



臻善圈決賽隊伍提案摘要 Project Summaries of WIT Finalists

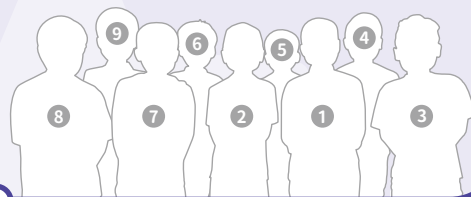
應用機器人在自動收費系統閘機加快車票測試 Using a Robot to Speed Up the Ticket Testing of AFC Gates



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成立日期 Date of Team Formation 01/2022

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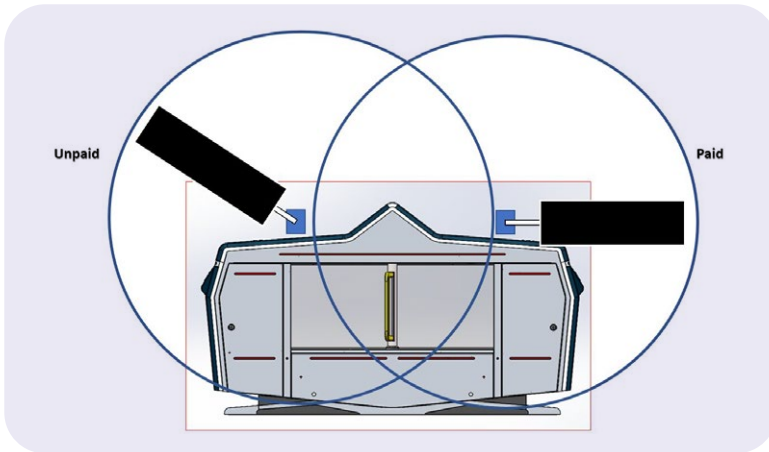


問題剖析 Problem Analysis

- 新車站啟用前，每部閘機皆須通過6000次的票務測試，以確保所有票種皆能穩定操作且無異常情況。這項測試通常由兩名員工負責，而每部閘機皆需時兩天完成。
- 儘管承辦商有義務遵守《職業安全及健康條例》來確保工作系統安全，但面對開站時間緊迫的壓力下，或需加快測試進度。承辦商日間需於工地施工，夜間則進行第二輪測試。
- 長時間朝同一方向走動可造成筋腱勞損，增加請病假的風險。FMD需與承辦商協作，並監督票務測試過程。
- For a new station opening, each gate requires 6,000 ticketing tests to ensure all ticket types are stable and function without issues. Typically, this testing takes two staff members two days per gate to complete.
- While contractors are obligated to follow the Occupational Safety and Health Ordinance for a safe work system, the pressure to open a station punctually may accelerate the testing process. This means the contractors must work on-site by day and conduct a second testing at night.
- As prolonged movement in one direction can cause musculoskeletal strain and increase the risk of taking sick leaves. FMD must collaborate with contractors and oversee the testing process to ensure safety and efficiency.



