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Based on Artificial Immune Algorithm of Robot Multi-Sensor Signal Variation Characteristics of the Detection Method

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Abstract

With the continuous improvement of robot intelligent, constantly expanding range of applications, as well as multi-sensor information fusion technology, the traditional single sensor signal transmission problem has become multi-sensor transmission problems or multiple source signal transmission problems. This brought a large amount of signal variation and signals multiple variation problems. The traditional detection algorithm has been unable to meet the requirements; therefore, this paper puts forward a kind of robot multisensory signal variation test method based on artificial immune algorithm. First, establish the dynamic changes of the signal variability of equations to get the cross point of the distribution of the signal variability of variability, then update signal variation characteristic database, in the database selection signal variation characteristics. The method overcomes the drawbacks of traditional algorithms; the experiments show that this algorithm can avoid the defect signal variability of mutation, to improve the accuracy of signal variation detection.

Keywords: *characteristic database, multiple source signal test, artificial immune, sensor*

1. Introduction

Due to the application of robotics is increasingly wide now, our requirement to the environment accommodate ability of robot is increasingly high. In the same time, due to the complexity of robot system and instability of environment, the environment analysis provided by traditional single sensor become limited, and don't meet the requirement to the information of accuracy and timeliness. In recent years with the rise of information fusion technology of multi-sensor, the multidimensional information processing method of this technology can effectively deal with the fuzzy point of single sensor, more accurately observe and interpret the surrounding environment, effectively reduce the phenomenon of missed and misdiagnosis [1-4]. But it also brings the problem of signal variation in the signal transmission, so it is necessary to detect the variation signal in the processing of robot signal transmission.

1) The detection of variation signal is a complex detection problem, like the problem of fault diagnosis.
2) Frequently-used fault diagnosis methods are generally based on the technology of sensor detection, it is effective usually only in single fault condition, it is useless for the problem of multiple faults
3) Due to the variation and even several variations signals don't be accurately detected and diagnosed, the inadvertent operations of robot are made, even the paralysis of system is caused, the effective way become useless.
4) Through the extraction of signal variation features, the comparison between signal variation and variation feature database, signal variation detection will be completed, but the substantial deviation between signal variation feature and original feature caused by several variation of signal in short time can reduce the detection accuracy of signal variation
5) Through the artificial immune detection method in biological is used and the dynamic equation of signal variation feature is established, the cross point distribution of feature variation of signal variation will be got, and the detection of signal variation will be got [5-6].

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2. The Detection Principle of Robot Sensing Signal Variation

The Detection Modle of Robot Sensing Signal Variation**:** When robot multi-sensor signal variation is detected, first the signal variation feature will be extracted, that signal feature and signal variation feature database will be compared, finally the detection will be finished. Principle diagram as shown in Figure 1 [6].

Assume the sample number of signal variation feature database is (n), the sample number of signal variation feature is(i), the serial number of signal variation feature is (V), the time interval of brain operation is(t), the brain operation number is(l), the characteristic number of signal variation in same time is(m). The weighted value of signal variation can be calculated by the formula (1):

$$\eta = \frac{m\sqrt{n^2 - l^2}}{V - t^2 \times i} \tag{1}$$

According to the formula above, the variation degree of multi-sensor signal is described, the variation coefficient of signal variation feature is calculated. The mutation coefficient of signal variation feature is described by the formula (2):

$$\lambda = \frac{\eta \left| \mathrm{n} + 1 \right|}{i - t^2} \tag{2}$$

To ensure the situation of sudden change of multi-sensor variation feature, the feature mutation coefficient is added to the feature weight value calculation. The next formula (3) can get accurate weight value.

$$\omega = \frac{\lambda^2 (n-1)}{t-1} \tag{3}$$

According to the formula above, the variation feature weight value of actual signal can be got. The signal variation can be detected and discriminated [7-10].

