

**Application of Internet of Things (IoT) Technology and Machine Learning Methods
for Promotion of Lithium Battery Recycling in HK Community**
應用物聯網技術和機器學習方法在香港推廣鋰電池回收

by Ji CHEN

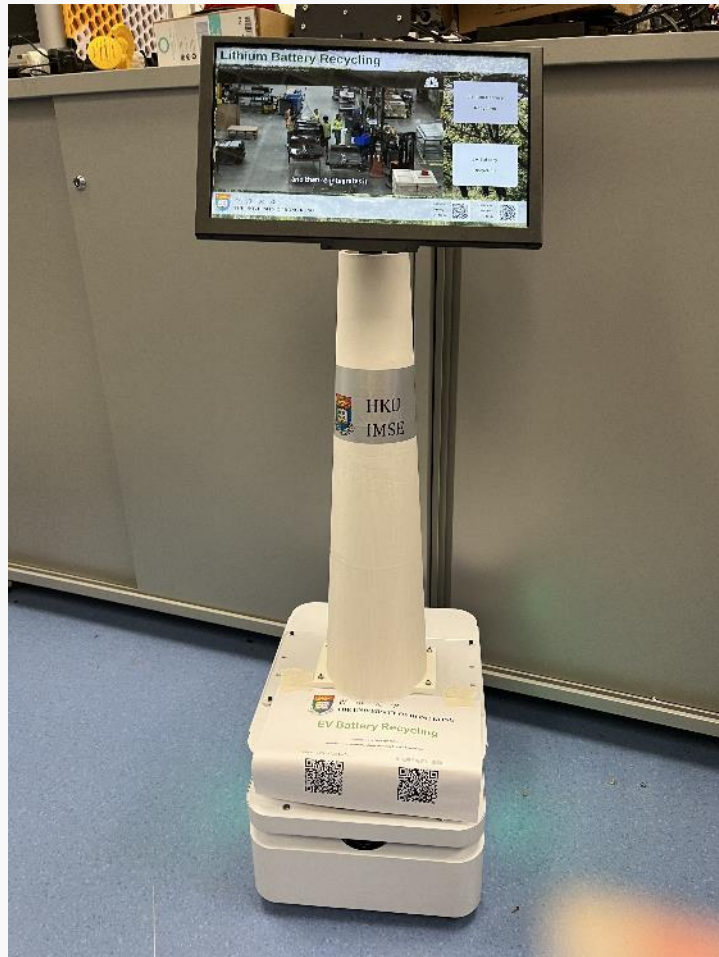
Engineering; Civil Engineering

Project No.: KE-SI-2023/24-28

Strategic Theme(s):

Green and Sustainable Energy

Smart Interactive Kiosk for Lithium Battery Recycling Promotion



Smart Robot



The project has developed a smart interactive kiosk called **smart robot** for Lithium Battery Recycling Promotion, which aims to increase public awareness and participation in the recycling of used lithium batteries through a mobile promotional platform.

The robot is capable of **flexible movement** and features a built-in **screen** for playing promotional **videos** and a **QR code survey**. This allows the public to participate in battery recycling campaigns anytime, anywhere. The robot is not only user-friendly and convenient, but also highly efficient and energy-saving, making it a powerful tool for promoting environmental awareness.

