New Products & Technologies

On-line Machine Diagnosis System, "CMS-3000 Series"*

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1 Introduction

There is a noticeable change in the trend of machine diagnosis recently. It used to be a simple judgment of abnormalities of mechanical elements of an equipment. Today, it goes far beyond and aims at efficient operation of an equipment by monitoring the operating conditions of entire manufacturing facilities. It is going even further toward quality diagnosis that includes in its judgment objective the quality of products manufactured.

To satisfy these needs, Kawatetsu Advantech Co., Ltd. has developed an on-line machine diagnostic system, "CMS-3000 Series," using high-speed LAN. As a tool for judging an overall condition of production facilities, it collects analog signals for measurement and contact signals indicating the operation conditions, as a useful reinforcement to a conventional diagnostic method utilizing the vibration process in use for judgment of mechanical elements. The paper introduces the new development.

2 System Configuration and Features

As shown in **Fig. 1**, this system consists of local stations (L/S), which collect various signals indicating the condition of the equipment, and the central station (C/S) which accumulates and analyzes data sent from the local stations.

Local stations are dispersedly placed at various loca-

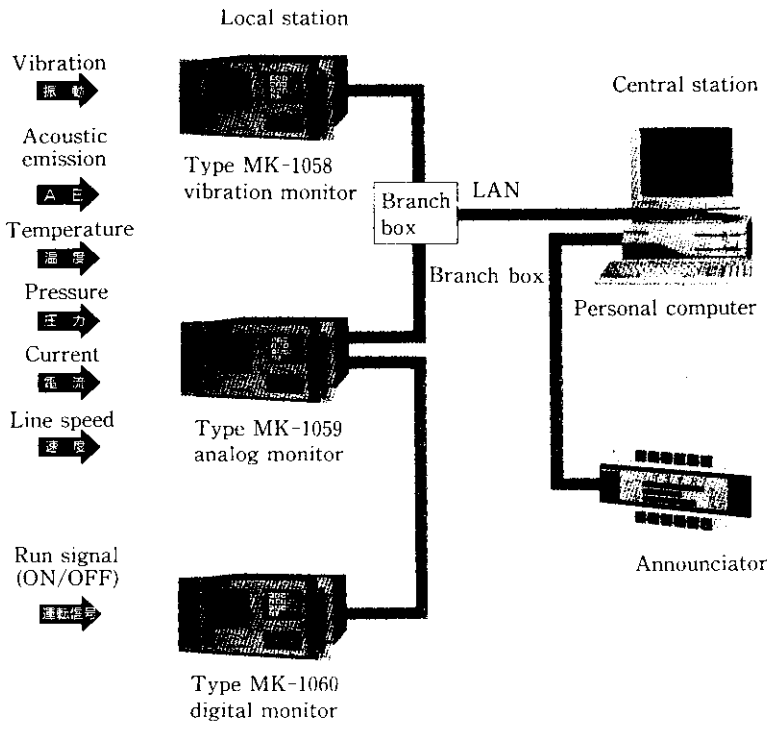

Fig. 1 Example of system composition

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tions of the equipment for diagnosis, and can collect information of signals from various sensors and measuring signals and perform primary processing such as averaging of data and comparative judgment between data and alarm levels, using a built-in microcomputer.

The C/S sorts out and files various sundry data sent from L/S by LAN communications and, with operator's actions, can freely display on the CRT those data which are necessary for diagnosing the operating condition of the equipment and trend control graphs.

In addition, the use of RS-232C interface has made it possible to connect C/S to other systems, such as equipment control process computer, or AI systems.

For LAN which connects L/S and C/S, the company has developed exclusive-use LAN communication boards and incorporated them into each L/S and C/S. Its communication speed is about 100 times 9 600 bps, the speed in using RS-232C of common conventional type, permitting mutual transmission and reception of bulk data between L/S and C/S.

This system can be linked to maximum 32 units of L/S and C/S combined, and the cable used for the connection is a pair of shielded twist-pair cables, with the total cable length extendable to 1.2 km (provided however that a repeater is required at each 300 m of the cable).

