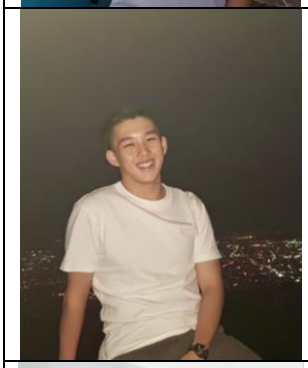
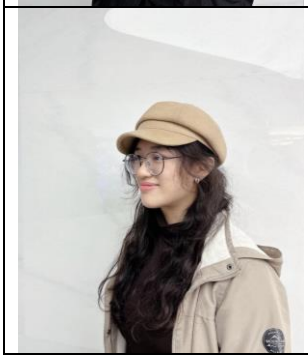
STEAM陪伴型機器人科學教具

一、摘要

隨著少子化的趨勢日益加重，許多雙薪家庭夫妻忙著上班，回家後仍需要繼續加班，比較沒時間陪伴孩子，因此只能將孩子交給3C保母，如手機、平板等，造成嚴重親子互動問題。目前在市場上也比較少看見有兼具陪伴及教學的輔具，故本研究以開發STEAM陪伴型機器人科學教具為例，整合機械結構設計、與電子電路設計，搭配3D列印等非傳統加工技術，開發具有教育性、趣味性、啟發性的陪伴型機器人教具。透過在玩陪伴型機器人時，培養孩童具備STEAM核心能力，包括：跨領域、動手玩、生活應用、解決問題、及五感學習等，讓孩子增進多元學習實力。藉此研究成果來協助，但非取代父母照顧孩童，成為快樂學習的好夥伴。從寓教於樂中，大幅降低兒童對3C產品依賴性，也能增加與他人溝通互動的機會。此外，在父母親也能夠透過STEAM陪伴型機器人科學教具的人機互動介面輔助，設定相關學習主題，陪伴孩子快樂地成長。並藉由問卷及測驗以驗證成效，從而培養孩童動手實作、創造思維、與解決問題能力。預期將研究成果，進行商品化評估及試量產，及透過簡單教學提供給更多人試用。透過此實作互動方式，增加孩子對於程式撰寫的樂趣，及提升未來競爭力。

關鍵字：AIoT、STEAM 教育、陪伴型機器人、多元學習、人機互動介面

成員介紹

	鄭瑞鴻 產品整合開發設計 機電整合設計與製造 研發與專案管理
	林昌哲 產品整合開發設計 機電整合設計與製造 程式設計與撰寫
	李長紘 產品整合開發設計 機構設計 機電整合設計與製造
	龐禕心 產品整合開發設計 3D 電腦輔助製圖 文書編輯
	何亭萱 產品整合開發設計 3D 電腦輔助製圖 文書編輯

二、前言

會發想到研究開發STEAM陪伴型機器人科學教具，是因為曾在樂高機器人的安親班打　工，在教導學生的過程中發現，現在的小朋友回家後，父母親卻仍在加班，或者無暇陪伴其學習或娛樂。因此，他們很多時間都是以3C電子產品，如手機、平板等，來打發時間。其實孩童是對相關機器人玩具很有興趣，但市售機器人產品價格高昂，而具不管是在人機介面操作、或內容學習上，也都有一定的難度。致使陪伴型機器人尚未普及。而透過STEAM科學教具的自主學習機會、與自主創造空間，有助於提升孩童學習興趣及參與度，藉此鍛煉孩童的創新能力。

因此本研究思考如何設計STEAM陪伴型機器人科學教具，能夠讓家長陪著孩子一起玩樂學習，遠離3C產品。也讓孩童感覺是一種好玩的玩具，並且能夠從遊戲過程中，學習到生活上的好習慣。並且透過簡單的人機互動介面，協助親子間進行圖像化積木程式撰寫的過程，培訓更多自主創造空間，鍛鍊創新及邏輯思維的能力。並研究如何開發低成本STEAM陪伴型機器人，並將研究成果商品化，透過自己設計教材，改變傳統教育型機器人一成不變的課程，讓孩子透過不同的面相學習多元的知識，從動手拼裝機器人的過程中，學到結構、電路等不同領域的知識。

