LOSANT

SEARCH

USING IOT AND MACHINE LEARNING FOR INDUSTRIAL PREDICTIVE MAINTENANCE

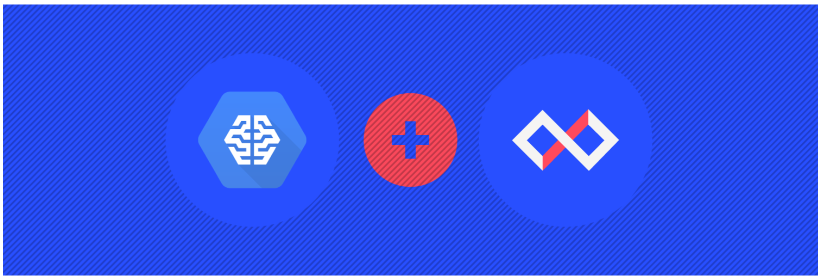
August 22, 2017

By Taron Foxworth / @anaptfox

MACHINE LEARNING

Overall, the Internet of Things will not work without intelligence and machine learning. IoT is not only about collecting the data, but it's also focused on obtaining value from the data after we've acquired it. Attaching sensors to everything only becomes worthwhile when we can predict, control, and make decisions in response to the data.

Now, as we collect massive amounts of IoT data, our ability as humans to make sense of it becomes quite the challenge. To be more efficient, a process is needed that will automatically and in realtime collect data, make predictions, and react. Machine learning and a complete toolchain that supports this model are required. Here is where Google Cloud Machine Learning and the Losant IoT Platform comes in.

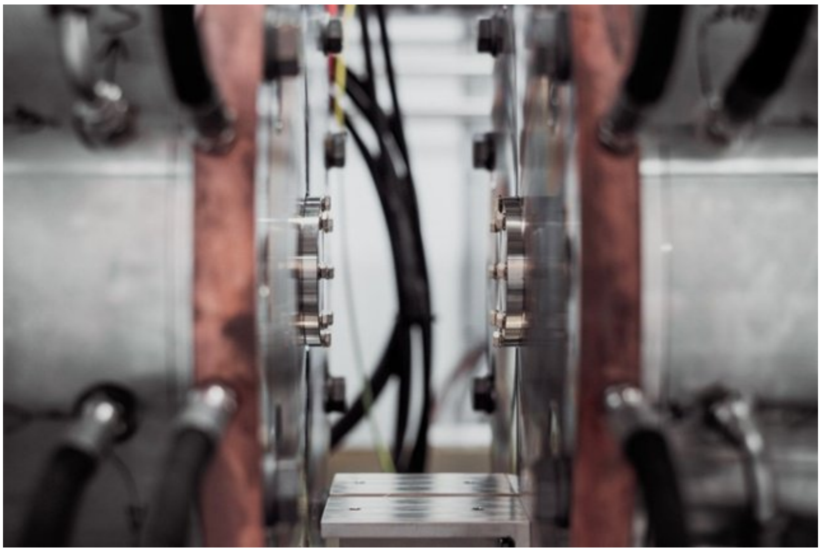


With these platforms, the process of collecting, predicting and deciding becomes simplified. Google Cloud Machine Learning Engine is a managed service that enables you to build, deploy, and scale machine learning models easily. Losant is an enterprise IoT Platform that provides the building blocks to create scalable IoT solutions. Together, Google Cloud and Losant provide a system that can ingest data, run the combined, these tools provide the following benefits:

- Quick time to production
- Increased operational efficiencies
- Overall cost reductions
- Scalable, flexible, and reusable IoT Architecture

This system and toolchain we described earlier is a key component to building a Predictive Maintenance System (PdM). In an industrial environment, a functioning PdM can predict problems in equipment before they occur—to perform corrective maintenance of the equipment before failure.

To accomplish PdM, most implementations use a form of condition monitoring that leverages a mixture of sound and vibration analysis to decide monitoring is in place, parsing through thousands of data points is necessary to decide what factors truly affect the status of the machine. Without machine learning, this task is nearly impossible.



