Academic Journal of Engineering and Technology Science
ISSN 2616-5767 Vol.5, Issue 3: 45-48, DOI: 10.25236/AJETS.2022.050309

The Application of Data Mining Technology in the Predictive Maintenance for Oil and Gas Equipment

Fei Zhu

Honeywell China Limited, Shang Hai, China
471491903@qq.com

Abstract: *Data mining is a new research topic in intelligent predictive maintenance by searching, counting, and processing a large amount of data to obtain valuable information. With the rapid development of the petroleum industry in recent years, automation and intelligent oil and gas equipment have been constantly updated and applied with a significant role in the daily production scheduling process control in the oil and gas fields. In this context, this work first discussed the basic concept of data mining technology and predictive maintenance, then presented the implementation route of data mining technology in predictive maintenance, and finally proposed the predictive maintenance scheme of deep hole drilling tools based on the two-mode algorithm. This study mainly discussed the basic problems and key technologies of data mining technology in the predictive maintenance of oil and gas equipment, aiming to provide new solutions to the equipment fault prediction.*

Keywords: *Data mining; Oil and gas equipment; Predictive maintenance; Bimodal algorithm*

1. Introduction

With the innovation and development of science and technology and the improvement of comprehensive national strength, China is realizing the transformation from a manufacturing power to an intelligent manufacturing power. Big data technology and intelligent manufacturing technology have been effectively applied in industrial manufacturing, highlighting the intelligent advantages of manufacturing. The guarantee in intelligent manufacturing is intelligent and efficient equipment maintenance. At present, data mining technology plays an active role in the maintenance of intelligent manufacturing equipment and has achieved good results by analyzing and predicting faults and guiding fault solving [1]. The steady development of the manufacturing industry is based on the normal operation of equipment, but the wear of parts in the operation of equipment causes various faults, resulting in production shutdown, and even accompanied by safety accidents. As such, it is imperative to give full play to the equipment maintenance advantages of data mining technology. Based on this, making the data mining technology play a positive role in the prediction and maintenance of oil and gas equipment will further lay the foundation for the development of the intelligent manufacturing industry.

2. Basic concepts of data mining technology and predictive maintenance

Predictive maintenance technology takes state monitoring technology as the core support, gives play to the advantages of online monitoring of monitoring technology for equipment status, and extracts the core indicators reflecting the operation state of machinery and equipment. Its core lies in the use of signal analysis techniques to interpret the core indicators, the prediction of clear fault type, fault location, and fault hazard degree combined with intelligent prediction analysis, so that the managers can put forward corresponding suggestions for fault solving. In this way, the enterprise management personnel or the front-line equipment maintenance personnel can realize the intelligent monitoring and maintenance of the equipment, which makes the fault identification more accurate and the fault processing more efficient. Moreover, according to the data analysis results, an effective plan of equipment maintenance and management can be formulated to improve the management effectiveness. Predictive maintenance mode realizes the passive to the active transformation of equipment maintenance and management, which is useful for reducing risks and losses in advance. The predictive maintenance mode brings accurate judgment, identification, and scientific estimation of the remaining life of the equipment to reduce the risk of shutdown, which can save the management cost of the enterprise and return the economic benefits of the enterprise more obvious [2].

The key operation of data mining is the data-driven. Data-driven data refers to the extraction and application of data value based on data analysis. Data collection is the first step to form information flow for decision analysis. And the information flow formed by data collection can realize the refining and summary of valuable information. In recent years, the rapid development of the intelligent manufacturing industry makes the mechanical equipment manufacturing workshop work with the integration, precision, intelligent trend characteristics. Sensors, "Internet +", Internet of Things and other technologies have been effectively applied in the manufacturing industry, realizing the data collection of the whole life cycle of products. Among them, there can be value chain data, operation process data, industry competitor data, and market public opinion data. The precise analysis of these data can realize the predictive maintenance of oil and gas equipment, which is the charm of data mining technology. The above data is also in the daily exponential growth state, which provides more possibilities for the application of data mining technology in the predictive maintenance of oil and gas equipment.

