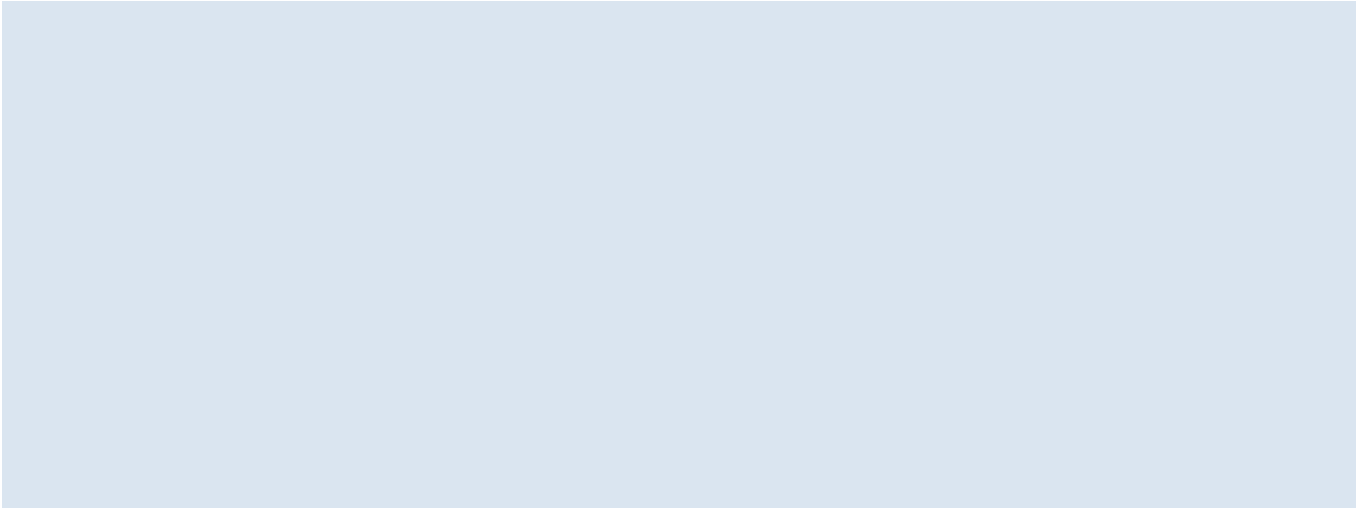# An Innovative Maintenance Service, K-COMMIT

user's site. In addition, it obtains data for predicting the robots' operations and load conditions and creates a database. It analyzes the acquired data and performs failure prediction, enabling accurate and optimal preventive maintenance.

(ⅰ) Example of failure prediction (current value analysis)

For example, TREND Manager can predict the failure occurrence date and issue a warning by performing statistical analysis of changes in its current value and the trend of the servo motor. Since this allows the user to implement preventive maintenance by planning maintenance before the predicted failure occurrence date, it becomes possible to avoid sudden failures. From the trend graph of TREND Manager illustrated in Fig. 2, changes in the current value over time and its trend can be grasped.

(ⅱ) Enhancement of the failure diagnosis function

In order to respond to more requests from users, we are working to enhance the functionality of TREND Manager. In order to identify the failure parts of the reduction gear that significantly affects downtime, FFT (FFT: Fast Fourier Transform) analysis of the waveform of the motor current was developed, and we are working to improve the prediction accuracy to utilize it for early diagnosis that matches the users' maintenance plans. We are planning to further enhance the functionality of TREND Manager by incorporating technologies such as machine learning and AI.

(2) Extensibility into systems

TREND Manager is capable of acquiring the data of painting equipment, pneumatic equipment, and the PLC
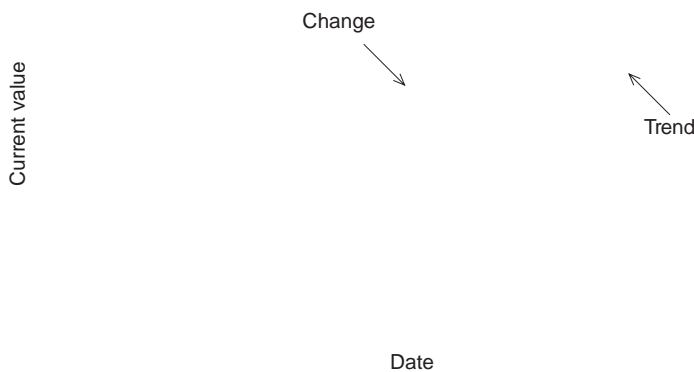
Fig. 2  Trend Graph of TREND Manager

(Programmable Logic Controller) that controls robot peripheral equipment and then performing trend management.

(3) Mail notification function

When an abnormality occurs, TREND Manager issues a warning or an alarm to pre-configured e-mail accounts. In addition, detailed data to be used for analysis, such as the motor current for each axis, is sent.

(4) Traceability function

In addition to the funct ion of comparing the current and past data for each robot, TREND Manager can visualize the operation amount, operation time, and alarm occurrence frequency for each axis and trace past robot conditions from such data.

(5) Remote monitoring/maintenance function

All of the functions described above can also be used through remote operation from the service center via a network. In addition, the state of the robotic equipment operating in the users' production sites can be made visible by installing network cameras. If the robotic equipment stops, and if fixing the problem does not require parts replacement, troubleshooting can be performed through remote control operation by watching the network camera image. This makes it possible to recover robots without visiting the users' sites, bringing significant advantages in recovery speed and cost.

## 5 Quantitative Inspection

Direct-reading ferrography analysis has been incorporated into the existing Quantitative Inspection as a new diagnosis method.

(1) Direct-reading ferrography analysis

Direct-reading ferrography analysis is a method in which quantitative changes of wear particles in lubricant or hydraulic oil by particle size are analyzed using the analyzer described in Fig. 3. We have succeeded in diagnosing the failure trend of reduct ion gears more accurately than with the conventional iron contamination measurement.

(2) Issues with iron contamination measurement

Conventionally, the state of wear of a reduction gear was determined by measuring the iron contamination of the grease and judging the value to be a "normal value," "warning value," or "abnormal value." Although iron contamination of the reduction gear grease rapidly increases when abnormal wear of the reduction gear occurs, a certain degree of increase was observed in the iron contamination even under a normal state of wear, as iron contamination measurement is a method that measures the total amount of iron particle in the grease. In addition, even for a reduction gear in an abnormal state of wear, the iron contamination value temporarily decreases if the grease is replaced even once, which interrupts judging to be "abnormal." That was an issue with using iron contamination.

(3) Resolution of issues by dir ect-reading ferrography analysis

In order to resolve the above issues, the direct-reading ferrography analysis method has been adopted. For a while since the use of a robot is started, many particles in the reduction gear grease have a diameter smaller than 5 μm (small particles). However, when an abnormality occurs in the reduction gear and abnormal wear starts, particles

## Conclusion

The development of K-COMMIT has made eliminating