2.2.1 AI 語音辨識模組

(1)運用語音模組來控制機器人執行所定義的簡單動作

(2)考慮到年齡較小的兒童發音較不正確，因此本作品新增一項 AI 語音辨識系統，本系統能透過來辨認小朋友較不清楚的發音

(3)結合以上的 AI 語音辨識系統，針對較不清楚的發音機器人能夠重複指令來達到確認以及教導孩童正確發音的功能

(4)一款如同 ChatGPT 的聊天系統,讓孩童能夠在自己孤單一人時能夠有聊天的對象

2.2.2 遠端監控系統

(1)父母能夠透過 APP 的遠端監視系統來觀察孩童的一舉一動

(2)家長能夠透過 APP 來控制機器人的即時動作

(3)本作品加入了孩童安全狀況報告，透過 AI 視覺辨識系統來判別哪些危險

的地方是兒童步仍夠靠近的，並且透過監控孩童身體健康狀況來通報給家長
(4) 本作品設有遠端視訊功能，讓孩童自己待在房間時能夠及時的和家長溝通聯絡

2.2.3 自定義動作

(1)如果對於程式有一定觀念及興趣的家長能夠透過本作品的拼圖塊程式撰寫系統來定義機器人的動作

(2)程式包下載

若是不會轉寫程式的家長，亦可透過管網上的程式包來做機器人動作自訂義

(3)本作品的課程內容分為兩個年齡層的劃分，以 3-6 歲及 7-10 歲為年齡劃分來做相對應的課程教授

2.2.4 自動跟隨孩童系統

透過地圖建構及地形建構系統來追蹤孩童的移動方向，讓其不會離開父母的視線

三、設計特色及功能介紹

STEAM 陪伴型機器人科學教具開發與研究流程，如圖 1 所示：

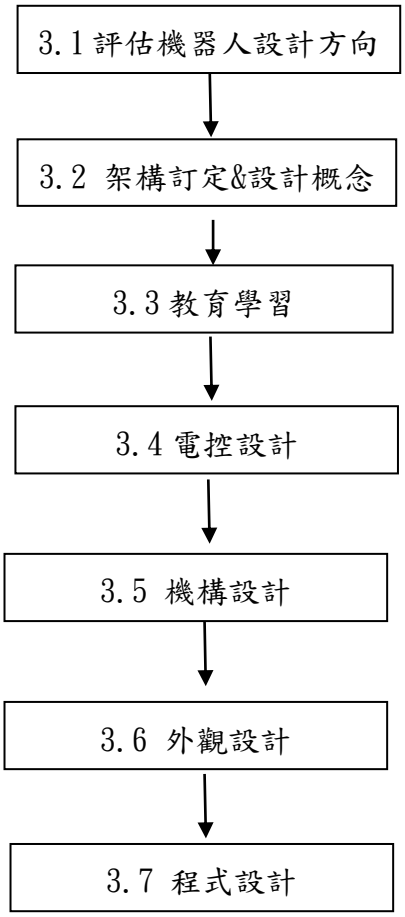


圖 1 STEAM 陪伴型機器人科學教具開發與應用研究流程圖

3.1 評估機器人設計方向

針對市場中現有機器人進行分析，從中發現大部分高階型機器人（圖 2），大多都是以金屬骨架為主，金屬骨架除了重量太重易發生危險外，成本也相對較塑膠材料較高，且螺絲過多拆裝過程太過複雜。即便簡易型機器人採用塑膠外殼（圖 3），但是在教學程式方面上較為公式化，在現實生活中存在很多可以讓孩子學習的地方，因此，一成不變的教學方式，是沒有辦法全面地教育孩子。因此訂定機器人設計方向為：組裝及維修簡單、材料互換性高，並且有一套簡單程式設計軟體，亦可在網路上下載程式包，讓不善常撰寫程式的使用者也能親自設計心目中理想的課程。

圖 2 市售高階型機器人

圖 3 市售簡易型機器人

3.2 架構訂定&設計概念

透過市場中現有陪伴型機器人資訊，進行分析、和初步規劃機器人架構配置，並設計運動方式及材料選用。根據現有市場之相關教具，規劃開發架構，及考慮各馬達之間的位置，來進行動作設計。搭配感測器及 LCD 材料，並且加上精心設計的教育課程，才能夠達到生動的教學，整體架構包括：幼兒教育學習、電控設計、機構設計、外觀設計、程式設計，如圖 4 所示。

本研究採用 PLA 材料，搭配 3D 列印技術，進行打樣測試。並藉由卡榫結構，來減少螺絲的使用，以達到降低成本、減輕重量及拆裝方便。

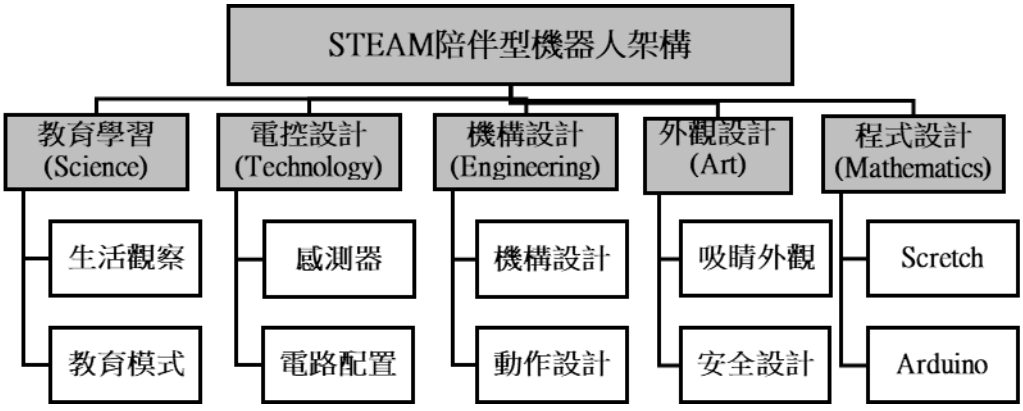


圖 4 STEAM 陪伴型機器人架構應用研究架構

3.3 教育學習

在研究本專題前，本團隊針對兒童教育方面向專家進行諮詢(圖 5)，並且結合之前的教學孩童的經驗，發掘孩子們對於機器人玩具方面勝過於遊玩 3C 產品，並且有及高的興趣來學習如何操作及組裝，如圖 6 所示。

圖 5 諮詢兒童教育專家

圖 6 發覺孩童喜歡自己組裝玩具

3.4 電控設計

將 Arduino 的機電整合設計、與程式系統架構規劃相對應，先從前面模組化的結構設計規劃，將各馬達模組編碼後(圖 7)，同時也對應於程式架構編碼，藉此自行設定動作，如手腳的擺動，即可設計出舉手、抬腳、跳舞等動作（圖 8)。

