AUTONOMOUS INSPECTION FOR AUTONOMOUS FLEETS

pitcrew.ai

OTR Tyre monitoring

Protect people, reduce downtime, increase profits

- Automatically detect OTR tyre injuries, cuts, and separations
- Industrial Internet of Things (IIoT) solution using thermal imaging, artificial intelligence, and machine learning
- No changes to site workflow, side of haul road solution, 24/7-365 operation, no human intervention
- Improve mine safety, reduce human-vehicle interactions, avoid preventable hot tyre events
- Increase mine productivity, reduce unplanned downtime due to tyre damage
- Reduce haul fleet total cost of ownership, identify repairable tyre damage early, repair rather than replace

Off the road (OTR) tyres are a significant investment and a critical asset for any mine. Premature tyre failures pose safety and financial risks to operations. Tyre damage regularly results in early failures reducing the working life of a tyre. Common failure types include small tyre injuries that are the result of rocks and debris damaging the outer tread, overwork induced heat separations of the tread and casing, and belt edge separations resulting from high cornering loads. The financial implications of shortened tyre life are significant. However, tyre damage also has major safety and productivity implications for mine operators.

ROUTINE INSPECTION

Current industry methods for detecting tyre damage involve routine manual inspection. Inspection frequency varies with site operations but is often conducted every few days. To inspect the vehicle requires downtime, where the truck is pulled out of cycle and appropriately isolated. Any unnecessary vehicle downtime results in a loss of production for the mine. Manual inspection also has limitations, and some damage will not be identified, for example if damage is present at the bottom of the tyre that is in contact with the road surface when the inspection occurs. Inspections require tyre technicians to be in physical contact with the tyre tread surface. OTR tyres are pressure vessels that store large amounts of energy, minimising direct interactions limits personnel exposure to a significant safety hazard.

AUTONOMOUS FLEETS

Autonomous Haulage System (AHS) fleets are being rapidly adopted by industry. This has several implications for OTR tyres. The move to larger ultra-class haul fleets, with larger tyre sizes, and the push for faster haul speeds has increased stress induced failures, such as heat and belt edge tyre separation. Simultaneously the requirement for exclusion zones around AHS operations make routine inspection more difficult. Inspection often requires additional controls and isolations in place and additional machine downtime. Often inspection frequency is reduced as a result. If a small tyre injury is not identified and monitored, it can very quickly grow into a significant heat separation and risk of a tyre fire.

There has been enormous investment within the mining industry into autonomous driving technology. But human drivers also perform many tasks in the vehicle beyond driving, for example, smelling smoke, hearing a rattle from the engine bay, feeling an abnormal vibration through the seat. To date, substantially less investment has been made into replacing these secondary driver functions. Examples of autonomous haul trucks suffering tyre fires are far too common, as there is no longer a driver to give an early warning of the smell of tyre smoke at a pre-start vehicle check. To maximise the performance of autonomous fleets and extract the full financial benefits of the investment in them, mine site operators need to embrace autonomous inspection and monitoring technologies.

Pitcrew AI Solution

The system is typically supplied as a rapid-deployment, self-contained, solar-powered skid that can be installed at the side of a haul road within a few hours. The system includes a high-end thermal imaging camera and an advanced artificial intelligence machine vision processor. Solutions for cold climates, where solar irradiance is limited, or underground environments with hazardous area classification are also available. The system is commissioned remotely by Pitcrew AI engineers. There are no changes to site operations required. The system can inspect every machine without needing the vehicle to stop. Every vehicle that passes the system is checked 24/7-365 without any human intervention.

The system can detect minor tyre injuries, such as rock drills, missing lug, or rock incisions, which are common on the rear four tyres (position 3 through 6) from haul trucks reversing over debris when backing into the face. Front tyre inspection is also possible, where heat and belt edge separations are more common. Each damage event can be tracked via an individual damage ID. After the initial detection, the tyre can be inspected, and if repairable, then the tyre can be removed and repaired, delivering savings on the tyre spend. Tyre repair is much kinder to the environment than new tyre replacement. It can play a significant role in helping mines achieve sustainability targets, with sites often rewarded through carbon credit programs.

