Research in Brief

Towards a high resolution ‘internet of things’ moisture detection system for railways
Background

Rail head adhesion, which refers to the ‘slipperiness’ of the rails due to surface contaminants such as leaves, rust, oil and grease, is a year-round, whole-system problem at the interface between train and track. The problem is complex because of the number of factors involved, some of which can be monitored and controlled and some of which cannot. The lack of reliable and predictable braking results in significant train disruptions and cancellations and an increased number of safety related incidents.

Low adhesion is also the cause of substantial cost to the rail industry. The estimated direct costs (such as rail head treatment trains, manual rail cleaning) and indirect costs (such as driver reaction and morale; service disruptions and delays) make low adhesion an expensive challenge for the rail industry to tackle. Annually, it is estimated that direct costs amount to:

- £20m Train delay
- £30m Rail Head Treatment Train operating cost
- £5m Manual rail cleaning
- £8m Additional maintenance cost

Aims

The overall aim of this project, undertaken by the University of Birmingham, was to prove the feasibility of harnessing the emerging Internet of Things (IoT) to develop a high resolution, low cost moisture sensing monitoring network for the railways.

The data from the network of sensors would complement the high resolution forecasting system developed by the Met Office, which takes into account site specific leaf fall forecasts, rail temperature and dew point temperatures to estimate the occurrence of dew, frost, light rain and fog.

The data from the IoT network of sensors would enable the Met Office to validate their forecasting model while calibrating it in near real time, and it would therefore improve the accuracy of the forecasts.
Findings and Impact

The low cost (<£100) self-contained moisture sensor developed by this study was tested against existing, more expensive, sensors in both a lab and field setting. The IoT moisture detection system improves upon existing systems used on GB rail.

TfL and London Underground currently have a limited number of unconnected, battery-powered sensors placed at vulnerable sites that communicate with the LU Adhesion Management System (ACCAT). These sensors measure the presence of railhead moisture every 90 seconds and use GRPS to feed the data into LU’s Adhesion Management Software in real time.

Industry recognises the need to update this sensor system. The model developed by this study promises a more integrated solution and the potential to capture richer and more accurate data.

Three bespoke low cost sensors were developed based on an existing commercial ‘off the shelf’ platform. The device can take readings between 1 and 30 minutes, as well as upload data via remote mode (WiFi) to a cloud server.

Despite its low cost, the sensor was able to successfully identify wet and dry periods under both lab and field conditions. It did possess a slight over sensitivity to high humidity when compared with more expensive devices. The study has demonstrated that the low cost sensing of moisture has the potential to be included as an integral component of an adhesion management system.

Method

Two approaches were utilised to test the sensor against existing and more expensive devices.

• The initial tests were completed in a climate chamber at the University during a number of controlled dew formation experiments.

• The performance of the sensor was also tested during a one month field trial on the London Underground at Loughton.

• Moisture monitoring was measured via an alternative system attached to a dummy rail located approximately 3 metres from the live rail.
Next Steps

The current lack of WiFi infrastructure was a limiting factor in the study, but the sensor has since been further developed to utilise ‘sub-GHz’ which permits wide area internet connectivity. The result is a self-contained sensor which can now be deployed virtually anywhere.

Based on this development, trial networks of the sensors are now ready to be deployed to fully underline the operational advantages of the approach and a number of enquiries from industry have already been received. The possibility of making measurements directly from a train could also be explored.

The team has also developed infrared sensors, able to measure track temperature, which could be useful to help forecast dew point as well as mitigate buckling risk. These sensors are now being trialled for other applications on the road network.

Work is also presently underway via a PhD studentship to produce a low-cost imaging solution which could be used in conjunction with a moisture sensing system to predict adhesion conditions.

Where to find out more

The technical report and this Research in Brief are available at www.sparkrail.org