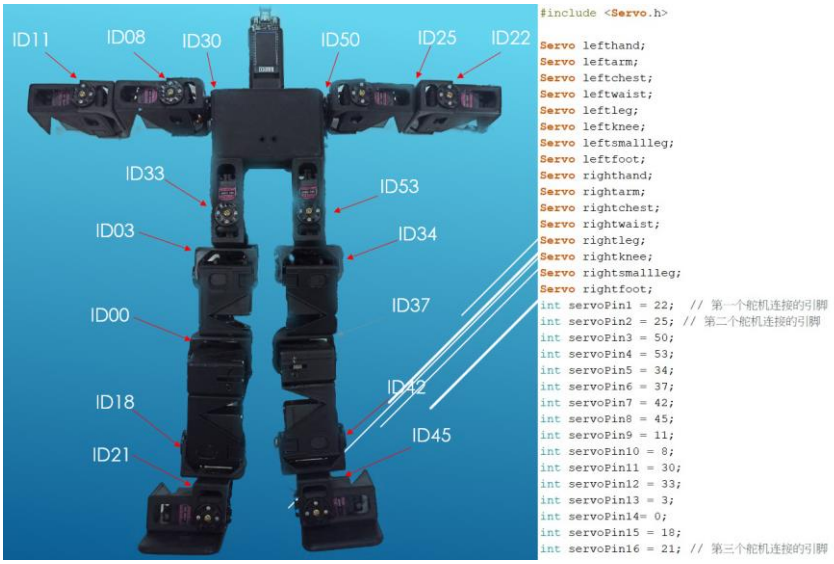


圖 7 馬達機構模組化設計程式

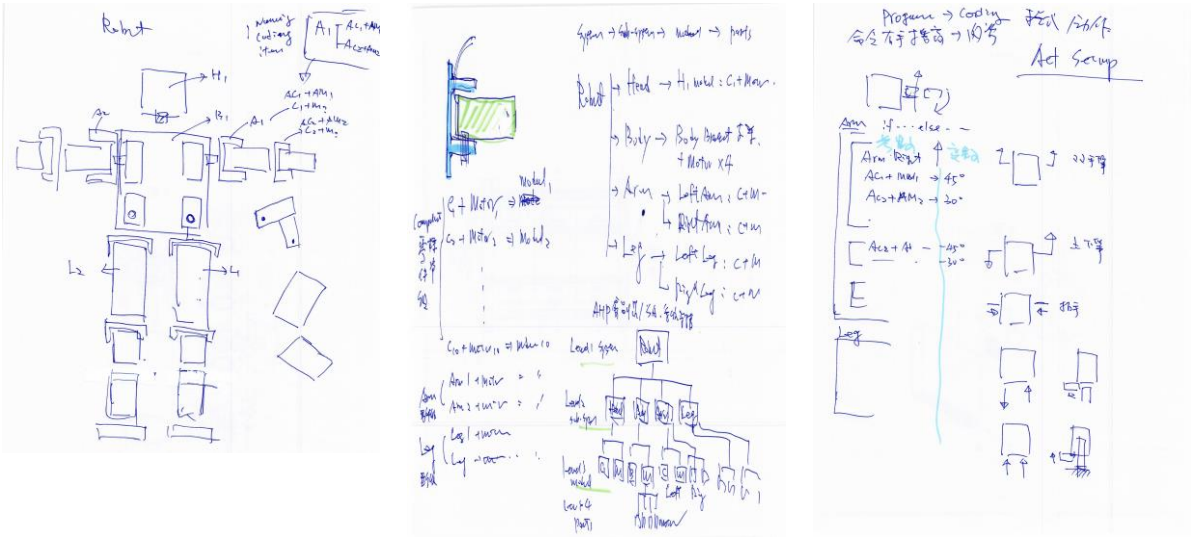


圖 8 模組化結構、程式架構編碼、自定動作設計示意圖

3.5 機構設計

市售高階型機器人大多使用金屬材料骨架（圖 9），但本 STEAM 陪伴型機器人主要使用者是幼童，因此重量不能夠太重。且為了達到堅固、又能夠壓低成本，將選用 PLA 塑膠作為骨架的材質（圖 10），進行 3D 列印打樣。同時將市售金屬板金材料機器人的螺絲鎖固，改良為不用工具方式，直接以徒手快速卡榫崁合固定（圖 11），以達到 DFMA 快速方便拆裝組合。

圖 9 金屬材料骨架

圖 10 塑膠材料骨架示意

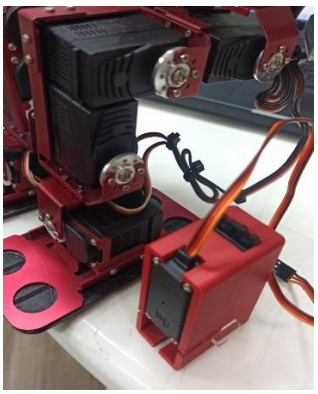


圖 11 塑膠卡榫崁合示意

3.6 外觀設計

在機器人肢體間的相互做動沒問題後，接下來就是外觀設計的環節。在多次討論後，預期設計以一個圓圓胖胖的機器人外型來製作，除了觀感上討喜外，也能避免稜角造成危險。在經過國立高雄科技大學同意後，預期將以高科大吉祥物”諾斯”作為外型參考（圖 12），外觀設計示意圖（圖 13）。

圖 12 高科大吉祥物”諾斯”

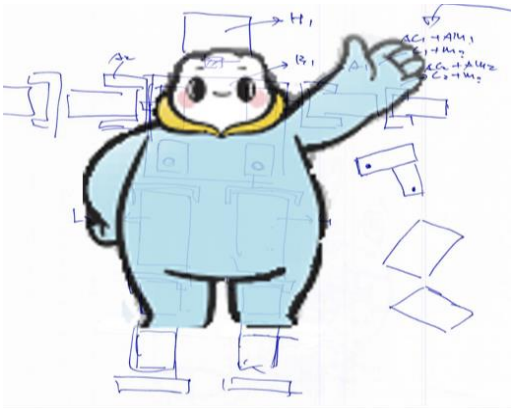


圖 13 外觀設計示意圖

3.7 程式設計

初學者在程式寫作入門方面，研究者針對年紀較小學童，具有程式編寫的豐富教學經驗，需設計簡單人機互動介面，故本研究採用 Scratch 圖像化積木程式撰寫（圖 14），能讓孩童自行輸入動作參數，同時也能和其他同儕互動討論（圖 15）。此外，針對已有 Scratch 程式寫作經驗的學童，可以訓練學習進階機器人動作設計。因此，需要讓每個人都能夠以輕鬆方式，進行圖像化積木程式撰寫。此外，也會另外架設教學及示範網站，讓不會寫程式的使用者，也能在網上下載程式包，來創作或修改為專屬的課程。

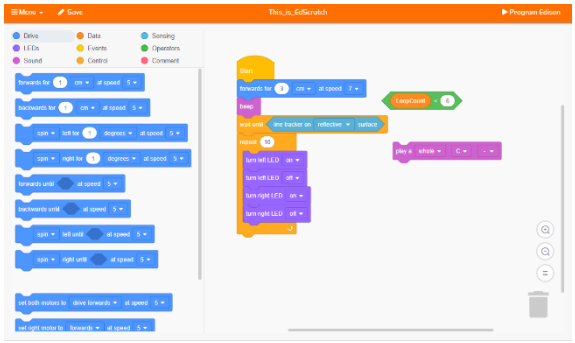


圖 14 Scratch 圖像化積木程式

圖 15 孩童透過程式撰寫的過程促進同儕互動

四、商業價值及市場性

4.1 商業價值

隨著科技的發展，陪伴型 STEAM 教育機器人市場呈現出快速增長的趨勢。其作為一種新興產品，具有巨大的市場潛力。隨著對於 STEAM 教育的重視和需求的增加，這著市場有望繼續擴大，以下列出幾項因素進行說明：

雙薪家庭增加，家庭市場潛力高

現代社會有需多雙薪家庭，具數據顯示已達 7 成，新手爸媽白天上班，經常把寶寶委託給保姆照顧，但新聞媒體播報著托育中心不當行為所造成的糾紛，經常使爸媽在工作時放不下心。又或是全值媽媽除了照顧寶寶外，還要忙著做家事，常常忙到三頭六臂，沒有辦法時時刻刻盯著寶寶的一舉一動。本產品將能改善這項情況。幼學齡前教育市家庭市場的重要一環，許多家長願意為孩子的早期教育投資。學齡前陪伴型 STEAM 教育機器人可以做為一個有價值的教育工具，吸引家庭購買。

