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使用 TacPic 系統和人工智能為視障者和盲人提供快速觸覺教材的開發

Rapid Tactile Educational Material Development Using the TacPic System and Artificial Intelligence for the Visually Impaired and Blind

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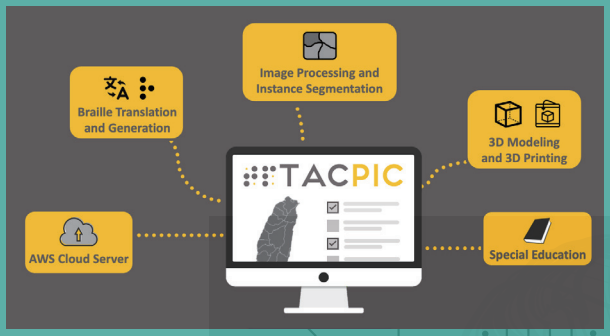
作品摘要

世界衛生組織（WHO）強調隨時間的推移，全世界視障和盲人（VIB）的數量逐年增長，不僅在開發中國家，已開發國家也身處其中。在視障和盲人每天面臨的眾多挑戰中， 移動和學習是時常面臨的問題，教育是人們學習世界新知和思想的基石，身處在高度需要視覺體會的環境中，視障者（VIB）很難理解周圍不同的物體和形狀。

訪問教育現場的特教師在給予視障和盲人學生的學習教材上，有以下四點困境：第一、由於多數教具侷限在音頻和印在紙上的點字介面，但紙本長時間使用會變形。第二、重新製造一本新書的成本高昂，且出版社不做小量印製（不低於1000本）。第三、特殊教育強調個別化教育，授予每位學生相同類型的傳統教材和教學方式並不合適，畢竟隨著每位學生的缺陷不同，使得學習優劣勢也會有所不同。第四、語言學習的工具也十分有限。

科技不斷地在提高人們的生活品質，同時也提供新穎的方式改善VIB的學習體驗，可客製（customize）及可個人化（personalize）為特殊教育學習之首要需求，因此使用印刷機和塑膠射出等常規技術的生產方式並非首選。為了克服上述困境，研究人員將人工智慧（AI）和3D列印視為可用於幫助為VIB 學生創建個性化學習材料的技術之一。 因此我們團隊為特教師及家長們設計了一款容易上手的系統，為VIB 學習者開發觸覺學習輔助工具，以配合解決兩項聯合國永續發展目標：優質教育和減少國內及國家間不平等。

TacPic系統平台可根據使用者上傳的圖像自動創造觸覺教材。該系統能夠使用機器學習、圖像處理、自然語言處理和3D重建之多項技術來產出不同類型的觸覺教材，而其輸出可生成STL或者其他3D列印的檔案。如系統概述圖1所示，觸覺教材主要是使用3D列印的原料，學生可透過老師的引導來認識每個物件的的點字和形狀。目前，可以順利產出的觸覺教材的類型有：觸覺圖字卡、觸覺地圖和觸覺釘拼圖。整個流程只需耗費2分鐘的轉檔外加幾小時的3D列印即可完成， 相較於需要花費數週時間製造的習之技術，本系統有極大的優勢。觸覺抽認卡是外型浮雕的教具，可讓學生認識物件的點字和形狀。透過TacPic系統平台，教師可以不費功夫的為VIB學生創建這些觸覺教材，而且同時具有生成新型觸覺教具的能力。



▲ 圖一 TacPic系統概述圖

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研究領域

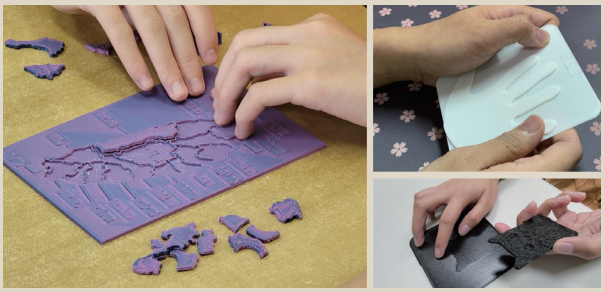
輔具設計及系統整合、工程教育、生醫訊號處理、生醫影像處理

Abstract

The World Health Organization (WHO) has emphasized on the growing number of visually impaired and blind people (VIB) around the world, both in developing countries and also in developed countries. They face many challenges every day and among these, their main difficulties are the aspects of mobility and education. Education is a stepping stone for the people to learn new concepts and ideas of the world, but in our highly visual world it is difficult for VIBs to understand the different objects and shapes around them. Thus, teachers of blind schools have difficulty in enhancing the learning environment of the VIB students because of the technical limitations. First, most of their materials are limited to audio and braille interfaces printed on paper and prolonged use deforms the braille words and images. Second, making new braille books is very costly and publishers are not willing to print below 1000 copies. Third, special education has placed an emphasis on individualized education because each student has their own strengths and weaknesses in terms of disability so mass production of the learning material is not the best option. Fourth, introductory learning materials tools are also limited.

Technology has come a long way to improve the quality of life of people and it can be used to improve the learning experience of the VIB by providing novel methods to customize and personalize development of learning aids, moving away from conventional technologies such as printing presses and plastic molding. To alleviate the difficulties mentioned above, the researchers looked at AI and 3D printing as technologies that can be used to help create individualized learning materials for the VIB students. The team has developed an easy to use system for non-technical teachers and parents to develop tactile learning aids for VIB learners that address two items of the United Nations Sustainable Development Goals namely: Quality Education and Reduced Inequalities.

The TacPic System is designed to automatically create tactile educational materials based on the image input given by the user. The system is able to create different types of tactile educational materials using different techniques of machine learning, image processing, natural language processing, and 3D reconstruction. The output would produce a .stl file or other 3D printing file types. The tactile learning aids are 3D printed materials that are induced with shape information and the braille labels of each object. Currently, the types of tactile educational materials that can be created are: tactile flashcards, tactile maps, and tactile peg puzzles as shown in Figure 2. It can be made within 2 minutes and printed within a few hours compared to weeks of development and creation in the traditional method. Tactile flashcards are shape embossed learning materials to give an idea of a shape of an object with the label in braille. Tactile maps are maps with removable pieces to help them learn a city's location in the general sense. Tactile peg puzzles are also removable pieces but are used for more general shape and object learning. Through the TacPic system, the teachers are empowered with the capabilities of generating new kinds of tactile educational materials without the additional work entailed to create these materials for the VIB students.



▲ Fig. 2 The tactile educational materials generated by the TacPic system are the (left) tactile maps, (right, up) the tactile flashcard, and (right, bottom) the tactile peg puzzle