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Detection of Parking Position Based on Laser

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Abstract: This study uses laser to detect parking position and to analysis to get the corresponding exact map of parking lot or other place. Data preprocessing is by the way of median filter with least square method. Median filter could can commendably filter out isolated point in the laser data and reduce the effect of noise. Least square method could smooth laser data. Seeking out the parking position is by the way of partition of grid and clustering so that the map of parking lot could be known by the computer of vehicle. So it lays a corresponding basis for the path planning of vehicle.

Keywords: Automatic parking, laser scanning, parking detection

INTRODUCTION

With the rapid development of the automobile industry and the continuous ascension of people requires for the vehicle, plus city vehicle share increasing continuously, parking position gradually become nervous. Automatic parking technology arises at the historic moment in such circumstance. Meanwhile, detection of parking position is indispensable link of automatic parking technology, so that researching of parking test is completely significant. a British companies use vehicle radar to fulfil the corresponding parking test which uses software of computer in the vehicle to dispose the information from the radar and camera and so on hardware in the vehicle so that vehicle could determines whether the corresponding parking Spaces are adaptive to the vehicle or not. And meanwhile if it detects someone on the parking route, vehicle could automatically stop to avoid the accident

Lindner and Wanielik (2009) use three dimension laser radar to measure the corresponding data and project the three dimension laser data onto the corresponding grid to establish corresponding obstacles map by using the method of grid occupy. Desai *et al*. (2011) Apply probability detection to reveals the corresponding map, simultaneously consider the problem of real time that when vehicle avoid the corresponding vehicle in disorder. Reina *et al*. (2011) apply the millimeter wave radar fixed on the roof of vehicle to perceive field environmental, which can be commendable extremely to overcome the problem of hostile environment. Powers and Davis (2011) apply spectrum ray method to detect the corresponding obstacles environment, which mainly use point cloud data achieved by the spectrum radar to form three dimensional aggregate to estimate the corresponding obstacles that include vehicle, high stakes, people (Michael *et al*., 2011). He Feng proposes a parking detection method based on ultrasonic sensor and incremental encoder and meanwhile analyses the measuring error of the method (He, 2009). Jae *et al*. (2010) apply camera to get parking image behind the vehicle and then match disorder map of the parking field according to the image of obstacle points, thus obtains the corresponding parking spaces. Matthias *et al*. (2011) put forward a method that applies three dimensional space grid to exhibit parking space. Using this method can simulate the corresponding obstacles size, height and other physical information, thus form local parking map and find out the corresponding parking spaces. This article used a laser radar to detect the parking position, which applies median filter and least square method to carry out the data filtering and determine the specific position of the vehicle in the parking lot according to data projected onto the corresponding grid, so as to obtain the corresponding parking position that whether can be used for vehicle parking.

LASER DATA PREPROCESSING

In order to explain detailedly the procedure of data processing, this study applies a flow chart shown as Fig. 1 that could be a detailed instruction.

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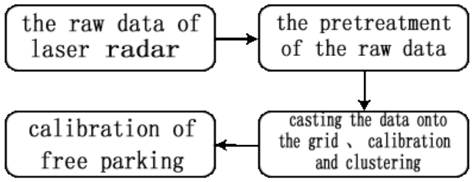


Fig. 1: Flow chart of data preprocessing

(a) (b)

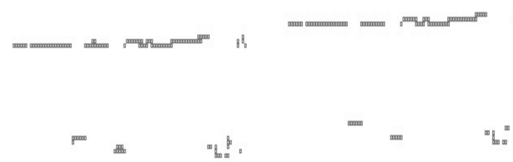
Fig. 2: Contrast diagram before and after Median filtering; (a) The data diagram before Median filtering, (b) the data diagram after Median filtering

The principle of Median filtering is to find the corresponding odd number point and ranges these data points by the size from big to small or oppositely. So the mediate value point could be found by the arrangements. That is the points around i-th point separately are $\{x_{i-j}, x_{i-j+1}, x_{i-j+2}, \ldots, x_i, \ldots, x_{i+j-2}, x_{i+j-1}, x_{i+j}\}$, afterwards these points are ranged in order to find the middle point. Median filtering can commendably filter out isolated point in the laser data and reduce the effect of noise. As is shown Fig. 2, the data after Median filtering become more continuous and meantime the isolated points is mostly filtered.

