Optical sensor technology applied in High-Speed Rail

光纖監測技術應用於高鐵系統

The inter-departmental research team includes (from left) Profs. Zhou Limin, Tam Hwa-yaw, Alex Wai, Ni Yiqing, Cheng Li and Dr Wang Dan.
跨部門研究團隊成員包括：（左起）周利民教授、譚華耀教授、衛炳江教授、倪一清教授、成利教授及王丹博士。

PolyU's optical sensor technology has been installed in the national High-Speed Rail to further enhance its structural health and safety.

理大的光纖監測技術已安裝於國家高鐵系統中，以期進一步提升其結構健康與安全性。

The optical fibre technology developed by PolyU has been installed in the national High-Speed Rail with a view to further enhancing its structural health and safety. Key members of the inter-departmental research team include Prof. Ho Siu-lau, Prof. Tam Hwa-yaw and Dr Michael Liu of the Department of Electrical Engineering; Profs. Ni Yiqing and Yin Jianhua of the Department of Civil and Structural Engineering; Profs. Zhou Limin and Cheng Li of the Department of Mechanical Engineering; and Dr Wang Dan of the Department of Computing.

Ir Prof. Alex Wai, PolyU Vice President (Research Development) and Chair Professor of Optical Communications, said, "The unique characteristics of optical fibre sensing technology offer many advantages that make them ideal for use in railway systems."

The team, led by Profs. Ho Siu-lau and Tam Hwa-yaw, has installed the PolyU-developed and award-winning Advanced Fibre Bragg Grating Railway Monitoring System in major parts of the Beijing-Shanghai High-Speed Rail to monitor the track and trains. The system now collects real-time data on vibration, acceleration and temperature changes, which are sent to PolyU engineering experts for monitoring the condition of tracks and railcars and the structural health of the rail foundation. The system can also monitor train speed, axle balance and vibration data for recording and further analysis. These data not only benefit the operation of the high-speed railway, but also contribute to further research in this important area.

Prof. Ni Yiqing, co-ordinator for the University-wide Interdisciplinary Research on Railway-related Projects, has been working closely with Dalian Jiaotong University to install PolyU-developed optical sensors on the new generation of high-speed inspection trains for monitoring purposes. The optical sensors for wind-pressure measurement developed by the team have also been successfully applied.

Profs. Ni Yiqing and Yin Jianhua are also collaborating with Southwest Jiaotong University to monitor the settlement of rail foundations with the use of specially developed optical sensors. The study is important for understanding the safety of foundations and related changes. The team has also kicked off a project with China CNR Corporation, Southwest Jiaotong University and Dalian Jiaotong University on the use of smart damping technology to enhance the stability of high-speed trains.

In addition, researchers at the Department of Mechanical Engineering will consolidate their experience and expertise in the area of structural health monitoring for use in the High-Speed Rail system. Using ultrasonic wave technology, the team has already developed an instantaneous diagnosis system that can detect cracks arising from metallic fatigue and the corrosion of key components of the track and rail.

理大研發的光纖技術已安裝於國家高鐵系統中，以期進一步提升其結構健康與安全性。研究團隊的骨幹成員包括：理大電機工程學系何兆鎏教授、譚華耀教授及廖信儀博士；土木及結構工程學系倪一清教授及殷建華教授；機械工程學系周利民教授及成利教授；以及電子計算學系王丹博士。

理大副校長（科研發展）兼光通訊講座教授衛炳江教授、工程師表示：「光纖傳感技術的獨特之處帶來了許多優點，故此應用於鐵路系統是非常理想的。」

軌道與列車運作監測工作由何兆鎏教授及譚華耀教授帶領的研究小組進行，小組已在京滬高鐵的重要路段裝設了理大的獲獎發明 —「光纖光柵監測系統」。該系統現收集有關震動、加速率及溫度變化等實時數據，然後把數據傳送給理大工程學專家，以監測軌道、列車與路基的結構健康。該系統能記錄列車的車速、軸重平衡及振盪資料等數據，以作詳細分析。這系統不但有助高鐵的運作，並且有利於在這重要領域中的進一步研究。

