

3D机器视觉在轨道交通行业 的整体解决方案

3D轨道交通案例分类

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轨面检测

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枕木质量检测

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基础设施模块化检测

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路面检测

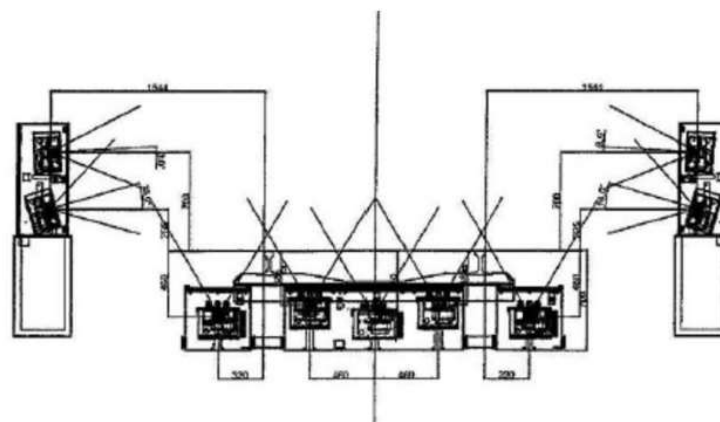
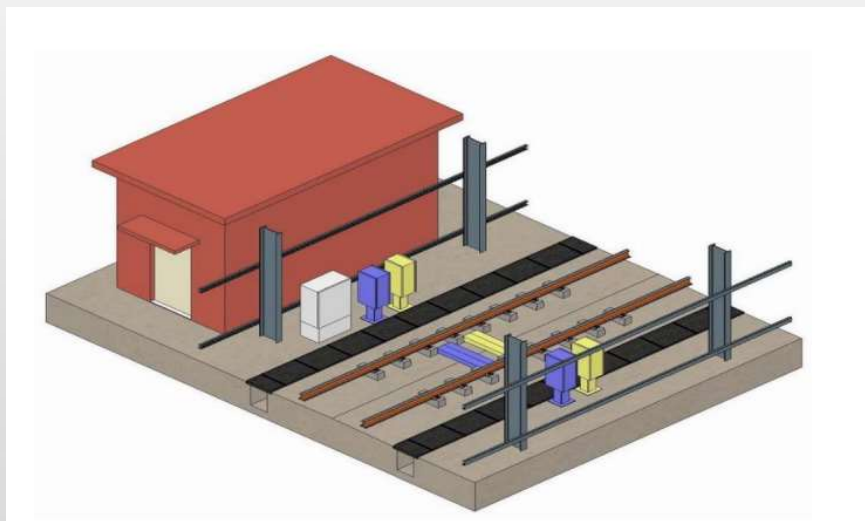


车体检测

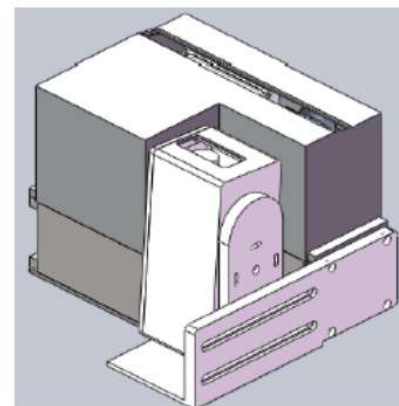


车体检测

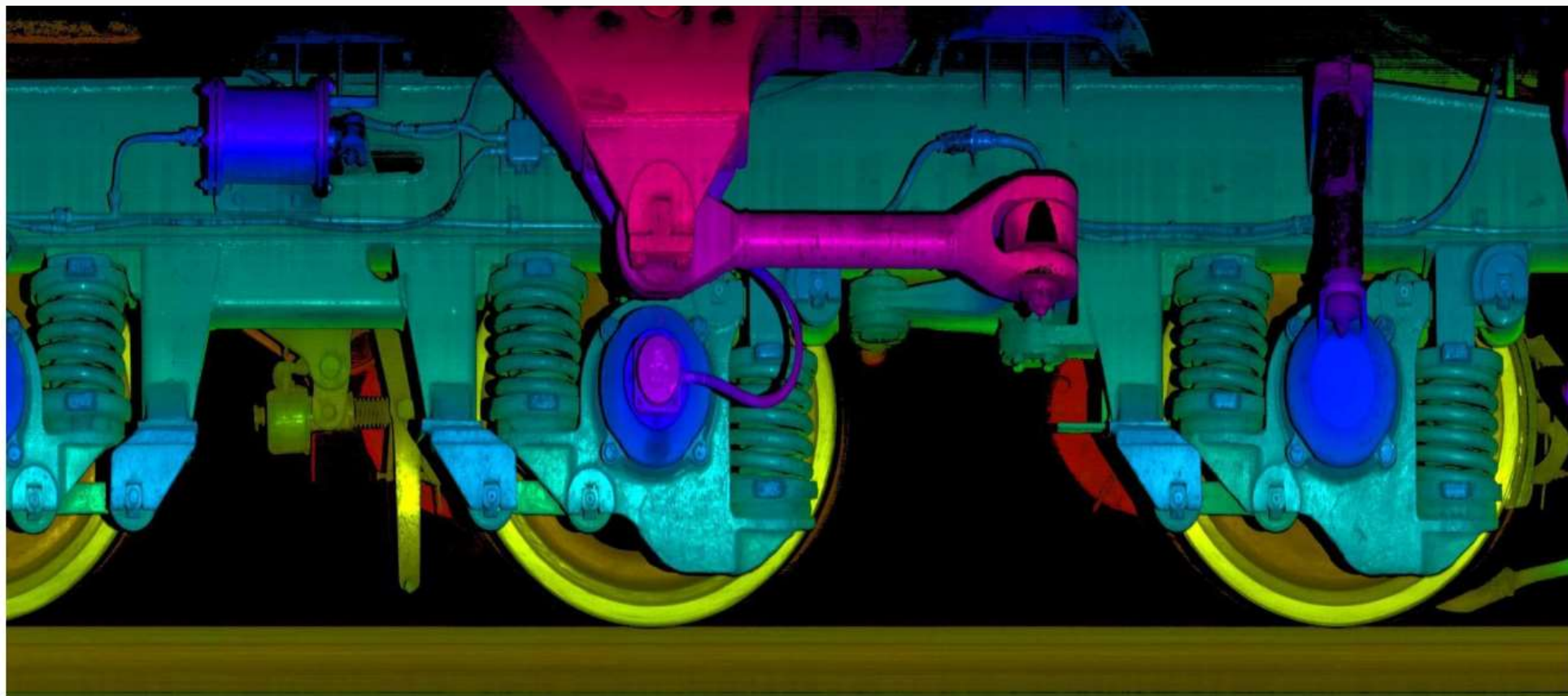
- ▶ TFDS(货载车缺陷检测系统)
- ▶ TEDS(客载车缺陷检测系统) 需求
- ▶ 适应速度40/80/120/180/300km
- ▶ 检测区域：车侧、车底关键区域
- ▶ 安装：检测站