USE CASE

Acme Industrial is launching an initiative to improve internal processes and monitor the total health of the Acme facilities. Ideally, this system will generate an alert if there are any problems ahead. Using the same data set and insight, Acme can also determine the health of their facilities as the PdM will have details about the current status of equipment in the facility.

To create this PdM, Acme must first decide and implement four key components:

LOSANT

COLLECT

Acme Industrial has thousands of machines in their manufacturing facilities. To detect problems, Acme will use a form of vibration analysis. Vibration analysis is efficient on most rotating equipment, which most of the machines in their facilities contain. To calculate vibration, Acme engineers will attach accelerometers to each of the machines sending the vibration data to the Cloud. Acme now has a data collection process in place.

ANALYZE

Next, Acme must determine the parameters that dictate if their machines are failing or not. Unfortunately, machine learning won't automatically predict problems or anomalies in data. You must first start with a problem or a question. Then, through machine learning, an answer can be found. Here is Acme's question:

```
Can we detect if a machine is likely to exper
```

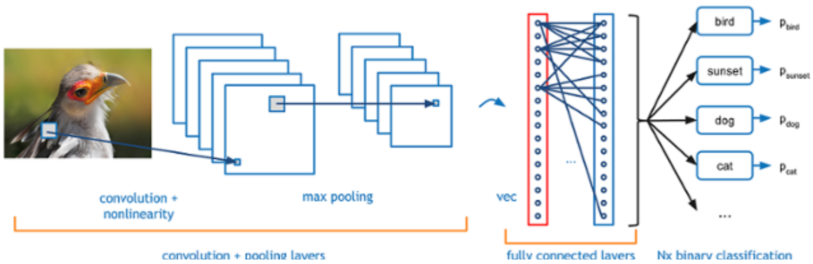
In machine learning, this is a considered a classification problem because Acme is looking for discrete answers in a data set. Acme's data set would be all of the vibration data collected from the machines. Acme is finding one of two

To determine what's failing or not, Acme must have enough data in each example to learn from it. Before Acme begins to predict when a machine will fail, they must have a large enough data set that provides examples of when the machines are failing and when the machines are operating normally. A good strategy to do this is to collect data from all the machines running in normal conditions. When a machine fails, we can capture the data during a specific period before the machine failed. This newly sliced data collected becomes my "likely to experience a failure" data set.

PREDICT

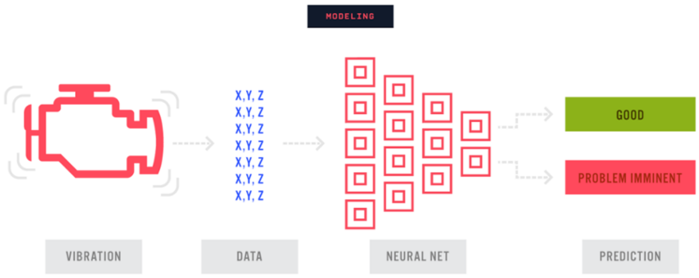
With a data collection process in place, a complete analysis, and data sets for training and testing, Acme can now build a model to answer the question.

Convolutional neural networks (CNN) are typically used to classify images. When a typical image classification model sees an image, it takes a long list of numbers. This list of numbers can be broken into subsets of 3 that represent R, G, B values of a pixel. Then, the model will identify which pixel(s) in that image determine whether or not that image contains the desired answer.



Acme's machine failure detection problem directly correlates to the image classification problem. From the vibration data collected, each accelerometer will output values of X, Y, and Z — data similar to R, G, B — then using a CNN we can similarly identify which vibration parameter(s) determines problems in our machines, or “likely to experience failure.”

Training is a very iterative process that can be done in the cloud. After training the model, Acme found that using this method we can predict with high accuracy if the machines in our test set are “likely to experience failure.”



Acme will now be able to use this model to predict when a problem is likely to occur on a machine. Along with a percentage likelihood, the model will also output a percentage confidence of the prediction. Acme can combine the confidence and prediction to determine when to perform corrective maintenance on the machine. Overall, this insight on a wide array of machines will give Acme the ability to calculate the health of the entire facility.

automated process from data collection to decision. With a prediction system in place, a reaction engine is needed to make decisions and generate notifications.