Difference approximation methods mainly include interpolation method (mainly including Lagrange interpolation, Newton interpolation, Hermite interpolation, section low time interpolation), cubic spline difference value, B-spline difference value, function best square approximation, least squares method data fitting, *et al*. In this study the least squares method based on linear function is used for data fitting filter. This study considers the vehicle and the surrounding environment in the parking lots approximately are linear. This study applies least squares method for data integration. The basic principle of least square method is to seek out a curve that makes sum of squares of distance minimum for a set of data point to. Set (x_i, y_i) (i = 0, 1, …m) for points of a set of data, w_i>0 (i = 0, 1, …m) for the weight coefficient of each point, the requirement in function space S = span $\{\varphi_0(x), \varphi_1(x), \ldots, \varphi_n(x)\}$ is to ask for a function:

$$s^*(x) = \sum_{k=0}^{n} a_k^* \varphi_k(x) \in S$$

and make the function satisfy function:



(a) (b)

Fig. 3: Contrast diagram before and after least squares method; (a) The data diagram before LSM, (b) the data diagram after LSM

$$\sum_{i=0}^{m} w_i (s^*(x_i) - y_i)^2 = \min_{s(x)\in S} \sum_{i=0}^{m} w_i (s(x_i) - y_i)^2 .$$

Least square method could smooth laser data so that it is better for the following work. As is shown Fig. 3, the data after LSM becomes more smooth.

PARTITION OF GRID AND CLUSTERING

At present there mainly are following several maps used to describe the environment: grid method; Geometrical element representation; Statistical area method and topological map. Grid method is based on sensor to create maps which are divided into the grid. and then marks the grid classification for three states include occupied, free and unknown. Geometrical element method describe the corresponding obstacles of the map based geometric graphics include points, lines and so on. Statistical area method does not need any environment model and more suitable for the complex environment to establish map. The topological map makes robot and environment for data exchange. This study applies grid method to establish map. Study uses Fig. 4 to complain the treating process of grid.

Grid calibration: This study applies the method based on grid to create map. This study selects 20×20m area to carry out the corresponding analysis according to the actual need and the real time considered. Different direction resolution is set as 0.1 m, namely size of each grid is $0.01m^2$. Author R proposed grid calibration for three kinds of shape body that are respectively occupied, free and unknown. Because of the different application environment, most of the non vehicle parking area is feasible region. According to this principle, the study calibrates grid as two kinds of state, namely occupied and free. Initial state are calibrated as free, When there is corresponding data on the grid, we will calibrate this grid as occupied, when there is no corresponding data on the grid, calibrate as free.

Grid clustering: Clustering mainly include K-means, C-mean, K MEDOIDS, BIRCH, STING, DBSCAN and so on. Every means has its characteristic. This study

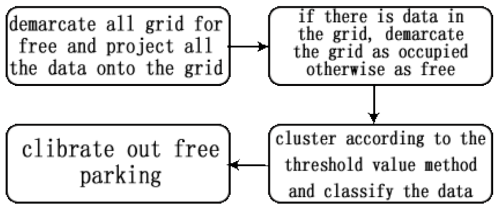


Fig. 4: Parking calibration flow chart

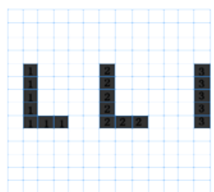
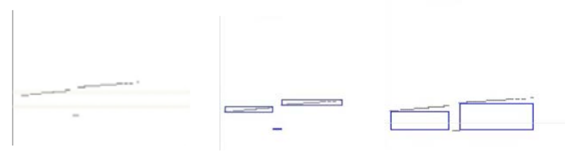


Fig. 5: Illustration of clustering principle

Fig. 6: Obstacle calibration

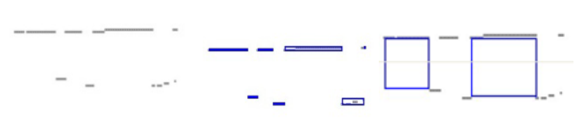
sets a threshold value to cluster. This grid clustering needs to find a grid as a starting point and looks for its neighboring grid. When calibration of the surrounding grids is the same as the starting point's, these grids are considered as the same cluster. This cycle is continuous until no such grid. Then selecting surrounding grid be the another clustering and at the same time repeats the action. This study selects a marginal occupied grid as a starting point and calibrates as class 1, constantly looks for peripheral similar point and calibrates as class 1. When there is no such point, finding another point is needful to calibrate class 2 and do as class 1. So as to all the grids are calibrated. Figure 5 could be easily comprehended.