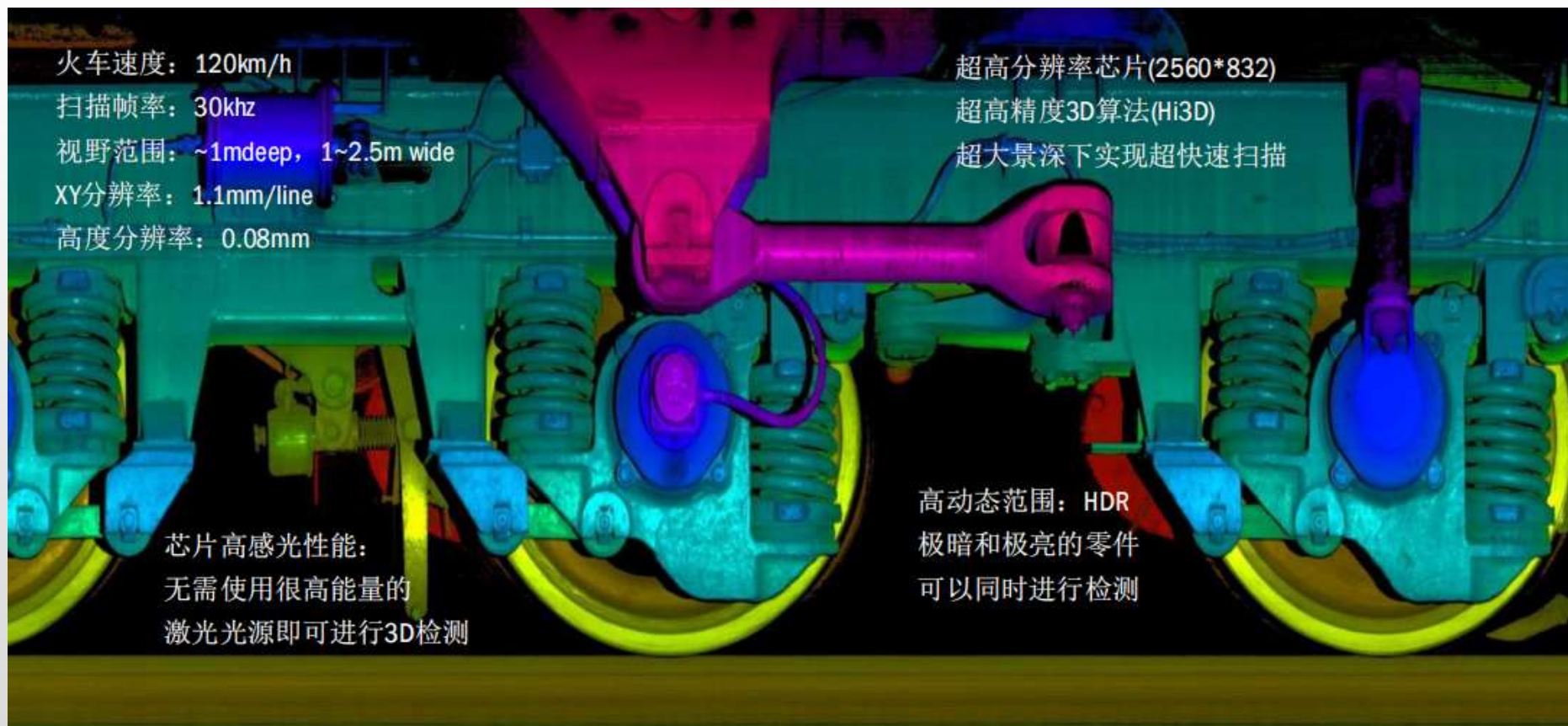
3D 成像模块安装位置及角度图



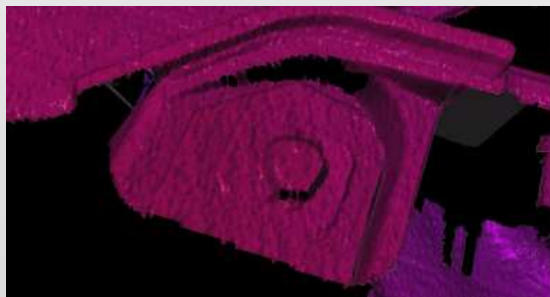
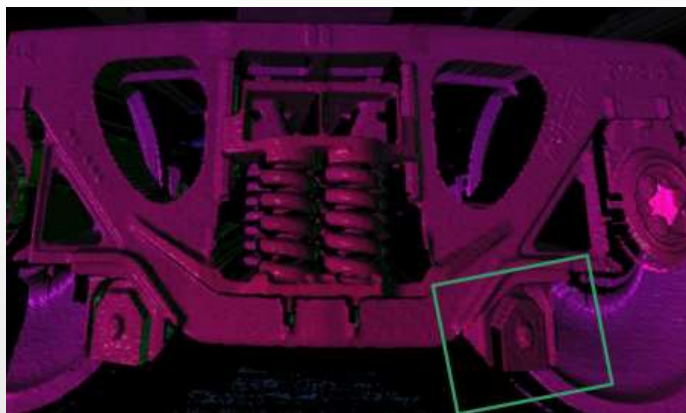
车体检测---火车制动/连接件监测



