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Research on ARTIS Tool Monitoring Technology Based on Auto Parts Processing

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Abstract: ***Aiming at the problems of many false alarms in the application of the ARTIS tool monitoring system in the processing of automotive parts, by analyzing the changes in the typical characteristics of the tool monitoring signal in the processing of automotive parts, it is proposed to develop different monitoring methods for different characteristics, and the monitoring signal The sensitivity is optimized. So as to reduce the number of false alarms and missing alarms, improve the effectiveness of ARTIS tool monitoring, improve the processing efficiency of auto parts, reduce scrap, and save costs.***

Keywords: ARTIS, Tool monitoring, Auto parts processing, False alarm

1. Introduction

With the rapid development of automotive industrialization, the importance of flexible manufacturing systems in automated processing is increasing. Process monitoring for workpieces, tools, fixtures and machining processes has been valued by many auto parts processing companies. Among them, tool wear or fracture will affect the processing cycle of the workpiece, and even cause the scrap of the workpiece. Therefore, online tool monitoring system is particularly important in automated production. At present, the tool monitoring technology researched by many scientific researchers and engineering technicians in the world is generally a process in which the sensor collects signals for data processing and status recognition, as shown in Figure 1.

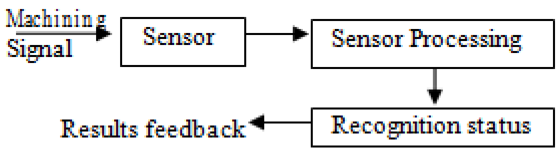

Figure 1: Tool monitoring technology process

The existing tool monitoring technology is divided into direct measurement method and indirect measurement method[1]. The direct measurement method is related to the tool material volume loss, and can intuitively judge whether the tool is damaged, but due to the need to shut down offline detection, it takes up production time; the indirect measurement method monitors the cutting process parameters, such as cutting force, torque, cutting power, vibration, sound Launch etc. The indirect method can monitor online and save time, but there are many interference factors in the monitoring process, which affect the authenticity of the monitoring, leading to too many false alarms or the phenomenon of missing alarms. Among them, the ARTIS tool monitoring system is to monitor the change law of the torque suffered by the tool during the machining process. The ARTIS system can monitor the abnormality of most tools during the machining process. Because this system has adaptive characteristics and the monitoring accuracy is not high, Unable to identify multiple working conditions, leading to false alarms and missing alarms.

2. ARTIS tool monitoring principle Size and Layout

The ARTIS tool monitoring system is a system that monitors the torque change of the tool during the processing process in real time. The torque signal of the processing process is transmitted to the general module GEM (Genior modular) through the sensor. After digital analysis, it is converted into an electrical signal and fed back to the man-machine. On the interactive panel, it is transmitted to the process control unit at the same time to realize real-time monitoring [2], as shown in Figure 2.

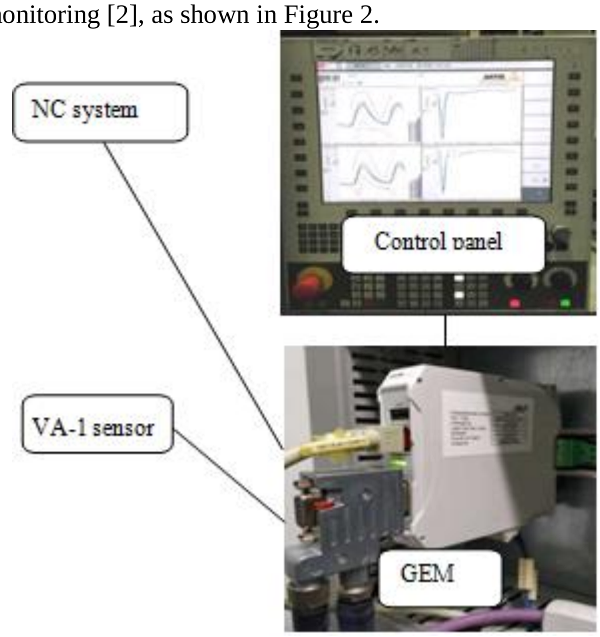

Figure 2: ARTIS monitoring theory

When the tool is first used, the monitored spindle torque variation rule is used as a reference standard. This process is called "learning". When the cutting edge of the tool wears, the torque on the spindle will increase; when the tool breaks, the spindle will suddenly be empty, and the torque will quickly change to the initial torque value. The two torque changes are compared with the learning curve. When there is a big difference, the system will immediately send an alarm to the PLC, and the tool will be notified of the abnormality through the PLC. ARTIS tool monitoring system can be equipped with open CNC system, such as Siemens 840D system. Realize tool abnormality alarm through human-computer interaction panel.