STEAM 教育成全球趨勢

陪伴型 STEAM 教育機器人融合了科學、技術、工程、藝術和數學等多項學科，可以幫助孩子們在玩樂中學習。透過機器人的陪伴，孩子們可以培養問題的解決能力、創造力和邏輯思維等重要技能。為了提升孩子的競爭力、培養國民面對未來的能力，全世界先進國家近幾年強調問題解決、動手做、跨領域整合的 STEAM 教育列為教育重點目標：教育部在 108 新課綱中之「科技領域」，與 STEAM 教育精神不謀而合，因此許多學校開始增設有關機器人、程式設計、電路板等科技相關課程，根據調查發現，技職科大高職國中小教師對 STEAM 教育的需求量大，但在專業技能、課程結構、設備環境上的供給，卻遠感不上需求，因此資源整合成為 STEAM 教育之重要關鍵。

圖：STEAM 教育成全球趨勢示意圖

教育需求夥伴增加

學校和幼兒教育機構會與學齡前陪伴型 STEAM 教育機器人供應商建立合作伙伴關係。這些機構可能會將機器人引入課堂或提供相關的培訓與課程，為教育機器人市場提供更廣泛的機會。

一、

4.2 市場性

目前市面上陪伴型教育機器人，據觀察大多陪伴與教育功能嚴重分區，使用年齡多為學齡孩童，針對學齡前孩童的照護型教育機器人相對稀少但需求卻增加，有此可見本產品市場具有一定發展潛能，以下為 SWOT 分析結果。

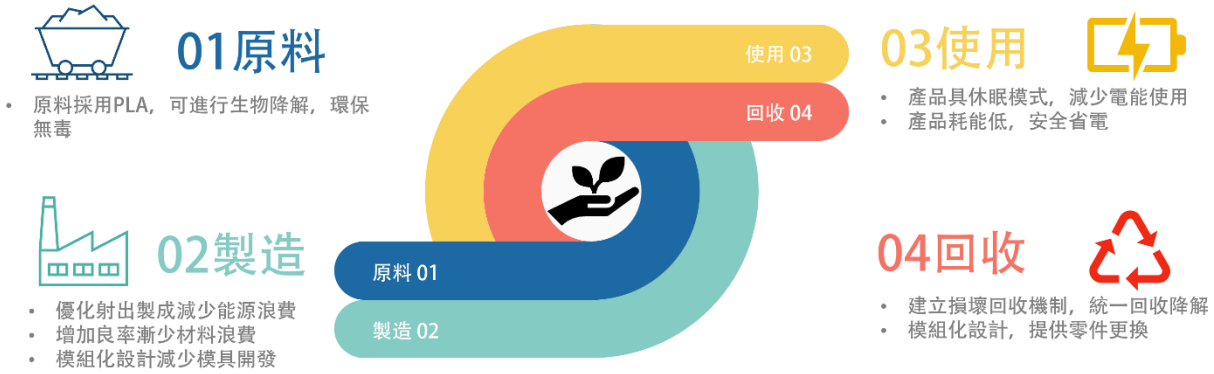
優勢(S)	**劣勢(W)**
智能節能省電 STEAM 教育 模組化設計 APP 智能監控	沒有名氣 尚在開發階段 成本較高
機會(O)	**威脅(T)**
教育部在 108 新課綱中之「科技領域」帶動 STEAM 教育機器人市場 雙薪家庭增加帶動家庭市場 教育需求夥伴增加	STEAM 教育市場競爭越來越激烈，需要穩固市場定位,與其他競爭業者有市場差異化。

成果應用:

此產品之 STEAM 陪伴型機器人成果，能夠協助家長在陪伴孩子遊玩中進行多元及跨科育樂效益，以動手實作之方式，輔助孩童學習機器人及機電整合等相關知識，培養綜合運用以及創造思維與解決問題的能力，並藉由隨時能夠變換課程之方式，幫助孩童在學習生活常識的過程中，培養出探索生活中各種事物的觀察力並規劃未來方向，以提升孩童在升學及創意發想知競爭力，並從而藉此引導孩童將所學知識與技能應用於生活及未來就業，培養超越同齡人的 STEAM 教育基礎。

五、綠色設計理念及訴求

綠色產品設計部分，將分為四大方向進行說明，分別為原料、製造、使用、損壞及棄置機制：



原料方面

本產品全機採用 PLA(Poly Lactic Acid)環保材料，此材料主要原料為玉米、甜菜、小麥、甘薯等澱粉或醣份等經過發酵、去水、聚合等過程製造而成，無毒性。在生產過程中並不會產生汙染，且原料為生物降解材料，可實現在自然環境中自然分解，不會造成地球的負擔。

製造方面

透過優化射出製造流程，改善產品品質同減少不良率，降低廢棄物同時減少資源損耗，配合模組化設計，減少模具開模，以減少模具開發產生的配料及汙染。

使用方面

本產品使用 Arduino 模組，其耗電量極低，並設有節能模式，在不同使用情境下，自動關閉無需使用的功能，減少耗能又安全。

損壞及棄置機制

本產品將機器人分為多個功能模組，可依需求購買所需零件加以組裝，若有損壞僅須購買該零件，不須整機更換，減少浪費，同時導入回收機制，可於更換零件時將損壞部分回收，統一進行生物降解，實現綠色循環。

新加坡商意迪恩亞洲廣告

有限公司台灣分公司

112 年亞洲金選獎 EE 創意挑戰賽

STEAM 陪伴型機器人科學教具

STEAM companion robot science education tool

參賽團隊名稱：馬蓋先生面子粉大

團隊成員：鄭瑞鴻、林昌哲、李長紘、

龐禕心、何亭萱

中華民國 112 年 6 月 15 日

Abstract

Our team has developed a STEAM companion robot science education tool, integrating non-traditional processes such as mechanical structure design, electronic circuit design, and 3D printing. The technology has created an educational, engaging, and inspiring companion robot tool. Through playing with the companion robot, children can cultivate their STEAM core abilities, including interdisciplinary knowledge, hands-on games, real-life applications, problem-solving, and sensory learning, thereby enhancing their diverse learning capabilities. While this research outcome assists but cannot replace parental care, it becomes a great companion for joyful learning. From entertainment to education, it can significantly reduce children's reliance on 3C products and increase opportunities for communication and interaction with others. Furthermore, parents can use the human-machine interface of the STEAM companion robot science education tool to set relevant learning themes and accompany their children in happy growth. Through questionnaire surveys and test validations, we aim to foster children's hands-on practice, creative thinking, and problem-solving abilities. The remote monitoring system of this project's app provides real-time monitoring information and robot control. The research findings are expected to undergo commercial evaluation and trial production, making them accessible to a wider audience through simple instructions. This hands-on interactive approach can increase children's interest in programming and enhance their future competitiveness.