3. Implementation route of data mining technology in predictive maintenance

3.1. Technical support system based on the Internet of Things

The advantages of the Internet of Things technology in device status monitoring and diagnosis are mainly reflected in the wireless monitoring of device status, the accurate transmission of high-speed data, the realization of edge computing, and the landing of fine diagnosis. The introduction of Internet of Things technology in equipment status monitoring can provide more accurate data special services for enterprises. Considering the needs of digital, networked, and intelligent enterprises, we need to complete the data cluster analysis with the effective correlation between data and extract valuable information to serve enterprises. The application value of the Internet of Things technology in predictive maintenance can not be underestimated. It is to expand the scope of equipment status monitoring with the standardization of knowledge modeling and experience to expand the scale of monitoring. Based on the overall network architecture level, the integrated management platform of the Internet of Things obtains the device health status monitoring signal with the help of sensor nodes and obtains the operation parameter information. The network layer is uploaded to the equipment health monitoring network of the Internet of Things management platform, and then the data is further transmitted to the application layer for monitoring signal analysis and fault feature extraction to realize fault diagnosis and prediction [3]. The equipment health monitoring platform of the Internet of Things has various functions such as data collection and analysis, data visualization processing, equipment maintenance, fault diagnosis, and early warning. The real-time monitoring, operation and maintenance of the equipment under its jurisdiction can be realized through the monitoring data monitoring, statistics and traceability of the equipment under jurisdiction. The operation information and maintenance information will automatically generate management reports to facilitate the maintenance personnel to develop a more ideal maintenance plan.

3.2. Equipment fault diagnosis based on data mining technology

For a manufacturing enterprise, production and management complement each other. It is generally believed that the freedom of system of the system determines the complexity of management. The smaller the system freedom of intelligent manufacturing enterprises, the higher the system reliability, and the higher the ability of equipment managers and maintenance personnel. The manager shall complete the equipment status monitoring and diagnosis with the decreased freedom of the production system, ensure the simplification, optimization and intelligence of the monitoring and diagnosis, and draw more accurate diagnosis conclusions for the equipment maintenance and analysis [4]. As an important component of the predictive maintenance technology system, the feature extraction algorithm and fault identification method play a key role through the continuous and parallel collection of the state signals of each mechanical part of the equipment. Only by selecting the appropriate state monitoring sensor can the feature extraction algorithm be effective and extract the original signal content. The more effective information collected by the sensor, the more accurate and rapid the identification of the fault type, and the more helpful to the production recovery. For the equipment troubleshooting processes, as shown in Fig. 1, the practical significance of equipment fault diagnosis in predictive maintenance is clear at a glance, mainly to remind equipment managers and maintenance personnel to do a good job of potential troubleshooting, so that the equipment can be in a stable operation state.

ISSN 2616-5767 Vol.5, Issue 3: 45-48, DOI: 10.25236/AJETS.2022.050309

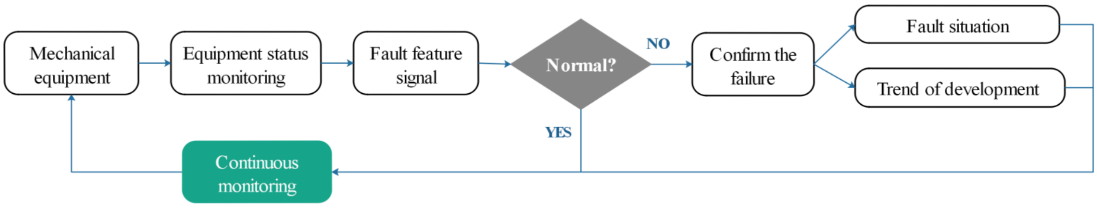

Figure 1: The equipment troubleshooting processes

At the present stage, the predictive maintenance fault diagnosis mainly depends on manual analysis. With the help of trend, waveform, spectrum, and other professional analysis tools, the diagnostic personnel evaluates the transmission structure, mechanical component parameters and other information to clarify the equipment faults and accurate positioning [5]. However, predictive maintenance will break through the limitations of manual analysis and achieve more accurate intelligent diagnostics with the support of the Internet of Things and artificial intelligence technology.