3. ARTIS tool monitoring method

Tool monitoring code

ARTIS can activate and deactivate various monitoring functions of ARTIS by adding the corresponding M and H commands in the NC program. Taking a machine code as an example, as shown in Table 1 M and H command function table.

Table 1: M and H instruction function table

Code	*Function*
H11	Program Number PN
M302	Conditional Stop
M303	Pause
M304	Thread monitor open
M305	Thread monitor close
M306	Monitor close
M307	Monitor open

ARTIS function introduction

ARTIS tool monitoring system is a system to judge whether the current tool has abnormality according to the torque change rule received by the spindle during the processing process, with time as the horizontal axis and torque Nm as the vertical axis, when the standard torque curve of the tool is wrong, the tool is replaced, and the blank is replaced When batches and optimized processing parameters occur, the torque needs to be collected again as a standard curve. This process is called "learning". The green line in Figure 3 is the standard curve for learning. "Learning" is a stage. This tool needs to process 10 workpieces of the same type. The torque curve collected by each piece is compared with the learning curve. Through continuous calculation, the upper and lower monitoring limits are obtained, which is the red curve. After 10 workpieces are processed, the precise monitoring stage is entered. The blue line is the current processing curve, and the gray line is the top 10 historical records.

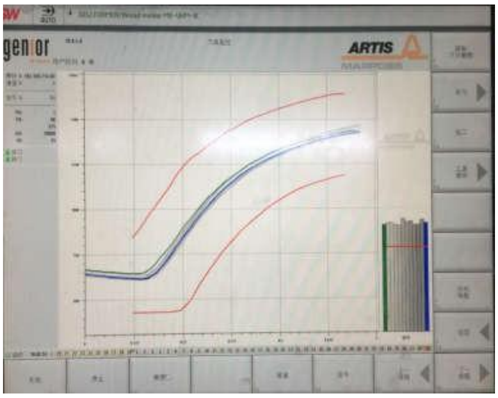

Figure 3: ARTIS monitoring interface

When the cutting tool breaks, the cutting edge is separated from the cutting tool body, the spindle is suddenly unloaded, and the torque force will quickly decrease. When the lower limit of monitoring is reached, the machine tool will issue a broken tool alarm and stop processing, as shown in Figure 4. When the cutting tool wears, the cutting edge becomes dull and the force becomes larger. When the upper limit of the contact is touched, the machine tool issues a wear alarm and stops processing, as shown in Figure 5. When the change of the tool monitoring curve is not obvious, or there is only a partial inconsistency, the upper and lower limits of the monitoring are not touched. By calculating the area and comparing, the tool shortage monitoring issues an alarm. At this time, the tool may break, as shown in Figure 6.

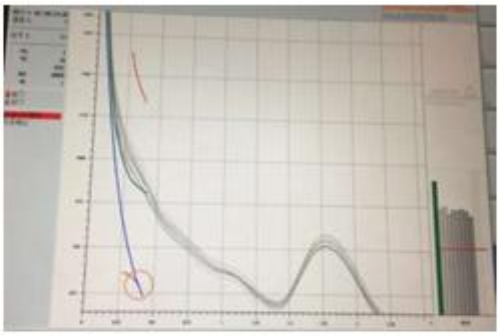

Figure 4: Tool breakage alarm

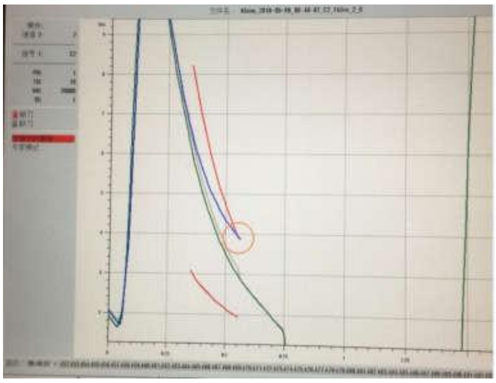

Figure 5: Tool wear alarm

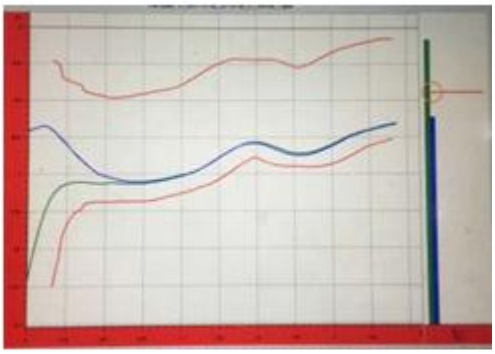

Figure 6: Tool missing alarm

4. Problems in application in complex machining

Leak alarm

Tools designed for different features have different torques due to different machining allowances and machining methods, especially for some reamers, taps and other tools with small machining allowances. The ARTIS tool monitoring system cannot collect the torque curve with large fluctuations, or even the curve fluctuations are not obvious, which will cause the upper and lower monitoring limits to not be close to the torque curve. As shown in Figure 7, when the tool breaks, the tool is empty and the torque will fall back to the initial value, the lower monitoring limit is lower than the initial value, then the curve will not hit the lower monitoring limit, and no alarm will be issued, resulting in batch scrapping.