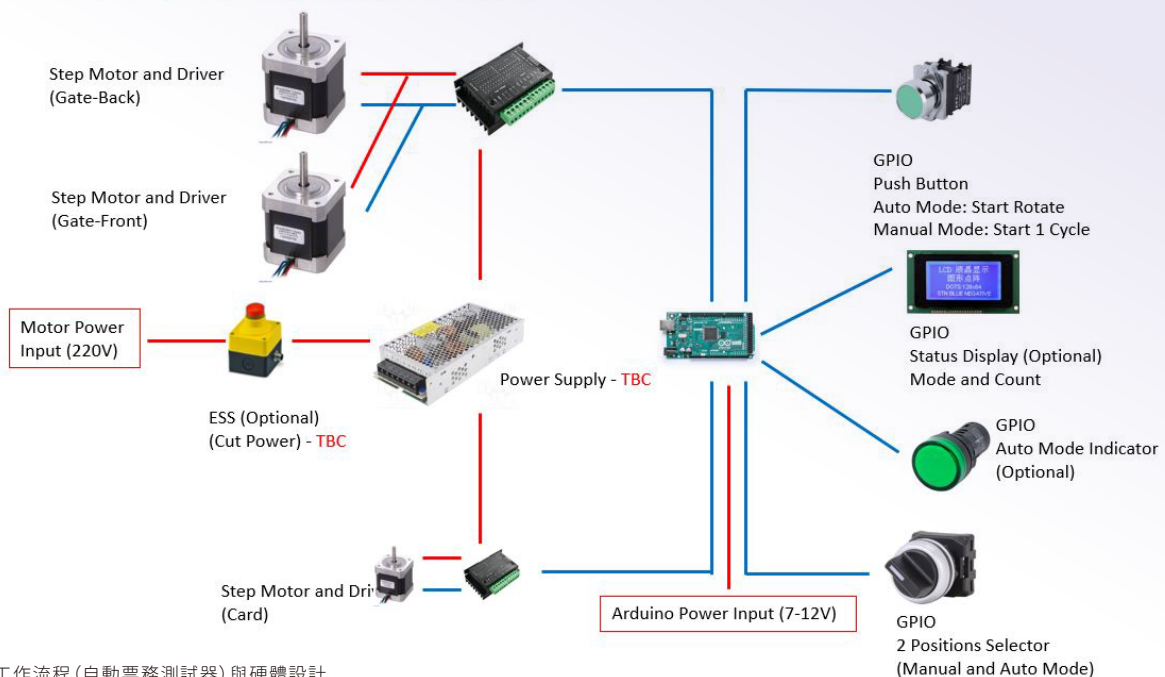
改善方法 Improvement Methods



機器人模擬人類通過閘口通道時的行走和拍卡動作
The robot simulates human's behaviour of walking and ticket-tapping actions of passing through a gate

- 團隊透過運用機器人，讓票務測試自動化，使其能夠於大型資產更新和鐵路線路擴展工程中應用。
- 該設備採用客製化機械設計、步進馬達驅動機制及Arduino CPU技術，使其能以低成本構造，同時符合產品設計規範，實現高效的AFC票務測試。
- 應用該機器人後，6,000次票務測試僅需6.6小時便能自動完成，較使用手動方法所需的兩天大為縮短。
- Our team intends that the development of using robot will enable the ticket testing to conduct in an automatic way for mega and railway extension projects.
- With its customized mechanical design, step motors driving mechanism and Arduino CPU technology – the device can be constructed at a low cost yet achieve high effectiveness and efficiency for AFC ticket tests under our product design specification.
- 6,000 ticket tests could be completed automatically in only 6.6 hours after applying the robot, a significant time reduction when compared with the manual method of 2 days.

Connection Illustration



機器人的工作流程 (自動票務測試器) 與硬體設計
The workflow (automatic ticket tester) and hardware design of robot

為評估該機器人的效能與效率，團隊已於車站進行實測。團隊在測試時，同時修正機械部件(如安裝配件和移動物件板)，以提升機器人的耐用性和穩定性，同時對微控制器和步進馬達進行時間的調整，以控制速度並提升穩定性。

On-site trial was conducted at station to evaluate the effective and efficiency of this robot. During testing, mechanical parts (for example, mounting accessories and moving object board) were modified to enhance the durability and robustness, while the Micro-controller and Step Motors had their timing adjusted for speed control and stability.



總結成果 Summary of Achievements

有形得益

- 每部閘機的票務測試時間由16小時縮減至6.6小時。
- 顯著節省成本：
 - 假設一個車站有51部閘機，原需2人進行16小時測試
每人人工成本：\$296/小時 x 16小時 = \$4,736；
2人成本：\$4,736 x 2 = \$9,472
測試成本：\$9,472 x 51部閘機 = \$483,072
 - 應用機器人後，僅需1人並需0.166小時作為設置時間就能開始測試。
測試成本：\$296 x 0.166小時 x 51部閘機 + \$5,000 (機器人成本) = \$7,506。
 - 票務測試節省超過港幣475,000元 (\$483,072 - \$7,506 ≈ \$475,000)。

無形得益

- 發展新的設計技能並鼓勵持續改進
- 加強部門間的溝通與協作
- 通過減少人員疲勞，來提高系統測試的效率和測試的安全性

Tangible Benefits

- The ticket testing time per gate has been reduced from 16 hours to 6.6 hours.
- Significant cost saving:
 - Assuming a station has 51 gates, it originally required 2 testers to conduct 16 hours of testing.
Cost per tester: \$296/hour x 16 hours = \$4,736;
Cost for 2 testers = \$4,736 x 2 = \$9,472
Testing cost: \$9,472 x 51 gates = \$483,072
 - After automation, only 1 tester is needed, plus 0.166 hours for robot setup before testing.
Testing cost: \$296/hour x 0.166 hours x 51 gates + \$5,000 (robot cost) = \$7,506
 - Ticket testing saves over HK\$475,000 (\$483,072 - \$7,506 ≈ \$475,000).

Intangible Benefits

- Cultivated new design skills and fostered continuous improvement
- Enhanced inter-departmental communication and collaboration
- Improved efficiency of system testing and enhanced test safety by minimizing staff fatigue