National conference on Technology innovation in Mechatronics,Energy Management and Intelligent communication(NCTIMEMIC-2017)

International Journal of Advanced Scientific Technologies ,Engineering and Management Sciences (IJASTEMS-ISSN: 2454-356X) Volume.3,Special Issue.1,April.2017

3D MAP BASED ON STEREO VISION USING SLAM

SAJNA NUJUMUDEEN
Dept. of Electronics and communication engineering
LBS Institute of Technology for Women Poojappura
Trivandrum, India
sajnanujumudeen93@gmail.com

DEEPAMBIKA VA
Dept. of Electronics and communication engineering
LBS Institute of Technology for Women Poojappura
Trivandrum, India
deepambika.va@gmail.com

Abstract— To navigate an autonomous mobile robot in an unknown environment, it needs to build a map of the environment and localize itself in the map at the same time. The solution to this problem is known as Simultaneous Localisation and Mapping (SLAM).This paper focuses on 3D mapping of an autonomous robot based on stereo vision. As compared to monocular vision stereo vision provide depth measurement that can be used for the mapping of an unknown environment.

Keywords—stereo, simultaneous localization and mapping(SLAM) , monocular camera, depth

I. INTRODUCTION

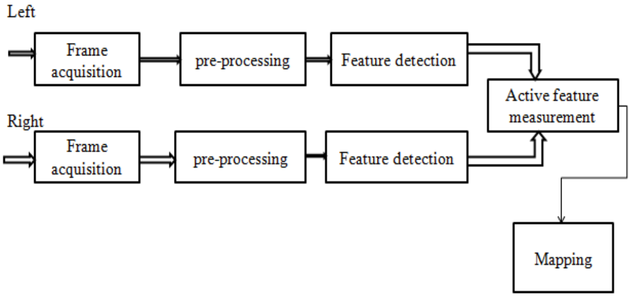
One of the fundamental problems of mobile robotics is to navigate autonomously. To fulfil this task, a robot wants to know about its position relatively to the position of its goal. Moreover, a robot has to take in consideration the dangers of the surrounding environment and adjust its actions to maximize the chance to reach the destination.. In the context of mobile robotics, localization means determination of the robot position in the environment. Acquiring and representing spatial information of the environment through mobile robot sensors is called mapping. The process of generating inputs for robot effectors to reach the desired destination is referred to as motion planning. Simultaneous localization and mapping (SLAM) is a technique used by robot to build a map of an unknown environment or update a map with in a known environment, while keeping track of their current location. SLAM is one of the most fundamental, yet most challenging problems in mobile robotics. To achieve fully autonomous behaviour a robot must possess the ability to explore its environment without user intervention, build a reliable map, and localize itself in the map.

In monocular visual SLAM absolute scale of the scene is not observable, true scale cannot be directly measured from a single camera. Poorly constrained scale can introduce inconsistency in the map; also depth can only be estimated up to a scale. By using stereo cameras, the absolute scale becomes observable leading to less scale drift, also instant depth measurements become available that can be useful for the mapping of an unknown environment. Stereo vision is one of the promising approaches to mobile robot localization. Stereo cameras can obtain 3D range data at high frame rate and also capture colors and textures, which cannot be detected sufficiently by laser scanners. It provides depth of a scene which in used for mapping of an unknown environment and also helps to estimate distance of the path that the robot travelled through the environment.

