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360 Degree Surround View Camera – An Overview

Rashmi Arjun Bavalatti*, Sheetal Bandekar**

*(Department of Master of Computer Applications, VTU/KLS Gogte Institute of Technology, Belagavi
Email: rashmibavalatti@gmail.com)

**(Department of Master of Computer Applications, VTU/KLS Gogte Institute of Technology, Belagavi
Email: ssbandekar@git.edu)

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Abstract:

In this study, the paper offers a low-cost driving assistance system that can show a bird's-eye perspective of a vehicle's surroundings. This system creates the around-vehicle vision in real time using four fisheye cameras positioned around the car and a quick picture stitching technique on an embedded platform. Additionally, the system provides a dynamic boundary determination technique to enable automatic switching between picture sources and lower the likelihood of missing obstacles in the overlapped area. Drivers can visually assess the state of their surroundings with the help of this technology for monitoring the environment from a bird's eye view. Thus, parking and driving may be done more safely and easily.

Keywords — **intelligent transportation systems; vehicle surrounding monitoring; bird's-eye view; embedded system.**

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I. INTRODUCTION

Intelligent Transportation Systems (ITS) have recently gained prominence as a research area. Road safety is the primary focus of the research on such systems. Due to the way that automobiles are built, there are numerous blind areas everywhere around them. It is especially dangerous when drivers fail to detect the state of the road in these blind spots. Using cameras is the most efficient technique to get rid of the blind spots. Rear view cameras and automated parking assist systems are two examples of the vehicle-mounted cameras that have gained popularity recently as a technique for improving driver safety. The images from the vehicle's cameras are analysed and shown on the monitor that is situated in the driver's line of sight. Drivers can easily detect the surroundings in order to avoid obstacles and so reduce the risk of accidents by employing these vision assistance systems.

Track Operating, a Vehicle Assistance System and Bird's Eye View Vision System [7] are two intelligent transportation systems that make extensive use of multi-view camera systems for vehicle surrounding monitoring. The neighbouring roadway images are recorded using four catadioptric cameras placed on a truck in the track driver assistant system. Six fisheye cameras are utilized in the bird's eye view system for vision to prevent obstruction from the car itself. The system splits the visible region of each camera based on the best seams, which are determined by the geographic distribution of each camera's calibration error, and stitches the acquired video images on a flat plane. However, if an object is in the area where the views of nearby cameras overlap, there is a probability that it will not be present in the bird's-eye view image [7]. The ghost effect will increase if the photos are combined in the overlapped region, but the missing item issue can be prevented. In this study, the paper suggests to synthesize the surrounding images obtained from the four fisheye cameras positioned around the car to create a new bird's-eye view sight system. Additionally, the paper suggests a dynamic boundary technique that can prevent both the ghost effect and the disappearance of impediments. The drivers can view the surrounding area clearly and avoid the obstructions by using the changing image boundaries rather than the fixed ones. The proposed system also uses an embedded system to achieve this strategy. In order to accelerate the image processing procedure, the system first uses a PC to build a lookup table that specifies the pixel mapping connection between the camera images and the bird's-eye view image. The embedded system then renders the display's contents using this table.

II. What is a surround view camera system?

A new automotive ADAS (Advanced Driver Assistance System) technology called automotive surround view and also known as 'around view' or 'surround vision monitoring system', gives the person driving, a 360-degree view of the surroundings around the car [4].

Figure 1 A surrounding view camera system with the fish-eye images that each camera recorded

Figure 1 shows a set of surround view cameras and the fish-eye images that each camera took. Four to six fish-eye cameras positioned around the car are the standard component of the surround view systems. For illustration, one behind each side mirror are placed, one at the front bumper, and the other one at the back bumper.

III. Exploring the various types of 360-degree cameras

There are various varieties of 360-degree cameras, and each one has specific benefits and drawbacks. Several of the most popular models of 360-degree cameras include:

A. Fisheye

Wide-angle lenses are used by fisheye cameras to capture an entire circle of view. They are perfect for usage in confined locations because they are frequently compact and small. However, the pictures they provide may be distorted, making it challenging to precisely determine distances [8]. Multiple cameras are used by parabolic cameras to obtain a 360-degree image. In order to lessen distortion and offer a more realistic image of the surroundings, the cameras are positioned at various angles. However, these types of cameras can be heavy, and stitching the images together might require additional computing power.

