Optik 127 (2016) 8070–8075

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.de/ijleo

An improved localization algorithm of taylor series expansion search target

Yanli Chu[a,b], Luyao He[a], Fan Yao[c,*]

[a] School of Marine Science and Technology, Northwestern Polytechnical University, Xi'an 710086, China
[b] Department of Information Engineering, University of CAPF, Xi'an 710086, China
[c] College of Information Engineering, Xizang Miuzu University, XianYang 712082, China

ARTICLE INFO

Article history:
Received 28 March 2016
Accepted 24 May 2016

Keywords:
Gross time delay error

ABSTRACT

Due to the real-time positioning, mobility and complexity by environmental goals control, reasonable, efficient determination of the measured time delay difference accuracy has been plagued researchers question. Aiming at this problem, this paper proposes a method to estimate the error signal delay discrimination based on characteristic parameters, using the method of Taylor series expansion location algorithms are search initial and end condition was improved. The experiment proves that this algorithm has high precision, strong robustness etc.

1. Introduction

Vibration source localization technology has been widely used in bridge monitoring, regional monitoring, environmental monitoring and other fields. Typically, vibration source positioning technology include positioning based on the vibration strength and TDOA (Time difference of arrival) [1]. As the positioning technology algorithm based on signal strength is simple and good real-time, but its positioning accuracy is not high [2], the time difference positioning technology has become one of the hot spots in this field. The Bayesian estimation is sensitive to the prior probability, and the data processing accuracy and complexity of the algorithm has some shortcomings [3,4]. Chan [5] algorithm uses the least squares method to solve equations for position, with the increase of TDOA measurement errors, the algorithm performance declined rapidly. The algorithm of Taylor series expansion [6] search has high accuracy. The algorithm is simple, robust, and it also has other characteristics, so it is widely used in engineering. In addition, in the traditional sense of the vibration, while measuring the difference of delay, due to environmental complexity and frequent sources of interference, leading measure of consistency is poor, even gross error, once an error occurs and the probability of coarse surge. The emergence of the gross error seriously affects search algorithm accuracy and convergence rate.

So for vibration targeting location, the discrimination of time delay error becomes very necessary. The initial search coordinates and the search end condition are the main factors in effect the precision and speed of Taylor search algorithm. This paper proposes a method to estimate the error signal delay discrimination based on characteristic parameters, use the method to determine the reliability of each sensor, then find the initial position of the source through the three high reliability sensors, and improve the search iteration end conditions based on the reliability of sensor, final by using Taylor

* Corresponding author.
E-mail address: fanyao11241983@163.com (F. Yao).

http://dx.doi.org/10.1016/j.ijleo.2016.05.084
0030-4026/

series expansion method to further locate the source of vibration. The experimental data show that the algorithm can effectively improve the robustness of the Taylor series expansion search and location accuracy.

2. Time delay error estimation based on characteristic parameters

Characteristic analysis is one of the key technology of the signal process. In the multi-node cooperative localization, the received signal quality of each sensor is usually described by the signal characteristic parameters. Rational and efficient signal process method can be extracted to reflect the characteristics of the target information in a whole view, provide reliable evidence to support the determination of signal quality. In fact, the same local oscillator, the signal of each sensor (such as zero-crossing rate, spectral width, the spectral density, etc.) has a strong similarity at the same time, it can be used to distinguish the merits of the respective signals received by the sensor by comparing the size of the parameter deviates which from the center of the signal characteristic values, and to determine the reliability of the sensor.

Suppose there are n sensors, signal feature of each sensor has m characteristic parameters, $s_i(j)$ is the j-th characteristic parameters of the i-th sensor, the mean of the j-th Characteristic parameters (parameters of reference) for N sensors can be described as follow:

$$\overline{s_i(j)} = \frac{1}{n}\sum_{i=0}^{n-1} s_i(j) \tag{1}$$

The definition of the i-th sensor on the Characteristic parameters of the generalized Euclidean distance [7]:

$$d_i(j) = \sqrt{\left[s_i(j) - \overline{s_i(j)}\right]^2} \tag{2}$$

where $i = 0, 1, \ldots, n-1$, it said that characteristic parameters $s_i(j)$ of the i-th sensor deviates from the features of the reference value.

For convenience of analysis comparing the deviation distance of different characteristic parameters, the normalized deviation distance is obtained by the normalization processing for type (1).

$$\xi_{ij} = \frac{d_i(j) - \min d_i(j)}{\max d_i(j) - \min d_i(j)} \tag{3}$$

So the m characteristic parameters normalized distance sum η_i of the $i-th$ sensor is:

$$\eta_i = \sum_{j=0}^{m-1} \xi_{ij}, j = 0, 1 \cdots m-1 \tag{4}$$

$$\gamma_i = 1 - \eta_i / \sum_{i=0}^{n} \eta_i \tag{5}$$

η_i is normalized processing,

$$\eta_i / \sum_{i=0}^{n} \eta_i \tag{6}$$

It is get the m characteristic parameters normalized distance sum η_i of the $i-th$ sensor.
Set:

$$\gamma_i = 1 - \eta_i / \sum_{i=0}^{n} \eta_i \tag{7}$$

The physical meaning of gray correlation degree γ_i is the credibility of the sensors, obviously, the greater its value, indicating that the signal characteristic parameters of the sensor closer to the center of the reference feature value, namely the signal quality is better, the time delay difference ascertain is the more accurate.

3. Taylor series expansion algorithm based on the reliability of sensors

3.1. The classic taylor series expansion search algorithm

The basic idea of Taylor series expansion search is that in the search of initial coordinates, the nonlinear equation into a linear problem [8], and then search by the certain step length starting from the initial coordinates, until satisfy the search end conditions, finally obtaining the optimal solution. The vibratory source localization figure is shown Fig. 1.