Creating map: In order to display parking space successfully, this study uses rectangular that surrounds all the same clustering points and makes the sum of all distance from point to rectangle least. So the corresponding obstacles (i.e., parking vehicles) could be detected by the principle. The space between different vehicle (or obstacles) can be calculated according to the absolute value of formula p_i-p_{i+1}. According to the size of the space, the vehicle could learns that whether it could be parked safely and reliably. As is shown Fig. 6, the rectangles take the place of vehicle in the parking lot or obstacles. The other place is free.



(a) (b) (c)

Fig. 7: Result diagram of Simple parking position; (a) Data display, (b) obstacle calibration, (c) parking display



(a) (b) (c)

Fig. 8: Result diagram of complex parking position; (a) Data display, (b) obstacle calibration, (c) parking display

EXPERIMENT

In order to check the result, the test data is a set of 2 dimension 181 laser data set. The data set is casted onto the corresponding grid by applying VC++ program, so as to get the corresponding projection area. Then empty position could be detected by the polymerization. The following figure shows the graphics display mode, so that the advantages and disadvantages of corresponding algorithm can be clearly identified.

As are shown Fig. 7 and 8, Fig a display the data that is by preprocessing. The map calibrates the obstacles accurately by grid clustering. Afterward, parking positions could be detected by the obstacles and threshold distance of vehicle. So the way of detection of parking position is feasible.

CONCLUSION

This study uses laser to detect parking position based on grid. Corresponding parking positions could be detected easily. The validity and correctness of this algorithm are tested out and verified. And development can base on the following several aspects in the future research:

- The least square method can combines excellently with median filtering method, which can achieve ideal data processing effect.
- Separate median filtering may affects effect of data processing and influences the precision.
- Grid method takes less time to process data and meanwhile achieves good real time effect. At the same time it also guarantees the accuracy.

REFERENCES

Desai, P., H.E. Sevil, A. Dogan and B. Huff, 2011. Construction of an obstacle map and its realtime implementation on an unmanned ground vehicle. IEEE Conference on Technologies for Practical Robot Applications (TePRA), Autonomous Vehicles Lab., University of Texas at Arlington, Arlington, TX, USA, pp: 139-144.

He, F., 2009. Parking detection method applying a kind of automatic parking system. Technology and Application, Sensor World.

Jae, K.S., G.J. Ho, B. Kwanghyuk and K. Jaihie, 2010. Automatic free parking space detection by using motion stereo-based 3D reconstruction. Mach. Vision Appl., 21: 163-176.

Lindner, P. and G. Wanielik, 2009. 3D LIDAR processing for vehicle safety and environment recognition. IEEE Workshop on Computational Intelligence in Vehicles and Vehicular Systems (CIVVS), Department of Electr. Eng. and Inf. Technol., Chemnitz University of Technol., Chemnitz, pp: 66-71.

Maria, T., S. Michaela, S. Anja, K. Martin, S. Arno, *et al*., 2011. Nitrososphaera viennensis, an ammonia oxidizing archaeon from soil. Proc. National Acad. Sci., 108(20): 8420-8425.

Matthias, R.S., S. Ates, J. Dickmann, F. Von Hundelshausen and H.J. Wuensche, 2011, Parking space detection with hierarchical dynamic occupancy grids. Intelligent Vehicles Symposium (IV), Department of Aerosp. Eng., Autonomous Syst. Technol. (TAS), University of the Bundeswehr Munich, Neubiberg, Germany, pp: 254-259.

Powers, M.A. and C.C. Davis, 2011, Spectral LADAR as a UGV navigation sensor. Proceeding of the SPIE, Laser Radar Technology and Applications, 16: 80371F-80371F-15.

Reina, G., J. Underwood, G. Brooker and H. Durrant-Whyte, 2011. Radar-based perception for autonomous outdoor vehicles. J. Field Robot., 28(6): 894-913.