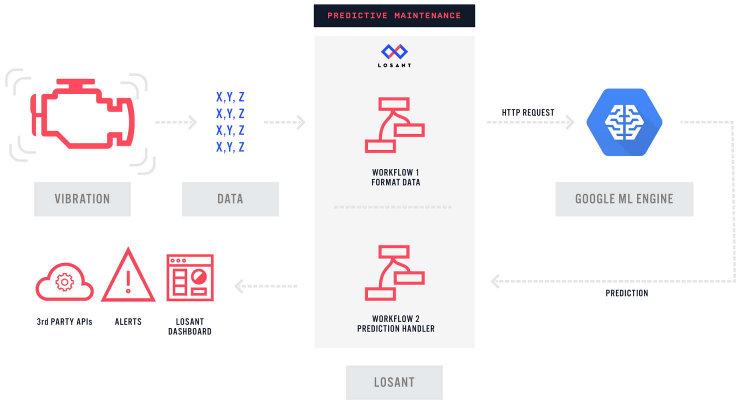
When a machine reports a vibration sample to the model, the model can decide if the machine is operating normally, or if the machine is likely to be experiencing a failure. When normal, no action needs to take place. While experiencing a failure, a support ticket can be created immediately to alert the necessary stakeholders.

SOLUTION

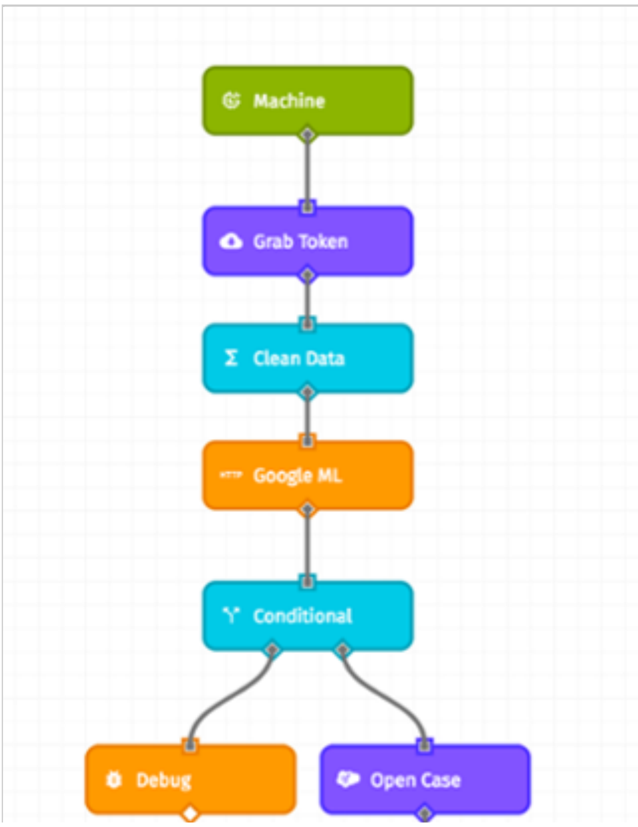
The end solution to Acme's problem and provides the most benefit leverages Google Cloud Machine Learning Engine (Google Cloud ML) and the Losant IoT Platform.

Google ML Engine supports training and deployments of TensorFlow models in the cloud. After training a TensorFlow neural network to detect machine failures, Acme can deploy and use the model to make predictions.

The hardware attached to the machine is reporting a vibration sample to Losant at a fixed sample using a Device Trigger.



This workflow will first reshape the data. Google ML Engine supports running data through hosted models with little latency via an API. This gives Acme the ability to make an API call directly to the Google ML Engine in the workflow. After a prediction is received, we can decide what to do next. In the example below, a positive result will trigger a Salesforce case ticket to be opened.



CONCLUSION

This system and toolchain support a growing IoT architecture. With Google ML Engine, Acme can continually deploy, re-train, and re-deploy models to gain more efficiencies. Changing business logic or decisions made from the predictions are a simple drag-drop update to the interface in Losant. Additionally, not only can Acme iterate quickly, but Acme can create new models to answer more questions, and the PdM system can scale to support it.

