Holographic Health Calculation Method of Video and Image Based on Fuzzy Comprehensive Evaluation

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Abstract. The intelligent system of video and image information has the characteristics based on large numbers of cameras, exposed and uninterrupted operating environment, rich data types, diverse related systems and complex cascading architecture. How to implement the entire network operation situation by means of automation and intelligent monitoring has become a critical issue. The holographic health of video and images refers to the overall health value of intelligent system of video and image during the operation process, which can objectively reflect the operation situation of the video image, the perceived weaknesses during the operation process of the system, and performs analysis and warning during the process. Based on the comprehensive fuzzy model, this paper constructs a holographic health degree calculation method, designs an operation situation index evaluation system, constructs the factor set and automatically obtains the indicator monitoring value, calculates the influence factor evaluation matrix, and calculates the holographic health degree value through the Eigen-vector. Finally, this article gives the calculation examples and critical numbers extracted from the video image information intelligent system, the description of the health level and the actual situation of the system's operating state, and verifies the validity of the holographic health degree calculation.

Keywords: Holographic Health Value, Operational Evaluation of Video and Image, Situation Assessment, Fuzzy Comprehensive Evaluation

Recent years, the National Public Security Organization has continued to promote the significant construction of the video surveillance named "Safe City" and "Skynet Project", etc. Relying on the public security information network and the public security video transmission network (the backbone network between ministries and provinces is carried by the E-government extranet), the application framework of video image information networking of public security organs at four levels of ministry, province, city and county has been constructed, realizing the nationwide video image data’s cross-network, cross-level, cross-region, cross-police categories and cross-level resource integration and sharing application. It makes the video image information an important weapon of Public Security Organization safeguarding national safety and stabilization and driving general situation of society public security.
1. Holographic Health Degree
The concept of situational awareness originates from military requirements [1], being an important part of decision-making process. Situation assessment is a kind of ability to understand environmental risk dynamically and comprehensively based on environment, basing on big data, improving the ability of discovering identifying, understanding analyzing and response handling to environmental threats from a global perspective, and eventually help realize the implementation and action of policies [2].

The holographic health degree of video image is to analyze and calculate the whole network operation situation of video image. Its goal is to apply the mature theory and technology of situation awareness to the running condition calculation of video image and is to efficiently organize the state information of all kinds of resources and to make indexing analysis of the health degree which they had operated in the complex and changeable environment. And it enhances the ability of understanding the operation of the system of system operating and maintaining people and provides decision support for senior commanders through the comprehensive analysis of resource operation data. Fig.1 gives the calculation process of holographic health degree.

![Figure 1. Research method picture of holographic health degree](image)

(1) Design index evaluation system. Design and research for video image operation situation target.
(2) Comprehensive vague model establishment and health degree calculation. Holographic health degree model eventually gets health degree value from factor set, result set of health degree, voluation and adjustment of influence factors.

2. System of Evaluation Index of Video Image Operation

2.1 Principle of Index Formulation
In the process of index selection, considering that the index are generally divided into positive index (the larger the better), the reverse index (the smaller the better), and moderate index (not too small or too large), need to deal with isotropy by directing the reverse index and the moderate index positively [3, 4], in order to being able to make a comprehensive summary. The main principles of index selection of the passage are as follows:
(1) Pertinence: is different from general software system, being able to reflect the essential characteristics of evaluation software, acting with functionality and high reliability specifically.

(2) Testability: is able to indicate quantitatively, and could get specific data through methods such as mathematics calculation, platform test and experience census.

(3) Conciseness: is easy to be understood and accepted by all parties.

(4) Completeness: is that the selected index should cover the scope which is related to analysis targets.

(5) Objectiveness: is objectively reflecting the essential characteristics of software, avoiding varying with each individual.

2.2 Index System of Health Degree

According to the video image operation gradation, the system can be divided into five main gradations, and each gradation subdivides the object, and selects the main monitoring index for any object. It constructed the index system of holographic health degree through the 3-level index system of gradation, object and index.

