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HK Seminar -One-stop Metro Tunnel Mobile Scanning & Al Automated Detection

by Jackie Cheung 2024/06/14

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1.

How metro tunnels are now being inspected in the world



1.1. Why metro tunnel inspection is a must?

Damages to metro tunnel structure and surfaces frequently occur mainly because of

- surrounding environment changes
- train-induced vibration
- human interference (eg. earthwork projects nearby)

No replay button in reality! Which will come first, Accident or Tomorrow?

construction stage – monitoring needed operational stage – monitoring + inspection needed



1.2. Which headaches? Which contents to inspect? Which existing methodologies?

Headaches:

- limited time window
- dim site and dusty air
- apparent movement hazards
- stuffy environments with few vents

To inspect:

- tunnel structural deformation
- tunnel inwall defects

Existing Methodologies:

- visual inspection
- photography
- robotic total station monitoring
- terrestrial laser scanning

Labor-intensive? Scientific and traceable records? Complete data for assessment?



2.

Mobile scanning helps greatly with efficiency



2.1. What's the new solution and what's included?

Mobile Scanning:

- motorized trolley-based laser scanning
- mobile platform instead of tripod-mounted
- software-driven settings and data capture
- on-site realtime display geared by industrial computer built in trolley body

Scientific. Traceable. Efficient. Visualized. Uniform. Complete.

MS100 system includes,

- all-in-one software Tunnel Scan&Go
- TrolleyAuto (with inbuilt industrial computer)
- laser scanner with Automation function
- multi-lens camera system Clover (option)
- full-life cycle control software Fulicle (option)

New Solution for Metro Tunnel Inspection

A Trusted Safeguard. Track & Field Proven. Engineered to Rail Tunnel.

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2.2. When to use this system in metro tunnel operation?

Suited Stage:

- tracks not laid X (no way to slide)
- tracks already laid (for structural monitoring)
- as-built survey ✓ (for track mid-line, by 6th gen)
- operational stage ✓ (for regular inspection)



6th generation

7th generation

Suited Environment:

bore tunnel
shield tunnel
open-cut to shield structure session
open-cut structure station





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13-lens, captures vault + haunch only, suited to high-speed rail tunnels



17-lens, captures vault + haunch + arch springing, suited to metro tunnels

distance: d1 = d2 = d3, then resolution: r1 = r2 = r3



2.3. Inspecting metro tunnels in different ways...

before



now

2.4. How long it will take to complete 1km tunnel uplink and downlink inspection?

200m per hour, 500m per job (access) (2.5 hours max. for each tunnel access) 1km uplink and downlink = 2km in total 2km / 500m per job = 4 jobs = 4 nights



- repeated station movements
- apparent tripping hazards
- typically every 20m for one scan
- approx. 30 days to analyze and report

1km per hour (structure+ defects)

1 hour to cover uplink1 hour to cover downlink

2 hours = 1 job = 1 night fieldwork only!



- motorized trolley running automatically
- a mobile and stable platform doing the job in one shot
 - 3-4 hours to analyze and report

3.

Automated detection saves big in manpower



3.1. Point Cloud & HD Image Outputs Are Not Final Products Yet



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3.2. AI Technology Applied to Dimensional Calculation & Feature Extraction



Dealing with the numerous points and images and working out the digital report is quite labor-intensive indeed.

3.3. Computer Vision and AI help much in...

Generally speaking, it's supposed to find out,

- Are there any structural deformation portions resulting in weaker structure support, tunnel collapse, or operational safety?

- Are there any inwall defects resulting in rusty rail tracks, electric leakage, or lining concrete damage?
- Where are such defects located?
- What's the size of each detected defect, like length or area?



Category	Major Content	Details to Inspect	Hidden Trouble	
#1	Tunnel Inwall Defects	moist	rusty rail tracks, electric leakage or	
			lining concrete damage, etc.	
		leakage (water seepage)	rusty rail tracks, electric leakage or	
			lining concrete damage, etc.	
		lining crack	weaker structure support, tunnel	
			collapse, etc.	
		segment breakage	weaker structure support, tunnel	
			collapse, operational safety, etc.	
		concrete peeling-off	weaker structure support, tunnel	
			collapse, operational safety, etc.	
		concrete falling-off	tunnel collapse, etc.	
# 2	Tunnel Structural Information	tunnel limit	operational safety	
		tunnel clearance	operational safety	
		tunnel convergence	tunnel collapse, operational safety,	
			etc.	
		sectional data	operational safety	
		segment ovality	weaker structure support,	
			operational safety	
		segment stagger	tunnel collapse, operational safety,	
			etc.	