Keywords: AIoT, STEAM education, human-computer interaction interface, companion robot, multiple learning

成員介紹

	鄭瑞鴻 產品整合開發設計 機電整合設計與製造 研發與專案管理
	林昌哲 產品整合開發設計 機電整合設計與製造 程式設計與撰寫
	李長紘 產品整合開發設計 機構設計 機電整合設計與製造
	龐禕心 產品整合開發設計 3D電腦輔助製圖 文書編輯
	何亭萱 產品整合開發設計 3D電腦輔助製圖 文書編輯

I、 Motivation and creative description

1.1motivation

I think of researching and developing STEAM companion robot science teaching aids because the team leader once worked in the parenting class of Lego robots. While teaching students, I found that their parents still work overtime or have no time after the children go home. Accompany it to study or entertain. Therefore, they spend much time with 3C electronic products, such as mobile phones, tablets, etc., to pass the time. Children are very interested in related robot toys. However, the price of commercially available robot products is high, and there are specific difficulties in man-machine interface operation and content learning. As a result, companion robots have yet to become famous. The independent learning opportunities and independent creative space through STEAM science teaching aids help to enhance children's learning interests and participation, thereby exercising children's innovative abilities.

Therefore, the team designed STEAM accompanying robot science teaching aids, allowing parents to play and study with their children away from 3C products. Let children feel that it is an exciting toy, and they can learn good habits in life from the game process. And through the simple human-computer interaction interface, it assists parents and children in writing graphic building block programs, train more independent creation space, and exercises the ability of innovation and logical thinking.

1.2 features

This product adopts the UCD (User Centered Design) user-oriented design method to design the robot and human-computer interaction interface so that users can get positive responses regarding usability and acceptance when using the product, and usability is also guaranteed. The product is easy to learn and can be used effectively, allowing users to bring a pleasant experience. Let children know diverse knowledge through different faces and retain knowledge in various fields, such as structure and

circuits, from assembling robots.

1.2.1 AI identification system

(1) Use the voice module to control the robot to perform the defined actions

(2) Considering that the pronunciation of younger children is unclear, this work has added an AI speech recognition system, which can identify the vocabulary of children.

(3) Combining with the above AI speech recognition system, the robot can repeat and confirm the word, and then give the correct pronunciation.

(4) A Chatbot, such as Watson, ChatGPT, can be added to have interaction with the children.

1.2.2 remote monitoring system

(1) Parents can observe their children's every move through the APP's remote monitoring system

(2) Parents can control the real-time actions of the robot through the APP

(3) This work has added a report on children's safety status through the AI visual recognition system to identify which dangerous places are still close enough for children to walk and notify parents by monitoring children's physical health

(4) This work is equipped with a remote video function so that children can communicate with their parents in a time when they stay in the room

1.2.3 custom action

(1) If parents who have a certain concept and interest in programming can define the action of the robot through the jigsaw block programming system of this work

(2) Parents who do not know how to transcribe programs can also customize robot actions through the program package on the tube network

(3) The course content of this work is divided into two age groups, with 3-6 years old and 7-10 years old as the age group to do the corresponding course teaching

1.2.4. Automatically follow children system

Use the GPS tracking system to obtain the location of children so that it easy to find your kid any time.

II、 Design features and function introduction

STEAM education

STEAM (Science, Technology, Engineering, Art, Mathematics) multi-education spirit uses interdisciplinary methods to guide students to adapt to constantly updated professional knowledge and rapidly changing social life, emphasizing hands-on and creative play. And combine exciting and challenging situations in life to ignite learning curiosity and desire to explore. Marston et al. (2013) also applied video game consoles such as Nintendo Wii and Microsoft Kinect to cognitive and motor training. It helps maintain physical health, promotes mental health, and encourages social interaction. Tak et al. (2017) used computers and the Internet to allow users to facilitate direct communication with family members and provide intellectual exercise, educational learning, and recreational activities. In particular, STEAM education has these core features: interdisciplinary knowledge, problem-solving, practice, life application, and five-sense learning. Through various core features, students can solve and apply problems, create ideas, and learn simultaneously. Moreover, STEAM robots are equipped with these five kinds of interdisciplinary knowledge: science (S), technology (T), engineering (E), art (A), mathematics (M), etc., which can effectively enhance children's creativity and adaptability, such as Table 1 shows:

Table 3 Science teaching aids with STEAM education method content

project	explain
Science	Use and observe your surroundings to discover what is interesting about science
Technology	Use various information devices to absorb knowledge and apply it
Engineering	Learn about engineering and find the joy of inventing
Art	Express the beauty of what you think and think in your heart, and learn the beauty that is omnipresent in life
Mathematics	Through numerical and logical operations, the most suitable solution can be deduced

2.1 Evaluate robot design direction

After analyzing the existing robots in the market, it is found that most high-end robots (Figure 2) are mainly made of metal skeletons. In addition to being too heavy and prone to danger, the cost of metal skeletons is relatively higher than that of plastic materials. There are too many screws, and the disassembly process is too complicated. Even if the simple robot uses a plastic shell (Figure 3), the teaching program is relatively formulaic, and there are many places for children to learn in real life. Therefore, a fixed teaching method can only partially educate children. Thus, the design direction of the robot is determined as follows: simple assembly and maintenance, high interchangeability of materials, and a set of simple programming software, which can also be downloaded from the Internet, so that users who are not good at writing programs can also design their own ideals course.

Figure 2 Commercially available high-end robot

Figure 3: Commercially available simple robot

2.2 Framework formulation & design concept

Based on the current companion robot information in the market, analyze and initially plan the robot architecture configuration, and design the movement method and material selection. According to the relevant teaching aids in the existing market, plan the development structure, and consider the position of each motor to design the

action. With sensors, LCD materials, and carefully designed educational courses, vivid teaching can be achieved. The overall structure includes early childhood education and learning, electronic control design, mechanism design, appearance design, and programming design, as shown in Figure 4.