If you are ready to improve your predictive maintenance through machine learning, contact us.

There are 3 Comments

AMIR KHADEMI 03/12/2017 à 18:26:43

Thank you for your great article
I want to implement such a system that you mentioned above on a machine, it's a test case machine. I use it for

fault.
Thanks

REPLY TO *AMIR KHADEMI*

/ **TARON FOXWORTH** 18/12/2017 à 22:33:03

Hey Amir,

For this demo, we were able to attach an accelerometer to the machine that was vibrating. Through time, we were able to collect good and bad samples. Then, we were able to build a model based on that.

Losant provides a system that can ingest the data from the sensor, call upon the machine learning model in Google Commute, react, visualize information, and generate alerts. The machine learning model was created in Tensorflow and deployed in Google Compute Engine.

Feel free to contact our solutions team if you want to have a conversation:
https://www.losant.com/contact-us

REPLY TO *TARON FOXWORTH*

AASHISH AGGARWAL 23/02/2018 à 07:59:02

Thank you for the good information.
However, can you please provide any test data for such application.

REPLY TO *AASHISH AGGARWAL*

LOSANT

First Name Last Name

Email

Website

Comments

Subscribe to follow-up comments for this post

SUBMIT COMMENT

LOSANT

SHARE THIS ARTICLE

NEXT UP:

BACK TO BLOG

THIS MONTH IN THINGS: AUGUST 2017

WHAT IS LOSANT?

Losant is an enterprise IoT platform that makes it easy to build secure, complex connected experiences.

Losant's platform enables you to intelligently manage your devices, collect and visualize data, and ultimately take action on data through highly customizable workflows - all in real-time.

GET STARTED FOR FREE

ALL THINGS IOT. STAY CONNECTED.

Email

Sign up to receive our newsletter with the latest updates from the Losant team.

BLOG / 02.27.18

HOW TO BUILD AN

LOSANT

NO CODE - PART 1

BLOG / 02.27.18

WHY EDGE COMPUTING IS IMPORTANT TO YOUR IOT STRATEGY

/ Ashley Ferguson

LOSANT

hello@losant.com

Predictive maintenance benefits for the railway industry

Detect problems before they cause downtime for linear, fixed and mobile assets

Highlights

- Identify maintenance issues before they impact operations, revenue or safety
- Extend the life of assets with predictive maintenance analytics
- Meet capacity needs with reduced capital expenditures

Overview

Railroads are one of the most asset-intensive industries in the world. In addition to tracks, rolling stock and terminals, railroads own communications infrastructure and other assets that must perform perfectly at all times, both for safety and efficiency. Rolling stock in particular is in constant use, enduring relentless punishment from traveling over all types of terrain in harsh environments. Managing and maintaining this enormous inventory of assets efficiently can be time-consuming, expensive and, at times, daunting. Maximizing the availability of assets to earn revenue directly impacts financial return on assets and shareholder value.

Instead of continuing the historical cycle of break-fix work orders and static maintenance schedules, what if you could spot problems before they happen? Not only are these older methods more expensive, but they also make your railway more vulnerable to unplanned service interruptions and outages due to equipment failures. Such unexpected events can result in lost revenue and customer dissatisfaction, and even jeopardize safety.

Because assets are increasingly generating more data, you are in the perfect position to exploit that data with predictive maintenance analytics. Modern analytics software solutions can identify subtle patterns or abnormal events that can help you more accurately predict and affect the future performance of assets. Organizations that adopt a full range of analytics capabilities can discover what is happening, determine why it is happening, predict what is likely to happen next and prescribe the best action to take in advance. Smart asset management and maintenance solutions can maximize availability and prolong the useful life of assets to help them reach their highest potential for creating revenue.

Gain a competitive advantage using big data and analytics

Big data is a modern marvel. But capturing and storing data is just the beginning. Today's advanced analytics technologies and techniques enable organizations to extract insights from data with previously unachievable levels of sophistication, speed and accuracy.