(1) Collection Layer mainly contains three categories of objects: Video stream device, image device and other device. Video stream device is the traditional camera sockets (afterwards referred to as monitor), used for collecting real-time video stream and memorying historical videos. Image device is pointed as intelligent cameras (afterwards referred to as ports) which possesses the recognition ability of face and license. Other device refers to as the device used for collecting other video related data, as certificate verification equipment (afterwards was short as Sense), etc.

(2) Infrastructure facilities, mainly contains basic hardware and operational software.

(3) Core data layer, mainly contains 3 categories of real-time video stream, historical videos and image or the structure data produced by image recognition.

(4) Service layer is pointed as the core service provided by interior of the video image system, such as VOD service, video consulting and picture searching, etc.

(5) Application layer is pointed as application software platform, a platform which could provide core business with video software functions, etc.

The specific monitoring index to objects of each layer refers to Fig.1.

2.3 Acquisition and Calculation of Index Data

Aiming at automatic measurement &calculation of three level indexes, the paper defines the rules of measurement &calculation, and could acquire credible value through objective data calculation and making mathematical statistical analysis. Details as Table 1.

| Table 1. Definition and calculation methods of three level index |
|---------------------|---------------------------------------------------------------|
| Index name           | Calculation way                                              |
| 1 Monitoring online rate | Daily cumulative online time / average of 24 hours           |
| 2 Monitoring connectivity rate | Connection times / total test connection times             |
| 3 Monitoring delay rate       | Times of delay meeting requirements / total times of monitoring |
| 4 Camera abnormality     | Abnormal 1, normal 0                                         |
| 5 Port online rate      | Daily cumulative online time / average of 24 hours           |
| 6 Port standard-reaching rate | Times of data volume reaching the standard / total times of data volume |
| 7 APE abnormality       | Abnormality 1 detected, no abnormality 0                     |
| 8 Perception online rate | Daily cumulative online time / 24 hours                     |
| 9 CPU condition         | CPU abnormal alarm 0, no alarm 1                             |
| 10 Internal storage condition | Internal storage alarm 0, no alarm 1                      |
|   |               |                                                                                       |
|---|---------------|---------------------------------------------------------------------------------------|
| 11| Cache condition| The alarm of insufficient exchange space is 0, and 1 without alarm                    |
| 12| Hard disk availability| Hardware fault alarm 0, no alarm 1                                                    |
| 13| Disk availability| Disk abnormal alarm 0, no alarm 1                                                     |
| 14| I / O condition| Abnormal I / O utilization alarm 0, no alarm 1                                         |
| 15| Network availability| Network connection abnormal alarm 0, no alarm 1                                       |
| 16| Packet loss rate| Packet loss rate abnormal alarm 0, no alarm 1                                         |
| 17| Condition of rate of flow| Flow abnormal alarm 0, no alarm 1                                                     |
| 18| Video stream intact| Video stream quality diagnosis intact number / total number of diagnoses              |
| 19| Mark intact rate| Number of video stream annotation intact / total times of inspection                  |
| 20| Video integrity rate| Video quality monitoring intact number / total number of monitoring                   |
| 21| Video storage rate| Video duration monitoring complete number / total number of monitoring                |
| 22| The pictures are well marked| Number of pictures marked intact / total times of inspection                          |
| 23| Picture intact rate| Image quality monitoring intact number / total times of inspection                    |
| 24| Graph number consistency ratio| Image data consistency / total number of monitoring                                     |
| 25| Structural data stable| Stable days of structure data upload / total operation time                           |
| 26| Structural data specification| Number of structured data specifications / total number of monitoring                 |
| 27| Service connectivity rate| Number of service connections / total number of connectivity tests                   |
| 28| Service integrity rate| Service access success times / total number of monitoring                             |
| 29| Service utilization rate| Number of service access users / initial threshold                                    |
| 30| Service delay| Number of times the service responded in the maximum time / total number of visits    |
| 31| Application software online| Platform online time / total operation time                                           |
| 32| Cascade stability rate| Online time / total running time of cascaded subordinate platforms                    |
| 33| Visit rate| Platform visits / initial threshold                                                   |
| 34| Program stability| program abnormal alarm, 0 and no alarm 1                                              |

3. Hierarchical Vague Comprehensive Evaluation Method of Health Degree

In this section, we propose a method to calculate the health degree of video image holography based on hierarchical vague evaluation model.