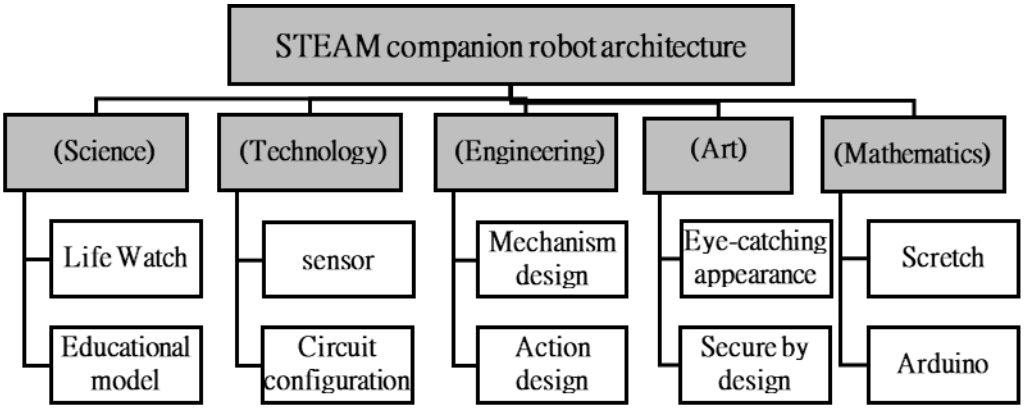


Figure 4 STEAM companion robot architecture application research framework

In this study, PLA materials were used, combined with 3D printing technology, for proofing testing. And use the tenon structure to reduce the use of screws to achieve cost reduction, weight reduction, and easy disassembly.

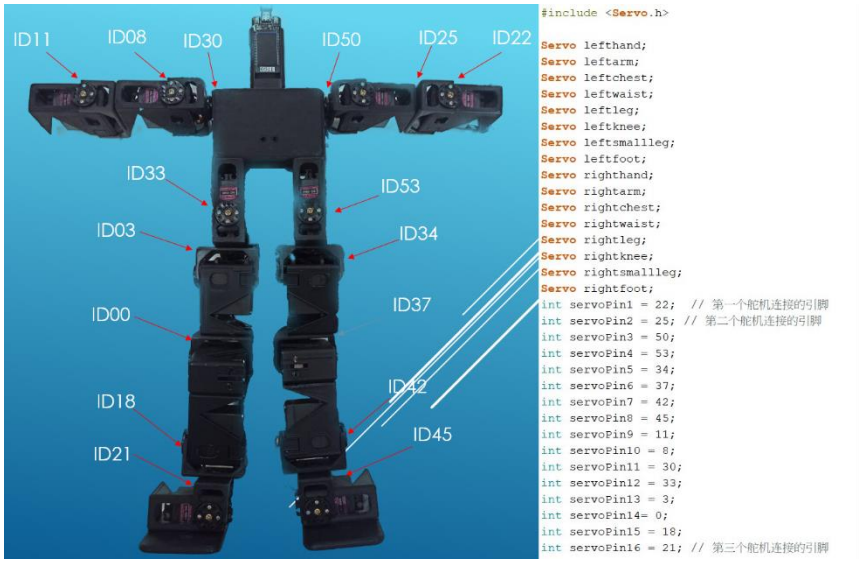
2.3 education study

Before the research, the team consulted experts on children's education , and combined with the previous experience of teaching children, it was discovered that children are more interested in robot toys than playing with 3C products and have a high interest in learning how to Operation and assembly, as shown in Figure 5.

Figure 5: I noticed that children like to assemble toys by themselves

2.4 Electronic control design

Corresponding the mechanical and electrical integration design of Arduino to the program system architecture planning, firstly, from the previous modular structure design planning, after coding each motor module (Figure 6), it also corresponds to the program architecture code to set up by yourself Actions, such as the swing of hands and feet, can design actions such as raising hands, raising feet, dancing (Figure 7).




```
#include <Servo.h>

Servo lefthand;
Servo leftarm;
Servo leftchest;
Servo leftwaist;
Servo leftleg;
Servo leftknee;
Servo leftsmallleg;
Servo leftfoot;
Servo righthand;
Servo rightarm;
Servo rightchest;
Servo rightwaist;
Servo rightleg;
Servo rightknee;
Servo rightsmallleg;
Servo rightfoot;
int servoPin1 = 22;  // 第一个舵机连接的引脚
int servoPin2 = 25; // 第二个舵机连接的引脚
int servoPin3 = 50;
int servoPin4 = 53;
int servoPin5 = 34;
int servoPin6 = 37;
int servoPin7 = 42;
int servoPin8 = 45;
int servoPin9 = 11;
int servoPin10 = 8;
int servoPin11 = 30;
int servoPin12 = 33;
int servoPin13 = 3;
int servoPin14= 0;
int servoPin15 = 18;
int servoPin16 = 21; // 第三个舵机连接的引脚
```

Figure 6: Modular design procedure for motor mechanism

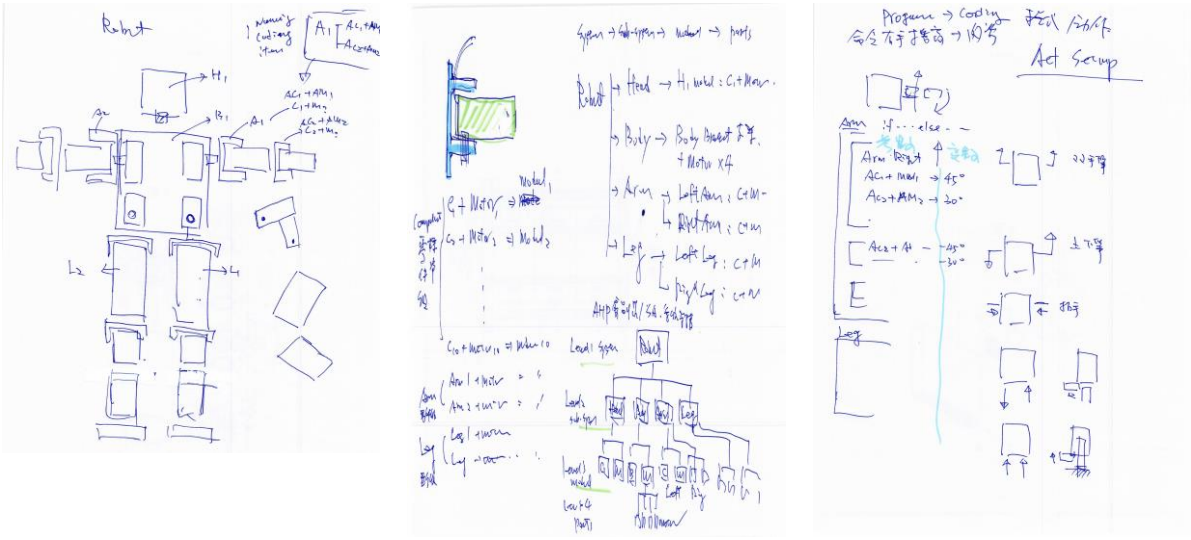


Figure 7 Schematic diagram of modular structure, programming code, and custom action design

