附件 2、參選說明表

填表日期： 114 年 10 月 30 日

產品或 服務名稱	（中文）**識別冠心病的輔助評估系統** 單位：**高雄醫學大學附設中和紀念醫院/中醫部/林宏隆醫師團隊**
	（英文）Auxiliary Assessment System for Identifying Coronary Heart Disease Unit：Kaohsiung Medical University Chung-Ho Memorial Hospital / Department of Traditional Chinese Medicine / Dr. Hung-Lung Lin’s Team
該產品服務 上架時間	預期於 3 年後商品化
產品或服務 創新介紹 與應用效益	（中文） 現今社會面臨人口高齡化與冠心病年輕化的趨勢，傳統冠心病診斷仍依賴心導管、心電圖等大型醫療設備，須至醫院檢查且流程繁複。為降低醫療與時間成本，本研究設計了一套冠心病輔助識別與評估系統及手機應用程式(APP)。 本系統以傳統中醫「望診」理論及《黃帝內經》中舌與心的相關論述為基礎，結合近年觀察性與回顧性研究指出：舌下絡脈的血瘀與曲張現象與心血管疾病具顯著正相關。基於此，本系統以 AI 分析舌下絡脈影像為核心，搭配**自行開發的自動反光去除演算法**與影像分割技術，並建立基於**新穎 multi-head attention 機制**的深度學習預測模型，整合於**手機 APP** 中，提供即時預測與快速篩檢功能。 經十回合交叉驗證測試結果顯示，所設計的自動反光去除演算法可使模型辨識準確率由 80.00%提升至 86.67%，具良好**準確性**與**穩定性**。測試亦顯示，同一受試者多次拍攝所得結果一致，具高度**可再現性**。使用者僅需以手機拍攝舌下影像，即可在 7 至 20 秒內獲得識別結果，系統並提供後續就醫或日常保養建議，達成**即時、便利**且具成本效益的初步健康篩檢目標。

	(英文) In modern society, the trends of population aging and the younger onset of coronary heart disease (CHD) have become increasingly evident. Traditional CHD diagnosis still relies on large-scale medical instruments such as cardiac catheterization and electrocardiography, which require hospital visits and involve complex procedures. To reduce medical and time costs, this study developed an auxiliary CHD identification and assessment system integrated with a mobile application (APP). The proposed system is grounded in the traditional Chinese medicine (TCM) theory of "inspection" and the correlation between the tongue and the heart described in the 《Huangdi Neijing》. Recent observational and retrospective studies have further indicated a significant positive correlation between sublingual varicosities (blood stasis and vessel dilation) and cardiovascular diseases. Based on these findings, the system employs AI-driven analysis of sublingual vascular images, incorporating a self-developed automatic reflection removal algorithm and image segmentation techniques. A novel deep learning prediction model based on a multi-head attention mechanism was constructed and deployed within the mobile APP, providing real-time prediction and rapid screening functions. Ten-fold cross-validation demonstrated that the proposed reflection removal algorithm improved the model's recognition accuracy from 80.00% to 86.67%, showing good accuracy and stability. Furthermore, consistent prediction results were obtained from multiple recordings of the same participant, confirming the reproducibility of the system. Users only need to capture sublingual images with a smartphone, and the system can generate identification results within 7 to 20 seconds. It also offers personalized recommendations for further medical consultation or daily health maintenance, achieving the goal of real-time, convenient, and cost-effective preliminary CHD screening.

經營團隊	(中文) 簡要說明團隊的特色及能力 本團隊為跨領域合作團隊，由高雄醫學大學附設中和紀念醫院中醫部針灸科林宏隆(Hung-Lung Lin)、小兒神經科林龍昌(Lung-Chang Lin)主任、小兒神經科楊瑞成(Rei-Cheng Yang)教授、一般醫學內科李智雄(Chee-Siong Lee)主任、小兒神經科鄭旻豪(Min-Hao Jheng)研究助理、高雄市立小港醫院心臟內科盧怡旭(Ye-Hsu Lu)主任、國立高雄科技大學資管系歐陽振森(Chen-Sen Ouyang)教授、義守大學電機系吳榮慶(Rong-Ching Wu)教授、國家運動科學中心運動科技與資訊開發處邱益鴻(Yi-Hung Chiu)助理研究員共組研究團隊。團隊合作至今已達 10 年之久，屬於長期且穩定之研究合作。技術涵蓋中醫、西醫臨床醫學應用、機器學習、量化腦波、臨床診療、深度學習、訊號處理、醫材開發、介面開發、影像分析等技術。本團隊成立以來，相關研究成果包括： (1). 發表 **27 篇 SCI 期刊**論文。 (2). 發表 **2 篇其他期刊**論文。 (3). 擁有 **2 個美國發明**專利 (4). 擁有 **7 個中華民國發明**專利。 (5). 執行超過 **25 件研究計畫**。 (6). 各類競賽中獲得 **7 個獎項。** (7). 先前研究成果(以智慧型手錶診斷注意力不集中併過動症)獲頒第十八屆國家新創獎臨床新創獎、2023 年國家新創精進獎、發明獎名人堂等。