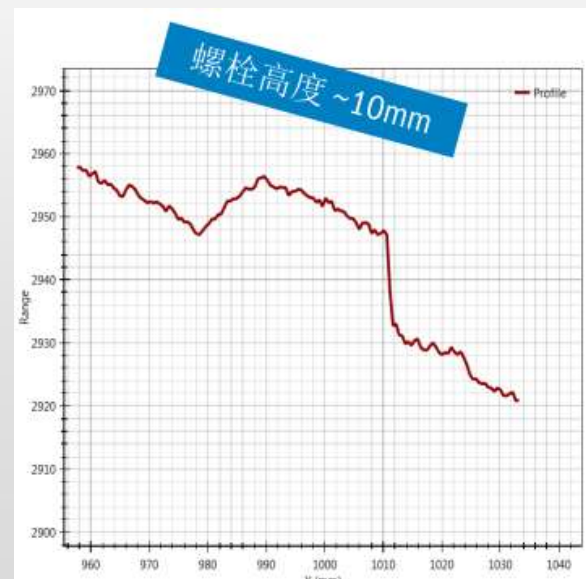
车体检测---火车制动/连接件监测



车体检测---火车制动/连接件监测

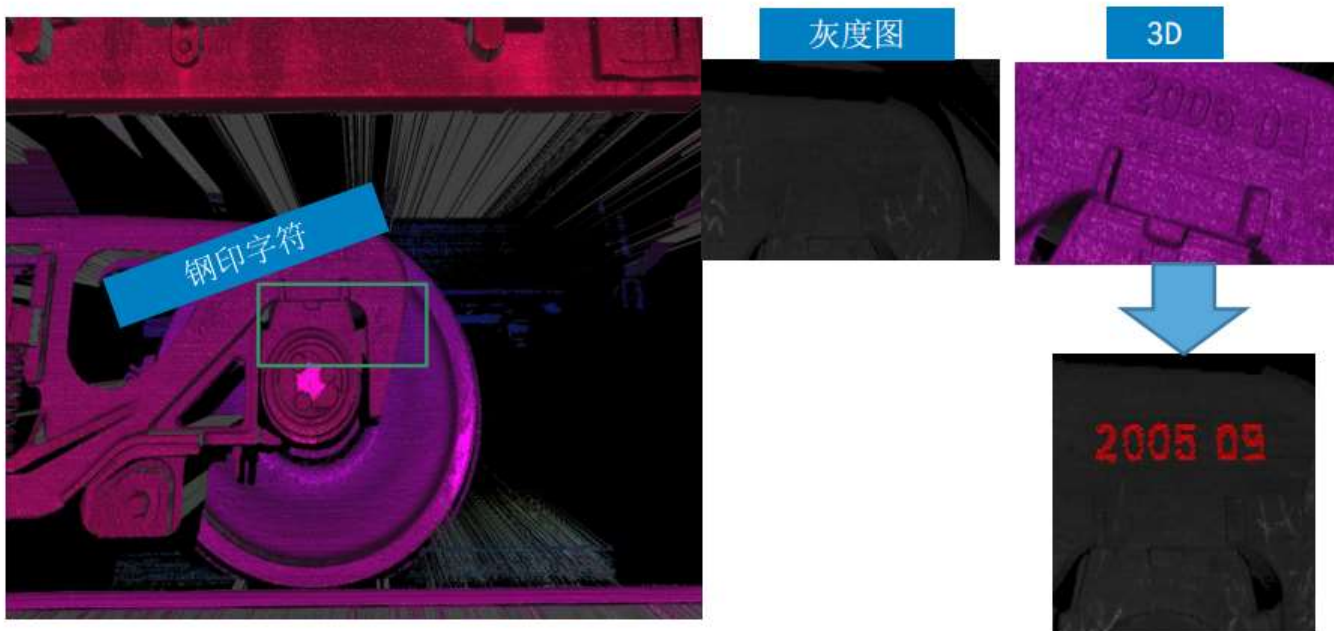


采用西克高达46KHZ的扫描速率和高光敏性的3D相机，非常适合高速和低对比度检测。火车，制动/连接件监测，对火车安全维护工作具有重要意义。

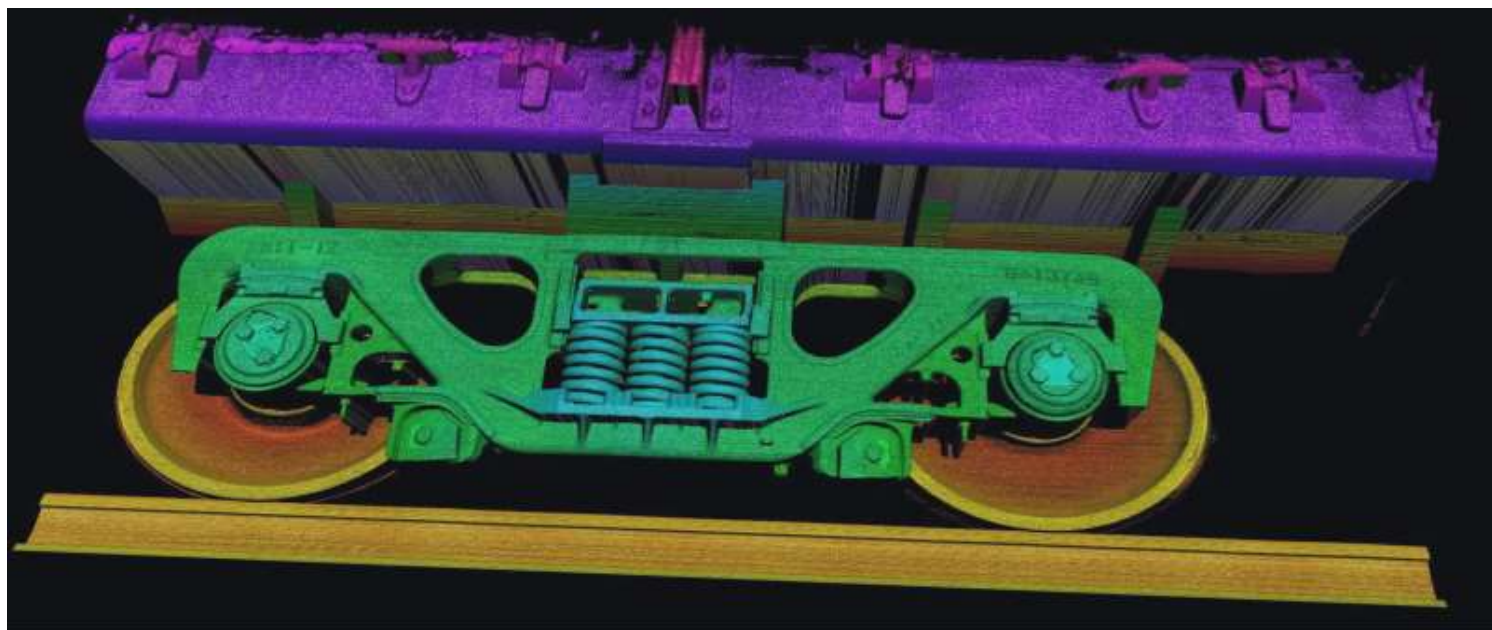
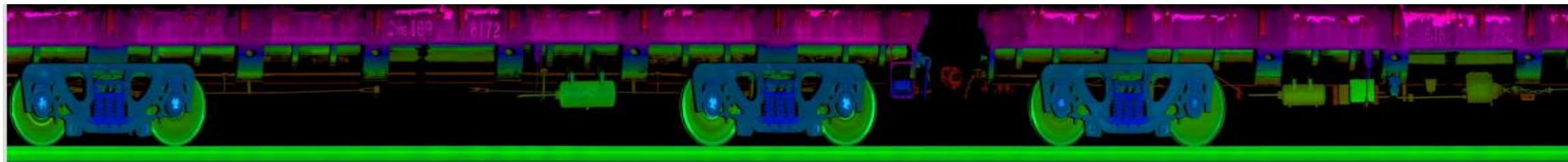


车体检测---火车制动/连接件监测

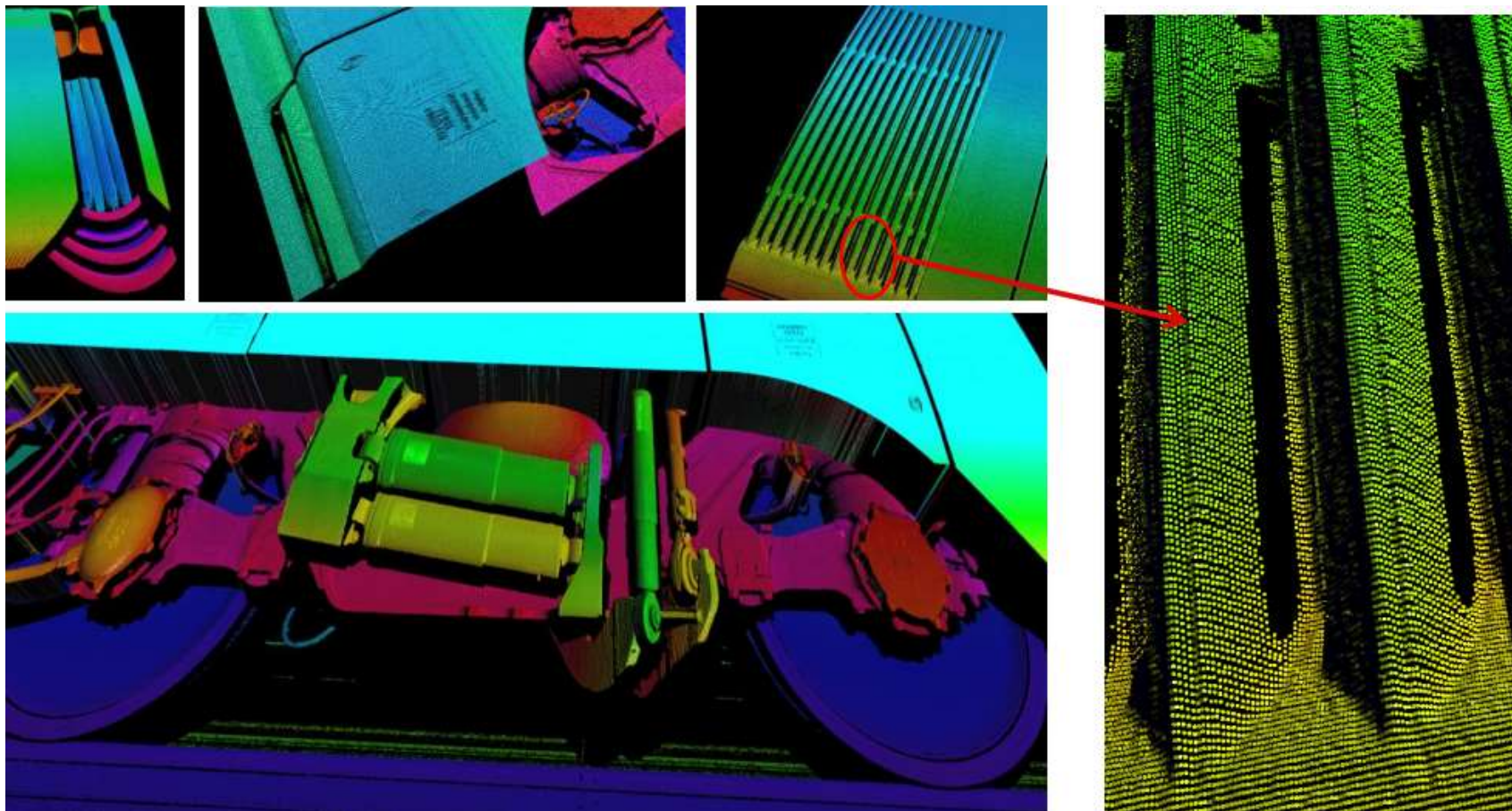
铁路和道路等运输系统的预防性维护是一项具有挑战性的任务。西克相机具有高速和高光敏性，IP65/67防护等级，使得它非常适合在苛刻的环境中使用，如道路或铁路等的OCR识别。