The outstanding features of this system can be summarized as follows:

(1) Multifarious and bulky information, which indicates equipment condition such as vibration, temperatures and pressure signals during operation, can be collected by local stations (L/S) placed in an optimum manner.
(2) Digitized bulk information can be mutually communicated between L/S and C/S at high speed through LAN.
(3) C/S permits incorporation of ample software, thereby coping with multifarious needs ranging from simplified analysis to precision analysis.
(4) The system operation has been made easier by the easily-visible conversational mode display screen.
(5) The system can be easily expanded when increasing the number of diagnostic objects.

3 System Functions and Specifications

3.1 Local Station

Local stations are broadly divided into three kinds, each of which has the following function:

(1) MK-1058 Vibration Monitor
The vibration monitor permits direct inputting from plural vibration sensors, and incorporates ① a logic which can measure vibration levels by sequential automatic changes-over of channels and, when a vibration level exceeds an alarm level set on the C/S side beforehand, can judge the situation as worth issuing alarm and ② a function to collect data for frequency analysis.

(2) MK-1059 Analog Monitor
The analog monitor has a function for an automatic high-speed sampling of measuring-signals, which indicate equipment conditions such as temperatures, pressure and flow rates, so as to compare these data with an alarm level previously set on the C/S-side for judgment.

(3) MK-1060 Digital Monitor
It has functions of ① monitoring the ON/OFF contacting states of operational signals, ② judging equipment abnormalities by cumulative calculation of the frequency of ON or OFF or by watching ON or OFF time-intervals, and ③ centralized monitoring of ON/OFF condition at C/S.

The specifications of L/S are shown below.

(1) MK-1058 Vibration Monitor
Inputs:
Vibration Signal ···· 8 channel, (As options, its additional installation upto 32 and 64 channels is possible.)
Revolution Signals ··· 8 channel, 1 to 5 V or 4 to 20 mA
Signal during operation ····· 8 channel, relay-contacts
Vibration Pickup: Piezo-electric type, 100 mV/G
Measuring Mode: Acceleration (O/A value, BPF value, peak value and envelop), velocity and displacement
Measuring Ranges:
Acceleration ····· 0.5, 5, and 50 G
Velocity ····· 0.5, 5, and 50 cm/s
Displacement ···· 50, 500 and 5 000 μm
Measured Frequency Range:
Acceleration $\bar{O}$/A ··· 5 Hz to 40 kHz
Acceleration BPF ··· 1 to 40 kHz (Peak and envelop also pass through the same filter.)
Velocity ····· 5 Hz to 1 kHz
Displacement ····· 5 Hz to 1 kHz
Channel Switching: Automatic and manual
FFT Frequency Range: 10, 20, 50, 100, 200, 500, 1K, 2K, 5K, 10K, and 20 kHz (11 ranges)
A/D Converter: 12 bit/W
Sampling Time: About 50 s/channel, when 4 modes are measured
Alarm: 2 stages at each pickup

(2) MK-1059 Analog Monitor
Inputs:
Analog Signal ····· 8-channel; additional installations up to 32 and 64 channels are possible by option (0 to 5 V, 1 to 5 V or 4–20 mA)
Conditional Signal ··· 8-channel, relay-contacts

Table 1 Function of central station

Item	Contents of data processing
Data registry	Equipment data registry Measurement condition parameter registry Diagnosis parameter registry Maintenance data registry Data edit and delete
Data gathering (Measurement)	Receipt of hourly data from local station Calculation of daily and monthly data Display of trend graph (hourly data, daily data, monthly data)
Single diagnosis	Comparison with alarm level Prediction of machine life
Precision diagnosis	Data input for FFT analysis FFT analysis, display of spectrum Automatic diagnosis Three-dimention display of spectrum
Data output	Printout of alarm message Printout of result of diagnosis Hardcopy of CRT display

Channel Switching: Automatic and manual
A/D Converter: 12 bit/W
Minimum Sampling Time: About 1 s/64 channels
Alarm: 1 stage/channel

(3) MK-1060 Digital Monitor
Input: No-voltage contact 8-channel (Additional installation up to 64 channels is possible by option.)
Functions: ① Cumulative calculation of the number of times of ON or OFF
② Cumulative time of contact ON or OFF
③ ON/OFF pattern during past one hour
Sampling Time: About 1 sec (min.) per 64 channels

