Journal of Computer Science 6 (10): 1108-1110, 2010
ISSN 1549-3636

Comparison of Distance Measurement Between Stereo Vision and Ultrasonic Sensor

Surachai Panich
Department of Mechanical Engineering,
Srinakharinwirot University,
114 Sukhumvit 23, Bangkok 10110, Thailand

Abstract: Problem statement: The traditional approaches in mobile robot research are the use of stereo vision systems to extract range information from pairs of images. One of the difficulties of techniques in navigation is that the intrinsic computational expense of extracting three dimensional information from stereo pairs of images. **Approach:** To compare performance sensor readings from environment between stereo vision and ultra sonic sensor. **Results:** The robot was tested by experiment that it runs with Markov localization algorithm in distance 5 m and records the robot's distance information from stereo vision system and ultrasonic sensor. **Conclusion:** This study mainly described and compared distance measurement by stereo vision and ultrasonic sensor.

Key words: Stereo vision, ultrasonic sensor, range information

INTRODUCTION

Stereo vision produces a doubling of the processing time in comparison to a monocular visual apparatus, because two images must be analyzed. Therefore, it is recommended to implement stereo approaches with parallel algorithms. For example, parallelism can be realized with threads. Threads are objects that can be executed in parallel. Therefore, every camera can be represented in a software program by one object running as a thread. Stereo vision is based on the human visual apparatus that uses two eyes to gain depth information (Vasil'ev, 1995). A Multi-baseline stereo System is successfully build up by Carnegie Mellon University for Advanced Research Projects Agency of the Department of Defense. The tradeoff is the increasing dimension of device and longer processing time. To reduce the dimension of navigation device in which such stereo depth recovery technique is considered, we try to use triangulation to derive a method for single rotated camera. First we must make sure that stereo images can be obtained from one camera by rotation, this can be ensured in case the rotation center is not the focus point. Second, we have to evaluate the reliability of such method, if the precision demand is too high, or the error is intolerable large, then the method shouldn't be eventually applied in true navigation device. If such a software program uses a single processor machine, quasi-parallelism is realized, because the threads have to share the single processor. To get a perfect solution is impossible but at least an appropriate way is expected which may satisfy most possible cases. Except the method that recovers the depth from stereo images that are taken by multiple cameras, there are quite a few different optical principles which have been used actively obtain range images (Gray and Caldwell, 1996). The programmer can determine the priority as a function of the used thread library. Real parallelism can be realized if a multiprocessor machine is used. For example, if two threads are running on a double-processor machine, whereby every thread represents a camera, it is possible that both threads use a different processor during the program execution. In stereo vision application, optical or laser sensors are prepared to use for high resolution detecting ultrasonic sensor, as mentioned, is under research of another group (Galbiati, 1990). Given consideration on different applied methods in such area, each method has its own advantages and disadvantages.

MATERIALS AND METHODS

Distance measurement by stereo vision: The theory of stereo imaging is a simple model, in which two identical cameras separated only in the x direction by a baseline distance b. The image planes are coplanar in this model. Two cameras at different positions in the image plane view features in the scene as shown in Fig. 1. And used as a template with which to match against a slightly larger window from the search image.

The feature based matching detects the extract semantic features from the scent and use them as match primitives. Ballard and Brown (1982) computed the cross correlation function of two windows, a template window is shifted pixel by pixel across a large search window. In each position the cross relation coefficient is computed between the template window and the corresponding part of the search window according to the equation.

The pair of pixels that generates maximum of the resulting cross correlation function defines the position of the best match between the template and the search window.

Distance measurement by ultrasonic sensor: This describes distance measurement method with ultrasonic sensors (Jain *et al*., 1995). Several methods for obtaining range data have been researched. Ultrasonic systems have lower resolution and its magnitude is less expensive than laser-based sensors, Phase-shift-based laser rangefinders are subject to uncertainty.