车体检测---火车制动/连接件监测

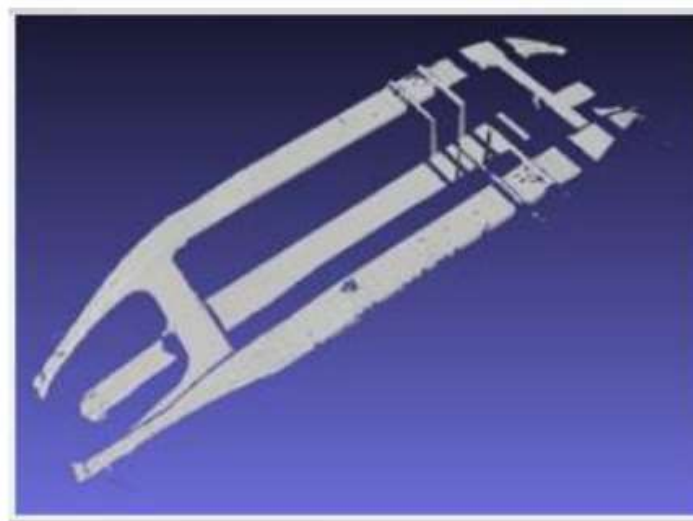
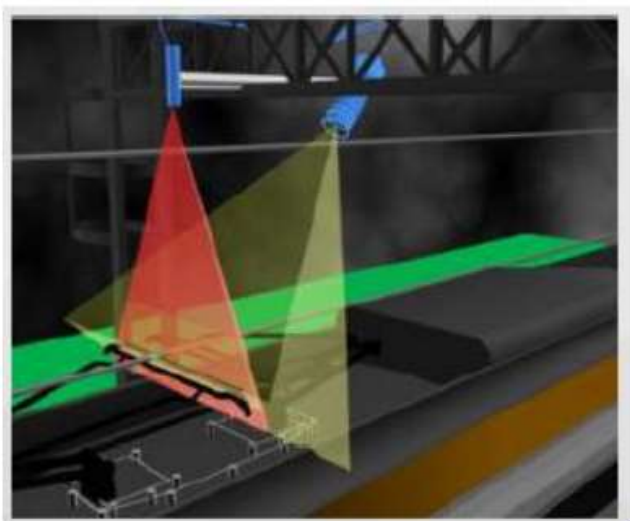


车体检测---火车制动/连接件监测



弓网检测

接触网磨损、偏移检测
受电弓磨损、偏移检测
安装：检测车、检测站



弓网检测--- 6C系统架构图



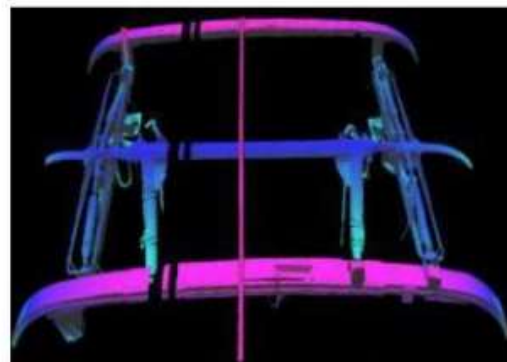
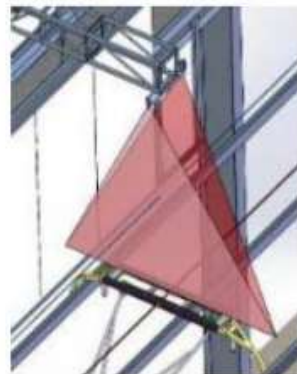
这里我们主要关注的是是接触网与受电弓滑板的C5系统，在线检测受电弓的磨耗状态。

这个相似的应用也直接可以在地铁行业，有轨电车行业进行拓展。

We pay more attention on the C5 system to inspect the abrasion of the pantograph.

The same application can be also applied in the underground and tramcar.

弓网检测---现场检测



接触网与受电弓滑板监测系统包括两个部分：在高铁的车站加装的受电弓滑板高清视频监测系统；在车站咽喉、隧道口、接触网线岔、分相关节、动车库进出线等特殊断面和地点加装的接触网视频监测系统。此系统监测接触网和受电弓滑板的技术状态，及时发现运营动车组受电弓滑板和接触网的异常状态，指导故障消缺，确保接触网和受电弓的运行状态良好。

将SICK Ranger3安装在动车入库前的检测大棚或者龙门架上，抓拍低速通过的受电弓滑板，监控受电弓整体状态。

Ranger3 system is installed on the inspection shed or gantry before the engine is loaded into the warehouse. Then capturing the low-speed pantograph slide to monitor the overall state of the pantograph.