此外，理大鐵道工程跨學科研究召集人倪一清教授率領的研究小組一直與大連交通大學緊密合作，在新一代高速檢測列車上安裝自研發的光纖感測器，而小組研發的光纖風壓感測器亦已成功應用於高速監測的活動。

同時，倪一清教授和殷建華教授現正與西南交通大學合作，利用自研發的光纖水準儀對高鐵路基的變形沉降進行監測，以掌握高鐵路基的變化規律和安全性。該小組更與中國北車股份有限公司、西南交通大學、大連交通大學展開合作，利用智能阻尼技術提高高速動車的穩定性。

另外，理大機械工程學系的研究人員結合了在結構健康檢測領域的經驗和專長，以應用於高速軌道運輸系統。研究團隊以超聲導波技術，研發出一個即時診斷系統，以監測高速軌道運輸系統關鍵部位因金屬疲勞引起的裂紋及腐蝕等缺陷。

Switched-off vehicles air-conditioned by green energy
綠色能源為熄匙汽車提供冷氣

The system has been installed on different types of vehicles, including minibuses, taxis, public light buses and trucks.
該系統已經安裝在多種交通工具上，包括小巴、的士、公共小巴及貨車。

The pioneering users and stakeholders attend the PolyU's "Green Transport Powering Ceremony" on 26 September to show their commitment for green transport. They included Under Secretary for the Environment Dr Kitty Poon Kit (fourth from left) and Legislative Councillor the Honourable Miriam Lau Kin-yee (sixth from left).
一眾率先使用該系統的用家及持份者於九月二十六日出席理大的「綠色動力創新『驅』」活動，以示對綠色交通的支持。他們包括環境局副局長潘潔博士（左四）和立法會議員劉健儀女士（左六）。

The award-winning Solar-powered Air-conditioning System for Vehicles provides professional drivers with green energy for air-conditioning.

獲獎項目「太陽能汽車冷氣系統」為職業司機提供由綠色能源驅動的冷氣系統。

A solar-powered air-conditioning system, jointly developed by Prof. Eric Cheng of PolyU's Department of Electrical Engineering and Green Power Industrial Ltd, has recently been installed on various types of vehicles, including minibuses, taxis, public light buses and trucks. The system was first installed on a beverage truck of Swire Coca-Cola Hong Kong and was proven to work on the road last year.

Solar energy panels made up of photovoltaic modules are installed on top of the vehicle, and the panels automatically harvest solar energy while the vehicle is moving. The energy is then stored in a battery supported by an optimized control system. The solar energy collected will support a stand-alone electric air-conditioner that can operate even when the car engine is not running. The system can operate even on cloudy and rainy days since solar energy is automatically stored during sunny weather.

The solar panels are made from bendy materials that can fit perfectly on any vehicle rooftop, giving them a sleek appearance. They also serve as good thermal insulation for the interior and other valuable equipment inside the vehicle.

Idling vehicles not only pollute the air, but also waste fuel. With this invention, air-conditioning can still be supplied when the vehicle's engine is switched off. In other words, this green innovation can help to reduce the fuel costs from leaving vehicles running for the sake of the air-conditioning.

由理大電機工程學系鄭家偉教授聯同陽光動力有限公司合力研發的「太陽能汽車冷氣系統」，最近安裝在不同類型的交通工具上，包括小巴、的士、公共小巴及貨車。這系統去年首次安裝在太古可口可樂香港的一輛汽水車的頂部，路面測試成效非常理想。

該系統是將配合光電模組使用的太陽能電池板安裝在車輛車頂部位。當車輛在路面行駛時，電池板會自動收集太陽能，並將之轉化為電能儲存在一個靠優化控制板支援的電池系統中。收集到的太陽能可以支援一個單機的電氣冷氣系統，即使在關掉汽車引擎後都能運作。這套系統在陰天或雨天也可以運作自如，原因是晴天時所收集的太陽能已自動儲存在電池中。