Analytic tools can be especially useful in helping railways refine data to determine what information is most valuable for optimizing business outcomes. Today, railways can integrate new and existing sources of data without the high costs associated with a traditional data warehouse environment. Big data and analytics also enable more rapid capture and integration of time-sensitive data from many varied sources including fixed sensors and instrumented equipment.

Real-world success: Increasing rail network availability

A European railway's previous monitoring systems were inefficient, with a one-day system problem resulting in 200,000 stranded passengers at a cost of almost USD5 million. The company implemented a new system that monitors the status of physical and IT assets across their network of more than 800 train stations and rail lines, providing automated diagnostics and alerts. Now, more than 50 percent of issues are recognized and resolved before they affect train operations, and the availability of the rail network has increased by 4.6 percent.

Apply predictive maintenance analytics to improve asset performance

Predictive maintenance analytics solutions can capture sensor data in real time and integrate it with data from visual inspections, manual measurements, videos, operational data and more. Big data and analytics solutions can help provide faster insights from this disparate variety of information. These insights can help you improve asset availability and service levels, reduce the risk of unplanned service delays and outages, and implement smarter maintenance planning. For example, your railway can:

- Gain improved visibility into asset health and extend asset life.
- Reduce the high costs of unscheduled maintenance.
- Forecast maintenance parts and labor costs more accurately.
- Increase warranty recoveries.
- Determine the root cause of failures for any type of asset.
- Reduce excessive or unplanned downtime of equipment in the field.
- Integrate information from increasingly sophisticated and disparate assets.
- Deliver insights to front-line employees so they can make better decisions at the point of impact.

Real-world success: Optimizing maintenance intervals

A major rail maintenance firm collected data from sensors on its locomotives about the wear of individual components, but personnel still relied on their instincts to determine when parts needed work. The company deployed a solution to sharpen its predictive capabilities and optimize maintenance intervals. Sophisticated software analyzes data from on-board sensors along with historical data about components from their asset management system to accurately determine an optimal maintenance schedule. Using data such as date of manufacture, periods of use, places of use and mileage in conjunction with sensor data, the solution calculates cost-effective maintenance intervals for individual components, thereby reducing the risk of breakdowns, increasing first-time-fixes and decreasing maintenance cost.

Predictive maintenance can keep assets performing while reducing costs

Using the insights available through a predictive maintenance solution, railways can maximize asset performance and productivity while reducing many associated maintenance expenses. Predictive maintenance allows proactive asset maintenance or repair on your schedule to help minimize disruption to normal operations instead of forcing you to react to sudden, unexpected breakdowns.

Using a predictive maintenance strategy, it is easier to preserve capital by reducing the number of spare parts required. Better insights into when and where parts are needed help reduce expensive expedited shipping costs for spares. It can also save storage expenses while helping reduce capital set aside for the cost of the parts themselves.

The same applies to maintenance personnel. Thanks to more precise insights, crews can be scheduled more accurately, helping reduce or even eliminate overtime expenses. Because predictive maintenance gives you insights into the most likely upcoming issues, it is easier to be sure the necessary skilled personnel are available. Mobile devices can provide technicians with instant access to the technical manuals and parts inventory information that they need for maintenance and repairs.

Predictive maintenance solutions can also help make supplier contract negotiations more productive by providing the data necessary to make decisions. The solution can provide procurement teams and the suppliers' demand forecasting teams with clean historical data, warranty information, traceability and forecasted demand. The information can quickly be aggregated and used as guidance for mutual agreement on the best pricing and terms for the new contract period.

As illustrated in Figure 1, IBM studies[1] have found that when compared to companies that use traditional approaches, on aggregate those that use predictive maintenance solutions can enjoy significant benefits.