弓网检测--- 3D组件



弓网检测---参数配置

Base distance: 644.43 mm

Camera:

Camera Version: Ranger3-60

Sensor size: 832 x 2560 pixels

Camera height: 1000 mm

Focal length: 12.5 mm

Camera angle: 30 deg

Top Sensor Row: 0

Bottom Sensor Row: 832

Laser:

Laser height: 1000 mm

Laser angle: 0 deg

Fan angle: 75 deg

System:

Fov Height: 266.26 mm

Fov Width on top: 1126 mm

Fov Width on bottom: 1461.9 mm

Enable instant update

Show measurementline:

Resolution (mm)	FOV Top	FOV Bottom
dx	0.46875	0.57104
dz raw (no subpixel)	0.9375	1.1421
dz 1/10th subpixel	0.09375	0.11421
dz DCM Algorithm (1/16th subpixel)	0.058594	0.07138

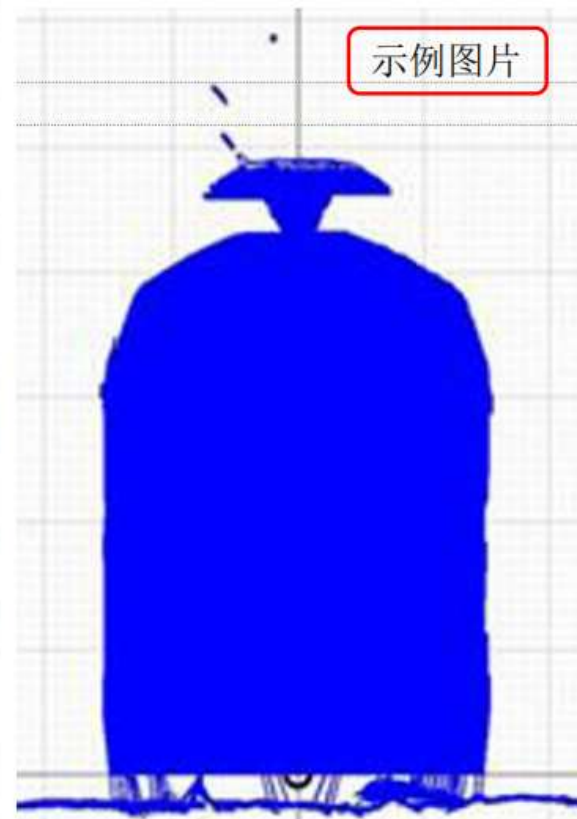
FOV: ~1200mm

X Resolution:
 $1200/2536 = 0.47\text{mm/pixel}$

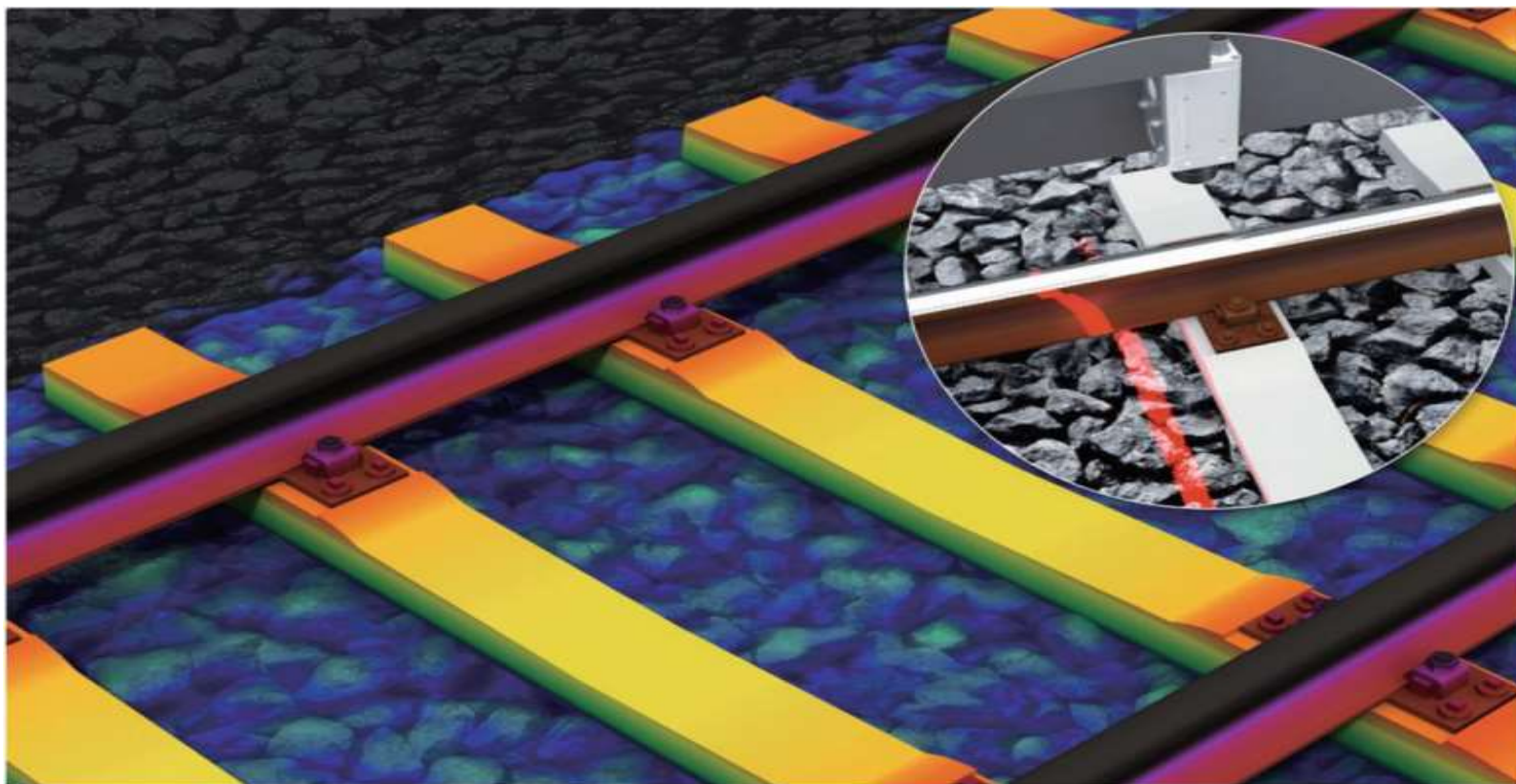
Z Resolution:
 0.06mm/pixel

车顶异物

- 车顶异物检测
- 安装：检测站

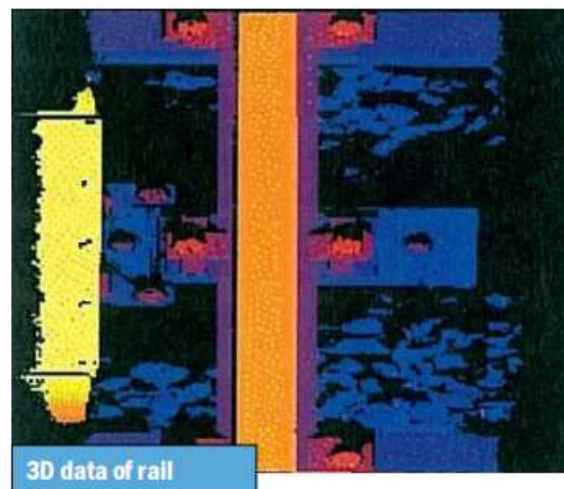
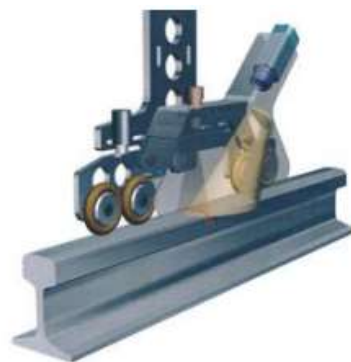
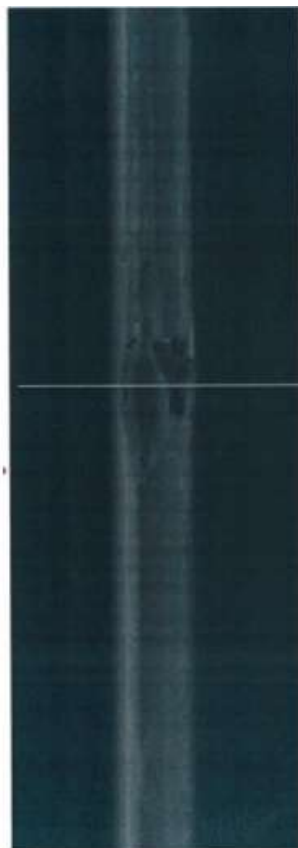