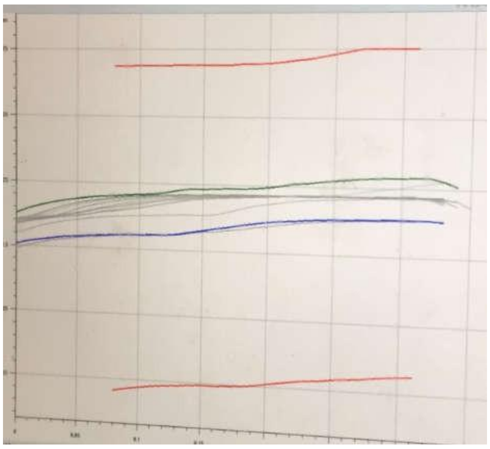

Figure 7: Monitoring upper and lower limit failure

Too many false alarms

The ARTIS monitoring system is extremely sensitive. Even if there is a small difference in the blank allowance, the torque collected by ARTIS will also be very different, resulting in too many false alarms, as shown in Figure 8. When the tool is processed to 3.5s, the torque increases, which is higher than the learning curve, multiple alarms occur, the tool is intact, and too many false alarms seriously affect the production efficiency and cause waste of working time.

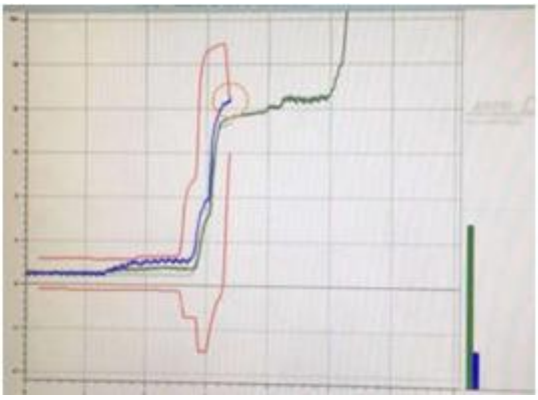

Figure 8: False Alarm

5. ARTIS monitoring and optimization methods

The torque curves of different parts of the gearbox shell of auto parts are different. For the curves processed by drills, milling cutters, taps, composite tools, etc., the ARTIS monitoring system can fully grasp the abnormal conditions of the tool, only for the force. Small tools, such as reamers, boring tools, etc., have the risk of abnormal monitoring. Different monitoring schemes can be determined for different features to avoid missing or false alarms in batch processing.

Leakage alarm optimization method

For the leakage alarm of the above problem, due to the small change in torque force, the fluctuation of the curve is not obvious and the upper and lower limits of the monitoring are not strict, but the area surrounded by the curve is accurate, and the difference between the front and rear parts is not large, by controlling the percentage of the missing tool area Can fully grasp the tool and break the knife. As shown in Figure 9. The blue curve is the current machining curve of the tool. Due to the large difference in the previous machining curve, the upper and lower monitoring limits are automatically moved away, resulting in monitoring failure. However, the area histogram on the right can be seen that the difference between the blue bar and the green bar enclosed by the standard green curve is not large, so the missing tool monitoring limit can be increased. According to the previous processing records, the missing tool monitoring limit can be set at 50 of the green bar At %, it not only avoids missing alarms, but also reduces false alarms, as shown in Figure 10.