If the tyre is damaged beyond repair and deemed not worth repairing (NWR), then, if it is safe to operate, the tyre can be returned to service. In the case of damage like a rock-cut, the separation will be detected, and its properties recorded on each pass of the Pitcrew AI system to monitor its growth. Machine learning models are used to project the damage growth and predict when a tyre change is necessary, allowing the maximum working life to be safely extracted from the tyre. Forecasting allows vehicle downtime to be planned well in advance and tyre inventory to be accurately managed, simultaneously minimising equipment downtime and delivering substantial savings to site operating expenses (OPEX).

By predicting the trajectory of tyre damage, many of the risks associated with hot-tyre events and tyre fires can be avoided. However, hot tyre events can still occur, and the Pitcrew AI system can detect hot tyres and immediately alert personnel via email, SMS or multiple other communication options. Early warning allows a vehicle to be isolated as quickly as possible, improving mine safety. The system offers the additional benefit of providing a remotely controlled thermographic inspection system that can be used to assess a vehicle remotely, enhancing visibility and intelligence during a mine safety event.

Many sites that operate a Pitcrew AI system install a second system at the entry to the tyre workshop. This system acts as an additional safety tool to alert personnel before any potential hot tyre or dangerously damaged tyre can enter the workshop.

The Pitcrew AI system is a perfect complement to tyre pressure monitoring systems (TPMS). Many tyre fires start on the outer casing of the tyre and are not detected by internal temperature sensors—for example, an oil fire on the tyre tread. The Pitcrew AI system can detect surface layer thermal anomalies immediately. This information can be passed directly to fleet management platforms that are in place.

The Pitcrew AI system provides a user-friendly web dashboard, accessible from anywhere with an internet connection. The interface is optimised for mobile devices and users with poor network connections, as this is the most common method of access by mine site users. Detailed inspection history and automated reports are available. Insights into mine operations can be seen in the data, and mine condition monitoring is possible. For example, if a common damage type on a common tyre position is detected, it may identify that upkeep of haul roads, benches or working areas is required. Targeted mine housekeeping ensures tyre and truck component damage is minimised and productivity is enhanced.

In the modern, connected world a system is only effective if it can be tightly integrated with other systems to form a bespoke, site-specific workflow. Pitcrew AI offers a flexible RESTful API for integration with 3rd party systems. This can be used for automatically generating work orders or job tickets for tyre inspection or change out, or for bi-directional communication with fleet or mine management software platforms.

Besides tyre damage, there are many mechanical issues that present as heat and can be viewed with the Pitcrew AI solution. For example, thermal asymmetry in the suspension struts may indicate unbalanced loading, or a temperature difference between the final drive units may indicate a potential mechanical or braking issue. The Pitcrew AI system is undergoing continuous software improvements with new functionality continually added. Reach out to a Pitcrew AI engineer today to discuss the system capabilities relevant to your site.

Value Proposition

DETECT
- Small tyre injuries resulting from physical rock and debris damage.
- Overwork induced heat separations of the tread and casing.
- Belt edge separations resulting from high cornering loads.
- Tyre surface temperature excursions and anomalies.

IMPROVE SAFETY
- Remove technicians from harm's way by reducing unnecessary inspections, OTR tyres are large pressure vessels.
- Eliminate preventable tyre fires and reduce the risk of catastrophic tyre failure by detecting damage early.

INCREASE PRODUCTIVITY
- No vehicle downtime for routine inspection. Automatically detect damage and assess only when required.
- Identify haul road maintenance issues in real time, loose rocks, camber or haul layout issues.
- Safely optimise haul speeds by monitoring outer tread temperatures without reducing tyre operating life.

EFFICIENCY GAINS
- Better use of tyre technicians time with targeted rather than routine inspection.
- Increase tyre repair rates and reduce the average repair cost by detecting damage early.
- Forecast the progression of tyre damage, plan for tyre changes and better manage tyre inventory.
- Extract maximum operating life of irreparably damaged tyres safely, by monitoring, tacking and forecasting damage.

REDUCE UNSCHEDULED DOWNTIME
- Plan for tyre changes and vehicle downtime in advance. Detect damage early, track and forecast growth.
- Avoid hot tyre events by planning for a change before heat excursions occur.

ENVIRONMENTAL SUSTAINABILITY
- Repair uses less raw materials and production energy than manufacturing a new tyre. This can save significant carbon emissions and help to meet sustainability goals.

QUALITY
- Technicians can't inspect the entire tread surface of a parked vehicle. Consistent and repeatable automated inspections and reporting, with flexible integrations to existing tyre management systems.