II. LITERATURE SURVEY

The first vision-based SLAM proposed by J. Neira, M. Ribiero, and J. Tardos [1] uses the vertical line as the SLAM feature, a robot is built with an odometer and a monocular camera. Feature location is predicted by extended Kalman filter to construct a 2-D map. When using monocular methods for autonomous navigation, one has to deal with the inherent scale ambiguity by either using additional sensors to estimate the scale or by initialization with absolute values. Monocular methods suffer from the problem that the absolute scale of the scene cannot be observed, so that further sensors are needed for absolute scale estimation. Moreover, the absence of absolute scale leads to scale drift over time, yielding inconsistent maps. Work by P. Smith, I. Reid, and A. Davison[2]propose monocular vision based SLAM approach use extended kalman filter SLAM with as endpoint as feature. This work is suited only for small workspace environments because the endpoints do not disappear from the camera view. E. Eade and T. Drummond [3] propose SLAM based on particle filter with edge as robot landmark. The system is based on a FastSLAM-type Rao-Blackwellised particle filter which exploits probabilistic independence properties of the SLAM problem.Given a set of exactly determined camera poses, landmark estimates are probabilistically independent of each other. It is more suitable for long-distance slam and likely to be not affected by the occlusion or disappearance of some line parts.But the problem is distribution is represented by many set of particle, these set of particles do not relate to reality and also informative particles lost due to resampling. By adding a second camera, the absolute scale becomes observable, greatly reducing scale drift and the necessity for additional sensor measurements. Moreover, instant absolute depth measurements can now be used for the direct tracking of the images, as well as for the mapping of the environment.

III. METHODOLOGY



A. Frame acquisition

Grab left and right frame from stereo camera. These frames are used for further process.

B. Pre-processing

Calibrating the camera parameter for rectification, each incoming image is rectified using the calibration parameter to ensure efficient scan line searches of corresponding left and right matches. And also discard bad frame in video sequence. Normalization and equalisation process are used

for improving the image quality for successful photogrammetric processing.

C. Feature detection

Using RANSAC algorithm detect feature from two stereo image frames. Data consists of inliers i.e. data whose distribution can be explained by some set of model parameter, outliers which are the data that do not fit the model .data that come from extreme values of noise or from erroneous measurement or incorrect hypotheses.

D. Active feature measurement

In active feature measurement, measuring the feature for the purpose of predict the image position of each feature before deciding which to measure. For the active measurement estimate the position of a point feature relative to the camera

with the help of camera position and feature position denoted by x_v and y_i respectively. It is found to be,

$$\mathbf{x}_v = \begin{pmatrix} \mathbf{r}^W \\ \mathbf{q}^{WR} \\ \mathbf{v}^W \\ \omega^R \end{pmatrix} \qquad (1)$$

Where r^W ,q^{WR},v^W,w^R are denotes 3D position vector, orientation quaternion, velocity vector, angular velocity vector relative to a fixed world frame *W* and robot frame *R* carried by the camera respectively.

Position of point vector is given by,

$$h_i = \begin{pmatrix} u \\ v \end{pmatrix} = \begin{pmatrix} u_0 - fk_u \frac{h^R_{Lx}}{h^R_{Lz}} \\ v_0 - fk_v \frac{h^R_{Ly}}{h^R_{Lz}} \end{pmatrix} \qquad (2)$$

Where *U* and *V* denote the horizontal and vertical position respectively, k_u and k_v are pixel element densities '*f*' denotes focal length of the camera.

Prediction of feature image location is represented by an innovation matrix S_i it is given by

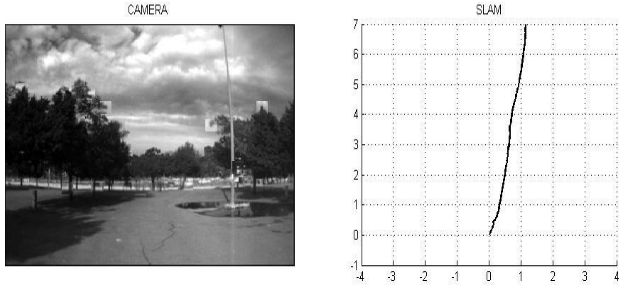
$$S_i = \frac{\partial u_{di}}{\partial x_v} P_{xx} \frac{\partial u_{di}}{\partial x_v}^T + \frac{\partial u_{di}}{\partial x_v} P_{xy_i} \frac{\partial u_{di}}{\partial y_i}^T + \frac{\partial u_{di}}{\partial y_i} P_{y_i x} \frac{\partial u_{di}}{\partial x_v}^T + \frac{\partial u_{di}}{\partial y_i} P_{y_i y_i} \frac{\partial u_{di}}{\partial y_i}^T + R.$$

(3)

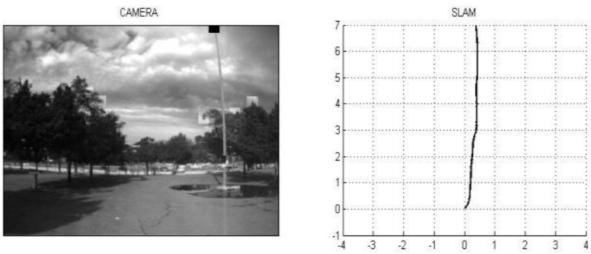
S_i contains the measure of information content expected of a measurement, with high value of S_i provide more information about the estimate of camera and feature position. With the help of these estimates path of autonomous robot can be mapped. The proposed stereo vision approach predicts the estimate by taking the mean average of the above position and feature location estimate.