4. Case reports: the predictive maintenance of deep hole drilling tool based on a two-mode algorithm

With the characteristics of long processing time and various random factors, this work designed a two-mode tool life prediction algorithm based on the combination of dynamic model and steady-state model, as shown in Fig. 2. In this tool, the dynamic model based on the edge calculation ensures the dynamic accuracy of the prediction model, and the steady-state model based on the big data ensures the stability of the prediction model.

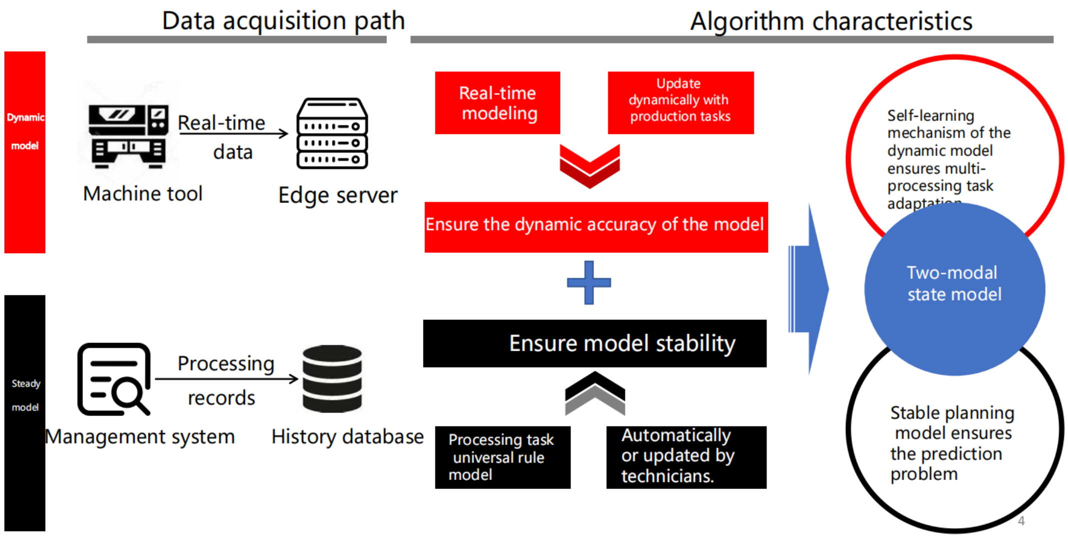

Figure 2: The two-mode tool life prediction algorithm based on the combination of the dynamic model and steady-state model

Firstly, the mathematical monitoring indicators of different process segments and different parameters are designed by collecting the historical processing data and quality data of machine tools and integrating the accumulated empirical value of process personnel. As such, a relatively stable rule benchmark model is established. The steady-state model is beneficial to enhance the processing power of short-term anomalous signals and improve the training data effectiveness of the dynamic model. At the same time, through the microservice framework, the system can automatically or passively regularly update the steady-state model to achieve synchronization with the actual production situation of the factory.

Secondly, through the online analysis of real-time dynamic processing data, the unsupervised machine learning model was developed based on current processing materials, processing processes, and tool characteristics through the collection of historical data, extraction of characteristics, and establishment of rules as shown in Fig. 3. This model conducts real-time online prediction and analysis of the processing process in the middle and back segments and sends the tool health information in real-time. When the knife life is reduced to the low area, the knife change instruction is sent immediately. As such, the adopted random forest-based unsupervised learning algorithm can solve the problem of

ISSN 2616-5767 Vol.5, Issue 3: 45-48, DOI: 10.25236/AJETS.2022.050309

unbalanced sample machine learning. Moreover, the establishment of a dynamic real-time model can effectively adapt to different types of processing tasks with good applicability for different brands and different quality of tools.