	（英文） Our team is a cross-disciplinary research team, composed of: • Hung-Lung Lin, Department of Acupuncture, Traditional Chinese Medicine, Kaohsiung Medical University Chung-Ho Memorial Hospital • Lung-Chang Lin, Director, Pediatric Neurology, Kaohsiung Medical University Chung-Ho Memorial Hospital • Rei-Cheng Yang, Professor, Pediatric Neurology, Kaohsiung Medical University Chung-Ho Memorial Hospital • Chee-Siong Lee, Director, General Internal Medicine, Kaohsiung Medical University Chung-Ho Memorial Hospital • Min-Hao Jheng, Research Assistant, Pediatric Neurology, Kaohsiung Medical University Chung-Ho Memorial Hospital • Ye-Hsu Lu, Director, Cardiology, Kaohsiung Municipal Siaogang Hospital • Chen-Sen Ouyang, Professor, Department of Information Management, National Kaohsiung University of Science and Technology • Rong-Ching Wu, Professor, Department of Electrical Engineering, I-Shou University • Yi-Hung Chiu, Assistant Researcher, Sports Technology and Information Development Division, National Sports Science Center The team has been collaborating for over 10 years, representing a long-term and stable research partnership. Our technical expertise spans Traditional Chinese Medicine (TCM), Western clinical medicine, machine learning, quantitative EEG, clinical diagnostics, deep learning, signal processing, medical device development, interface development, and image analysis. Since its establishment, our team's research achievements include: **(1). 27 publications in SCI-indexed journals** **(2). 2 publications in other journals** **(3). 2 United States invention patents** **(4). 7 Republic of China (Taiwan) invention patents** **(5). Execution of more than 25 research projects** **(6). 7 awards in various competitions** **(7). Previous research outcomes**—specifically, using **smartwatches to diagnose attention deficit and hyperactivity disorder (ADHD)**—have been awarded the **18th National Innovation Award, Clinical Innovation Prize**, the **2023 National Innovation Advancement Award**, and induction into the **Invention Award Hall of Fame**

經營績效及未來發展	（中文） **目前研發成果：** **(1).** 案例數據：目前已收案多位受試者，並使用其中 60 位術前的健康受試者及冠心病患者的各 3 張舌下影像進行訓練，達到 86.67%的確度度、86.67%的靈敏度、86.67 的特異度、92.84%的 AUC。 **(2).** 技術驗證：已發表學術論文，參與台北醫學研討會及第二十二屆國家新創獎，並已申請專利中(申請號: 114126190，申請日：2025/07/10)。 **未來發展方向：** 為持續推動本產品之技術成熟度、臨床實用性與市場佔有率，未來將依下列方向進行優化與部署： (1). **模型強化與資料擴增：**將持續擴增舌下絡脈影像樣本數，並增加不同年齡、性別與多樣化舌下特徵的案例，用以提升模型對各種舌下絡脈影像變異情況之識別能力。並針對現有的 AI 輔助識別模型進行持續優化，包括演算法改良與參數微調，進一步提升模型的準確率、靈敏度及長期偵測的穩定性。此外，未來將增加視覺化回饋機制，例如生成模型關注熱力圖(heatmap)，提供臨床醫師可視化的輔助判讀依據，增加模型結果的可解釋性。 (2). **APP 與雲端平台整合開發：**將持續優化行動端 APP 的使用者介面，並提升操作便利性與功能完整度。其中，為了因應實際應用場景中可能遇到的設備差異與拍攝環境變異，例如：不同手機鏡頭規格、亮度條件、使用者操作差異等，後續系統將納入裝置型號辨識、閃光燈自動亮度檢測機制，確保輸入影像品質穩定。目前手機 APP 版本已完成 Android 平台開發，未來將同步開發 iOS 與 Android 雙平台，並評估是否委託專業 APP 開發公司進行進一步優化，以提升產品成熟度與穩定性。 (3). **產品商品化與市場推廣：**將完成手機 APP 正式上架並部署後台監控系統，藉以確保服務品質與使用者體驗，並評估委託專業手機 APP 管理與維運公司進行長期維護與升級。此外，將透過舉辦健康講座、健檢中心與社區醫療單位合作，進行初期市場推廣與用戶擴散。最後，目標為建立完整的智慧醫療服務架構，依據不同風險程度提供個別化的健康管理與就醫建議，進一步拓展本產品於臨床應用與健康管理市場之影響力。 本產品預計透過上述規劃，逐步從技術研發走向商品化，結合 AI 技術、行動裝置與雲端平台，打造一個可規模化推廣的冠心病早期篩檢與健康管理解決方案，預期將在醫療照護及精準預防醫學領域發揮重大影響力。