Autonomous OTR Tyre Inspection

A haul truck passes the Pitcrew AI system at the side of haul road. No need for any changes to route, speed or existing site workflow.

The Pitcrew AI system detects a small tyre injury for the first time.

The Pitcrew AI system assigns a unique damage ID and tags relevant information, such as truck ID, tyre position, damage type etc.

A Work Order or Job Ticket is automatically created for tyre damage inspection.

The tyre is inspected by a technician. Damage details are entered into the Pitcrew AI system.

Details include type (missing lug, rock drill, rock cut, exposed belt etc), size/dimensions, severity etc. This information helps the Pitcrew AI system improve.

Is the tyre repairable

No

Is the tyre safe to continue use

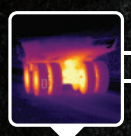
Yes

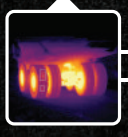
No

Yes

Pitcrew AI system continues to monitor the vehicle on each pass of the system. The growth of the damage is tracked.

The Pitcrew AI system provides an estimated change out date based on recent tyre statistics, damage type and observed growth rate.

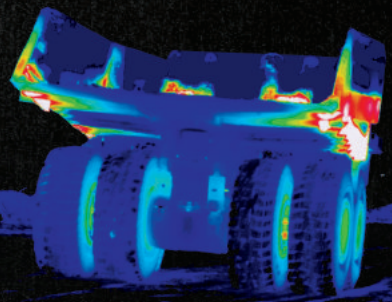




Tyre changed out and sent for repair. Repair rather than replacement saves money and reduces carbon emissions.

Tyre changed out and sent for recycling. Potential safety incident or costly isolation of vehicle avoided.

A tyre change Work Order or Job Ticket is planned well in advance minimising downtime. Tyre inventory can be better managed.



SYSTEM CAPABILITY

BASE SYSTEM

- Detection of damage and separations on tread area of rear four haul truck tyres (position 3, 4, 5, 6)
- Tyre surface temperature monitoring

OPTIONAL

- Inspection of front tyre set (position 1 and 2)
- Qualitative tread assessment
- Mechanical inspection, including final drive asymmetry, suspension strut loading imbalance, radiator inspection and many more
- Inspection of additional vehicle types
- Damage forecasting (requires integration with tyre management system)

PHYSICAL DESCRIPTION

OPTION 1

Turn-key stand-alone solar powered solution, suitable for surface and open pit mining operations.

OPTION 2

BYO power and data solution. Key hardware supplied in a prefabricated equipment enclosure. Site provides power supply and internet connection, requirements:

- Power – 24V DC, 200W
- Data – approximately 7MB upload per target vehicle scan

KEY SENSOR DESCRIPTION

Focal plane array (FPA), uncooled microbolometer, 640x480 pixels, 17µm pitch, time constant <8ms, thermal sensitivity (NETD) <30mK, maximum frame rate 200Hz, focal length 41.3mm (standard, options available)

ENVIRONMENTAL

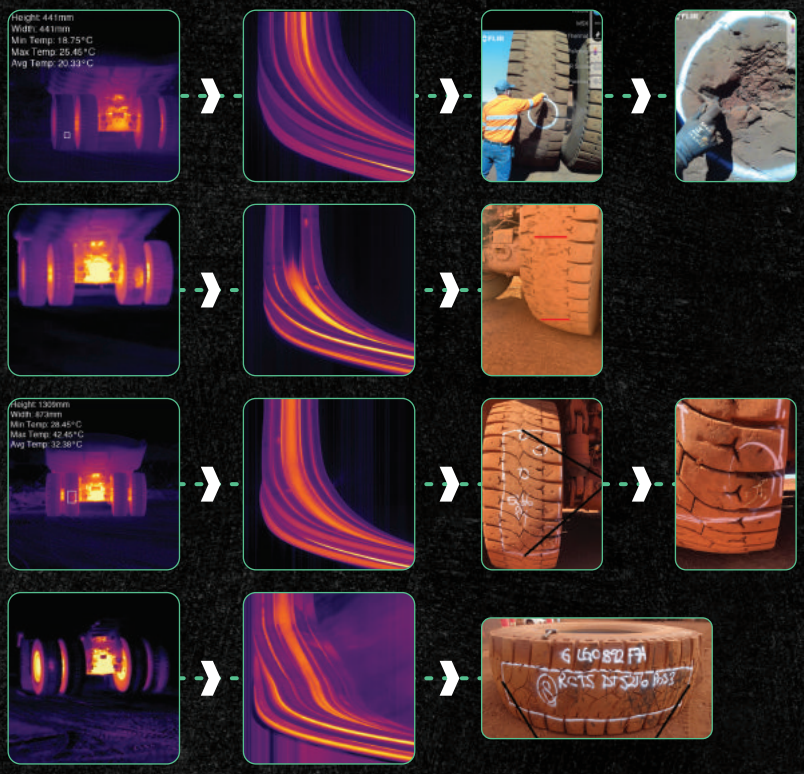
Standard configuration suitable for use in ambient operating temperatures –15°C to +50°C (+5°F to +122°F). Special cold climate configuration available, suitable for ambient temperatures –51°C to 60°C (–60° to 140°F).

