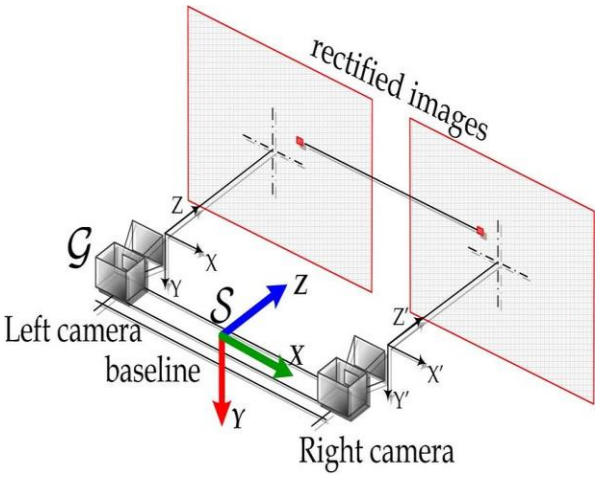
3. Prescribed Solution:

The main aim of this system is to overcome the drawbacks in the accident safety controller in vehicles and provide better accurate accident prevention methodology. It mainly includes the following:

- Obstacle detection with integrated stereo vision, ultrasonic, V2V

-stereo vision:

Obstacle detection with a pair of real-time video input acquired by a stereo vision device for the detection and distance computation of a preceding vehicle in 3D space. Using stereo vision-based depth estimation, more accurate distance can be



obtained. Important thing to measure depth include point correspondence (be x1, x2) and the camera's relative position (be c1, c2). By using these 2 parameters for all 3D points, direction vectors (be l1, l2) and from that the depth info can be obtained. By using the disparity, i.e., the shift between two images captured by the camaras, and analysing the extent to which those images are shifted, depth of obstacles can be measured with more perfection.

Disparity = x – x' = Bf/Z = xleft - xright

B is the baseline (Distance between the cameras)

f is the focal length

z is the depth of object

Here we are using the block matching algorithm, to find the correspondence. Disparity calibration is shown below:

Stereo camera provides a greater field of view. From the disparity map, depth map can be obtained since it's inversely proportional, by setting up the threshold for the depth value, if any object more than that threshold can be detected as obstacles, and this will alert the driver to apply brake through some signals, if the obstacle value is too near to the threshold, than brake will be applied automatically to prevent accident.

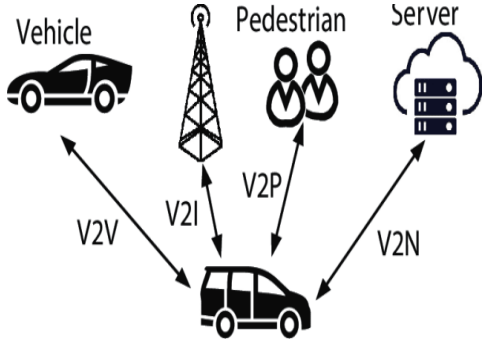
Click here for a disparity map generation video

-ultrasonic based obstacle detection for lower objects:

Accident detection using ultrasonic sensor provides the facility to detect an accident under various natural conditions like rains. So, it acts as a secondary backup for the stereo vision if the surround capturing failed by camaras or in the condition of blur surroundings.

In both the stereo vision and ultro-sound based braking system, if the vehicle is near to another vehicle based on a particular threshold value, the system will notify or aleat the driver to apply brake, if the distance crosses below the lower threshold value, than the vehicle will stop automatically. High range rader can be used instead of ultrasonic for a long range coverge.

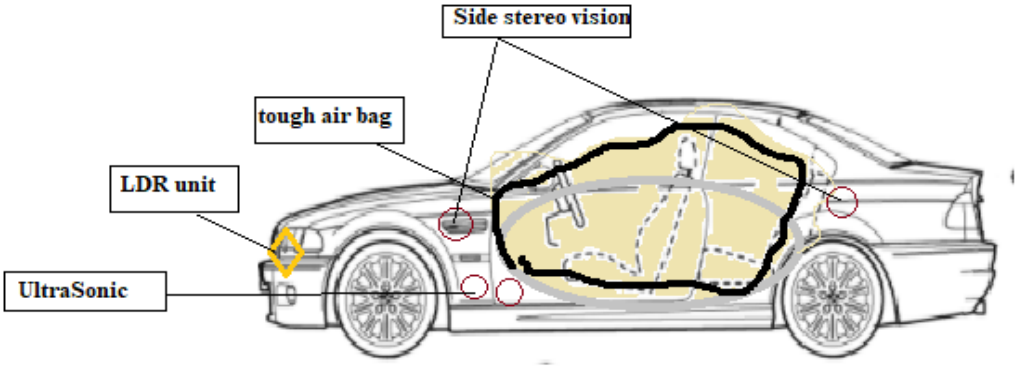
-V2V communication for exchanging vehicle routing information