3.1 Factor Set

Factor set refers to the five levels and objects that can affect the health of video image information, as well as the index set to evaluate the operation status of the object. Represented by the factor set \( U = \{A, B, C, D, E\} \). Where A represents the evaluation set of acquisition devices.
3.2 Evaluation Set

The result evaluation result set of video image operating health degree is represented by \( R \), \( R = \{R_1, R_2, R_3, R_4\} \), where \( R_1 \) is the corresponding health state. \( R \) represents the current health status of video image system, and comprehensively evaluates the status of acquisition equipment, infrastructure, core data quality, service and application. The operating state of the system is divided into four levels: healthy, good, poor and dangerous by calculating the score of holographic health degree.

| Health condition | Value Area | Description |
|------------------|------------|-------------|
| Health           | [80,100]   | The health value of video image is between 80 and 100, and the whole network video monitoring equipment, access network and basic software and hardware facilities are in a healthy state. |
| Fine             | [60,80)    | The health value of video image is between 60 and 80 points. In a few areas, the video monitoring equipment, access network and basic software and hardware facilities fail, and most of them have faults. |
| Poor             | [40,60)    | The health value of the video image is between 40 and 60 points. The local area or application can't read it normally after receiving interference, and the rest of the video and image can't be used normally. |
| Dangerous        | [0,40)     | The health value of video image is lower than 40 points, and the key equipment is abnormal, resulting in most of the video and image cannot be used normally. |

3.3 Influence Factor Matrix

In view of the different levels, objects and evaluation indexes of holographic health degree, it is necessary to design influence factors to describe the influence degree of indicators, objects and levels on holographic health. Thus, an appropriate comprehensive calculation model is obtained. The idea of AHP to determine the weight vector [5] is: organizing expert review meeting, asking experts to compare the importance of the first level index set in the calculation of holographic health degree, and construct the global impact factor evaluation matrix \( T \) by using the comparison results. Scoring table and its meaning:

| value | meaning |
|-------|---------|
| 1     | The two factors have the same effect on health |
| 3     | The effect of the former on health is slightly stronger than the latter |
| 5     | The influence of the former on the health degree is obviously stronger than that of the latter |
| 7     | The former has stronger influence on health than the latter |
| 9     | The influence of the former on health is extremely stronger than that of the latter |

(1) The global impact factor evaluation matrix \( T \) is constructed. Through pairwise comparison of five first-class indexes A, B, C, D and E, the influence index \( I = \{I_{ij}, I_{ij} \in [1,5], J \in [1,5]\} \).
I=

|   | A   | B   | C   | D   | E   |
|---|-----|-----|-----|-----|-----|
| A | I_{11} | I_{12} | I_{13} | I_{14} | I_{15} |
| B | I_{21} | I_{22} | I_{23} | I_{24} | I_{25} |
| C | I_{31} | I_{32} | I_{33} | I_{34} | I_{35} |
| D | I_{41} | I_{42} | I_{43} | I_{44} | I_{45} |
| E | I_{51} | I_{52} | I_{53} | I_{54} | I_{55} |

(2) Judgment matrix TX layeredly. For the internal judgment matrix TA and BCDE of A, B, C, D and E, the corresponding internal judgment proof TX can be constructed according to this method.

