Development of Control Failure Recovery Support System

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Abstract:

JFE Steel has constructed a control fault recovery support system (J-mAIster^{TM}) applying IBM Watson^{TM}

experts on regular duty have been called in at night.

2.1.2 Proposals for addressing issues

Under these circumstances, the methods of failure analysis and failure response by veteran employees were investigated. Because it was found that the response to trouble by veterans was largely based on know-how accumulated over many years, that is, past experience and abundant knowledge, technology and skills, the establishment of an environment where such information could be visualized and utilized was considered to be an effective countermeasure. In fact, because each manufacturing site possesses a large amount of information such as failure reports and operating procedures, which had not been shared between sites, a project was started in 2016 with the aim of constructing a system that would enable central

2.3 System Features

2.3.1 Basic features

This section describes the two basic functions of the newly-developed system (see **Figure 4**). The first is the ability to perform fuzzy searches. When a user enters the content to be investigated in a conversational format, the system automatically extracts the search keywords by a natural language classification function and also automatically identifies the categories of documents to be searched in order to extract more relevant documents. Second, when the search results are displayed, they are prioritized to make it easier to find useful information. These functions are described in further detail in the following Section 2.3.2.

2.3.2 Details of basic features

The TF-IDF method[2)] is used for the display order of search results. The idea of the TF-IDF method is

$n_{t,d}$: Number of times word t occurs in document d
$\Sigma_{s \in d} n_{s,d}$: Sum of occurrences of all words in document d

Example of calculation: If the word "Inverter" appears 10 times in a fault history consisting of 200 words, the TF value of "Inverter" in that fault history is 10/200 = 0.05.

(3) Formula for calculating IDF value

$idf(t) = \log N/dt(t) + 1$

*Calculated as a logarithm to reduce the effect of a larger document size; + 1 to prevent *idf* from becoming zero.

Here,

idf (t): IDF value of word t
df (t): Number of documents in which word t occurs (document frequency)
N: Total number of documents

Example of calculation: If "Inverter" appears in 100 of 10 000 documents, the IDF value of "Inverter" is log 10 000 - log 100 + 1 = 4 – 2 + 1 = 3.

(4) Actual example[3)]

① Assumptions

In 10 000 documents, the document frequency (DF) of the next 2 words shall be

df (Inverter) = 100, *df* (Cable) = 200
idf (Inverter) = log 10 000 – log 100 + 1
= 4 – 2 + 1 = 3
idf (Cable) = log 10 000 – log 200 + 1
= log10 000 – log100 – log 2 + 1
= 4 – 2 – 0.301 + 1 = 2.699

② Calculation of TF values

Suppose there are 200 words in a document d and "Inverter" appears 10 times and "Cable" appears 11 times.

tf (Inverter, d) = 10/200 = 0.05
tf (Cable, d) = 11/200 = 0.055

③ Calculation of degree of features

The characteristics of "Inverter" and "Cable" in document d are obtained as follows:

tf (Inverter, d) /

References

1) JFE Steel News Release, March 7, 2019.
https://www.jfe-steel.co.jp/release/2019/03/190307.html
2) Rajaraman, A.; Ullman, J.D. Mining of Massive Datasets. 2011, p21–17.