2.5 Institutional design

Most commercially available high-end robots use metal skeletons (Figure 8). However, this STEAM companion robot is mainly used by young children, so the weight should be manageable. And to achieve sturdiness and lower costs, PLA plastic will be selected as the skeleton material (Figure 9) for 3D printing proofing. At the same time, the screw locking of the commercially available metal sheet metal robot is improved to a method that does not require tools and is directly fastened and fixed with bare hands (Figure 10) to achieve DFMA quick and convenient disassembly and assembly.

Figure 8: Skeleton of metallic materials

Figure 9 Illustration of the skeleton of plastic material

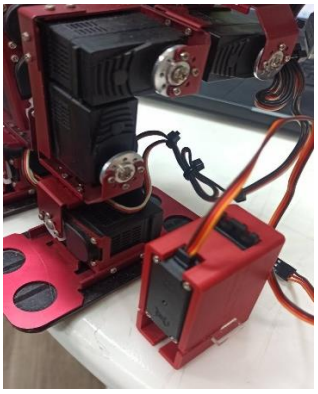


Figure 10 Illustration of plastic card mortise and tenon joint

2.6 Exterior design

After there is no problem with the interaction between the robot's limbs, the next step is the appearance design. After many discussions, the invention is expected to be made in the shape of a round and fat robot. In addition to pleasing the eye, it can also avoid danger caused by edges and corners. After being approved by the National Kaohsiung University of Science and Technology, it is expected to use the high-tech mascot "North" as a reference for the appearance (Figure 11) and a schematic diagram of the appearance design (Figure 12).

Figure 11 High-tech University mascot "North"

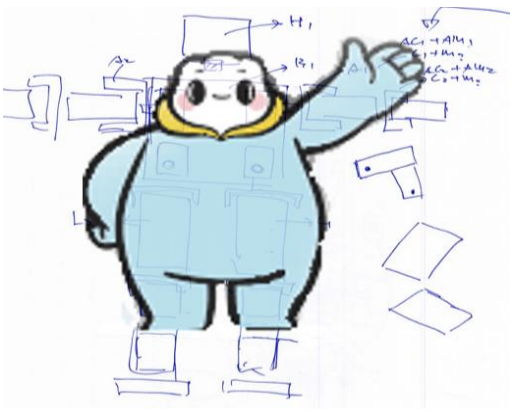


Figure 12 Schematic design diagram

2.7 Programming

This product adopts the UCD (User Centered Design) user-oriented design method for robot and human-computer interaction interface design. This user-centered design concept focuses on making the product's design meet the user's habits and needs so that the user can get a positive response in terms of usability and acceptance when using the product, and the usability is also guaranteed. The product is easy to learn and can be used effectively, allowing users to bring a pleasant experience. For beginners in terms of getting started with programming writing, for younger schoolchildren who have rich teaching experience in programming and need to design a simple human-computer interaction interface, this research uses Scratch graphical building block programming (Figure 13), which can enable children Input the action parameters by yourself. At the same time, you can interact and discuss with other peers (Figure 14). In addition, students with Scratch programming experience can train and learn advanced robot motion design. Therefore, everyone must be able to program graphical building blocks effortlessly. In addition, another teaching and demonstration website will be set up so that users who cannot write programs can also download program packages online to create or modify exclusive courses.

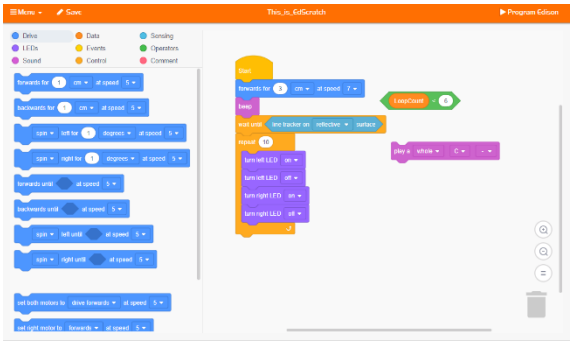


Figure 13 Scratch graphical building block program

Figure 14: Children promote peer interaction through the process of programming

Ⅲ、 Business value and marketability

3.1 Business value

With the development of science and technology, the accompanying steam educational robot market is showing a rapid growth trend. As an emerging product, it has enormous market potential. With the increasing emphasis on and demand for STEAM education, this market is expected to continue to expand, as explained by the following factors:

3.1.1 Double-income families are increasing, and the family market potential is high

There are many double-income families in modern society, and statistics show that 70% of them. Novice parents go to work during the day and often entrust their babies to nanny care. However, the news media broadcasts disputes caused by improper behavior in childcare centers, often making parents work during the day. I can't let go. Or full-time mothers are busy with housework and taking care of the baby. They are often so busy that they can't watch the baby's every move. This product will improve the situation. And preschool education is an integral part of the family market, and many parents are willing to invest in their children's early education. Preschool-accompanying STEAM educational robots can be a valuable educational tool to attract families to purchase.

3.1.2 STEAM education became a global trend

Companion Steam educational robots integrate science, technology, engineering, art, and math to help kids learn while having fun. Through the companionship of robots, children develop essential skills such as problem-solving, creativity, and logical thinking. To enhance the competitiveness of science and technology and cultivate the ability of citizens to face the future, advanced countries around the world have listed STEAM education that emphasizes problem-solving, hands-on, and cross-disciplinary integration as a critical goal of education in recent years; The field

of science and technology coincides with the spirit of STEAM education, so many schools have begun to add science and technology-related courses such as robotics, programming, and circuit boards. According to the survey, technical, vocational, vocational, national, and primary school teachers have a tremendous demand for STEAM education. However, the supply of professional skills, course structure, and equipment environment must meet the request. Therefore, resource integration has become an essential key to STEAM education.

Figure 15: Illustration of STEAM education as a global trend

3.1.3 The demand for education partners has increased

Schools and early childhood education institutions may partner with preschool companion STEAM educational robot providers. These institutions may introduce robots into the classroom or provide related training and courses, providing a broader market opportunity for the educational robot business.

