A WEB-BASED INTELLIGENT SYSTEM FOR USED-OIL ANALYSIS

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ABSTRACT
The analysis of oil in an operating machine is considered as a very useful means to assess the condition of the machine. However, classical techniques of oil analysis are strongly dependent on the analyst's expertise to perform wear particle inspection, condition classification, colligation of the test results by ferrography, AES, and physical or chemical detection and interpretation of the possible existing faults in a machine. To solve these problems and realize the intelligence of oil analysis, a Web-based intelligence system for oil analysis has been devised. This system is composed of an automatic ferroscope controlled by a computer to obtain improved wear debris images, a platform to process the images and to connect the field analyst with the experts in machine diagnosis through internet and an intelligent software platform to evaluate the tribological conditions and diagnose the faults. Furthermore, some intelligent diagnosis methods used in the system are introduced.

1. INTRODUCTION
In recent years, more and more attention have been paid to the intelligent diagnosis methods in the used-oil analysis to break through its bottlenecks for the industrial application. High quality image acquirement technique, feature extraction, morphological and fractal description and pattern recognition are introduced to realize the computerized wear debris classification, integrated intelligent diagnosis methods are adopt to improve the quality of used-oil analysis\(^{[1]}\).

In order to realize the intelligent diagnosis process in a low-cost manner that can be easily accepted by an enterprise, a common ferroscope is reconstructed as automatically control in our research, then a remote diagnosis system is developed to meet the needs of web-based oil analysis for machine condition monitoring. In this paper, the system is illustrated in detail.

2. FRAMEWORK OF THE SYSTEM
The structure of the system is demonstrated in Figure 1. It is consist of an improved wear debris analyzer with a fully automatic ferroscope and a web-based intelligent diagnosis platform.

3. THE IMPROVED WEAR DEBRIS ANALYZER
The analyzer includes a Fully Automatic Ferroscope System (FAFS) controlled by a computer and a software developed to analyze the wear debris images.
The basic hardware frame of FAFS is shown in Figure 2. By means of the communication between a computer and the controller, the three dimension movements of the microscope platform, the conversion of object lens and the lamp brightness can be controlled.

![Figure 2. The basic hardware frame of FAFS](image)

The controlling parameters of the ferroscope can be transferred to a remote computer for the experts on the web to adjust the ferroscope and analyze the wear debris in real time. In FAFS, multi-focus image fusion algorithms are introduced to acquire improved wear debris image.

### 4. THE INTELLIGENT DIAGNOSIS SYSTEM

By synthetically using common physical and chemical data, ferographic data and spectroscopic data in used-oil analysis, the system mainly supplies three kinds of services:

#### 4.1 wear condition evaluation

Because ferographic data and spectroscopic data have different influence upon the evaluation of wear condition, a weight based fuzzy C-Means is presented as shown in Figure 3.

![Figure 3. The model for wear condition evaluation](image)

#### 4.2 Fault diagnosis

One remarkable feature in used oil analysis is that a fault is generally asserted in accordance with serials of monitoring data but the logic relationships are uncertain. In this case, an integrated BP Neural Network(BPNN) is used to establish a model to diagnose the lubrication and wear faults. The model is shown in Figure 4.

![Figure 4. The fault diagnosis model based on integrated BPNN.](image)

#### 4.3 Wear trend prediction

The wear trend prediction is the key point in the wear condition monitoring. In the system, a BPNN prediction model optimized by genetic algorithm is adopted. Its principle is show in Figure 5.

![Figure 5. The prediction algorithm](image)

The system has been successfully used in the oilfield equipment fault diagnosis by a remote manner between our lab and a oilfield in the west of China.

### 4. CONCLUSIONS

A web-based intelligent diagnosis system for used-oil analysis is developed at a lower cost, in which both the local and remote diagnosis resources can be utilized in a real-time manner through the internet, the efficiency of machine condition monitoring is improved remarkably.

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### REFERENCES