Augmented reality solution to the blind spot issue while driving vehicles

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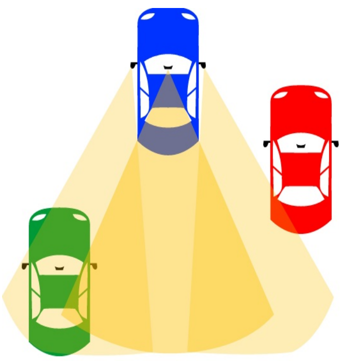
***Abstract*— In the current scenario there has been a significant increase in the accidents rate pertaining to reasons like blind spots and confusing lanes. This paper presents a novel idea with use of augmented reality to overcome such issues. In this idea we obtain the 3-D view of the surroundings, including blind spot's view using stereo vision. The results were tested on a miniature scale, were examined under various circumstances and were positive.**

Keywords- vehicle driving, blind spot issues, augmented reality stereo visions

I. INTRODUCTION

Blind spots are the areas of the road that cannot be seen while looking forward or through the mirrors. The most common are the rear quarter blind spots, areas towards the rear of the vehicle on both sides. Vehicles in the adjacent lanes of the road that fall into these blind spots may not be visible using only the car's mirrors. Rear quarter blind spots can be: (1) checked by turning one's head briefly (risking rear-end collisions) (2) eliminated by reducing overlap between side and rear-view mirrors (3)reduced by installing mirrors with larger fields-of-view. Other areas that are sometimes called blind spots are those that are too low to see behind, in front, or to the sides of a vehicle, especially those with a high seating position, such as vans, trucks, and SUVs. Detection of vehicles or other objects in such blind spots are aided by systems such as video cameras or distance sensors, though these remain uncommon or expensive options in general-purpose automobiles.



The blue car's driver sees the green car through his mirrors but cannot see the red car without turning to check his **blind spot.**

The solution to the mentioned problem can be given in various ways like in by adjusting mirrors inside and outside the car or using radar to scan the adjacent lanes and for vehicles that may disappeared from view while driving.

Other solutions are like using altered mirror like the following

The shown mirror has the problems like the small over pasted on the bigger doesn't give the full view of whats around the car. Just a small portion of it is visible.

Hence it creates more problems than solving the present one.

Our solution is in the domain of computer vision and augmented reality. We used OpenCV as the Application Program Interface (API) for C/C++ or python. OpenCV is an open source computer vision tool developed by Intel and maintained by willow Garage and using a head gear for the driver.

II. EASE OF USE

A. Proof of need

On speaking to various drivers and surveying about various difficulties they face during driving we came up the following hindrances while driving.

1.) **The normal human visual** field extends to approximately 60 degrees nasally (toward the nose, or inward) in each eye, to 100 degrees temporally (away from the nose, or outwards), and approximately 60 degrees above and 75 below the horizontal meridian. During driving this field of vision is reduced drastically to 138 deg [1] only. This limits the driver from using his full potential.

2.) **Height of Driver Seat:** Today's cars come with features like varying seat height. But at time there is a limit for this too. The driver is too short to view through their blind spots in the lower sides of the windows as a problem; few cars have a sloping hood which posses a blind spot while driving to many drivers.

3.) The frames of the windows or the car body: Door pillar and head restraint, rear window pillars, the

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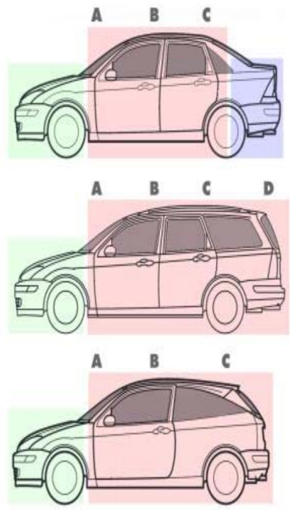
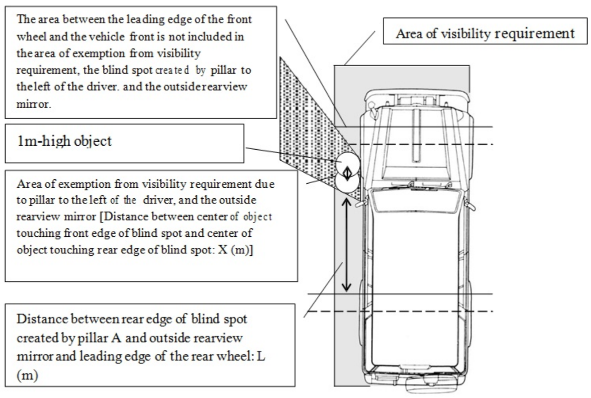
driver's field of seeing is also reduced due to these factors.