Vehicle-to-vehicle (V2V) communication enables vehicles to wirelessly exchange information like speed, location along with the broadcast and receive omni-directional messages (up to 10 times per second), creating a 360-degree information availability to other vehicles in proximity. By making frequent jumping auto WiFi connection to nearby vehicles and by sharing the position and speed information, accidents can be controlled. Even with exchanging the information related to deep curvings, accidents can be controlled in road curves.

- Glare of High Beam and Sideway Accidents

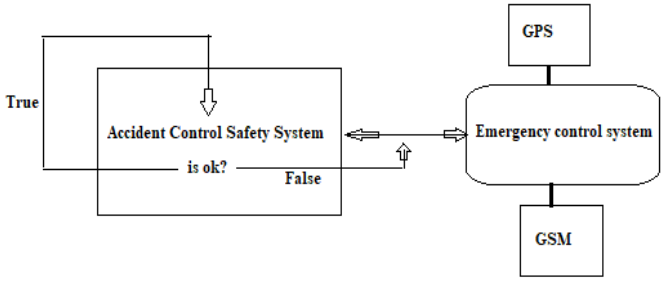
During the night time, while driving, there may be a chance of accidents because of flashing of high beam light of the upfront vehicle if the driver forgot to dim the sharp beam of their vehicle. So, by making the lights automatic dip and dim by recognising the upfront vehicle, night road accidents can be prevented. This can be done by using a simple controller with LDR and relay.
By using the 360 surrounding stereo vision along with ultrasonic sensor (small radar for more efficient working), and calculating the distance, and then speed and acceleration of the vehicle which is coming towards this vehicle from the sideway if its speed is very high, than probability of accident happening is more, so this system automatically detects this and opens the tough airbag suddenly. So, this sideway tough air bag prevent the accident being happened because of side coming vehicle, and protect from accident.



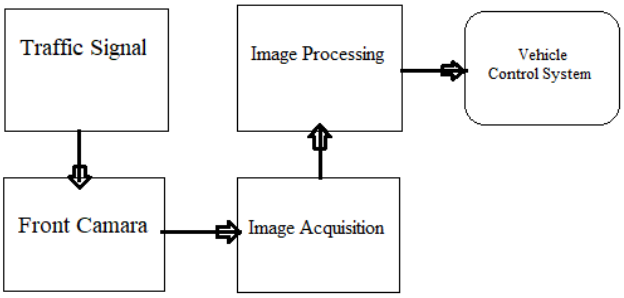
Automatic Headlights and Tough Side Airbag

- Smart braking System and auto traffic controller

If in worst case, brake fail occurs or due to uncertinity accident happens, this can be detected if the obstacle crosses the emergency threshold value, than this will trigger the emergency alert by sending the real time location information through the gps to the nearby hospitals as emergency measures through the gsm.



Emergency Control Unit



Auto Traffic Vehicle Controller

By braking the traffic signals or sometimes due to ignorance of the traffic signals and crossing the roads may leads to accident. Inorder to prevent this, with the help of of processing image from the front camara and by making auto detection of traffic signals and controlling the vehicle, accients at the road junctions can be controlled.

