

A25-050

七軸手臂服務機器人

Seven-Axis Robotic Arm Service Robot

隊伍名稱 | 機器世界 Robotic World

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成功大學工程科學系博士，現為虎尾科技大學資訊工程系教授，專精於工程與資訊科技領域，致力於智慧科技與互動系統相關教學與研究。

研究領域

生成式AI、虛擬實境、行動與嵌入式平台及人機互動介面設計。



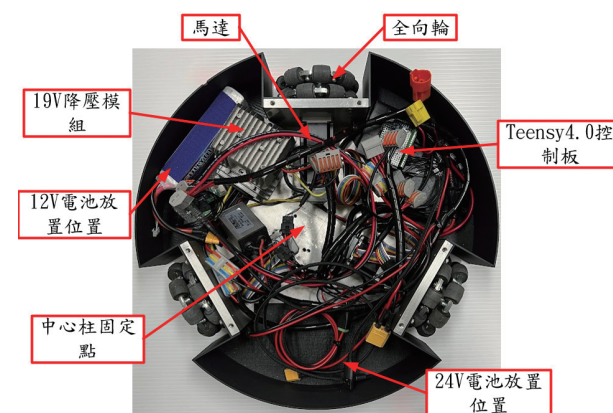
作品摘要

隨著臺灣餐飲業面臨人力短缺與效率提升的挑戰，服務機器人的需求日益增加。本作品的創新之處在於其七軸機械手臂設計，相較於傳統三至五軸手臂，七軸結構提供更高的靈活度與操作範圍，能模擬人類手臂的複雜動作，適用於多元化的餐飲服務場景。此外，機器人整合了影像辨識技術，能夠自主判斷餐桌上是否需要收取餐具或進行清潔，從而減少人工介入，提升作業效率。此設計不僅限於物品搬運，還能執行精細的操作任務，展現了高度的智慧化與自動化潛力。

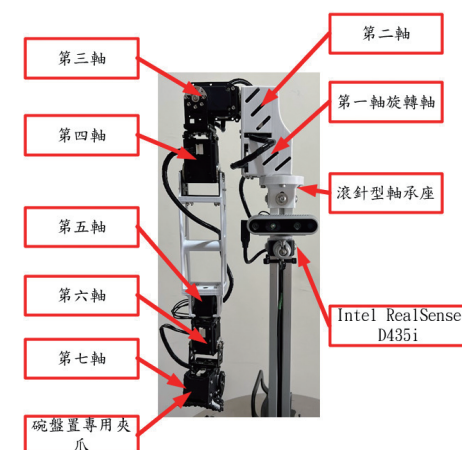
本作品的設計包含底盤結構如圖一所示、動力系統、機械手臂如圖二所示、電力系統與嵌入式控制系統等多個核心模組。底盤採用穩定的結構設計，確保機器人在複雜環境中的平穩移動；動力系統提供充足的驅動力，支援長時間運作；七軸機械手臂則是核心組件，透過精密的PID控制算法，實現平滑且精準的動作控制。影像辨識模組利用先進的視覺處理技術，能夠識別餐桌上的物品狀態，並根據需求執行相應任務，例如收取餐盤或整理桌面。電力系統採用高效能電池與能源管理設計，確保機器人能夠持續穩定運行。

在控制系統方面，本作品採用嵌入式系統作為核心，整合底盤控制、機械手臂操作與影像辨識功能。底盤控制模組負責路徑規劃與障礙規避，確保機器人能在餐廳環境中安全移動。機械手臂控制系統透過七軸PID調整，實現高精度的動作執行，適用於抓取不同形狀與重量的物品。影像辨識模組則利用深度學習技術，精準識別餐桌上的物品類型與狀態，並與控制系統協同工作，實現自主決策與操作。

未來，團隊計畫進一步優化系統效能，增強機器人的環境適應能力，並探索更多應用場景，例如醫療或物流領域，以實現更廣泛的商業價值。本作品不僅體現了技術創新，也為服務型機器人的發展提供了重要的參考價值。



圖一 底盤架構。



圖二 機械手臂架構。

Abstract

In recent years, Taiwan's dining industry has faced challenges such as labor shortages and the need for improved efficiency. This project introduces a novel solution through its seven-axis robotic arm, which offers greater flexibility and range of motion compared to traditional three-to-five-axis arms. This design enables the robot to mimic complex human arm movements, making it suitable for diverse tasks in dining settings. Furthermore, the robot incorporates image recognition technology to autonomously determine whether tableware needs to be collected or tables cleaned, reducing human intervention and enhancing operational efficiency. Beyond mere item transport, the robot can perform intricate tasks, showcasing significant potential for intelligent automation.

Fig. 3 The robot's design encompasses several core components: chassis structure, power system, robotic arm, power supply, and embedded control system. The chassis is engineered for stability, ensuring smooth navigation in complex environments. The power system provides sufficient energy to support prolonged operation. The seven-axis robotic arm, the centerpiece of the design, employs precise PID control algorithms to achieve smooth and accurate movements. The image recognition module utilizes advanced vision processing to identify the state of items on tables and execute tasks such as collecting plates or tidying surfaces. The power supply system, equipped with high-efficiency batteries and energy management, ensures consistent and reliable performance.

The control system integrates an embedded platform that coordinates chassis control, robotic arm operation, and image recognition. The chassis control module handles path planning and obstacle avoidance, enabling safe navigation in dining environments. The robotic arm control system, optimized with seven-axis PID tuning, ensures high-precision task execution, capable of handling objects of varying shapes and weights. The image recognition module, powered by deep learning, accurately identifies item types and conditions on tables, working in tandem with the control system to enable autonomous decision-making and operation.

This project successfully delivers an autonomous service robot tailored for table clearing and resource recycling, addressing key challenges in the dining industry. The integration of a seven-axis robotic arm and image recognition technology enhances operational flexibility and precision, demonstrating significant potential for real-world applications. Moving forward, the team plans to optimize system performance, improve environmental adaptability, and explore additional use cases, such as in healthcare or logistics, to unlock broader commercial value. This project not only showcases technical innovation but also provides a valuable reference for the development of service robots.

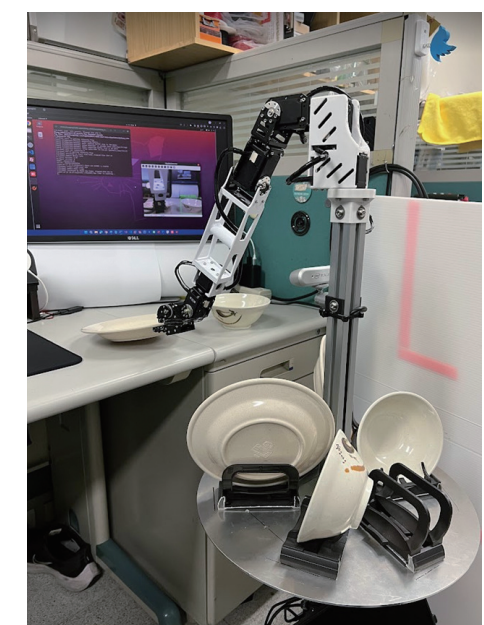


Fig. 3 Robot.