- In this car there are 3 pillar configurations. Which are mainly 6 pillars all around the car. These 6 are hindrance to the driver
- In this type of car it is 4pillar configurations. This makes the number of hindrances to 8.
- This one is a hatch back type cars. It has only 2 pillar configurations . These have 4 hindrances while driving

4.) The vehicle dimensions: These posses a high threat to the driver's visibility. The driver cannot see the immediate front part of his vehicle if the hood is very long and has difficulties while taking reverse also. For example: cars like Bentley Brooklands Base.

5.) According to NHTSA, the most dangerous road design involves intersections with **inadequate signs**, **blind spots**, and **confusing lanes** which accounted for two-thirds of all fatal crashes caused by hazardous roads.



In a recent survey conducted by the US national Highway Traffic safety administration (NHTSA), poor road designs, account for more than 23 percent of annual traffic deaths in the country. With this finding, experts estimated that dangerous roads kill at least 8,000 people-every-year.

According to NHTSA, the most dangerous road design involves intersections with inadequate signs, blind spots, and confusing lanes which accounted for two-thirds of all fatal crashes caused by hazardous roads.

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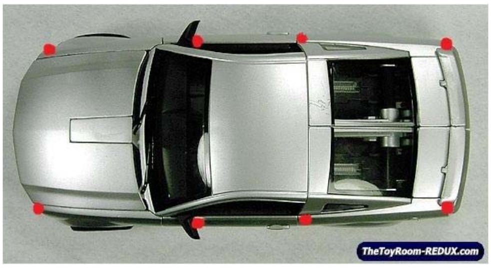
As shown in the image. We could see that the area of visibility which is required for the driver to avoid any near blind spot errors.

The final positions of the cameras for removing the above listed hindrances could be this.



NOTE: This is just for the proposal of the idea. The blind spot positions and number of blind spots would vary depending on factors like the **length of the vehicle**, **width of the vehicle**, **orientation of the front hood of the vehicle**, etc.

B. *Specifications and implementation in a miniature level*

The project was implemented using OpenCV libraries and 2 cameras placed at each of those positions.

III. PROPOSED SOLUTION TO THE PROBLEM

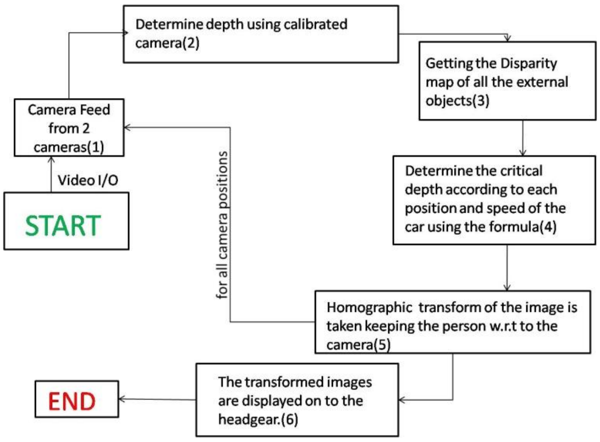
The solution to this is by fixing a pair of cameras at each of those positions

According to our surveying, the solution that we are giving is under certain idle conditions like

- The length of the car is not more than 4.5m.
- The width of the vehicle is not more than 2 m.

As the length of the car n width of the car increase the no of points for placing the cameras also would increases strategically. The fixing of pair of cameras at each position is to get the disparity map, which in fact gives the distance of the external object from the vehicle.

The Proposed solutions description is as follows.