轨面检测



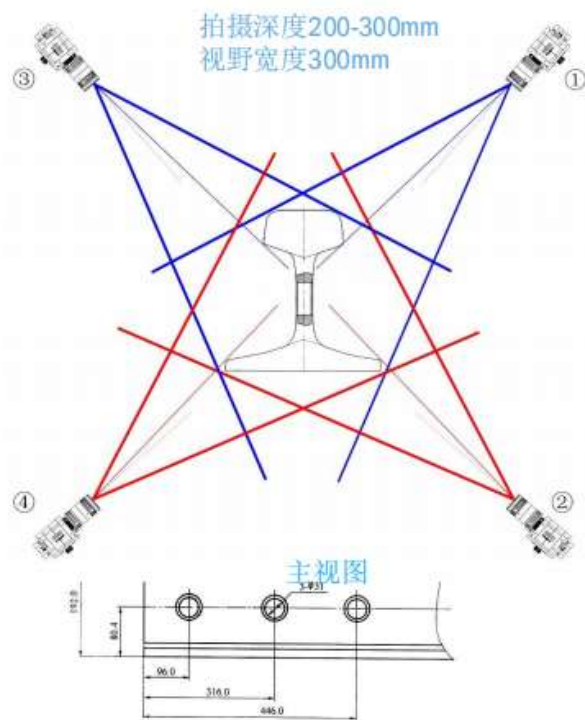
轨面检测

- 需求：
 - ▶ 枕木紧固检查
 - ▶ 水泥枕紧固检查
 - ▶ 扣锁检查
 - ▶ 紧固件平面检查
 - ▶ 几何测量（轨距等）
 - ▶ 铁轨磨损检查
 - ▶ 道渣容量检查
- 安装：检测车



轨面检测---检测要求

- 1、检测轨面的轮廓
- 2、两条轨道，4个检测面

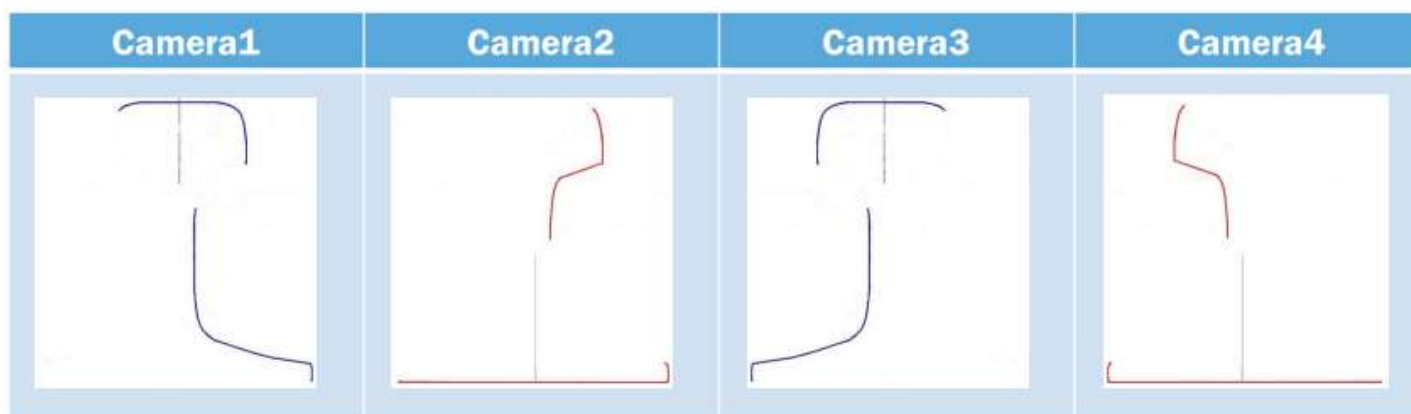


应用概述Application Overview

- 量测铁道钢轨的尺寸信息
- 视野宽度需求：200-300mm
- 检测精度需求：~200~500um



轨面检测---图像分析

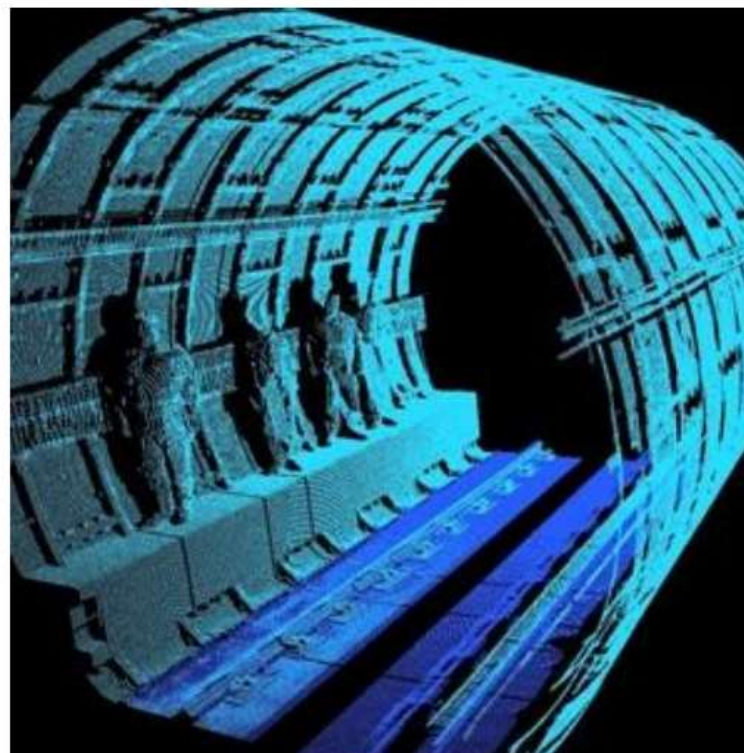
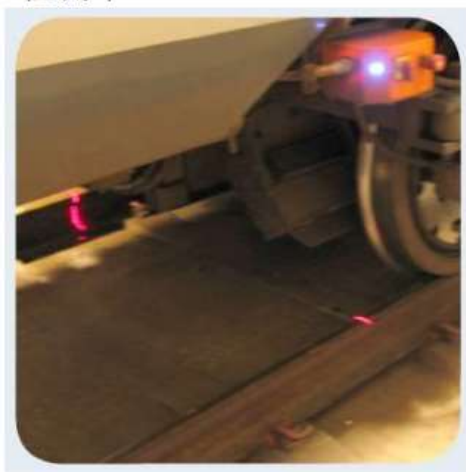


- : 各相机分别拍摄轮廓线的一部分，各自拍摄部分存在一定遮挡
- : 通过西克Ranger软件特有的图像拼接技术，实现3D图像还原
 - 图像拼接后，图像无遮挡和数据丢失
 - 通过Profile提取，可进行轮廓线分析，实现测量