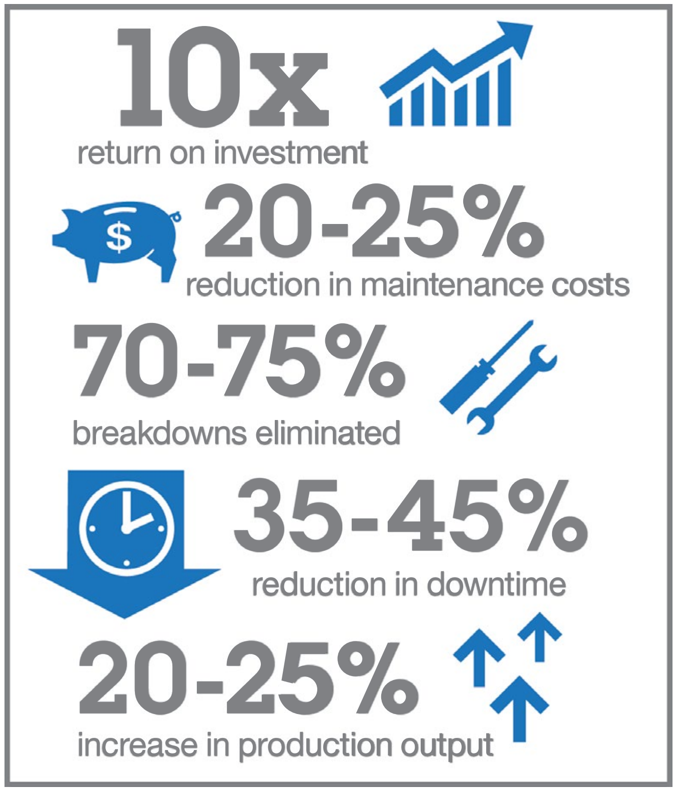


Figure 1. Average improvements of IBM customers that have utilized predictive maintenance solutions.

Conclusion

Rail customers expect flawless service. Now more than ever, your railway cannot afford to be unprepared or surprised by equipment downtime. With a sophisticated predictive maintenance solution in place, you can be more confident assets will perform when they are needed, helping you deliver a better customer experience and maximize every asset's ability to produce revenue.

About the IBM Predictive Maintenance and Quality solution

The IBM® Predictive Maintenance and Quality solution combines the functionalities of data integration, analytics and decision management into one pre-configured, packaged software solution that is easy to install in the majority of IT environments. It can accelerate your return on investment and reduce the need for additional IT service engagements because nearly all of the necessary foundational content is included. In addition, Predictive Maintenance and Quality contains connectors to enterprise asset management systems such as IBM Maximo® Asset Management.

With capabilities to efficiently and effectively analyze structured and unstructured data, the solution delivers benefits in several ways. It can help you:

- Monitor, maintain and optimize assets.
- Predict asset or part failure, and optimize maintenance and supply chain processes.
- Make critical decisions faster and more accurately.

For more information

To learn more about the benefits of predictive maintenance for the railway industry, please contact your IBM representative or IBM Business Partner, or visit the following website: **ibm.com**/travel

Additionally, IBM Global Financing can help you acquire the IT solutions that your business needs in the most cost-effective and strategic way possible. We'll partner with credit-qualified clients to customize an IT financing solution to suit your business goals, enable effective cash management, and improve your total cost of ownership. IBM Global Financing is your smartest choice to fund critical IT investments and propel your business forward. For more information, visit: **ibm.com**/financing

IBM Sales and Distribution
Route 100
Somers, NY 10589

Produced in the United States of America
April 2015

[1] These results are based on averaging the ROI of IBM customers that have utilized predictive maintenance solutions. They also appear in an IBM infographic published here: http://www.huffingtonpost.com/2012/09/11/ibm-predictive-maintenance_n_1873701.html?1347826655

TTE03007-USEN-00

comment

Print

Email

Share

Comment

J'aime 2 Share

Tweet

15.11.16

Improving safety through early track void detection

Source: RTM Oct/Nov 16

Dr Farouk Balouchi, project technical lead at the Institute of Railway Research, University of Huddersfield, Dr Adam Bevan, head of enterprise, Institute of Railway Research, University of Huddersfield, and Roy Formston, lead development engineer at Siemens UK, explain how a new vehicle cab-based monitoring system could help improve track void detection.