B. Mirror-based

For photographing a 360-degree view, mirror-based cameras employ one sensor and a number of mirrors. They might be simpler to install and are often smaller than parabolic cameras. However, the mirrors may cause picture distortion, which may make it challenging to precisely judge distances [8].

C. Hemispherical

Hemispherical cameras take a 180-degree image of the surroundings and then use software to combine several photos into a 360-degree panorama. They can be cheaper and are often smaller than other kinds of cameras. They might not offer as much information, though, as other kinds of cameras.

D. Panoramic

For capturing a wide-angle perspective of the surroundings, panoramic cameras employ numerous cameras. They are suitable for usage in broad spaces and can be utilized to produce high-resolution images. However, they can be pricey, and stitching the images together might need more processing power [8].

Overall, every kind of 360-degree camera have a distinct set of benefits and drawbacks, and the selection of camera will be based on the particular requirements of the application. Before making a choice, it is crucial to carefully evaluate the technical details and the picture quality of each camera.

IV. How to generate a surround view from four fish-eye camera inputs?

Geometric alignment and compound view synthesis are the two main algorithm parts that make up a fundamental surround view camera solution. Geometric alignment alters the input video frames' fish-eye distortion to give them a typical birds-eye perspective. After geometric correction, the synthesis algorithm produces the composite surround view. However, a different crucial process called 'photometric alignment' is needed in order to provide a flawlessly connected surround view output. To accomplish smooth stitching, photometric alignment corrects both the colour and brightness difference between neighbouring views [4].

A. Geometric alignment

The surround view camera system's geometric alignment, also known as calibration, is crucial. This technique combines perspective transformation with fish-eye lens distortion correction (LDC). Using a radial distortion model, we fix fish-eye distortion by applying the inverse conversion of the radial distorted value to the original input frames. To ensure that all input views are correctly registered with the ground plane after LDC, we dynamically estimate four transformations of perspective matrices one for each camera, to convert four input LDC-corrected frames. We consider the earth to be a flat, 2D surface. We used a calibration chart-based technique for this. The chart's information is created to make it easier for the algorithm to reliably and accurately discover and match features. Figure 2 displays a specific chart layout.

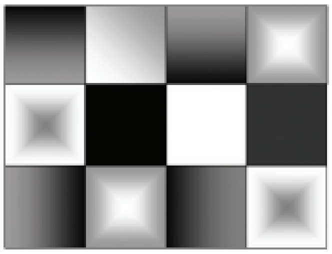

Figure 2: A sample geometric calibration chart

Four calibrating charts are positioned around the car for the surround view cameras' calibration. Every pair of adjacent cameras should 'see' the same chart by placing it in the common field of view (FOV) of two neighbouring cameras. After then, each camera simultaneously records a frame.

The algorithm's initial step is applying the LDC correction to every frame. Then, apply the initial transformation of perspective to each frame that has undergone LDC correction. The camera location guidelines or an estimate of the frame's content can be used to determine the settings for the initial transformation. The LDC strategy was employed. To locate regions of interest, Harris Corner Detection is then used to the picture data in the overlapped space between adjacent views. In order to match corners from both cameras using BRIEF (Behaviour Rating Inventory of Executive Function) scores, first filter raw Harris Corner information to find the strongest corners, after which one can calculate the BRIEF description of each corner feature. Finding the best perspective matrix for each frame that reduces the gaps between matched features is the following step. Then, to encode the LDC and perspective transformation information, develop a look-up table (LUT). The geometric LUT is produced, kept to memory, and used to produce the final surround view output during composite view synthesis.

B. Photometric alignment

Varied cameras may record the same item with significantly varied colours and brightness due to differences in scene lighting, camera auto exposure (AE), along with auto white balance (AWB). As a result, there may be a clear photometric variation between two neighbouring views (i.e., camera input) in the stitched composite image. For a surrounding view system, photometric alignment aims to match both the brightness and colour of various perspectives so that the composite picture looks to have been captured by a single camera mounted above the vehicle. To do this, it is suggested to create a universal colour and brightness adjustment method for each view that minimizes differences in the regions where adjacent views overlap [4].