	（英文） Current R&D Achievements: (1). Case Data: The study has enrolled multiple participants, using three sublingual images from 60 preoperative healthy participants and coronary heart disease (CHD) patients for training. The model achieved an accuracy of 86.67%, sensitivity of 86.67%, specificity of 86.67%, and an AUC of 92.84%. (2). Technical Validation: The research has been published in academic journals, presented at the Taipei Medical Symposium and the 22nd National Innovation Awards, and a patent has been filed (Application No.: 114126190, filed on 2025/07/10). Future Development Directions: To continuously enhance the product's technological maturity, clinical utility, and market share, the following strategies will be pursued: (1). Model Enhancement and Data Augmentation:The dataset of sublingual vascular images will be expanded, including cases of varying ages, genders, and diverse sublingual characteristics, to improve the model's ability to recognize different variations. The AI-assisted recognition model will be continuously optimized, including algorithm refinement and parameter tuning, to further improve accuracy, sensitivity, and long-term stability. Additionally, a visualization feedback mechanism, such as heatmaps generated by the model, will be incorporated to provide clinicians with interpretable references for decision-making. (2). App and Cloud Platform Integration:The mobile app's user interface will be continuously optimized to enhance usability and feature completeness. To address potential variations in device specifications and imaging conditions (e.g., different camera quality, lighting conditions, and user operation), the system will include device recognition and automatic flash brightness adjustment mechanisms to ensure consistent image quality. The Android version of the app has been completed, with plans to develop iOS support and evaluate collaboration with professional app development companies for further optimization, thereby enhancing product maturity and stability. (3). Product Commercialization and Market Promotion:The mobile app will be officially launched along with a backend monitoring system to ensure service quality and user experience. Long-term maintenance and updates may be entrusted to professional app management companies. Initial market promotion will be carried out through health seminars and collaborations with health check centers and community medical units. The ultimate goal is to establish a comprehensive smart healthcare service framework, providing personalized health management and medical recommendations based on