The GB railway is one of the busiest – consisting of 15,760 km – and densest networks in Europe. Currently track recording vehicles survey the network and detect track faults. These vehicles are deployed more frequently on mainline routes with higher traffic volumes, but less frequently on branch lines due to the limited availability of this resource. This has a potential impact on the safety and maintenance costs of these lines.

An RSSB and Network Rail initiative called upon the railway industry to come up with potential solutions towards resolving these issues. Siemens partnered with the Institute of Railway Research (IRR) to develop an inexpensive Remote Condition Monitoring (RCM) system to monitor the track from in-service rail vehicles using the existing GSM-R cab radio system.

The problem

The support conditions of a track system can change significantly for a number of reasons, including contaminated ballast, drainage problems (wet beds) or gaps between the sleeper and ballast layer. If not monitored and maintained regularly, these can develop into voids underneath railway tracks which can cause substantial delay minutes and possibly line closures.

Voids located within high-value assets, such as S&C, tend to have a feedback effect. A voided sleeper is not able to support the vehicle axle load and does not transfer any force to the ballast layer. Instead, the force is distributed on the adjacent sleepers around the void which causes the void to grow in size, resulting in greater track movement. Eventually, if unattended, such track movement causes damage to the S&C which then requires repair work to allow continued operation. The increased deflection of the rail also increases the risk of rail breaks, and therefore becomes a safety concern, along with resulting in poor vehicle ride performance (e.g. passenger comfort).

Solution

The Siemens Tracksure track monitoring system is able to identify voids underneath track from the acceleration response measured in the vehicle cab. It can also identify the type of track asset (e.g. S&C, structure or plain-line track) that the void is located

related

Commercial close on Thameslink deal expected this week

Siemens buys Invensys rail division for £1.74bn

Siemens wins €60m Crossrail signalling project

DfT 'considering alternatives' to Siemens over Thameslink

Further delays for Thameslink possible – RMT

Technology for the future

Thameslink contract sign-off delayed until autumn

Still no Thameslink trains deal – but IEP financing 'close'

Train building

A new depot for Derby

on this site

Rail News

The Sleepers Daily Blog

Rail Industry Focus

RTM TV

Events

Comment

Interviews

Editor's Comment

most read

Mark Carne to step down as Network Rail chief executive

more >

Network Rail CP6 plan: Route details revealed

more >

Grayling consults on plans to reopen historic northern line

more >

most commented

Grayling throws three major electrification plans out the window

more >

Fatal smash at level crossing prompts safety calls

more >

East West Rail 'no longer third most important project in country'

more >

under and provide an indication of the severity of the void. Installation of a Tracksure sensor card into multiple trains provides the potential for automated monitoring of a significant proportion of the rail network, including small branch lines, as well as the assessment of each track-section by multiple trains.

Analysis and trending of the acceleration data by the Ground System takes advantage of the multiple passes over a track section that have been recorded by each train. This allows the identification and removal of false alarms, and improves the estimates of location accuracy and void sizing. As well as reporting voids, the Tracksure Ground System will also report the occurrence of large vertical or lateral accelerations at S&C and plain track, when observed by multiple trains, which could indicate the location of other defects.

Project outcomes

The RSSB-funded study has supported the development of a prototype Tracksure system which allows for in-service multi-train monitoring of the track, using existing technology, for the detection of track voids and other track defects.

Through simulation, signal processing and analysis, the IRR has developed a detection algorithm using a state machine design methodology and tested it with experimental data. The test results show a good agreement with reported track faults at S&C, bridges and on plain-line locations of the test routes.

The system provides a low-cost solution to identifying and monitoring track defects that could provide additional coverage of the GB rail network, and feeds directly into existing infrastructure maintenance tools.

Increased reliability, lower maintenance costs, reduced delay minutes from line closures, and reduced speed restrictions can be seen as immediate benefits of the system. Furthermore, the inclusion of multi-train self-learning algorithms can be used to predict with more accuracy the condition of large portions of the network, supporting the requirement for more predictive maintenance.

