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THE PASSIVE APPROACH OF DISTANCE MEASUREMENT WITH TRACKING USING BINOCULAR STEREO VISION

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***Abstract*- There are many approach of measuring the distance of the object the most commonly used approaches are LASER range finder, Ultrasonic measurement etc. These approaches provide good accuracy but it needs human assistance and many times it is not possible in application like industrial automation. By using the stereo vision approach for the distance measurement we can make it automatic and determine the object distance as well as object geometry. The model of stereo camera imaging is established using traditional camera calibration method. The internal and external distortion parameters of cameras are calculated and optimized. Then the suitable algorithm for matching the left and right image is developed to calculate the disparity on MATLAB. After that the desired object from the disparity map is extracted and the distance of the object is calculated using the epipolar- triangulation method.**

I. STEREO VISION

As we can observe in image from the single camera that all the point into the same projection line are same image point. In fig 1.2.2(a) Both real points (P and Q) project into the same image point (p ≡q) This occurs for each point along the same line of sight and useful for creating optical illusion. With two (or more) cameras we can infer depth, by means of triangulation, if we are able to find corresponding (homologous) points in the two images shown in fig 1.2.2(b).

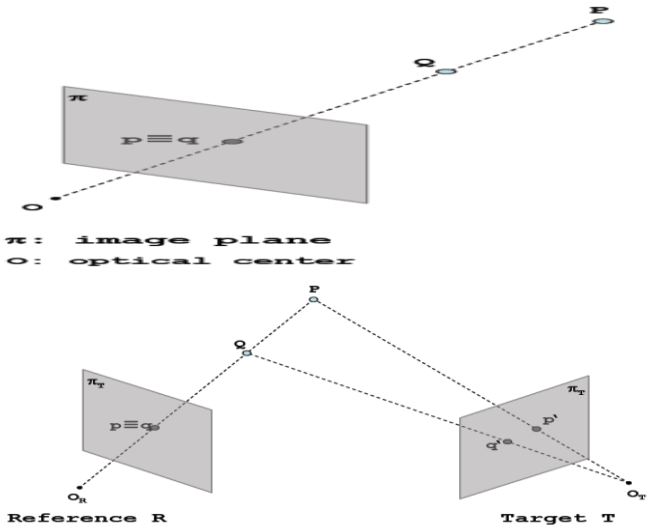

Fig 1 (a) single camera

Fig 1 (b) stereo camera

Binocular stereo vision determines the position of a point in space by finding the intersection of the two lines passing through the centre of projection and the projection of the point in each image. The recovery of the 3D structure of a scene using two or more images of the scene, each acquired from a different view point in space. The images can be obtained by using multiple cameras or one moving camera. The term binocular vision is used when two cameras are employed.

II. STEREO CAMERA

A stereo camera is a type of camera with two or more lenses with a separate image sensor or film frame for each lens. This allows the camera to simulate human binocular vision, and therefore gives it the ability to capture three-dimensional images, a process known as stereo photography. Stereo cameras may be used for making stereo views and 3D pictures for movies, or for range imaging. The distance between the lenses in a typical stereo camera (the intra-axial

distance) is about the distance between one's eyes (known as the intra-ocular distance) and is about 6.35 cm, though a longer base line (greater inter-camera distance) produces more extreme 3-dimensionality. Stereo camera can be created by mounting two cameras having same configuration on the common base. The most important restrictions in taking a pair of stereoscopic pictures are the following:

1) Cameras should be horizontally aligned ,
2) The pictures should be taken at the same instant