3.4 Consistency Test

The random consistency index RI was randomly simulated and $a_{ij}$ was formed into A, and CI was calculated to get RI. The consistency ratio $CR = CI / RI$ was defined; when $CR < 0.1$, the consistency test was passed.

$$CI = \frac{\lambda - n}{n - 1}$$

|   | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   |
|---|-----|-----|-----|-----|-----|-----|-----|-----|
| RI | 0   | 0.52| 0.89| 1.12| 1.26| 1.36| 1.41|
| 9  | 10  | 11  | 12  | 13  | 14  | 15  |
| RI | 1.46| 1.49| 1.52| 1.54| 1.56| 1.58| 1.59|

4. Results and Verification

4.1 Influence Factors Calculation

After calculation, judge matrix T by holographic health degree influence factors, which is shown in Table 5 below.
Table 5. Conformity inspection review form

| Coefficient | Coefficient | Health Factors |
|-------------|-------------|----------------|
| A           | 0.091       |                |
| A1          | 0.039       | A11 0.015      |
|             |             | A12 0.005      |
|             |             | A13 0.003      |
|             |             | A14 0.015      |
| A2          | 0.039       | A21 0.025      |
|             |             | A22 0.008      |
|             |             | A23 0.005      |
| A3          |             | 0.013          |
| B           | 0.273       |                |
| B1          | 0.12        | B11 0.04       |
|             |             | B12 0.01       |
|             |             | B13 0.01       |
|             |             | B14 0.04       |
| B2          | 0.12        | B21 0.09       |
|             |             | B22 0.03       |
| B3          | 0.04        | B31 0.03       |
|             |             | B32 0.01       |
| C           | 0.091       |                |
| C1          | 0.039       | C11 0.029      |
|             |             | C12 0.010      |
| C2          | 0.039       | C21 0.017      |
|             |             | C22 0.017      |
|             |             | C23 0.006      |
| C3          | 0.013       | C31 0.005      |
|             |             | C32 0.002      |
|             |             | C33 0.002      |
|             |             | C34 0.005      |
| D           | 0.273       |                |
| D1          |             | 0.082          |
| D2          |             | 0.082          |
| D3          |             | 0.082          |
| D4          |             | 0.027          |
| E           | 0.273       |                |
| E1          |             | 0.108          |
| E2          |             | 0.036          |
| E3          |             | 0.022          |
| E4          |             | 0.108          |

4.2 Measurement & Calculation Results of Index Value

Through the video image operation monitoring center, the operation index data of 2921874 monitoring, port and sensing equipment in China were monitored and counted for 8 months [6-10]. The values of the three levels of index are shown in through the values in Table 6 constructs eigenvector \( \mathbf{V} \).

Table 6. Three level index monitoring value form

| A11 | A1 | A1 | A1 | A2 | A2 | A2 | A2 | A3 | A3 |
|-----|----|----|----|----|----|----|----|----|----|
| 98  | 89 | 78 | 86 | 95 | 60 | 89 | 87 |    |    |
| B11 | B1 | B1 | B1 | B2 | B2 | B2 | B2 | B3 | B3 |
| 90  | 88 | 78 | 79 | 68 | 68 | 75 | 65 |    |    |
| C11 | C1 | C2 | C2 | C2 | C3 | C3 | C3 | C3 | C3 |
| 2   | 1  | 2  | 2  | 3  | 1  | 2  | 3  | 3  |    |
4.3 Calculation Result of Holographic Health Degree

Holographic health degree $T = T_v \cdot \ln(v)$; Among them, $T_v$ is the health factor vector in Figure 4, and $\ln(v)$ is the index value vector.

According to the calculation formula of holographic health degree, the result is 80.81 points, and the system is in a healthy state.

5. Conclusions

The holography health degree of video image is the main index to evaluate the operation situation of video image intelligent information system. This paper summarizes and refines the index that affects the operation quality of video image system from five levels: perception acquisition, network access, data quality, service quality and application system, and quantifies them numerically. The comprehensive vague model is used to calculate the health factors of each level, object and index, and finally the holographic health degree value is obtained, and the health degree of system operation is evaluated. In this paper, the initial value of health factors is determined by expert evaluation method. In the subsequent adjustment process of health factors, the reverse transmission mechanism is adopted to ensure that the impact factors meet the actual business needs and are scientific.

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