A Method for Failure Detection Based on Monitoring Data from Existing Facilities

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We have been studying technologies for detection of failures and ways in which alarms can be triggered based on data obtained from existing facilities and sensors. However, it is often the case that no method can be found for directly sensing the conditions of target objects or phenomena that we wish to detect. In such cases, two options can be considered. One is to install new sensors to detect the target objects or phenomena directly. The other is to determine the existence of failures from existing data which is considered to relate to or depend on the phenomena and occurrences.

The option of installing new sensors to monitor failures allows them to be detected directly. This option offers the advantage that processing of the information to determine the existence of a failure is simpler when compared with indirect detection method. The disadvantage is that the sensors attract an installation cost and an increase in maintenance costs. In contrast, the option of detecting failures using data available from existing facilities incurs no additional costs, although some care is needed to determine whether or not failures are occurring. Having considered these factors, we performed an empirical study to approach this problem using the latter option.

The concept of failure detection is as shown in Fig. 1. First, data is collected during normal conditions (normal data). Next, the range of values that may be regarded as normal through statistical analysis techniques is determined, based on the normal data obtained. Then, if the observed data falls within the range, the data is considered to be normal. If it falls outside the range, the data is considered to be unusual. This is a basic concept that can be applied to any facilities.

For example, we have investigated whether or not the breakage of crossing rods can be detected from the level of electric current used to operate existing automatic barrier machines. Since there are so many crossings, the installation of sensors to each automatic barrier machine would incur significant cost. Also, the situation in which a crossing rod is broken would lead to passers-by being exposed to danger, and accordingly detection of the failure is required as quickly as possible. Therefore, we think that, if the failure can be detected by measuring the electric currents operating automatic barrier machines, safety can be improved at low cost.

In this study, we carried out a test in which five situations were simulated by the operation of two automatic barrier machines (Fig 2), each of which was supplied by a different manufacturer. We analyzed whether or not the breakage of crossing rods can be detected using the electric current data obtained in the test. In order to evaluate the effectiveness of the fault detection, we tested three methods: (1) using average values of electric currents; (2) using maximum values of electric currents; (3) using electric currents in time-series from the start of operations. As a result, in the discrimination method (3), we were able to detect failures correctly from electric current values of the automatic barrier machines (Table 1). Since our method has only been applied to a limited number of devices, we will continue to carry out more case studies in order to ascertain the effectiveness of our method.

Since the use of sensornet has attracted considerable attention, and the deployment of it is increasing, we will be able to acquire data for a range of facilities in the near future. We expect that the scope of this technique will continue to increase.

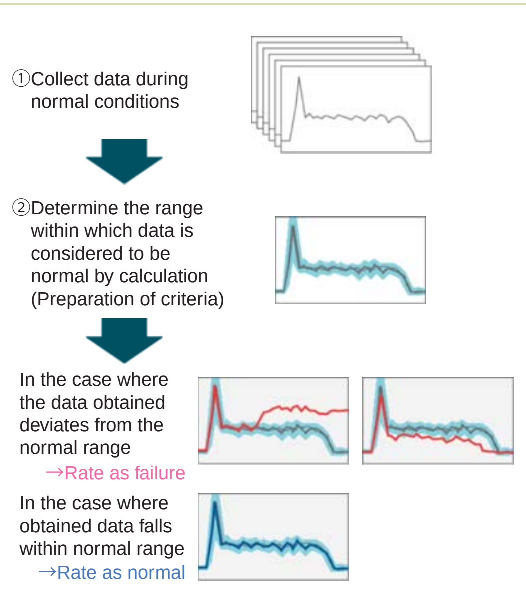

Fig. 1 Concept of failure detection

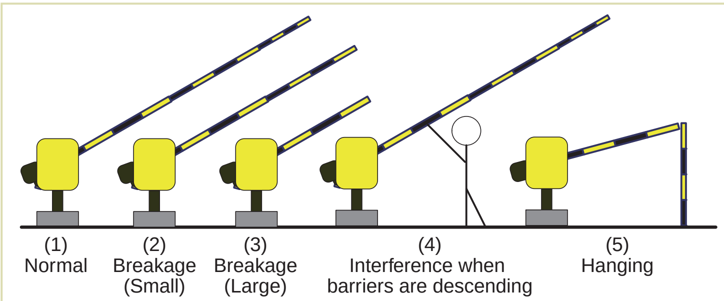

Fig. 2 The contents of a simulation test for breakage of crossing rods / interference when barriers are descending

Table 1 The result of rating using electric currents time-series data

	Crossing A				Crossing B			
	Automatic barrier machine 1		Automatic barrier machine 2		Automatic barrier machine 3		Automatic barrier machine 4	
	Ascending	Descending	Ascending	Descending	Ascending	Descending	Ascending	Descending
Breakage (Small)	◎	◎	◎	◎	◎	◎	◎	◎
Breakage (Large)	◎	◎	◎	◎	◎	◎	◎	◎
Hanging	◎	◎	◎	◎	◎	◎	◎	◎
Interference when barriers are descending	−	◎	−	◎	−	◎	−	◎

◎: 100% rated ○: One rating of normal case as failure
△: One rating of failure case as normal ×: Two or more erroneous ratings