Website for Lithium Battery Recycling Popularization

Buttons for displaying videos

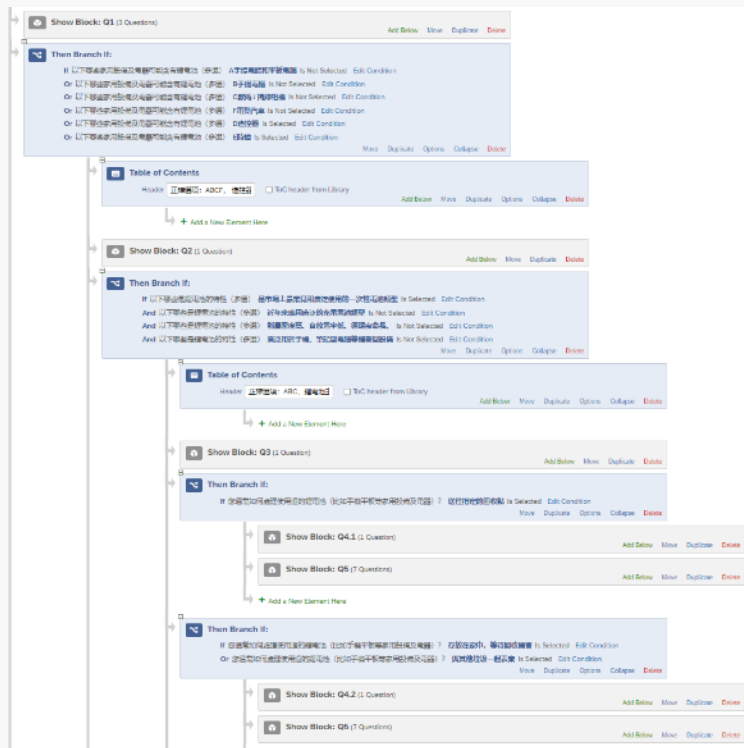


Knowledge popularization videos

Survey QR Code

The project has developed a website called Website for Lithium Battery Recycling Popularization, which features two promotional videos aimed at raising public awareness and encouraging participation in lithium battery recycling. Additionally, the website offers a QR code survey for users to complete.

Survey for Lithium Battery Recycling



年齡

18歲以下

18-22歲

22-30歲

30歲以上

學歷

中學及以下

大學（專科/大學專科）及本科

碩士及博士

以下哪些家用設備及電器可能含有鋰電池（多選）

A 手提電話和平板電腦

B 手提電腦

C 數碼 / 攝錄相機

D 遙控器

E 時鐘

F 電動汽車

請勾選你目前所知道的鋰電池回收點

MTR (如: 灣仔火車站, 堅尼地城站)

商場 (如: 新豐街-西貢城地鐵地下(G07號舖/皇后大道西484-490號新安大樓地下, 豐澤-西區總匯西390號華明中心地下)

屋苑 (如: 寶翠園, 綠悠庭, 學士薈, 富林苑)

市政 (如: 石塘咀市政大廈門口, 堅尼地城卑路乍利街單邊對出行人路)

您通常如何處理使用過的鋰電池（比如手機平板等家用設備及電器）？

送往指定的回收點

存放在家中, 等待回收機會

與其他垃圾一起丟棄

以下哪些是鋰電池的特性（多選）

近年採用更先進的充電技術

能量密度高, 自放電率低, 循環壽命長

廣泛用於手機, 筆記型電腦等攜帶設備

是市場上最常見和廣泛使用的一次性電池類型

The survey data analysis showed that the educational videos displayed at the information kiosk were successful in increasing public knowledge and significantly promoting recycling participation.

Lithium Battery Recycling Knowledge Popularization Video



[Lithium Battery Recycling.mp4](#)

EV Battery Recycling Knowledge Popularization Video



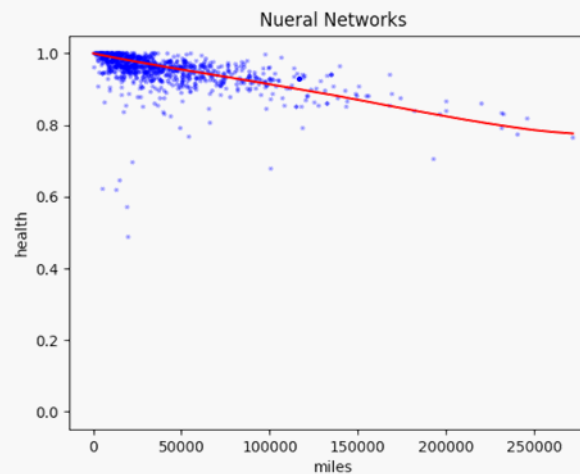
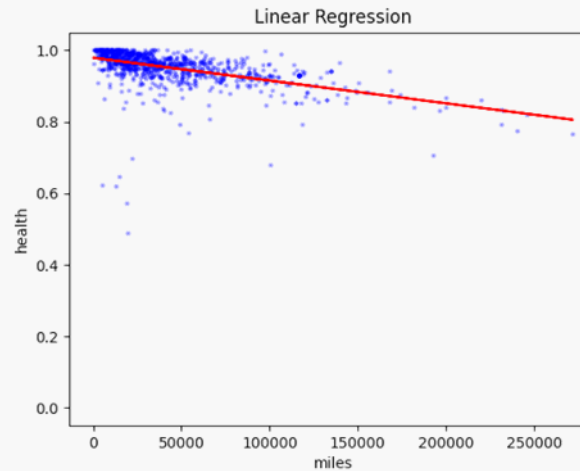
[EV Battery Recycling.mp4](#)