3.2 Marketability

According to observations, most of the accompanying educational robots currently on the market have a severe distinction between accompanying and academic functions, and most of them are used by school-age children. There are few care-oriented educational robots for preschool children, but the demand is increasing. This shows that the market for this product has a particular development. Potential, the following

is the result of the swot analysis.

Strength(S)	Weakness(W)
Intelligent energy saving and power saving STEAM education Modular design APP intelligent monitoring	No fame Still in the development stage Higher cost
Opportunity(O)	Threat(T)
The Ministry of Education has driven the STEAM educational robot market in the field of science and technology in the 108 new curriculum The increase in dual-income households has driven the family market Partners in demand for education have increased	The STEAM education market is becoming increasingly competitive, and it is necessary to stabilize its market positioning and differentiate itself from other competitors.

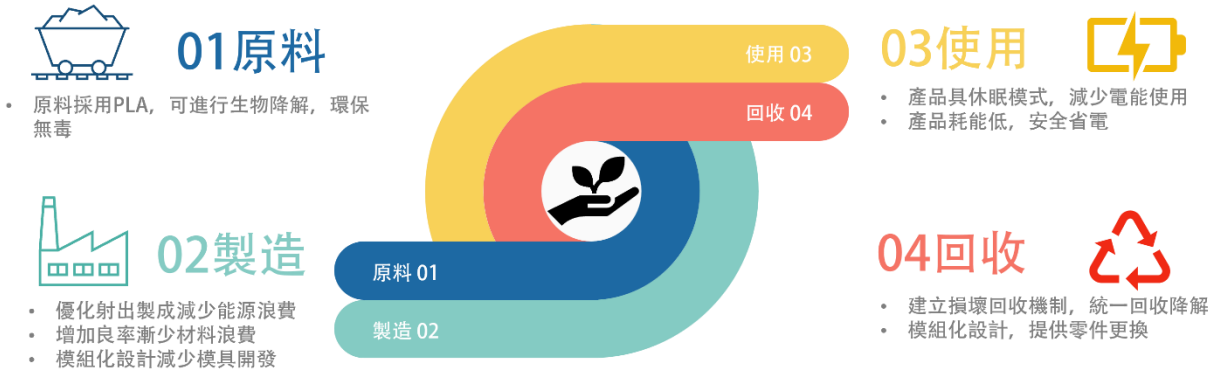
Application of results:

The STEAM accompanying robot results of this product can help parents achieve diversified and interdisciplinary educational benefits while accompanying their children to play, and assist children in learning robotics and electromechanical integration and other related knowledge in a hands-on way, cultivating comprehensive application and Creative thinking and problem-solving skills, and by changing the course at any time, help children develop the observation ability to explore various things in life and plan future directions in the process of learning common sense in life, to enhance children's ability to enter school and creative development The competitiveness of thinking, and thus guide children to apply the knowledge and skills they have learned to life and future employment and cultivate a

STEAM education foundation that surpasses their peers.

Ⅳ、 Green design concept and appeal

In the part of green product design, it will be divided into four directions for explanation, which are raw materials, manufacturing, use, damage and disposal mechanism:



Raw materials

The whole body of this product is made of PLA (Poly Lactic Acid) environmental protection material. The primary raw material of this material is corn, beet, wheat, sweet potato, and other starches or sugars, which are produced through fermentation, dehydration, polymerization, and other processes and are non-toxic. No pollution will be generated during the production process, and the raw materials are biodegradable, which can realize the natural cycle.

Manufacturing

By optimizing the injection manufacturing process, we can improve product quality while reducing defect rate, reduce waste and reduce resource consumption, and cooperate with modular design to minimize mold opening to reduce waste and pollution caused by mold development.

Use

This product uses the Arduino module with low power consumption and an energy-saving mode. Under different usage scenarios, it will automatically turn off unused functions to reduce energy consumption and be safe.

Damage and Disposal Mechanism

This product divides the robot into multiple parts modules, which can be purchased and assembled according to the needs. If there is any damage, only the part needs to be bought, and there is no need to replace the whole machine, reducing waste. At the same time, a recycling mechanism is introduced, which can be used when returning parts. The damaged region is recycled and biodegraded uniformly to realize a green cycle.

References

[1] Covaciu, F., Bec, P., & Băldean, D. L. (2020, December). Design and Development of a Low-Cost Automated All-Terrain Intelligent Robotic Vehicle for Detection to Study Its Faults and Vulnerabilities from SWOT Perspective. In *Proceedings* (Vol. 63, No. 1, p. 38). MDPI.

[2] Hsieh, Y. Z., Su, M. C., Chen, S. Y., & Chen, G. D. (2015). The development of a robot-based learning companion: A user-centered design approach. *Interactive Learning Environments*, *23*(3), 356-372.

[3] Liao, H., Chang, Y., Wu, D., & Gou, X. (2020). Improved approach to quality function deployment based on Pythagorean fuzzy sets and application to assembly robot design evaluation. *Frontiers of Engineering Management*, *7*(2), 196-203.

[4] Martin, P., Kelly, N., Kahana, B., Kahana, E., Willcox, B. J., Willcox, D. C., et al. (2015). Defining successful aging: A tangible or elusive concept? The Gerontologist, 55(1), 14-25.

[5] Pauliková, A., Gyurák Babeľová, Z., & Ubárová, M. (2021). Analysis of the impact of human – cobot collaborative manufacturing implementation on the occupational health and safety and the quality requirements. *International Journal of Environmental Research and Public Health*, *18*(4), 1927.

[6] Pizzagalli, S. L., Kuts, V., & Otto, T. (2021, May). User-centered design for Human-Robot Collaboration systems. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1140, No. 1, p. 012011). IOP Publishing.

[7] Rankohi, S., Carbone, C., Iordanova, I., & Bourgault, M. (2022). Design-for-Manufacturing-and-Assembly (DfMA) for the construction industry: A review. *Modular and Offsite Construction (MOC) Summit Proceedings*, 1-8.

[8] Tak, S. H., Beck, C., & McMahon, E. (2007). Computer and internet access for long-term care residents: perceived benefits and barriers. Journal of Gerontological Nursing, 33(5), 32-40.

[9] Tan, T., Mills, G., Papadonikolaki, E., Li, B., & Huang, J. (2022). Digital-enabled Design for Manufacture and Assembly (DfMA) in offsite construction: A modularity perspective for

the product and process integration. *Architectural Engineering and Design Management*, 1-16.