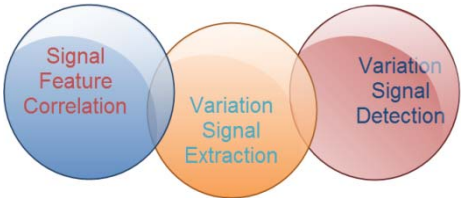

Figure 1. Signal Mutation Detection Principle Diagram

The Defects Of The Method Of Robot Signal Variation Detection: Due to the external environmental complexity and the robot intelligence requirements continue to increase, so the use of multi sensor fusion technology, it is possible in a very short period of time has several variations, resulting in signal variability substantial deviation from the original feature, feature mutations dramatically. Assume that the signal variability of mutations, according to the Equation (1) can learn, signal variability increase, will cause the signal variation characteristics of mixed coefficient. According to the Equation (2) can learn, signal variability characteristics of mixed coefficient increases will cause signal variability coefficient increase mutation. According to the Equation (3) can learn, signal variability mutation coefficient increases will cause the signal variation detection method [9-10].

In order to avoid the above defects, this paper puts forward a kind of borrowing in the biological artificial immune this concept detection method, the robot multisensor signal variation test method. Through the establishment of signal variation characteristics dynamic

change equation, and then in the database select signal variation characteristics. This way, you avoid the different signal variation characteristics caused by the mixed signal variation characteristics of the defects of mutation and reduce the signal variation for detection of residual rate.

3. Robot Sensing Signal Multiple Mutation Detection Method

Robot sensing signal mutation detection method, the research field of the robot is a major issue, the robot can accurately realize the human requirements, quickly adapt to the environment play a decisive role. The use of traditional signal variation detection approach, cannot be avoided because the signal variation characteristics of mixed signal caused by the variability of mutations in the defect, causing the signal variation detection missing rate increase. This paper presents a method based on Artificial Immune Algorithm for signal mutation detection method. Signal variation detection diagram as shown in Figure 2.

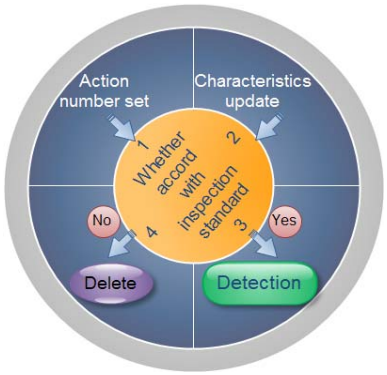

Figure 2. Signal Variation Test Block Diagram

The Dynamic Alter Equation of Signal Variation Feature Is Built: H_c is the data collection of signal variation feature, H is sample number of the signal variation data collection in the specific period. The dynamic alter situation of signal variation feature can be described by the formula (4).

$$H(u+\Delta u)=H(u)-\mu\cdot\Delta u-(\frac{\partial H_\alpha}{\partial y_\alpha}+\frac{\partial H_e}{\partial y_e})\cdot\Delta u \tag{4}$$

$\mu\cdot\Delta u$ is a new robot multi-sensor signal variation characteristic. $(\partial H_e/\partial y_e)\cdot\Delta u$ is Signal variability update time. Affinity coefficient is(χ). Signal variability during the update process is replaced with the feature H_e. Sensor information using (y)normal operation behavior description. Each signal variability of the update process includes sensor update cycle parameters (ξ) and affinity parameters (χ). Need to use the formula (5):

$$\begin{aligned}\xi(u+1)&=\xi(u)+u<\mu\\ \chi(u+1)&=\chi(u)+1\end{aligned} \tag{5}$$

In the above formula, Through the calculation to obtain the signal variation and the affinity between the normal sensor signal parameters, used to describe the degree of affinity constant accumulation. Sensor information updated after each iterations, the cumulative processing sensor information cycle parameter values. Hypothesized affinity registration is successful, then you will need to affinity parameters of accumulation. Usually divided into the following three kinds of circumstances:

1) Hypothesis $\chi > \vartheta \wedge u < \mu$, then the signal variability is activate, signal variability is transformed into a sample characteristic.