Standard ingress protection rating (encapsulation); IP66 (IEC 60529). Special configuration IP69K available on request.

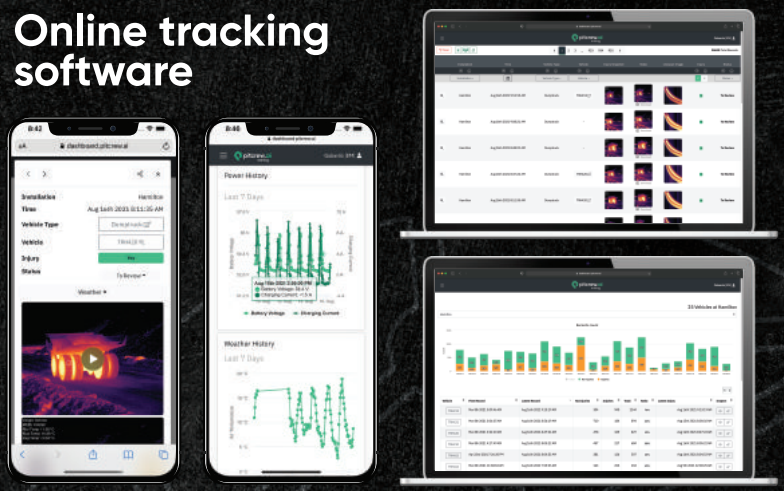
Low voltage equipment suitable for safe area installation. Equipment suitable for hazardous are installation (Zone 1) is available on request and supplied with appropriate IECEx/ATEX certifications.

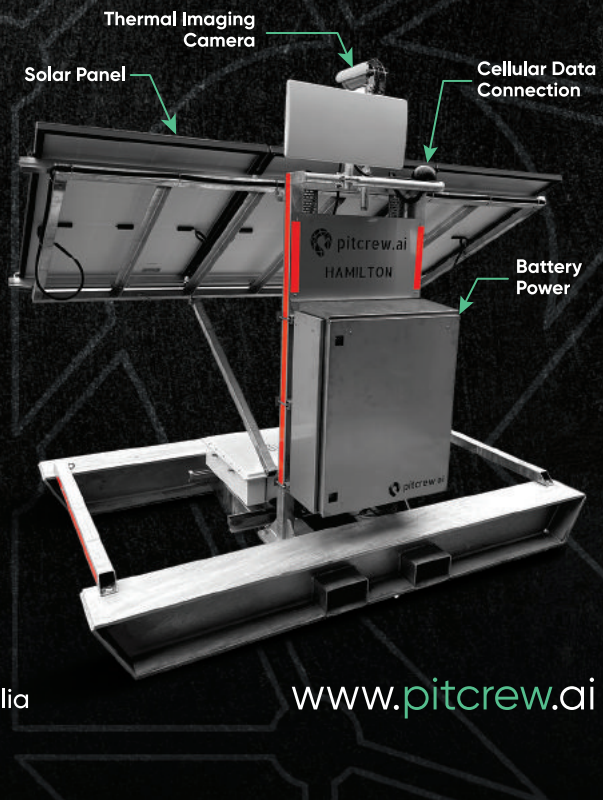
INTEGRATIONS

RESTful API (Open API, Swagger) provided with full documentation. Existing integrations for many TPMS, TMS and fleet management software packages. Pitcrew AI offer a custom integration service if required to help tightly integrate the system into your site's existing workflows.



Online tracking software





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