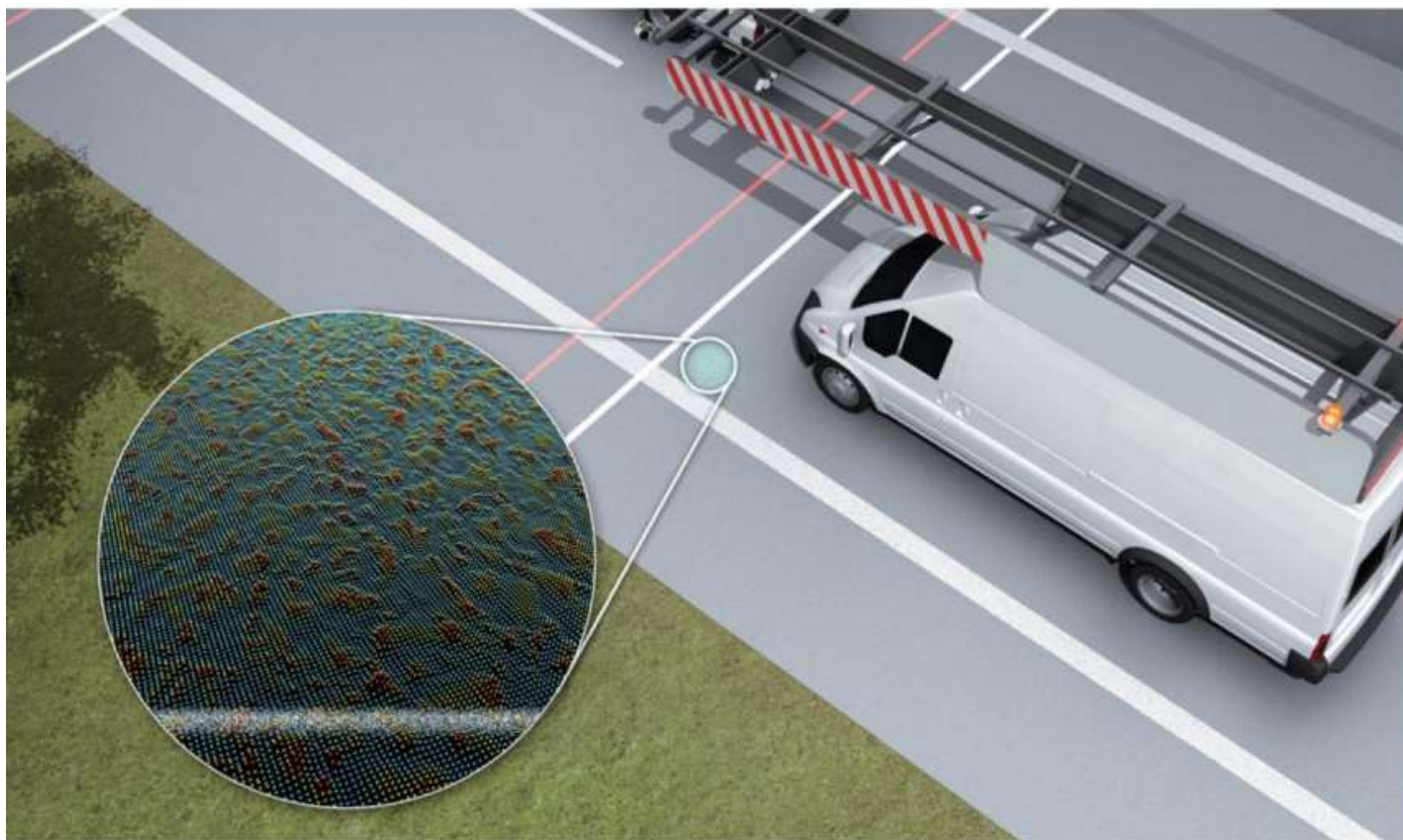


基础设施模块化检测(隧道/隔音墙)