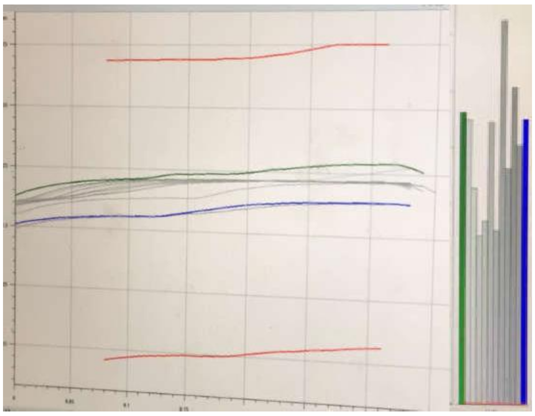

Figure 9: Tool breakage and alarm

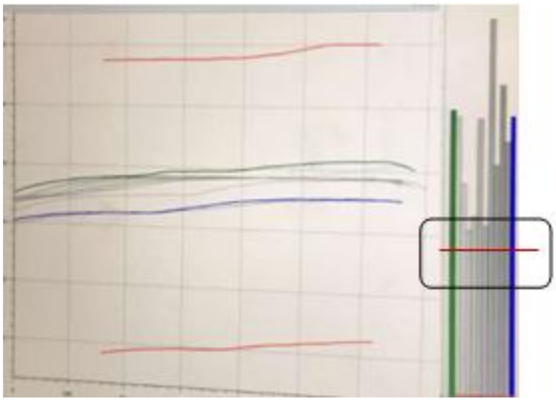

Figure 10: Leak alarm optimization

False alarm optimization method

Method 1: Due to the number of false alarms caused by the difference in the blanks, the problem of excessive production efficiency is affected. Through observation, it is found that the difference point of the entire processing curve is only at 3.5s, so you can set a monitoring time period and choose a stable and consistent curve to strengthen Monitoring, to avoid the occurrence of false alarms, as shown in Figure 11. The monitoring starts from the 4s, and turns gray in the first 4s, and no longer monitors. It can avoid the difference segment of the blank and make the upper and lower limits adaptively tighten.

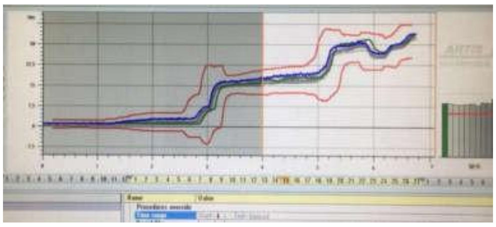

Figure 11: Set time period monitoring

Method 2: View the torque value of the learning curve at 3.5s and the torque value of the current blank abnormal curve at 3.5s, as shown in Figure 12. The difference between the two (17.19-15.65=1.54Nm) is the actual distance between the two curves.

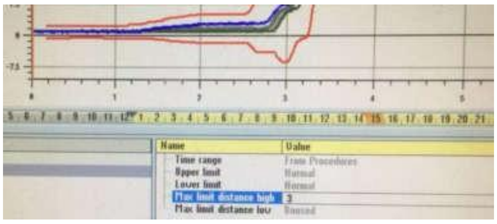

Figure 12: Actual torque value of learning curve and current curve

One of the reasons for the false alarm is that the monitoring distance is too close, so the monitoring distance of the upper monitoring limit can be set to be greater than 1.54Nm. Considering the stability of the blank and the stability of the machine tool, the maximum monitoring upper limit distance is set to 3Nm, which means that the monitoring upper limit distance cannot be less than 3Nm from the current learning curve, to ensure that the monitoring is effective, but also to reduce the number of false alarms, as shown in Figure 13 As shown.

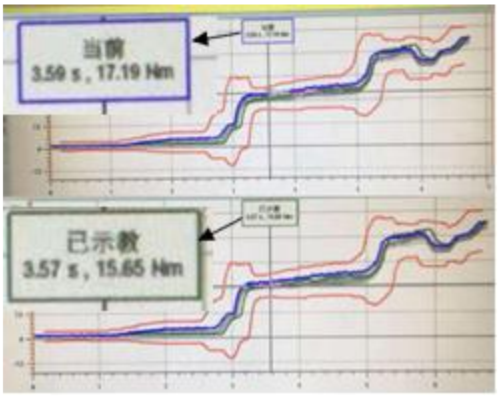

Figure 13: Setting the maximum distance of the monitoring upper limit

After optimizing the monitoring upper limit, after several rounds of stable processing, the distance between the monitoring upper limit and the learning curve is moderate, and the number of false alarms is effectively reduced, which achieves the optimization goal, as shown in Figure 14.

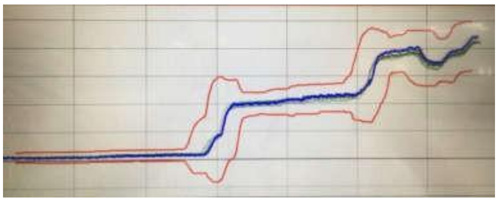

Figure 14: Monitoring upper limit after optimization

6. Conclusion

By analyzing the torque variation law of the tool for different characteristics during the machining process, the current ARTIS tool monitoring system has the problems of missing alarms and false alarms, and puts forward an optimization plan to improve the effectiveness of the alarm by controlling the percentage of the missing tool area, and by Time period monitoring or setting a reasonable monitoring distance improves the situation of too many false alarms. Facts have proved that the above method can greatly improve the problem of missed alarms and false alarms, improve processing efficiency, and reduce product scrap.

References

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Author Profile

Chen Zhang graduated from Tianjin Vocational and Technical Normal University with a master's degree in mechanical engineering, and has been engaged in mechanical design and processing technology since 2016. Currently engaged in the pre-planning work of auto parts products technology and quality.