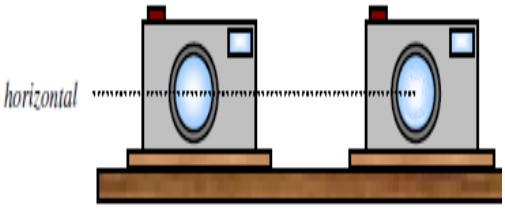

Fig 2 Construction of stereo camera

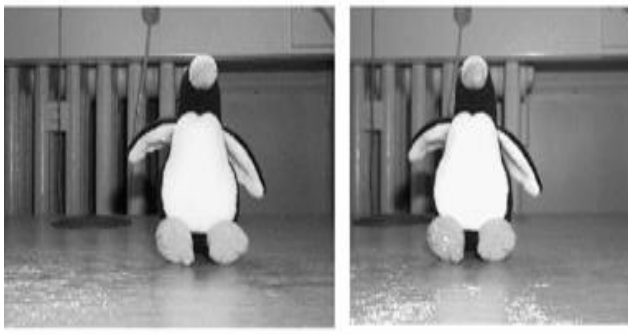

Fig 3 stereo image pair

III. TRIANGULATION PRINCIPLE

Triangulation is the principle which is used to determine the distance between the object in the scene and stereo camera. The system uses two CCD cameras with the same parameters. Figure is the schematic diagram of the system. The distance of two cameras optical center is b. The optical axes of the two cameras are parallel. They have the same focal length f. A is the point with the vertical distance from the cameras of L. Its images on the two cameras are A1 and A2. x = x1 + x2 is the parallax.

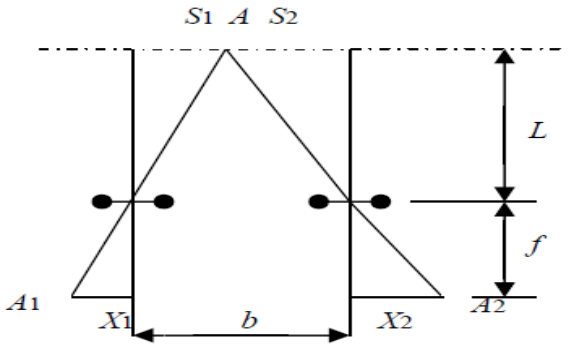

Fig 4 Triangulation

According to fig ▲ S1AO & ▲ A1X1O are equivalent .▲S2AO'& ▲A2X2O' are equivalent.

$$\frac{S_1}{x_1} = \frac{L}{f} \quad \text{.....(1)}$$

$$\frac{S_2}{x_2} = \frac{L}{f} \quad \text{.....(2)}$$

$$b = S_1 + S_2 \quad \text{.....(3)}$$

by taking value of x1 and x2 from eq(1) and eq(2) and putting it into eq(3)

$$L = \frac{bf}{x_1 + x_2} \quad \text{.....(4)}$$

$$x = x_1 + x_2 \quad \text{.....(5)}$$

$$L = \frac{bf}{x} \quad \text{.....(6)}$$

So from the equation (6) if we can calculate the disparity x then we can estimate the distance of object.

IV. OVERVIEW OF A STEREO VISION SYSTEM

Below show the steps follows in the stereo vision measurement system.