- 隧道几何测量系统
- 隔音墙检测系统
- 适应速度：40~380km/h
- 精度要求：5~20mm
- 安装：检测车



路面检测

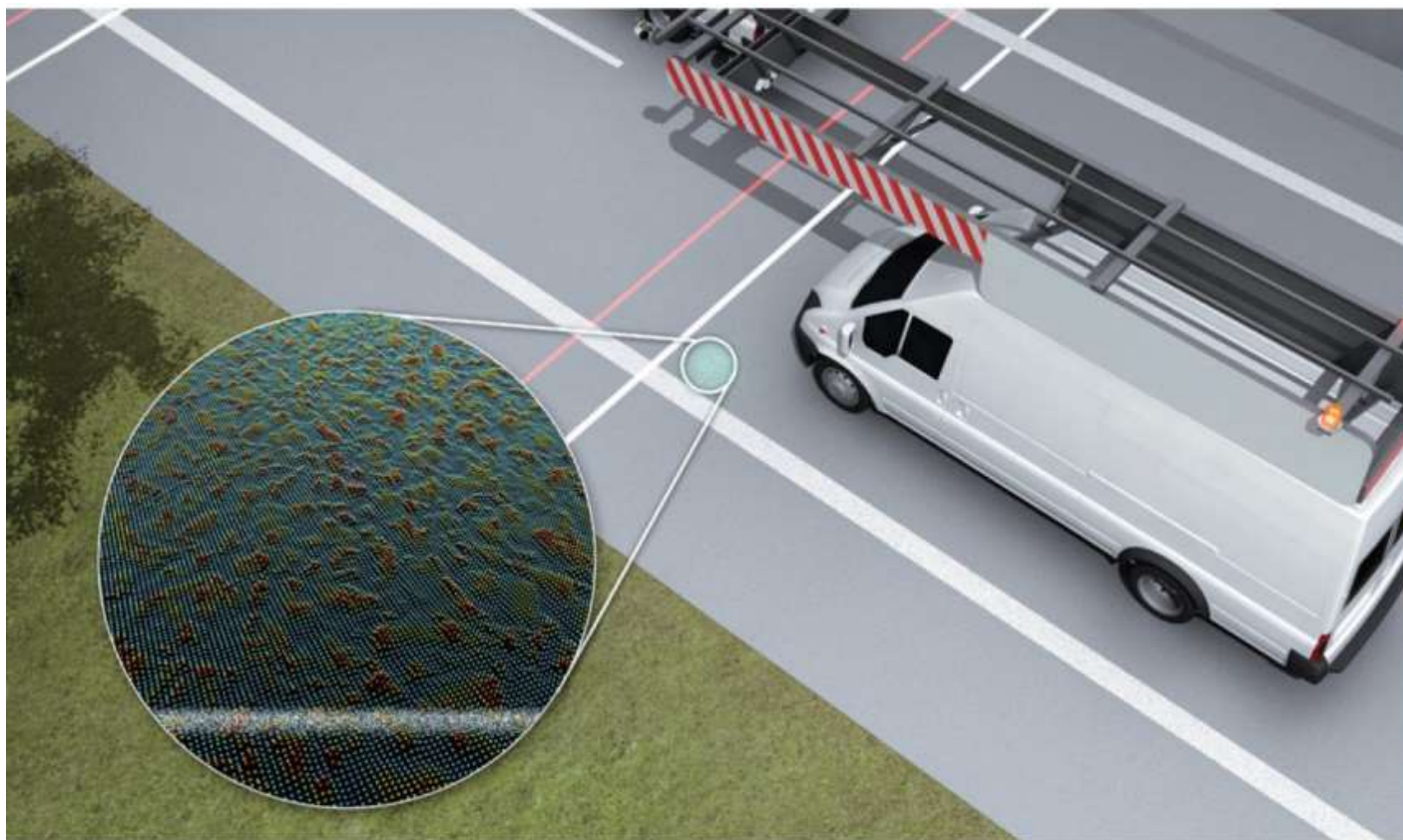


路面检测---工作原理

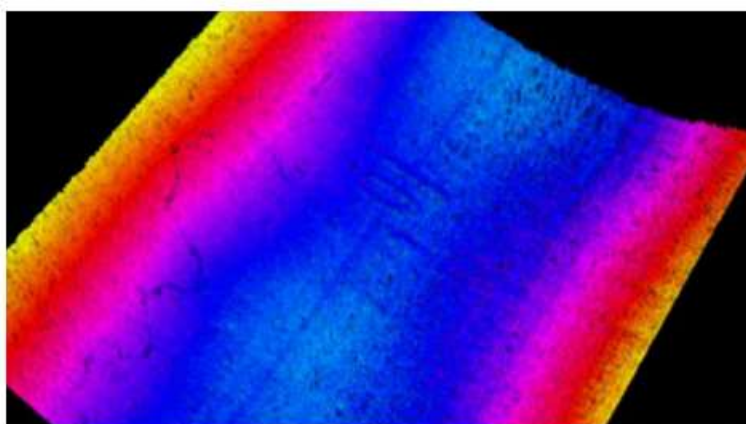
道路综合检测车的本质是搭载相应智能检测系统的车辆，利用各类高新技术设备对公路情况进行信息采集工作。当前装备的高分辨率线阵图像采集系统可以采集公路路面图像，用以识别路面裂缝、坑槽、破损等路面病害，利用激光相机三角测量系统可以连续测量路面车辙数据，多目CCD立体测量系统可以有效捕捉公路沿线立体景观图像，惯性补偿激光测距系统则能精确的对公路平整度指数进行连续式测量。在设备进行数据采集后，由车上的人员或后期数据处理人员用数据处理软件进行数据处理，从而得到相关路段的各类数据并加以上传，是我国各公路管理部门开展道路管理工作的使用新技术及装备。

The essence of the road comprehensive inspection vehicle is the vehicle equipped with the corresponding intelligent detection system, and uses various high-tech equipment to collect information on the highway situation. The currently equipped high-resolution line array image acquisition system can collect road surface images to identify road surface cracks, pits, damage and other road surface diseases. The laser structured light 3D measurement system can continuously measure road rutting data and multi-eye CCD stereo measurement. The system can effectively capture the stereoscopic landscape image along the highway. The inertial compensation laser ranging system can accurately measure the road flatness index continuously.

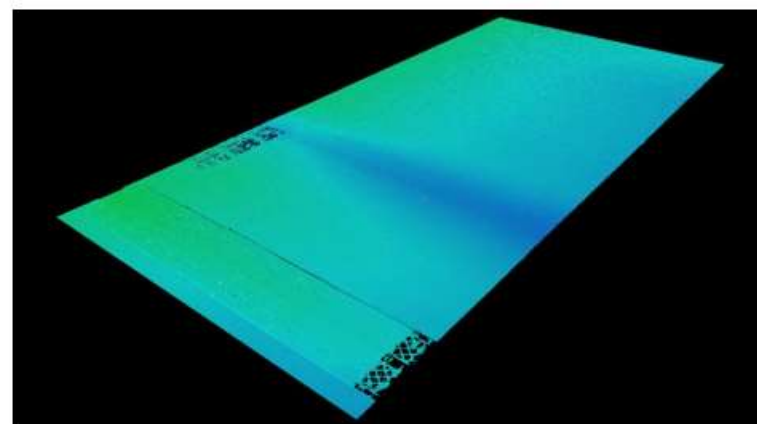
路面检测



路面检测---内容细分



- 1.车辙(Track)
- 2.坑槽(Chunk Hole)
- 3.裂缝(Pavement Crack)
- 4.破损等(Pavement Damage ...)



路面检测---方案

将3D相机的整套组件安装在SUV车顶的后端，利用激光三角的原理，不断将反馈位置的脉冲发送至3D相机，将整体路面的三维点云数据采集后发送至PC。PC端根据获取的点云数据进行图像处理，检测出路面的裂缝，凹凸不平等等不良信息。

The complete set of SICK Ranger camera is installed at the rear end of the SUV roof. Based on the laser triangle, Ranger get the pulse of the feedback position continuously. And the 3D point cloud data of the whole road surface is collected and sent to the PC. The PC performs image processing based on the acquired point cloud data, and detects bad information such as cracks on the road surface, unevenness in unevenness, and so on.

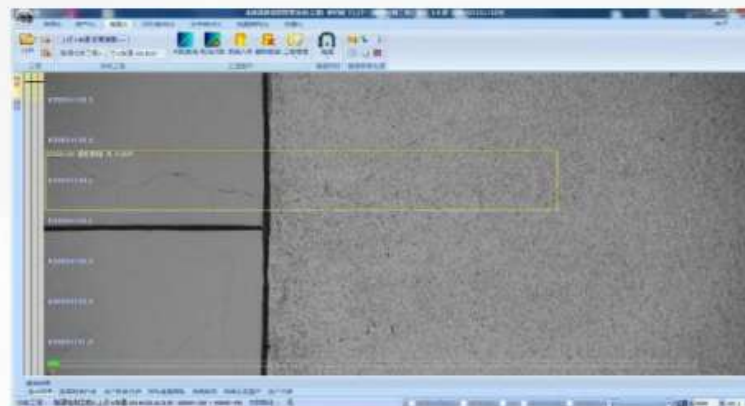
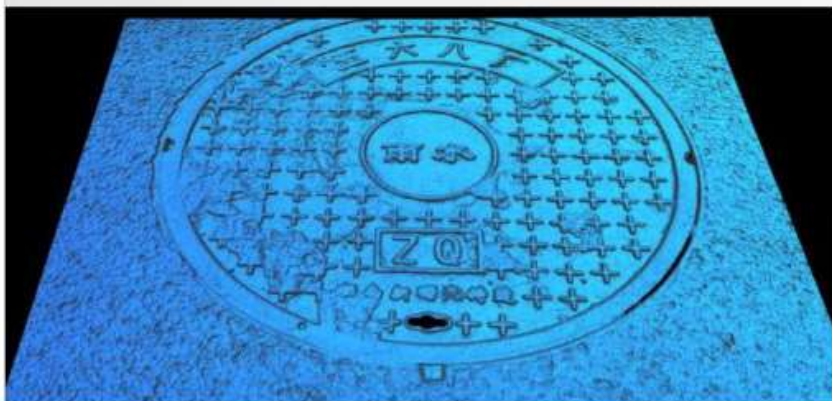
路面检测---视觉系统搭建



路面检测



路面检测



路面检测---视觉系统搭建

Base distance: 350 mm

Camera:

Camera Version: Ranger3-60

Sensor size: 832 x 2560 pixels

Camera height: 1600 mm

Focal length: 12.5 mm

Camera angle: 10 deg

Top Sensor Row: 0

Bottom Sensor Row: 832

Laser:

Laser height: 1600 mm

Laser angle: 0 deg

Fan angle: 70 deg

System:

Fov Height: 701.94 mm

Fov Width on top: 1184.4 mm

Fov Width on bottom: 2012.6 mm

Enable instant update

Show measurementline:

Resolution (mm)	FOV Top	FOV Bottom
dx	0.46265	0.78616
dz raw (no subpixels)	2.6643	4.5273
dz 1/10th subpixel	0.26643	0.45273
dz DCM Algorithm (1/16th subpixel)	0.16652	0.28296

FOV: ~2000mm

X Resolution:

$$2000/2536 = 0.78\text{mm/pixel}$$

Z Resolution:

$$0.28\text{mm/pixel}$$

个性化3D机器视觉整体解决方案，助力智能制造

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