(4) Local Station Common Specifications
Displayer Portion: LCD (display of measured data, measuring conditions, etc.)
Memory Portion:
Memory Capacity ····· ROM 64 KByte and RAM 64 KByte
Memory Contents ····· Time signal data, alarm data and measuring conditions
Communications Interface ··· LAN communications interface
Power Source: AC 100 V, 50/60 Hz, 20 VA
Working Temp. Range: 0 to 40°C
External Dimensions: 376 (W) × 177 (H) × 125 (D) mm
Weight: About 12 kg

3.2 Central Station

For the central station, PC-9800 series manufactured by NEC is used. This diagnostic system has the following functions:

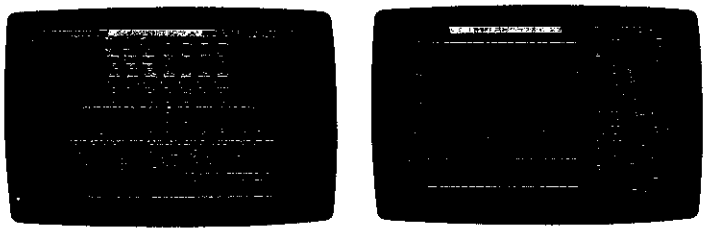
(1) Summing-up operations such as sorting-out of measured data sent from L/S, processing of Daily and Monthly Reports and filing of these data into the disk.
(2) Graphic display on the CRT of data stored in the disk and thier hardcopy.
(3) Setting-up of parameters such as measuring conditions and alarm levels.
(4) Display and printout of alarm information sent from L/S.
(5) Outputting of diagnosis-supporting data.

Machine diagnosis software using the vibration method is now made into a package, and has various functions shown in **Table 1**. The typical example of its CRT display screen is shown in **Photo 1**.

3.3 LAN Communications

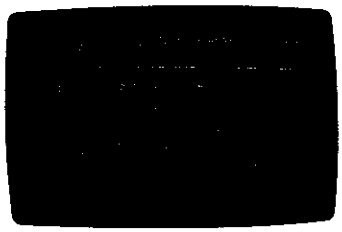
LAN communications system can be structured with comparative ease by incorporating exclusive boards developed by the company into L/S and C/S. Since the LAN board for C/S is made compatible with PC-9800-series expansion board, it is possible to additionally install the LAN interface simply by inserting the expansion board into the expansion slot.

Further, this expansion board incorporates CPU, and

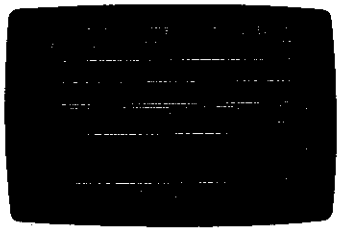


(a) Layout display

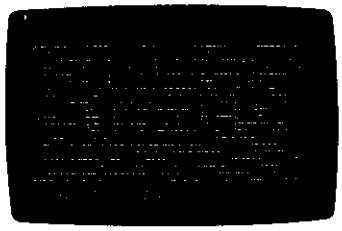
(d) Trend graph display



(b) Alarm list display



(e) Wave and spectrum display



(c) Machine name list display

(f) Management file display

Photo 1 Examples of CRT display

since all transmission and reception processings between L/S and LAN are carried out by CPU, it is convenient that there is no need of considering special communication processing at the application software in C/S.

LAN specifications are shown below.

(1) Applicable Circuit: RS-485
(2) Circuit Composition: Multi-point bus-type branch-connection network
(3) Communication Method: Semi-double communications method
(4) Transfer Speed: 1 Mbps
(5) Transfer Sequence: Omni-net Protocol II
(6) Collision Detection Method: CSMA/ACK method
(7) Transfer Distance: 1.2 km (provided however that a repeater is necessary at every 300 m)

4 Concluding Remarks

In the above, the On-line machine diagnosis system has been introduced. This system permits a low-cost structuring of an on-line diagnostic system by combining local stations manufactured by Kawatetsu Advantech Co., Ltd. and a personal computer sold on the market.

Today in this information-intensive society, the method of connecting computers with LAN to mutually transfer information is implemented widely. In the field of the machine diagnosis, trends are progressing from the simple monitoring of machine troubles toward collecting various data from widely dispersed areas and giving overall diagnosis to the entire production line.

Under such conditions, it is expected that the LAN system, which has been introduced here, will be a useful means of machine diagnosis for effective applications.

For Further Information, Please Contact to:

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