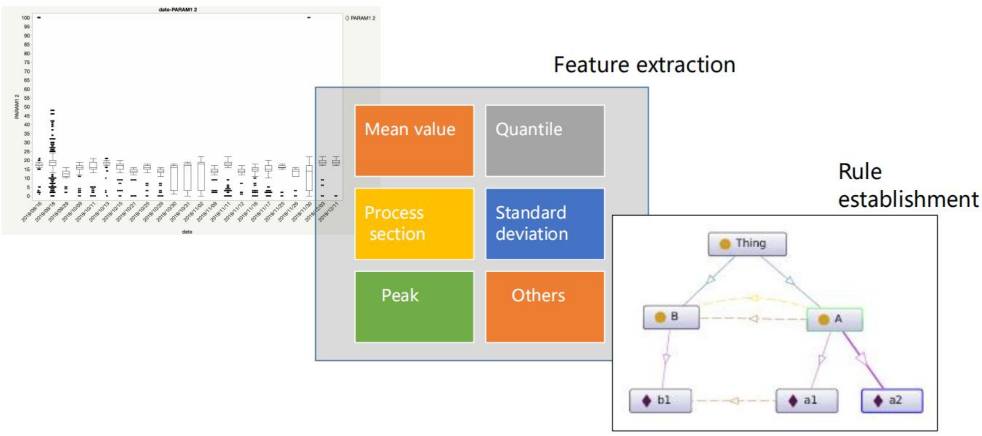

Figure 3: The collection of historical data, extraction of characteristics, and establishment of rules for the unsupervised machine learning model

5. Conclusions

Data mining technology plays an important role in the predictive maintenance of oil and gas equipment. The real-time monitoring of the equipment operation state, the timely discovery of potential mechanical faults, and the fault type identification and positioning analysis can offer proactive solutions of faults, which can make the equipment be always in a stable operation state. This work discussed the basic problems and key technologies in the application of oil and gas equipment, to effectively conduct equipment fault diagnosis and degradation prediction of mechanical equipment health. At the same time, through the big data based monitoring and guiding, the research can help to promote the health of machinery and equipment during the development of "Industry 4.0".

References

[1] Abbasi, T., Lim, K. H., & San Yam, K. (2019, April). Predictive maintenance of oil and gas equipment using recurrent neural network. In Iop conference series: Materials science and engineering (Vol. 495, No. 1, p. 012067). IOP Publishing.
[2] Cline, B., Niculescu, R. S., Huffman, D., & Deckel, B. (2017, January). Predictive maintenance applications for machine learning. In 2017 annual reliability and maintainability symposium (RAMS) (pp. 1-7). IEEE.
[3] Abbasi, T., Lim, K. H., Rosli, N. S., Ismail, I., & Ibrahim, R. (2018, August). Development of predictive maintenance interface using multiple linear regression. In 2018 International Conference on Intelligent and Advanced System (ICIAS) (pp. 1-5). IEEE.
[4] Carvalho, T. P., Soares, F. A., Vita, R., Francisco, R. D. P., Basto, J. P., & Alcalá, S. G. (2019). A systematic literature review of machine learning methods applied to predictive maintenance. Computers & Industrial Engineering, 137, 106024.
[5] Shanbhag, V. V., Meyer, T. J., Caspers, L. W., & Schlanbusch, R. (2021). Failure Monitoring and Predictive Maintenance of Hydraulic Cylinder—State-of-the-Art Review. IEEE/ASME Transactions on Mechatronics, 26(6), 3087-3103.