V. TECHNOLOGIES

A. Radars

In order to prevent an accident, brakes and other car controls may be interfered with by the automotive radar sensors or by an additional level of automation of the car.

B. Lidar

Lidar creates a 3D profile of the area around the car using a combination of radar and reflected laser/light. Lidar officially does not detect moving objects, but instead rapidly generates a succession of 360-degree profiles, compares them to one another, and keeps track of changes (i.e., movement) in a database.

Figure 3: Lidar with high flash resolution

C. Cameras

With its four cameras - three in the front, one in the back, and two on the exterior rear-view mirrors—it can not only monitor the surroundings all around the car but also identify pedestrians, alert the driver, and even stop the car in emergency scenarios.

Figure 4: Cameras

D. On-Board Sensors

For Safer Lane Changes, Rear Cross Traffic Alert, Rear Cross Assist, Blind Spot Detection, and Overtaking, several sensors are utilised. Additionally, they seek to prevent hazardous driving conditions, enable more stress-free driving and significantly lessen the driver's workload, improve safety when backing out of a parking space, distinguish between stationary and moving objects with ease, and achieve a high degree of spatial detail in a constrained bandwidth.

A different kind of sensor is employed to provide a wide field of vision using two separate scans. It supports adapted cruise control (ACC) halt and go upto 200 kilometres/hour, Auto Alignment in the two directions (horizontal + vertical), Traffic Block Assist, Forward Collision Alert, Emergency steering and Junction Assist, all with a single sensor. It also easily distinguishes between stationary and moving objects.

Because it offers a direct worldwide location and velocity of the self-driving car, a GPS is frequently utilised for localisation systems. However, because the accuracy of the GPS location is strongly impacted by the satellite signals and other circumstances, the location of the GPS, or Global Positioning System, in its raw form is not suitable for an autonomous driving system. When the GPS signal from the satellite is poor, the accuracy, dependability, and consistency of measured GPS location data will quickly diminish. Many earlier studies concentrated on the integration of a GPS with other data such as motion sensors for automobiles (sensing wheel-speed, gyroscope, acceleration, and magnetic sensors), perception of environmental data, and digital maps, to make up for GPS's shortcomings [2].

Figure 5: Variety of sensors.

VI. Need for 360-degree cameras

In the growth of autonomous vehicles, 360-degree cameras have become more and more significant since they are essential for the vehicle to be able to comprehend and navigate its surroundings. Some of the main justifications for why 360-degree cameras are necessary in self-driving cars:

- Bird's eye view: A more complete picture of the world around the vehicle is provided by 360-degree cameras, which enhance situational awareness by enabling the detection and tracking of objects and impediments from all directions. This improves the vehicle's awareness of the situation and empowers it to decide for itself how to get around its surroundings.
- Increased safety: 360-degree cameras can aid in the reduction of crashes and accidents by giving a thorough picture of the surroundings. They can identify dangers that other sensors might overlook, like blind spots or objects that are obscured from the driver's line of sight.
- Better navigation: The precision and accuracy of the vehicle's navigation system can be increased with the use of 360-degree cameras. The car is able to more accurately identify and react to modifications in its the surrounding area, such as changing road conditions or signals, by offering a thorough image of the environment.
- Greater effectiveness: 360-degree cameras can aid in maximizing the vehicle's traveling path and speed by giving a full picture of the surroundings. They can assist the car in navigating traffic more effectively and avoiding pointless detours or stops.
- Better user interfaces: 360-degree cameras can offer more immersive and engaging experiences to drivers and passengers. They can be utilized to take high-definition pictures and videos of the surroundings, which may then be shared or shown on screens inside the car.

VII. Conclusion

An attempt has been made to develop a useful, affordable, and computationally effective vehicle surrounding tracking system that can offer a bird's-eye view picture to significantly reduce the vehicle's blind spots. According to the contents of the image, the dynamic boundary mechanism switches between the intersecting areas in the bird's-eye view image automatically, allowing the integrated image to show the majority of the moving items in the overlapping area. The outcomes of the experiment showed that this approach could increase road safety by assisting drivers in visualizing the conditions of their surroundings.

VII. References

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