<table>
<tr><td></td><td colspan="6">individual risk levels, thereby expanding the product’s impact in clinical applications and health management markets.
Through the above strategies, the product is expected to transition from R&D to commercialization, integrating AI technology, mobile devices, and cloud platforms to create a scalable solution for early CHD screening and health management, with significant potential impact in medical care and precision preventive medicine.</td></tr>
<tr><td rowspan="10">對應之淨零策略／SDGs 目標（請勾選）</td><td></td><td>1.消除貧窮</td><td></td><td>2.終止飢餓</td><td>v</td><td>3.建康與社福</td></tr>
<tr><td></td><td>4.優質教育</td><td></td><td>5.性別平權</td><td></td><td>6.淨水與衛生</td></tr>
<tr><td></td><td>7.可負擔的潔淨能源</td><td></td><td>8.適合的工作及經濟成長</td><td></td><td>9.工業化、創新與基礎建設</td></tr>
<tr><td></td><td>10.減少不平等</td><td></td><td>11.永續城鄉</td><td></td><td>12.責任消費及生產</td></tr>
<tr><td></td><td>13.氣候行動</td><td></td><td>14.保育海洋生態</td><td></td><td>15.保育陸域生態</td></tr>
<tr><td></td><td>16.和平、正義及健全制度</td><td></td><td>17.多元夥伴關係</td><td></td><td></td></tr>
<tr><td></td><td>1.風能/光能</td><td></td><td>2.氫能</td><td></td><td>3.前瞻能源</td></tr>
<tr><td></td><td>4.電力系統與儲能</td><td></td><td>5.節能</td><td></td><td>6.碳捕捉利用及封存</td></tr>
<tr><td>v</td><td>7.運具電動化及無碳化</td><td></td><td>8.資源循環零廢棄</td><td></td><td>9.自然碳匯</td></tr>
<tr><td></td><td>10.淨零綠生活</td><td></td><td>11.綠色金融</td><td></td><td>12.公正轉型</td></tr>
<tr><td>公司/學校/單位 logo</td><td colspan="6"></td></tr>
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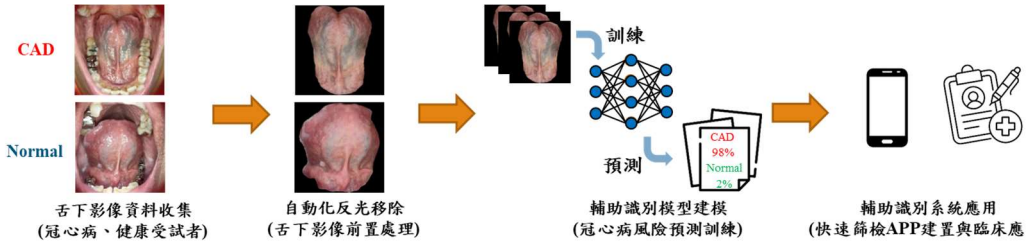
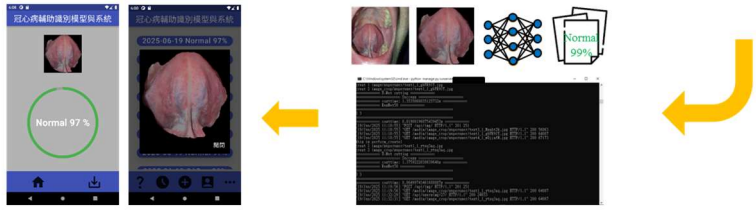
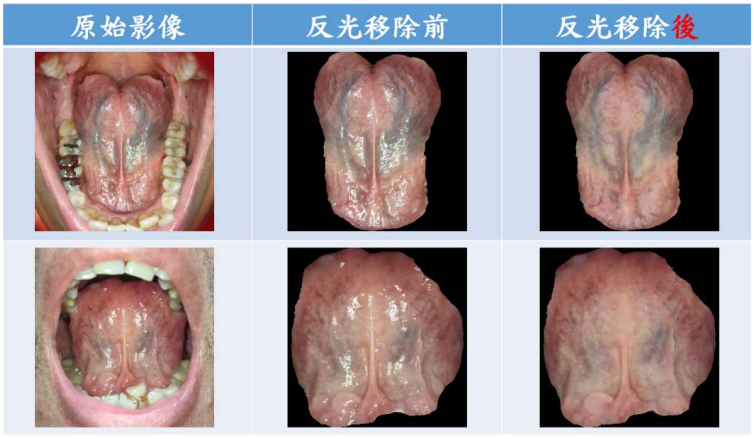
佐證圖片
或影片



圖一 本研究之冠心病輔助識別模型與系統流程圖。



圖二 本產品實際系統運作成果與流程圖。



圖三 反光去除前後之影像比較。

表一 本技術與競品分析比較表。

	系統/產品	檢測方式	是否為非侵入式	是否可居家使用	是否含AI輔助	使用者使用成本	檢測準確性	檢測結果產出速度
	本技術	拍攝舌下影像+AI自動分析	是	是	是	低 (手機拍照)	高	快 (7~20秒
現行產品	心導管攝影	經血管插入導管觀察心臟血流	否	否	無	極高 (手術級檢查)	極高	慢 (術前準備+恢復
現行產品	運動心電圖	分析體能負荷下的心電訊號變化	否	否	無	中高	中	慢 (需臨床安排與判讀)
現行產品	冠狀動脈電腦斷層掃描	進行心臟血管斷層影像檢查	是	否	少部分使用AI輔助判讀	高	高	中 (需臨床安排與判讀)

表二 本產品之專利檢索關鍵字與檢索結果。

專利檢索關鍵字	檢索結果	關聯專利
((冠狀動脈) OR (冠心) OR (Coronary artery))@CL AND (舌頭 or 舌部)@CL	5	1
[((冠狀動脈) OR (冠心) OR (Coronary artery))@CL AND (識別 OR 辨識 OR 預測 OR 評估 OR 預估 OR 診斷 OR 判斷)@TI AND (影像 or 照片 or 影片)@CL AND (舌頭下 or 舌部下 or 舌下)@CL]	0	0
(識別 OR 辨識 OR 預測 OR 評估 OR 預估 OR 診斷 OR 判斷)@TI AND (去除反光 or 反光去除 or 消除反光 or 反光消除 or 移除反光 or 反光移除)@CL AND ((影像 or 圖像 or 圖片 or 照片 or 影片))@CL	14	1
Google (舌下) and (血管) and (冠狀動脈)	未知	1 篇文獻

註：檢索資料庫須含括所有擬申請國家別。

介紹影片連結： https://youtu.be/y01fsJGLPJQ

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附註：表格大小不足，請自動調整欄位大小，以便利於撰寫