- Location based Speed Limiter

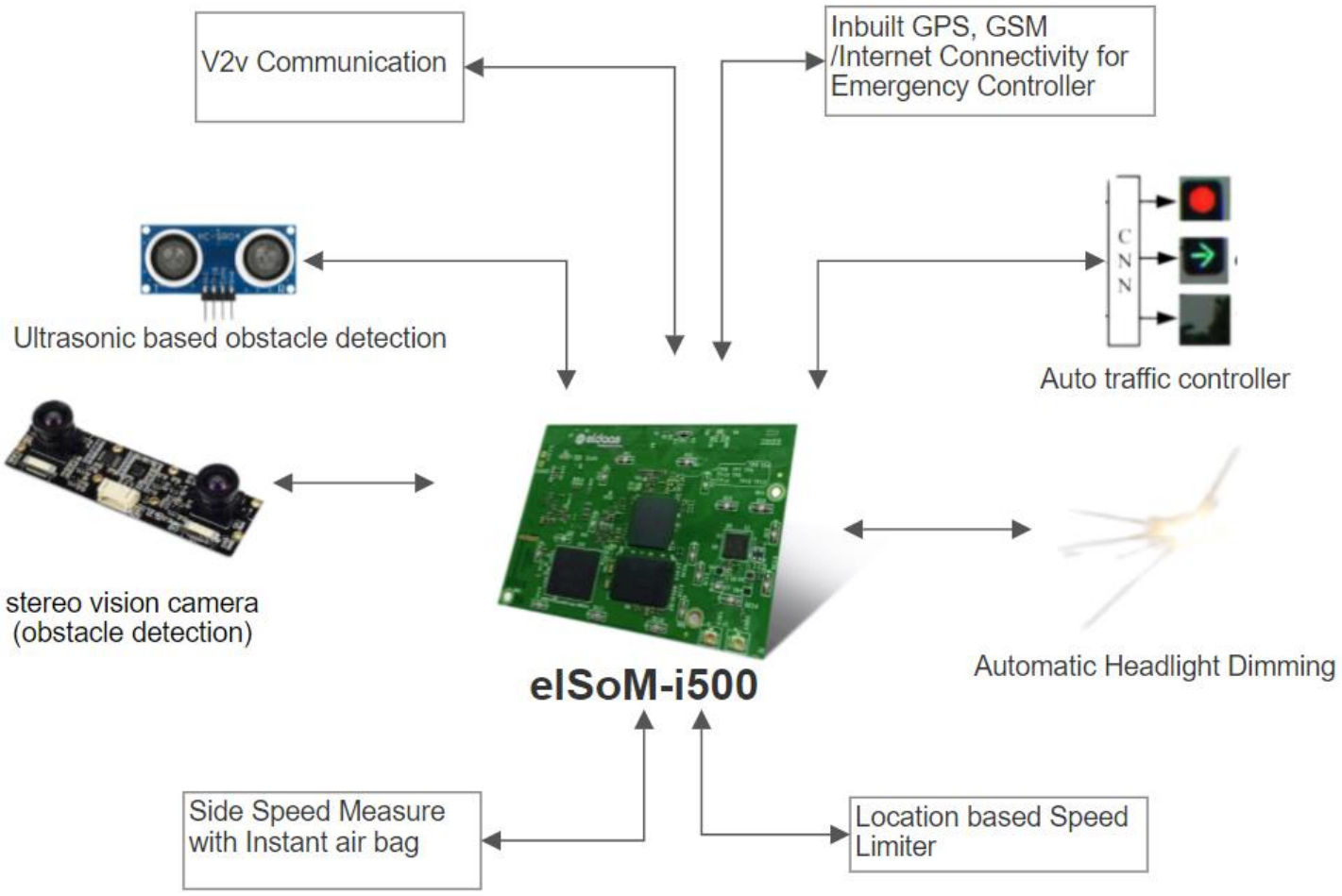
Due to over speed in certain regions and ignoring the speed limit on roads, accidents may happen. So with the help of location info of vehicle information, based on the speed limit location, vehicles speed limit will set to pre-defined speed automatically thereby preventing the over-speed accidents

4. Uniqueness of the project

As per the iso26262 safety requirement, in autonomous vehicle, even for a simple decision making, there should be minimum of 3 processors. By using a single safety checking implementation, it's dangerous if the single system fails. So more accurate decision is required to take decisions. On combining the above proposed techniques, it robust the safety system. By using stereo vision on 360 degree surrounding and implementing side tough air-bags, it's even possible to

prevent the accidents in most of the situations. So, this idea may resolve most of the accidents with better accuracy. This system can be integrated to present vehicles too.

5. System or Concept level Block Diagram



Smart Vehicle System - Accident safety Controller System

6. Limitations

Though most of these advancement helps us to do incredible things, there exist always an unexpected glitch to emerge. Even the potential loss of privacy may happen because of these advancements may help unknown to track vehicles. By using the encrypted data transmission, this may be solved, but it results in increased bandwidth communication.

7. Hardware, Software and Cloud platforms

Hardware:	elSoM development kit, Stereo Vision Camara Module, Ultrasonic/Radar, Tough Air Bags and Opener
Software:	C++/Python integrated Development, Cadence Virtuoso, OpenCV
Cloud Platforms:	Firebase Database, dvrblacktech

8. References

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