The above mentioned design will be replicated on to all 8 different positions of the cameras. Hence the explanation of one is similar to all the positions.

A. Explanation of Each stage

The stages (1),(2) and (3). Has the following.

The concept behind using double cameras is to have a Stereo vision of the scene. A stereoscope is simply a device that is designed to view stereographs, two images of the same scene on a card just differing in the only in the horizontal placement of the camera. When the stereo scope is used, the left and right images are presented with the two different views of the scene. The two images are blended together as if the user is viewing the scene, with all the lifelike depth information present.

The key to stereo vision processing is that the relation of the left camera to the right camera is known. This knowledge of positioning and characterization of stereo vision is known as the calibrated stereo system.

Stereo Vision: Binocular vision is defined as the vision in two eyes where the data being perceived from each is overlapped by some amount. The overlap from the two different views is used in biological vision to perceive depth. Stereoscopic vision is use of binocular vision to perceive the three dimensional structure of the world.

In stereo vision, cameras are aligned horizontally and separated by a distance known as the baseline distances.
The distances called Z (the range of the depth) can be found using the following the equation

$Z=B*f/d$

Where f is the focal length, B the baseline, and d is the disparity which is defined as the

$d=x^l-x^r$

Where x^l and x^r are the horizontal positions of the points w.r.t the left and right cameras.

Camera calibration: The calibration process provides numerical values for the intrinsic camera parameters such as focal length, extrinsic parameters such as the relative orientation angles between the two cameras. In principle, any characterized object can be used as calibration target, as long as the 3-D world coordinates of the target in references to the cameras. We are using the checker board pattern based calibration technique

Rectification: Rectification of the stereo image pair is the process of transforming the two images so that the corresponding points lie on the same image rows. To be more formal, the transformation causes epipolar lines to become collinear. Rectification is commonly performed to improve the speed of the search for stereo correspondences.

Correlation: During correlation the undistorted and rectified images of the left and right camera can be used to match points from one image to other. In order to determine the distance from the camera, the disparity need to be found, change the location of points in the left image and the right image. It follows that there is an overlap in the two images so that the point in the left image also exists on the right image and correspondence can be found.
The result of correspondence routine is an image with each pixel being the disparity that was found from the left and right images, this image is called a disparity map. Brighter intensity values represent objects that are the closer to the camera where darker objects are those farther away from the camera. Black pixels are those points where no correspondence was found between the images
(4) To determine the critical depth concept the definition goes as follows. The critical depth is the depth or the distance, is the distance between the vehicle and the object below which if fallen there is a higher chance of a collision with that external object. If the vehicle goes into this critical distance the driver has to notify about this by blinking (in red) on the headgear or producing vibrations on the steering wheel.

For example:

Critical distance << braking distance

The estimated braking distance can be calculated using the formula.

$d = v^2 /2\mu g$

Where v is the speed of the vehicle.

μ is the coefficient of friction between the tires and the road this is usually 0.8.

g is 9.8ms-2.

For example:

Speed of the car is 100km/hr

Hence v=27.778ms-1

μ=0.7(assuming)

Hence the braking distance will be "d"=56.2394 m =184.51 ft……………………………………(1)

This can be more improvised by putting in various actual scenarios.

In real driving, the driver needs to **SEE** the developing situation, **IDENTIFY** the fact there is a threat and then **DECIDE** if the required **RESPONSE** is to brake.
To calculate the stopping distance from moving at the speed of 100km/hr.
Assuming the driver takes 2s to decide there is hazard ahead and make a decision.
By then car would have travelled 54m.

"Thinking" Distance=54m=176ft.
Reaction Distance=18m=60ft.
Stopping distance =56.2394= 184.51ft. (From 1)
Overall stopping distance =128.2394m=420.51 ft.
Hence not to leave all the above calculations to the driver, the system will do the same and alert the driver accordingly.

Our Proposed system does this work of calculation of depth on an average of **190000 microsecond== 0.19 seconds.**

(5) A homographic transform is taken after this w.r.t the driver's position. The distance can be calculated based on pre-fabricated existing techniques.

(6) The transformed images are joined from all the eight camera positions and displayed at the drivers head gear.