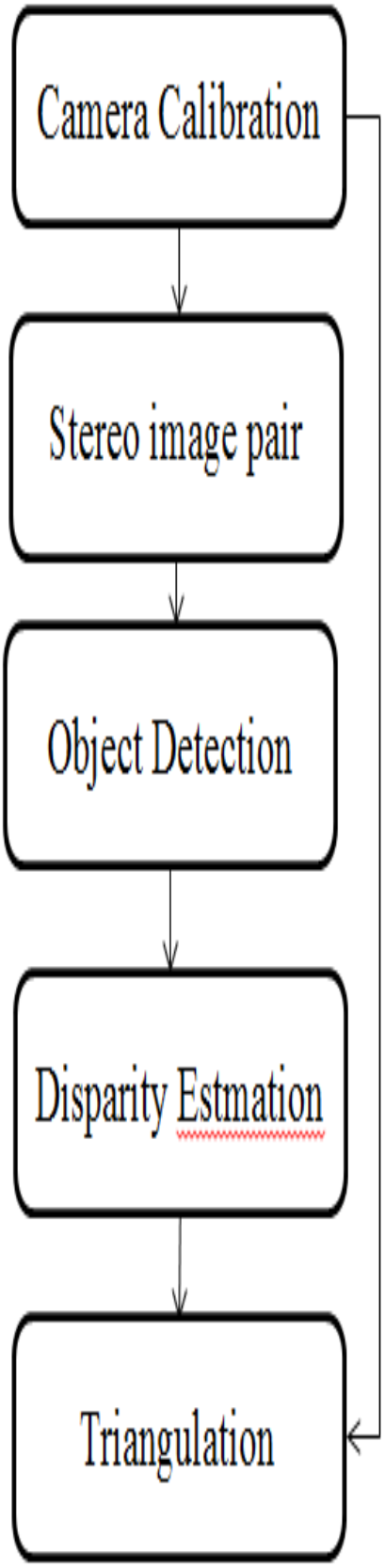

Fig 6 Overview of a stereo vision system

V. ALGORITHM FOR STEREO VISION SYSTEM

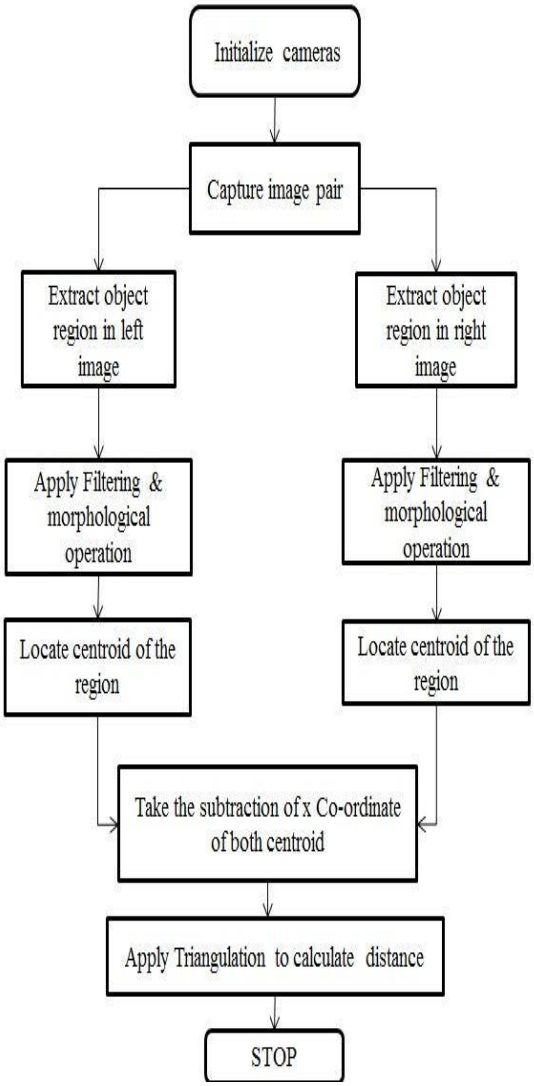

Fig7 Algorithm for Distance measurement

As we can see the above algorithm we conclude the following steps to execute this programme that can give the required result.

STEP:

- Initialize the stereo camera model
- Capture the image pair with the both cameras at same time.
- Extract the object from the image based on colour or shape. In our case object is extracted from the image on the based on the colour of the object. Original image is converted into grey scale image & colour channel image .grey image is subtracted

from the colour channel image. Then using hole filling & thresholding object region is extracted.

- Apply the filtering for noise removing & morphological operation like opening & closing to locate the boundary of the object
- Calculate the centroid of the located object in both left & right image.
- Take subtraction of x coordinate of centroid in both images to calculate disparity.
- Using triangulation measure the object distance.

Observation Table

Table 1

No	X1	X2	Disparity	D (cm)	Error (%)
1	60.14	588.46	528.31	12.34	2.833
2	148.50	504.99	356.48	18.28	1.555
3	192.27	549.99	267.71	24.35	1.458
4	223.90	436.75	212.85	30.62	2.096
5	215.65	393.02	177.36	36.75	2.083
6	224.37	382.24	157.86	41.29	3.242
7	238.20	363.69	125.49	51.94	3.899
8	249.29	354	104.70	62.06	3.433
9	260.90	340.34	79.44	82.06	2.579

VI. CONCLUSION

- Study of basic concepts of image processing. Importance of image processing in Stereo vision system.
- Prepared stereo camera model & done camera calibration.
- Development distance measurement algorithm for fixed shape or color object with above 90% accuracy.
- Study the relation between disparity & distance of object from the experimental observation.

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