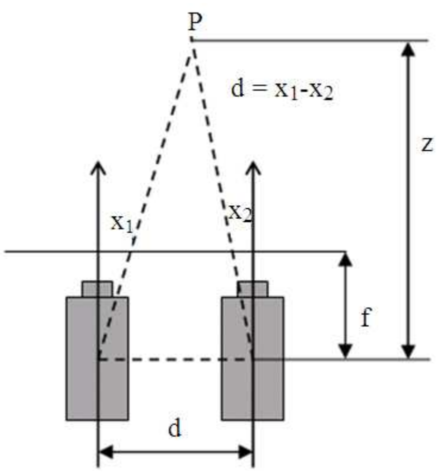

Fig. 1: Stereo vision concept

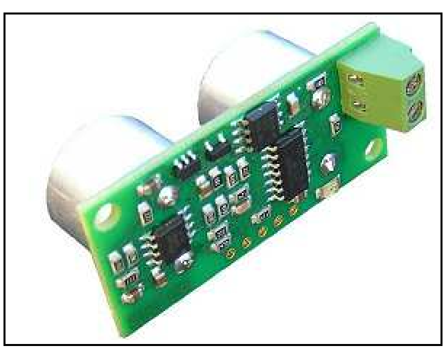

Fig. 2: SRF06-ultra-sonic ranger

This study selects the SRF06 ultra sonic to measure distance, which is a low cost ultrasonic ranger with a 4-20 mA current output as shown in Fig. 2. The SRF06 is powered from the 4-20 mA current loop and requires no other power. Measurement range is from 2 cm-5 m.

RESULTS

We develop the concept of Markov Localization to update robot's position by sensor readings from the environment. We compared performance sensor readings from environment between stereo vision and ultrasonic sensor. The effect of sensor reading in the update step is dependent only on the current orientation of the robot. We make the experiment that the robot runs more time in distance 5m and record the robot's distance information from stereo vision system and ultra sonic sensor. We measure robot's distance with measure tape and record robot's distance error in Table 1. In Markov Localization, progressing from $X_{n/n}$-$X_{n+1/n+1}$ proceeds in two steps as below:

Prediction step: $X_{n\backslash n} \rightarrow X_{n+1\backslash n.}$

Update step: $X_{n+1\backslash n} \rightarrow X_{n+1\backslash n+1}$

Notation let 0, 1, 2… k be a sequence of time steps $X_{i/j}$ is the estimated distance of the robot at time i and sensor information at time j. By using this notation, the estimated position of the robot from dead-reckoning is $X_{n/0}$ that is no sensor information is utilized.

DISCUSSION

For this study, we compared distance between stereo vision and ultrasonic. From result, the distance error by ultra sonic sensor is about 3.6 cm and by stereo vision 36.9 cm. the error from stereo vision is ten times of ultra sonic sensor.

Table 1: Robot's distance error

	Distance error (cm)	
Distance of robot's run (m)	Sensor reading by stereo vision	Sensor reading by ultra sonic sensor
1	20.5	2.1
2	30.2	3.2
3	35.4	3.5
4	43.3	4.1
5	55.3	5.2

CONCLUSION

This study mainly described distance measurement by stereo vision and ultrasonic sensor. Depth recovery by obtaining stereo images by rotating a single camera may be a possible method for range measuring in theory and benefit in reducing the device dimension. By the using of small camera module the overall dimension can be reduced, meanwhile still getting good results. The resolution of images heavily affects the measured accuracy. High accuracy could be achieved by increasing the resolution of optical sensors. Distance measurement by ultra sonic sensor has more accuracy in commercial device. We use ultrasonic sensor to show the performance of our stereo vision. The robot is tested by experiment that it run with Markov Localization algorithm in distance 5 m and records the robot's distance information from stereo vision system and ultrasonic sensor.

ACKNOWLEDGEMENT

This research from Measurement and Mobile Robot Laboratory (M and M-LAB) was supported by Faculty of Engineering, Srinakharinwirot University.

REFERENCES

Ballard, D.H. and C.M. Brown, 1982. Computer Vision. 1st Edn., Prentice-Hall, Eaglewood Cliffs, New Jersey, ISBN: 10: 0131653164, pp: 544.

Galbiati, L., 1990. Machine Vision and Digital Image Processing Fundamentals. Facsimile Edn., Prentice-Hall, Eaglewood Cliffs, New Jersey, ISBN: 10: 013542044X, pp: 180.

Gray, J.O. and D.G. Caldwell, 1996, Advanced Robotics and Intelligent Machines. 1st Edn., Institution of Electrical Engineers, London, ISBN: 10: 0852968531, pp: 374.

Jain, R., R. Kasturi and B.G. Schunck, 1995. Machine Vision. 1st Edn., McGraw-Hill, USA., ISBN: 0070320187, pp: 549.

Vasil'ev, P., 1995. Ultrafast Diode Lasers: Fundamentals and Applications. Artech House Publishers, USA., ISBN: 10: 0890067368, pp: 320.