FOR MORE INFORMATION

W: www.hud.ac.uk/research/researchcentres/irr

Tell us what you think – have your say below or email
opinion@railtechnologymagazine.com

Print Email Share Comment

J'aime 2 Twe Share G+

comments

There are no comments. Why not be the first?

add your comment

Please note that there is a limit of 3000 characters

Your email (we will not display this):

Your name (This is displayed with your message):

Your comment:

Security Check:

Je ne suis pas un robot
reCAPTCHA
Confidentialité - Conditions

Add Comment

Last Word

Rail Pages UK

rail news by category

Rail jobs, staff issues and training

Railway safety and crime

Civils and stations

Track and signalling

Rail service improvements and disruptions

Fares, rail policy and DfT news

Crossrail

London Underground and TfL

HS2

Rolling stock

Rail franchises operators & contracts

Network Rail regulation and performance

Light rail and trams

Rail freight

Awards, contracts & appointments

'the sleepers' daily blog

High-tech tablets and jars of honey: The assortment of gifts sent to Network Rail employees

Network Rail employees receive, on average, a gift every week from residents, rail organisations, and private companies, with items varying from jars of honey to brand new tablets. Freedom of Information requests submitted by RTM reveal the vast range of expensive and unusual products that firms send to the organisation every week. A... more >

read more blog posts from 'the sleeper' >

interviews

Transforming travel in the north west

RTM's Josh Mines talks to Robin Davis, head of new trains at TransPennine Express (TPE), about the huge rolling stock change journey the co... more >

Thameslink: Nearing the end of the line

RTM's Josh Mines catches up with Mark Somers, project director for Thameslink, on how the final stages of the programme are progressing and... more >

more interviews >

rail technology magazine tv


What they say about #TransCityRail


Illustration time lapse video

Book now to attend #UKRIA2018

What did HS2 say about #TransCityRail

more videos >

[illegible]

[illegible]

more >

latest rail news

Network Rail to begin 'crucial' track straightening work on Midland Main Line

Network Rail engineers are set to complete the first section of a major line speed upgrade in Market Harborough this weekend. The work will see track...

read more

Siemens unveils plans for £200m train factory in East Yorkshire

Siemens has revealed plans to build a £200m train factory in East Yorkshire aimed at developing and commissioning new rolling stock. The...

read more

UK Government takes major step towards Welsh rail devolution

The Welsh Government has taken a huge step towards devolved control over the railways after a new bill was put in front of Whitehall ministers this...

read more

more articles >

rail industry focus

A game changer for Midland Metro

The West Midlands Combined Authority (WMCA) u... **more >**

Testing tomorrow's technology today

David Brazier, site manager and area sales ma... **more >**

more rail industry focus >

editor's comment

Despite a few disappointing policy announcements, especially for the electrification aficionados amongst us, 2017 was, like Darren Caplan writes on page 20, a year generally marked by positive news for the rail industry. We polished off the iconic Ordsall Chord (p32), hit some solid milestones on Thameslink (p40), progressed on ambitious rolling stock orders (p16), and finally started moving forward on HS2 (p14) – paving the way for a New Year with brand-new infrastructure to...

read more >

last word

Encouraging youngsters to be safe on the railway

This summer, Arriva Group's CrossCountry and the Scout Association joined to launch a new partnership to promote rail safety among young people. Chris Leech MBE, business community manager at the TOC, gives RTM an update on the innovative scheme. Recognising that young people are more likely to take a risk trespassing on railway tracks, C... **more >**

more last word articles >

Rail News	Interviews	Subscribe	Site Map
Railway Blog	Comment	News by E-mail Alerts	Advertise
The Last Word	Digital Edition	E-newsletter Signup	Privacy Policy
Rail Industry Focus	Rail Events	rtm tv	Subs T's & C's
Events	Inbox	Meet the editorial board	About Us

Members Of:

Contact Us

Cognitive Publishing Ltd
Magazines That Mean Business
2nd Floor, 82 King Street, Manchester, M2 4WQ

phone: 0044 (0) 161 833 6320

email: newsdesk@railtechnologymagazine.com

Registered in England. Reg No. 4011145
A subsidiary of Cognitive Business Media Ltd

Other brands produced by Cognitive Publishing Ltd