B. Implementations of the algorithm

At the cameras end.

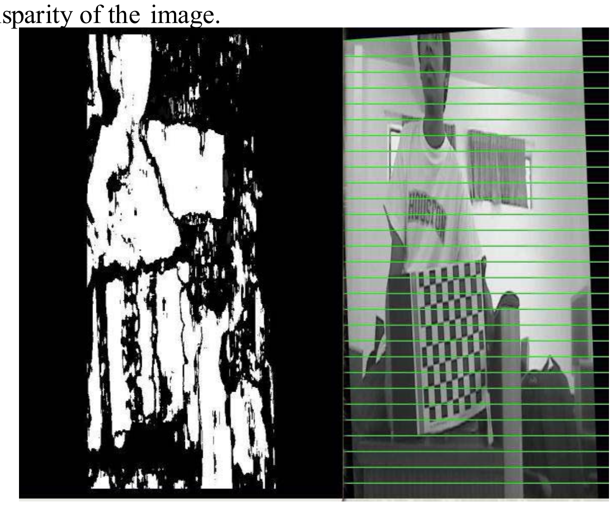
- The feed from the right and left cameras is taken simultaneously at the same time. To get two images of the scene in real time.
- As the cameras are calibrated. The left camera knows the position of the right camera.
- The system now can is ready to be used for determining the depth, the two images now are just drifted by a small variation along the horizontal components.
- The two images are made to align along certain horizontal lines for making the computation for stereo easier.
- The two images are used to determine the depth using the fact that one point existing on right images exists on the left image as well.
- The final disparity map is gray scale. The white images represent the objects are closer to the camera and the darker part of the image is farther away, and varies accordingly.

At the head gears end

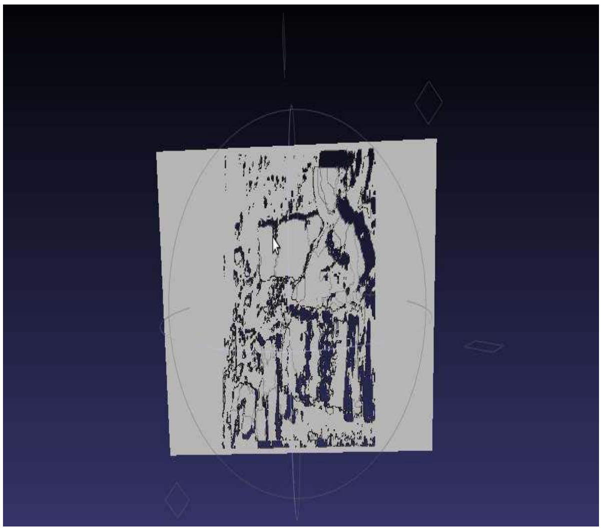
- The driver will be wearing a headgear which is connected to the onboard computer via wireless.
- The headgear will get the feeds from various cameras simultaneously along with the preprocessed information augmented on to it. Hence the driver will be flooded with information about the environment around the car. Based upon the situation the driver is able to make appropriate decisions.
- The headgear which we will be using for this project will be vuzix vr920.

C. Result

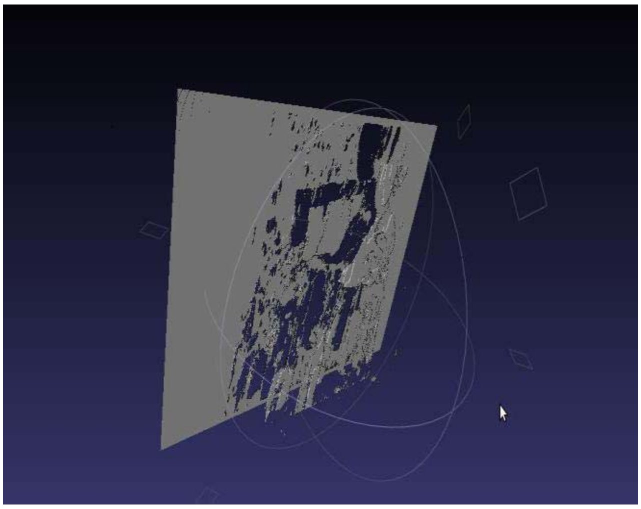
The results of the obtained disparity map are as shown below. The image shows the actual image and the disparity of the image.