EV Battery Recycling Knowledge - Degradation Curve

From the collected EV battery samples in the project, we used various methods to analyze and obtain the decreasing trend of the EV battery health with driving distance.

In order to improve the rationality of the degradation curve, constraint conditions were added to the model \hat{F} during AI-based learning.

$$\begin{aligned}\hat{F}(0) &= 1 \\ \frac{\partial \hat{F}}{\partial \text{miles}} &\leq 0\end{aligned}$$



Based on the curve, it can be inferred that at approximately 220,000 miles of driving, the battery health will decrease to around 80%, indicating the need for replacement.

KE outcomes and impact

This project aims to promote lithium-battery recycling in Hong Kong to contribute to the city's sustainability. Our team designed a smart interactive kiosk, conducted campus promotions, created posters and videos, and carried out surveys to raise public awareness and participation in lithium-battery recycling. Additionally, the project addressed the disposal needs of electric vehicle (EV) lithium-batteries. Our team utilised machine learning to analyse data from 625 Tesla vehicles, establishing a neural network model that describes the battery capacity decline with mileage. Combining this with Hong Kong's EV data, we projected the EV lithium-battery disposal demand in HK for the next 10 years, providing a decision-making basis for the government and enterprises to plan disposal or recycling facilities. In summary, this project tackles lithium-battery recycling from both the household appliance and EV perspectives. It is crucial for reducing battery disposal in landfills and recovering valuable metals. Through innovative approaches, such as smart kiosks and data-driven forecasting, the project aims to promote lithium-battery recycling and support Hong Kong's sustainable development.



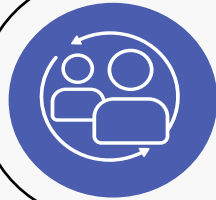
知識交流的成果和影響

本項目致力於促進香港鋰電池的回收。團隊通過設計智慧互動亭、開展校園宣傳、海報及視頻宣傳和問卷調查，提高了民眾對鋰電池回收的認知和參與意願。同時，針對EV鋰電池回收需求，團隊利用機器學習等方法，分析了625輛特斯拉的實際使用資料，建立了描述電池容量隨使用里程下降規律的神經網路模型。並結合香港電動車資料，預測了未來10年香港EV鋰電池的回收需求，為政府和企業規劃回收設施提供決策依據。總的來說，本項目從家用電器和EV兩個層面，致力於推動香港的鋰電池回收，對於減少電池進入垃圾填埋場、回收利用有價金屬具有重要意義。

