



改善列車路標 測試方法 To Improve Trainborne Beacon Testing Method

團隊背景 Background of the Team

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項目背景

路標設於路軌中央，是港鐵市區綫信號系統中極為重要的一部分。路標的損壞模式通常是逐漸衰弱，並引致列車延誤。因此需要研發一套有效的測試方法，找出已衰弱的路標，作出主動性維修，防止信號系統因接收衰弱的路標信號而不穩定。

Background of the project

Installed in the mainline, beacons are an essential part of the signalling system in MTR. Usually a defective beacon will undergo a process of fading out and cause service delay. To prevent instability of the signalling system due to weak beacons, it is required to develop an effective way to find out the weak beacons for proactive maintenance.

問題成因

- 路標裝於路軌中間，沿行車綫鋪設。路標藉著向列車發出間歇性信號，讓列車可以即時定位；故此，路標是信號系統中極為重要的部分。
- 當兩個相鄰的路標發生故障時，列車未能測定位置，列車自動保護系統便會啟動，因而可能導致列車服務延誤。
- 但路標一般不會突然失靈，通常是輻射功率逐漸衰弱。若派員工直接往工地量度路標狀態，則需要大量人手及時間。因此需要研發一套有效的測試方法，確保找出已衰弱的路標，作出主動性維修。

Causes of the Problem

- Beacons are placed between the rails along the running lines. They transmit intermittent signals for train localisation and initialisation. They are an essential part of the signaling system.
- As a fail-safe design, 2 consecutively missed beacons will trigger delocalisation by Automatic Train Protection, which might in turn cause service delays.
- The radiation power of defective beacons will be fading out rather than a sudden total loss. The traditional method of manual on-site detection for weak beacons involves a lot of manpower and time. Therefore, there is a need to develop an effective way to find out the weak beacons for proactive maintenance.

解決方法

- 我們利用 RC 天綫強度來做路標測試。列車上 RC 天綫的強度可透過車上設備而調整。經過統計及計算後，製作出路標測試器。
- 列車裝上路標測試器後，會在預先計劃的軌道上行駛，由偵錯終端機實時記錄有關路標的狀態。
- 列車完成測試運行後，我們將有關資料下載，用 MissBeaconAnalysing Tool 分析，清楚列出路標的類型及位置，方便進一步詳細分析，需要時安排維修。
- 全綫每半年進行一次測試，並制定工作指示，確保人員能遵循正確的測試方法。

Solutions

- RC antenna is used to assist beacon testing. The intensity of the RC antenna can be adjusted using Trainborne devices. After a series of data analysis, a beacon tester has been built.
- A beacon tester is installed on the EMU which runs on the predefined route. The Debug Terminal records real-time condition of the beacons.
- After the test run, the data collected can be analysed by using MissBeaconAnalysing Tool. The beacon type and position are listed. The related information will be further analysed. Appropriate maintenance will be carried out if necessary.
- Beacon testing is to be carried out every half year. A Work Instruction has been developed to ensure the maintenance procedure is followed properly.

成果及效益

有形得益

透過主動性維修，減少路標需要糾正性維修的機會，每年可節省約 525 萬港元。

Achievements & Benefits

Tangible Benefits

A proactive maintenance approach is adopted to minimise corrective maintenance, bringing a saving of HK\$5.25 million.

無形得益

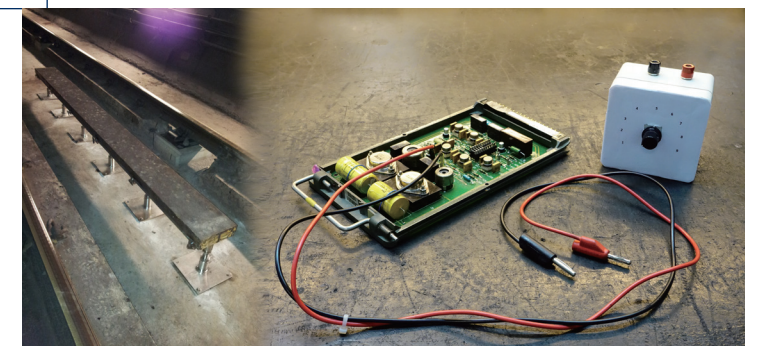
- 優質服務：避免發生故障，提升列車服務水平。
- 互敬互重：來自不同部門的圈員合作無間。
- 創造價值：設計一個全新的測試方法來提高系統的可靠性。
- 勇於進取：透過加強主動性維修來減少糾正性維修。

Intangible Benefits

- Excellent Service: Service delay can be avoided that quality of train service can be improved.
- Mutual Respect: Team spirit is developed among team members who come from various departments.
- Value Creation: A new testing method is designed to improve the reliability of the system.
- Enterprising Spirit: A proactive maintenance approach is adopted to minimise reliance on corrective maintenance.

直接往工地量度，需要大量人手及時間
Beacons are installed in the mainline that manual on-site detection will involve a lot of manpower and time

Sample Test Results:
Train is localised at 4510 140.50
MTIB at XYZ-123aT (1234, 56.78) is missed
RB1 at ABC-987aT (9876, 54.32) is missed
.....
.....
Train is delocalised at 6520 199.75 due to Lastinvariant.
3 beacons (out of 122) are missed.



測試結果 - 列出已衰弱的路標
Result of Beacon Test - find out the weak beacons

路標測試器 - 可偵測已衰弱的路標
Beacon Tester - detect weak beacons which avoid service delay