3.4. AI Computation VS Manual Analysis

Though structural data could be computed via point cloud,

Is it possible to search the inwall defects one by one?

How long will it take to search carefully and find all?

All such defects would not be missed by manual checking?

How to digitize the defects scientifically and come out with a logical report?



4.

One-stop refers to 'from field to office, up to final report'



4.1. One-stop enjoys a complete workflow independent of a third party

Field

Office

Submission







All the necessary hardware and software contributing to an acceptable submission to Rail Authority come from a single source. And all support would be provided by this team as well.

This revolutionary solution features mobile scanning, motorized control, on-site output and automated detection. In one software, data capture and final export may be accomplished.

M35100

	153-2	0.0887	1	1	moist	
	154-1	0.0726	1	1	seepage	
	154-2	0.2171	1	1	moist	
- a ×	155-1	0.1402	/	/	moist	1919 A.
Control Contr	155-2	0.1592	L	L	moist	150-2 S-0.150222
日成功启动小车	155-3	1	0.5580	0.0024	crack	155-3

5.

How AI takes part in this workflow



5.1. Artificial Intelligence & Machine Learning Technology



5.2. AI Technology Applied to Dimensional Calculation & Feature Extraction

Process Workflow:

(fieldwork setting \rightarrow on-site display \rightarrow) data import \rightarrow data analysis \rightarrow sectional data computation \rightarrow defects detection (by algorithm) \rightarrow manual review \rightarrow final report

Automated Detection

- mega database reference
- computer vision
- machine learning & deep learning
- artificial intelligence

Full-life Cycle Control

- historical data management
- statistics, analysis and comparison
- out-of-tolerance alerts









While scanning on site, the system can generate the circular orthophoto almost realtime. You won't spend long hours on post processing in office!

0



165

160

155-3



In the circular orthophoto, nothing could hide. The next step goes to computer vision and big data analysis and that's automated detection of the tunnel diseases.



= 0.088



segment breakage

A&E doctor capable of automatically finding out the diseases with details like location, length, size, category by AI-based algorithm and machine learning techniques.



moist

concrete falling-off

inwall crack

Nearly all problematic portions will be detected in big data computation and analysis while the remaining 10%, more or less, requires double checking and manual editing. Are you crazy about this kind of magic?



actual moist on site



detected moist in software



actual concrete falling-off on site



detected concrete falling-off in software detected inwall crack in software



actual inwall crack on site





3.8mm

Segment Number



Inspection Missions

Metro Tunnel Geo-spatial Information System

🤌 admin

sectional view

×



Guangzhou Metro Line 6

Guangzhou Metro Line 8

Shenzhen Metro Line 2

Guangzhou Metro Line 5

X Shenzhen Metro Line 11

Shenzhen Metro Line 10

Guangzhou Metro Line 1

The system platform will be responsible for the tunnel full-life cycle management. All data is traceable and of great reference value in a variety of applications.



admin

quit

With the 3D data, the site will be within your approach any time. In the long run, all inwall diseases and deformational progress could be scientifically analyzed and tracked at home, which is really amazing.





You may find it much easier to extract any of the historical data and compare it with the recent groups. And that's the way to find out periodical changes against deformation monitoring.

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蔡思貝何廣沛主演 TVB 2023良心劇《你好,我的大夫》

<u>《黄帝内經》提到醫學道理——</u> <u>上醫治未病</u>,中醫治慾病,下醫治己病。

Shortly after accident occured (已病): News, announcement, rescue, repair, research, inspection, maintenance,,, and plenty of handling came up.

While accident is on the brink (慾病), Only inspection and maintenance (if necessary).

Long before accident comes (未病), Only inspection and maintenance (if necessary).

<u>Why not try a scientific solution for the routine inspection to</u> <u>治未病/ 然病?</u> 程嘉应父亲去世,更为了能和辜清劲一起在教研中心工作,考试故意考差,放弃了转去 工商管理的机会,谁知辜清劲一点商量的机会都没有,就说自己决定去大陆义诊,增加 行医经验,但是义诊是不算工作经验的。经过一晚的深思熟虑,辜清劲还是选择了分 手,原因是要去"治未病。"



PS:也是看了这个剧,我才去了解"治未病"的意思。1.根本就没得病的时候,有轻微不舒服的时候,我们去调整它。2.得了病,我们避免它的转移,或者是进一步的恶化。



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