2) Hypothesis $\chi \le \vartheta \wedge u \le \mu$, then the sensor information characteristics of low affinity accumulation result, the continued need for accumulation.

3) Hypothesis $\chi < \vartheta \wedge u > \mu$, then the signal variation characteristics of cumulative results consistent with the affinity measure, it can determine signal variability has been completely replaced by new features. Among them, the characteristic ϑ is the signal variation characteristic affinity profile metrics.

Signal variability of dynamic transformation process, the need for characteristics of cross processing. In the signal variation detection, signal variability hypothesis renewal speed of (*V*) continues to increase, then the sensor operating data transmission speed increased by (*V*), $V=l_1 v$described the relationship between the two. $L_1$is signal variability update rate and operating rate of data transfer correlation coefficient. Set signal variability data collection is $H_2=\{h_1,h_2,L,h_i,\ldots L,h_p\}$, Arbitrary signal variability variability is(h_i) , the point mutation rate is (q_i). To get updates the processed signal variability data set $H_2=\{h_1,h_2,L,h_j,\ldots L,h_p\}$. Among them, the signal variation characteristics of variability in the treatment of intersection point distribution can use the formula (6):

$$P_i(Y=\lambda)=\frac{\mu^2 e^{-1}}{\lambda!},\lambda=1,2,3,L \tag{6}$$

Y is signal variability of the number of cross points.

Update Signal Variation Characteristic Database**:** V is a sensor operating feature data set, which includes two subsets of data (T)and(ST) , where (T) is the normal sensor information operation data subsets, (ST) sensor signal mutation operation is a subset of data. (T) includes the normal sensor characteristic information and the affinity parameters, sensor normal operating characteristics of information included in the operation of data flow, control terminal interface information, robot multi sensor related parameters. Sensor normal operating characteristic information through the formal description: {1000111010 0000101011 1011110010 1010}, The relationship between (T) and (ST) can use the formula (7):

$$\begin{aligned}\{T\}\cup\{ST\}&=V\\ \{T\}\cup\{ST\}&=\phi\end{aligned} \tag{7}$$

Variation in signal detection process, is to achieve accurate judgment of sensor signal operation behavior whether to belong to the signal mutation operation. Sensor information normal operation data in the data set to represent the normal operating features from the data collection, assuming arbitrary sample as signal mutation operation sample detection antibody, then to the advantage of the artificial immune method for complete self tolerance, thus obtaining the signal variation feature detection formula. According to the (*T*) characteristics of data set, To be able to select one of the sample $T\cdot B_j(j=1,2,L)$,Use the formula (8) to reverse transformation operation:

$$P_j=\overline{T\cdot B}(j=1,2,L) \tag{8}$$

The results establish a set of data, using $ST=\{P_1,P_2,L\}$ description. The data of the number of elements in the collection are 1. From the *ST* data collection of arbitrary elements P_j as signal variability to detect candidate detector, P_j and samples in the sample are calculated in T, $P_j=\{b_1,b_2,L,b_{12}\}$ can be $T\cdot B=\{c_1,c_2,L,c_{12}\}(j=1,2,L)$. If measure is ϕ and ϕ is a constant, then use the formula (9) to calculate the correlation coefficient of two:

$$E=\sum_{j=1}^{12}\varepsilon \tag{9}$$

Hypothesis $\beta_j=c_j$, you can get $\varepsilon=1$, Hypothesis$\beta_j \neq c_j$,, you can get $\varepsilon=0$. If $E<\varepsilon$, then can determine the sample signal mutation operation, otherwise, the sample is normal brain operation. According to the above described, to establish the signal mutation operation characteristics of the dynamic equation, in the update signal variation database selection intrusion feature, thus completing the signal variation detection.

