ProM@in

Task T2:

Automatic switch diagnosis

Automatic switch diagnosis: cost efficient implementation strategy

The interest stated in the questionnaire is highest for the cost area. It will be a specific subtask to prove LCC advantages of automatic diagnosis for switches for different railways.

State of the Art

For many years efforts have been undertaken in different countries [1] - [5] to implement automatic condition monitoring and diagnosis for switches in the field. The purpose is to have a continuous sensor-based supervision to prevent failures by the detection of slight changes in monitoring signals. This results in higher availability of the track and reduces inspection and maintenance efforts. Due to that railway staff have to spend less working hours in the track and their personal safety is increased.
In spite of these obvious advantages some obstacles to a broad introduction of switch diagnosis have to be overcome which is the purpose of this task.
The best known system [2] for switch diagnosis, which is implemented in different countries, provides a lot of information through physically heterogeneous sensors at different measuring points in a switch. These measuring points are:

- Monitoring of switch-stock rail contact area
- Monitoring of open switch
- Monitoring of switch operating rods and/or switch locking system
- Monitoring of minimum distance between open switch and stock rail (switch flangeway)
- Direct measurement of the force needed for each single operation of switches
- Residual stress in the switch and/or the rodding (retaining force)
- Current and time needed for the operation of switches
- Monitoring of the pressure needed in the switch machine for the operation of switches
- Monitoring of the position of the detector rods
- Monitoring of the strikes at the crossing point, indicating wear of the check rail and/or wing rail
- Monitoring of screw preloading forces in bolted compound crossings
- Longitudinal forces in the rail
- Rail temperature and ambient temperature
- Point machine current

The sensors at the measuring points and the monitoring system are connected by means of flexible cables, which are embedded in protective tubes. Special software programs combine and pre-process the collected data and prepare these for subsequent transmission. The collection system is realised in a modular open microprocessor technology and consists of appropriate bus components. The pre-processed measured data are transmitted by means of bus protocol communication to a central station for data processing (trends, statistics...) and supervision by one expert surveying many switches in the field, who takes the decision on necessary maintenance actions.

Problems to be addressed

The short description of the state of the art reveals that the diagnosis and decision making is not yet fully automated. This is one key concern of railway companies, which can be solved by adding an expert component to the system.
Another concern is the manifold of sensors of heterogeneous physical nature at different locations which may require maintenance themselves and provoke consequential costs for their reattachment in cases of repair actions. This problem can be tackled by more sophisticated information processing of sensor signals (especially of the current in the point machine) to eliminate the need for some sensors and by using geometric information from measuring cars for the same purpose.
A specific problem with the outlined measuring points is the fact that different railways follow diverging safety concepts requiring different measuring points and different levels of interaction. This divergence mainly causes that a switch diagnosis system up to now is not a standardised product with a big European market, but always needs tailoring for its specific national railway applications. The identification of requirements common to several railways would be a progress.
A last relevant problem to be mentioned here is the difference in type and value of parameters used by different railways for the calculation of life cycle costs. Therefore the big cost reductions possible through switch diagnosis (see under Benefit) and proven for DB installations is not accepted by other railways. A

solution in this field would be to generalise the LCC-model used for calculations so far [6] and to make it applicable for the purposes of different railways.

Expected Benefits

An obvious benefit of automatic switch diagnosis would be great reductions in life cycle costs (LCC). Analyses for a conventional line (160 Km/h) of DB AG reveal this [6]. In this investigation the annual life cycle costs prior to installation of a Roadmaster 2000 system amounting to about 25000 Euro/year could be reduced to less than 15000 Euro/year depending on the installed option of Roadmaster 2000.

Through the harmonisation of requirements among railways a better standardised system with a bigger market and lower procurement costs is to be expected.

Finally the work on sensors and measurement procedures (type of sensors, stationary or non-stationary) will result in a simplified procedure requiring less sensors and less dedicated maintenance.

General approach offered by ProMain

To succeed in the development of a cost efficient implementation strategy for automatic switch diagnosis it is proposed to proceed in two major phases as follows:

Phase I has the general objective to analyse the requirements of different railways, to propose an integrated harmonised system and a general LCC-model (with ProMain resources). This work in co-operation with additional experts and members willing to co-operate (in case of recommendations and interest please send back the attached response sheet). Subtasks to be covered are:

- Compilation of concepts followed in railways today
- Comparison of functionalities of existing diagnostic systems
- Collection and harmonisation of requirements from railways
- Elaboration of an integrated harmonised system
- Generalisation of the LCC model used so far for the individual application by different railways
- Dissemination of results with recommendations for future activities (phase II).

The **deliverable** of this phase will be a report on general requirements, a concept for an integrated system and a general LCC model for the use of railways. An efficient and simple dissemination will again be performed via the ProMain internet server.

It is anticipated that future activities will be necessary to solve remaining cross-company needs. This is planned in **Phase II** for which the following topics probably will deserve attention:

- Developments towards a fully automated system using advanced information technologies like automatic reasoning and expert systems
- Harmonisation efforts in safety requirements for switch diagnosis

Work of this phase cannot be done with ProMain resources exclusively.

Sources

[1]	Kusak, H.U.:	Ferndiagnose von Signalanlagen und ihre Auswirkung auf die Instandhaltungsstrategie. Signal und Draht 87, 1995, Heft 12, 5-8
[2]	Povse, H.:	Überwachung, Sicherung und vorbeugende Instandhaltung von Weichen. Zukunftsorientiertes Qualitätssicherungskonzept für Hochleistungs- und Hochgeschwindigkeitsstrecken. Eisenbahningenieur 44, 1993, Heft 8, 479-481
[3]	Redi;P.; Gaspari, S; Lori, L.:	Cedias railway Lines Diagnostic System. WCRR Firenze, 1997, vol. B, pp393-398
[4]		Cogifer: http://www.cogifer.com
[5]	Weiss, H.:	Weichendiagnosesystem SIDIS W, Motor als Sensor. Siemens Verkehrstechnik, Braunschweig, April 2000
[6]	Kreutz, J.:	REMAIN: Modular System for Reliability and Maintainability Management in European Rail Transport. Final Report. IITB Karlsruhe, 1998

Further information on this task

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