IV. RESULT

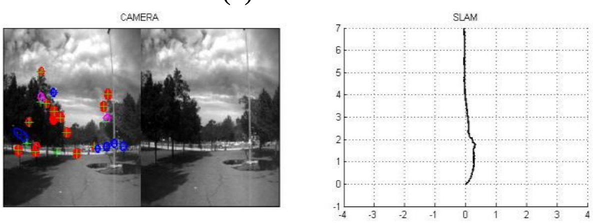
The stereo image frames are collected from KITTI vision. From the available dataset detect the features, SLAM is implemented in MATLABR2010 a .Check the difference of left and right frame SLAM by processing separately for the comparison study of monocular vision based approach. Result shows separate left and right frame SLAM and stereo vision based SLAM. Difference in the figure (d) is due the feature detection in left and right frame when taking the frames separately.



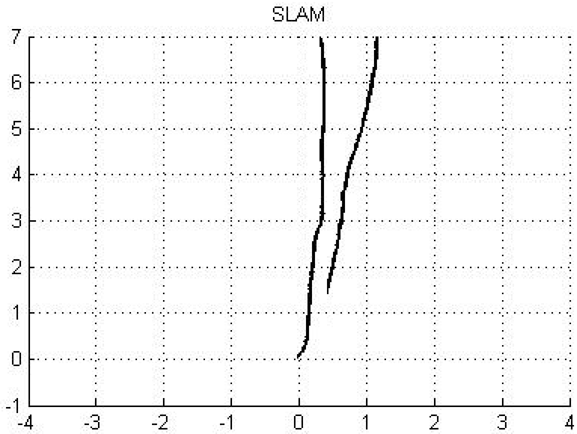
(a) Right SLAM



(b) Left SLAM



(c) Stereo Vision based SLAM



(d) Figure show the difference of left and right frame processed separately.

V. CONCLUSION

For the autonomous robot navigation it need visual perception for that stereo vision is the promising approach, as compared to monocular vision based SLAM stereo vision provide depth measurement which in turn used for the map of an unknown environment. Monocular vision does not provide absolute scale; poorly constrained scale can introduce inconsistency in the map. Stereo vision based SLAM provide better map as compared with monocular vision.

VI. REFERENCE

[1] J. Neira, M. Ribiero, and J. Tardos, “Mobile robot localization and map building using monocular vision,” presented at the 5th Int. Symp. Intell. Robot. Syst., Stockholm, Sweden, 1997.

[2] P. Smith, I. Reid, and A. Davison, “Real-time monocular SLAM with straight lines,” in *Proc. Brit. Mach. Vision Conf.*, Edinburgh, Scotland, 2006, vol. 1, pp. 17–26.

[3]E. Eade and T. Drummond, “Edge landmarks in monocular SLAM,” presented at the Brit. Mach. Vision Conf., Edinburgh, U.K., 2006.

[4] T. Lemaire and S. Lacroix, “Monocular-vision based SLAM using line segments,” in *Proc. IEEE Int. Conf. Robot. Autom.*, Rome, Italy, 2007, pp. 2791–2796.

[5] J. Sol`a, T. Vidal-Calleja, and M. Devy, “Undelayed initialization of line segments in monocular SLAM,” in *Proc. IEEE/RSJ Int.Conf. Intell. Robot. Syst.*, St. Louis, MO, USA, 2009, pp. 1553–1558.

[6] V. Pradeep and J. Lim, “Egomotion estimation using assorted features,” *Int. J. Comput. Vision*, vol. 98, no. 2, pp. 202–216, 2012.