4. The Simulation Results

Variation in signal detection process, need to extract the signal variability, will signal variability and signal variability in the feature database sample is compared, can complete signal variation detection. Multi sensor signal variability may be in a very short period of time has several variations, causing the robot sensor signal variability substantial deviation from the original feature, feature mutations dramatically. Assume that the signal variation characteristics of mutation, using the traditional algorithms of signal variation detection, cannot be avoided because the signal variation characteristics of fast multiple variation, caused by the characteristics of degradation, reduces the signal mutation detection accuracy.

In order to verify the effectiveness of this algorithm, the need for contrast experiment. Establishment of robot multi sensor model, respectively using the traditional algorithm and the algorithm of robot multi sensor model 10 detection. Wherein, relevant parameters are set as follows: $n=1000, i=389, V=0.39, t=5, l=500, m=450$, each experiment on 100 robot multi sensor strong variation in signal detection, record does not successfully detected signal numbers as the missing rate measure, for each signal variation detection results for calibration, specific distribution as shown in Figure 3.

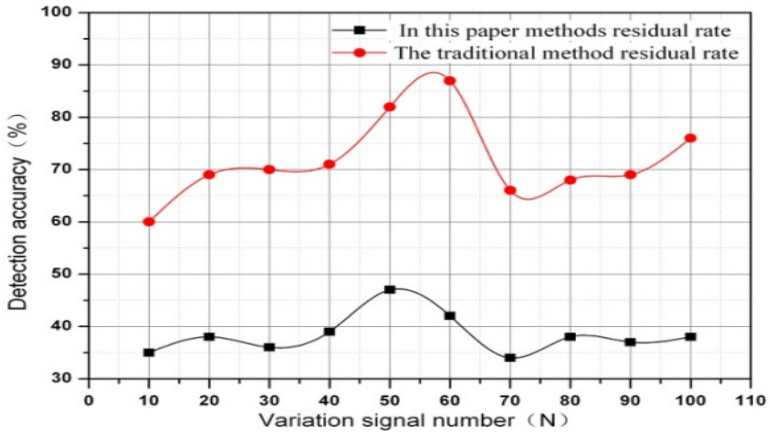

Figure 3. Different Testing Methods Miss Rate Contrast

From Figure 3, can be seen clearly, using this algorithm for robot multi sensor signal variability to detect missing rate curve is far lower than the traditional algorithm, this algorithm in signal variability expressed mixed case, signal variation detection has the certain superiority. The experimental data can be recorded, in Table 1 and Table 2. Wherein, Table 1 signal variability is independent of context, signal variability in the detection of relevant data. Table 2 signal variability is mixed case, signal variability in the detection of relevant data.

Variation in signal detection process, through the data in Table 1 are analyzed to learn that, if signal variability is independent of each other, so the use of this algorithm signal variation detection error and the traditional algorithm is basically the same. Table 2 through analyze the data to learn that, assuming robot multi sensor signal variability are mixed together, then using this algorithm signal variation detection error is far less than the traditional algorithm.

Table 1. Biological Signal Variability Independent Data Table

Signal variation detection data	The traditional algorithm	This algorithm
Frequency of testing	100	100
Detection signal variation number	24	26
The actual signal variation number	32	32
Detection of error	23.3%	20%

Table 2. Biological Signal Variation Characteristics of Mixed Data Table

Signal variation detection data	The traditional algorithm	This algorithm
Frequency of testing	100	100
Detection signal variation number	20	22
The actual signal variation number	30	30
Detection of error	36.7%	23.3%

5. Conclusion

This paper presents a borrows this concept in biology, artificial immune detection method to detect the variation of robot multi sensor signal. Through the establishment of signal variability of dynamic equation, to update the signal variation characteristic database, thus realizing the signal variation detection. The experiment proves, this algorithm improves the accuracy of detecting signal variation.

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