太陽能板以軟性物料製造，方便配置於各類車頂上，安裝後仍光滑而美觀。同時，太陽能板也能為車廂或車內貴重的儀器起着絕緣的作用。

停車而不關掉引擎不但造成空氣污染，而且浪費汽油。有了這個發明，車輛在關掉引擎後仍然可以提供冷氣。換言之，如果駕車人士是為了冷氣才在停車時保持開動引擎，這項綠色發明更有助他們節省汽油支出。

Sensors technology commercialized for further applications
傳感器技術產業化　拓濶應用層面

PolyU Executive Vice President Mr Nicholas Yang (front row, first from left); E-T-A Head of Innovation and Technology Mr Peter Meckler (front row, second from left); E-T-A Asia Pacific Pte Ltd Managing Director Mr Darren Poh (front row, middle); Dr Derek Or (back row, third from left); Prof. Ho Siu-lau (back row, fourth from left); and Prof. Charles Surya, Acting Dean of Faculty of Engineering (back row, fifth from left)
理大行政副校長楊偉雄先生（前排左一）、E-T-A公司創新科技主管Peter Meckler先生（前排左二）、亞太區總裁Darren Poh先生（前排中）、柯少榮博士（後排左三）、何兆鎏教授（後排左四）及工程學院署理院長徐星全教授（後排左五）

German industry giant E-T-A sponsors the advancement of PolyU-developed smart sensors technology.

德國工業巨頭 E-T-A 資助理大進一步開發其高智能傳感器技術。

PolyU has signed a Memorandum of Understanding with German industry giant E-T-A Elektrotechnische Apparate GmbH, which will provide sponsorship of EUR500,000 for the University to advance and commercialize the Self-Sustainable Magnetoelectric Smart Sensor Technology invented by Dr Derek Or Siu-wing, Associate Professor of the Department of Electrical Engineering, for electrical circuit protection applications.

This power-supply-free, signal-conditioner-free, passive-current sensor technology has advantages including high detection sensitivity, wide-range current linearity, wide operational frequency range, high temperature stability and tailorable performance and geometry. The passive current sensors are simple, reliable, cost-effective and suitable for a broad domain of applications, including the real-time, isolated/non-contact measurement of electric currents and magnetic fields.

In addition, Dr Or and Prof. Ho Siu-lau, Head of the Department of Electrical Engineering, have successfully deployed these passive current sensors and wireless communication units in the self-powered wireless monitoring of modern railway and/or electrical power distribution systems in Hong Kong, Macau, the Chinese mainland and Thailand.

The research on sensor technology has been granted two US patents, in addition to being published in more than 60 Science Citation Index (SCI) Grade-A journal papers.

理大與德國工業巨頭E-T-A Elektrotechnische Apparate GmbH簽訂合作協議，E-T-A公司將向理大提供五十萬歐元的資助，進一步開發理大電機工程學系副教授柯少榮博士研發的「高智能磁電傳感器技術」，並將其產業化，以應用於電路保護產品。

這項免電源、免信號調節器的無源電流傳感器技術，具有高檢測靈敏度、線性電流範圍大、操作頻率範圍大、高温度穩定性，以及可度身設計特性和形狀等優點。這些無源電流傳感器有結構簡單、可靠、高成本效益等特徵，可應用於廣泛領域，包括實時、隔離或非接觸式測量電流和磁場。

此外，柯博士與電機工程學系系主任何兆鎏教授成功將無源電流傳感器與無線通信器結合，成為自供電式無線狀態/健康監測系統，分別安裝於香港、澳門、中國內地及泰國的鐵路和/或配電系統上。

這傳感器技術的研究已獲得兩項美國專利授權，研究結果亦於六十多篇科學引文索引（SCI）收錄的甲類國際期刊論文中發表。