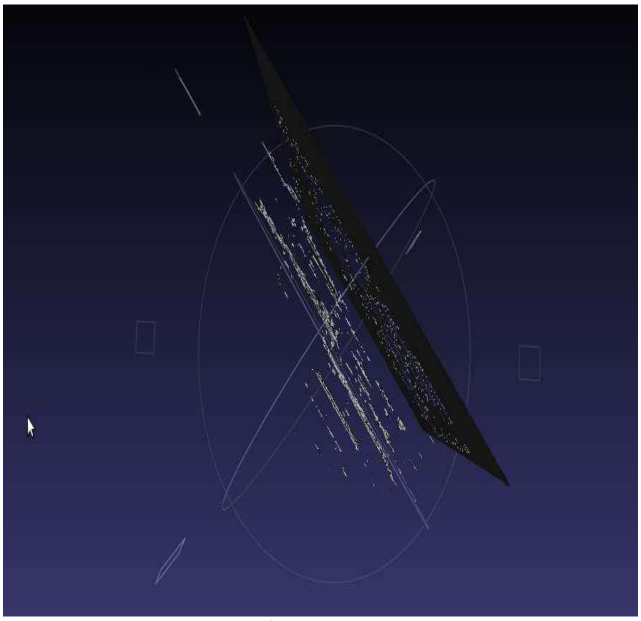
Different view of the images



Front view

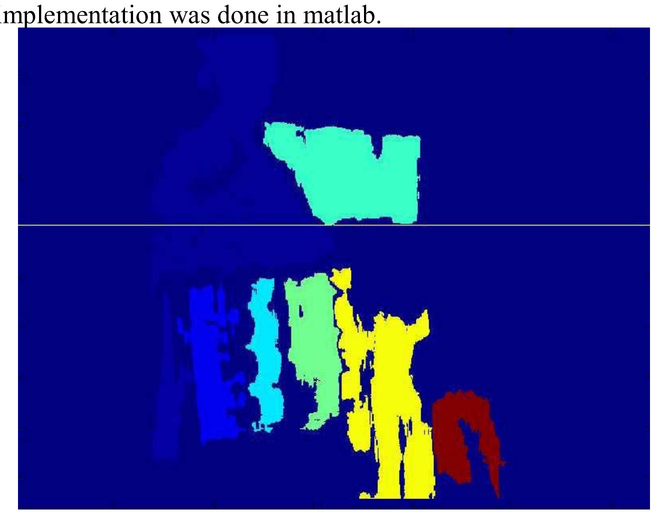


Side view



Top View

This is the color coding of the image based upon the distance of the each object from the cameras. The red ones are near the camera then the blue ones. This color coding implementation was done in matlab.



At the head gear the driver will get the panorama of the all the merged together scene of the surrounding.

For example:

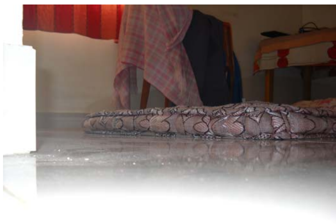


Fig.1

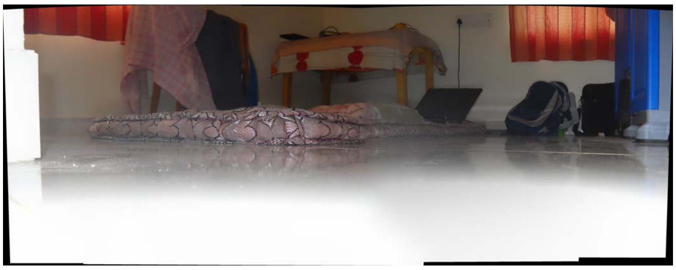
Fig.2

Fig.3

Fig.4

When the images are merged together, the final image is the merged image of the all above images (From Fig.1, Fig.2, Fig.3, and Fig.4).

The final image is



The modules are developed separately, they will be joined together.

ACKNOWLEDGMENT

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