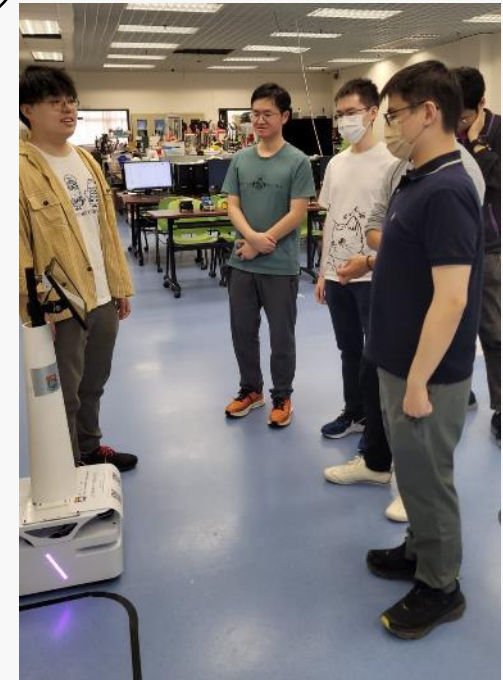


Knowledge Promotion

We organized events to promote lithium battery recycling to secondary school students. The event included interactive activities and educational videos designed to increase awareness and encourage participation in battery recycling. The students were able to learn about the importance of recycling and how to properly dispose of their used batteries. The event was a success and helped to raise awareness among the younger generation about the importance of environmental sustainability.



Knowledge Promotion for Secondary School Students



Knowledge Promotion Booth

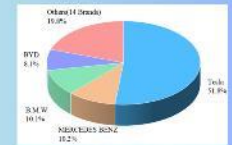
We set up a booth within a university to promote lithium battery recycling. The project included the design of promotional posters, the placement of intelligent robots to promote battery recycling, and the distribution of gifts and souvenirs to encourage participants to watch educational videos, listen to lectures on battery recycling, and complete designed surveys. The event received positive feedback and was successful in raising awareness about the importance of proper battery disposal.



Knowledge Promotion Booth in HKU Campus

KNOWLEDGE EXCHANGE (KE) FUNDING EXERCISE
Civil Engineering & Industrial and Manufacturing Systems Engineering
電動汽車鋰電池回收是重要的環保議題

Hong Kong: No new registration of fuel-propelled private cars including hybrid vehicles in 2035 or earlier

Growth trend of EVs in HK **Proportion of EV brands in HK**

屯門環保園電動車電池回收再造設施動工 料最快後年底運作

全港現時已有九萬多部登記電動車

當它們的電池表現下降，或用了八至十年，即過了平均壽命週期就更換，舊電池交由持牌收集商。



每年平均約有24公噸車用電池運往外地 (2017-21)

當目前本地只有初步處理的化學廢物處置設施，最終要將電池運到南韓、比利時等循環再造。



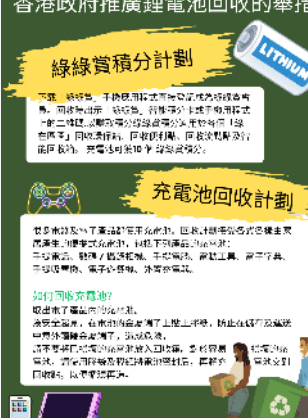
香港政府推廣鋰電池回收的舉措

綠綠賞積分計劃

不棄、維修、二手使用等方式可節省經濟成本，而此計劃更進一步，將廢物分類及回收，將廢物分類及回收，將廢物分類及回收...

充電電池回收計劃

當電池及電子產品不再使用，請將這些電池及電子產品交到指定的回收點，以便進行回收及處理...



KNOWLEDGE EXCHANGE (KE) FUNDING EXERCISE
Civil Engineering & Industrial and Manufacturing Systems Engineering
應用物聯網技術和機器學習方法在香港推廣鋰電池回收

製成互動式，用於提高回收的教育和推廣

It is a high-tech content that is a labor to learn to learn on the making participants in the cases, or raise awareness regarding the knowledge of EV car batteries as well as their lifecycle and behaviour towards recycling.

MORE ABOUT LITHIUM BATTERIES



如何回收充電電池?

廢品收集及電子廢物回收中心，已設有回收充電電池的專用收集點，市民可將舊電池交到該中心，以便進行回收及處理...

請勿將舊電池放入回收箱，否則會導致電池短路，甚至引發火警。請將舊電池交到指定回收點，以便進行回收及處理。

PLEASE HELP FILL IN THE QUESTIONNAIRE






Original sized photos are requested for HKU's website/social media

