Project reflection

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Abstract

Existing use cases of food printer has generally been limited and singular. Depending on its user, a tool can be used to serve different purpose such as a fork made for eating can be used as a cooking tool, a card used as a ruler to draw lines and a 3D printer can also be used in a kitchen to print food. This paper will explore the possible use case of a 2D food printer in early childhood education and how it can create an opportunity to incorporate technology to assist teachers in teaching preschool students, concept stage and fabrication details of the prototype.

1 Introduction

A food printer's main functionality is to convert the user's design into edible prints which adds aesthetic on to food products. The project's referenced system is the evebot handheld printpen that is mainly marketed to barristers for latte art and to pattiserie chefs for baked goods designs.

The evebot printpen's use cases is limited to only applying designs on to food products.However, if we solely look at its printing edible design capability it can also be used for a different purpose in while still being used in related food industries.

2 Domain exploration

2.1 Dyslexia disability domain

The first iteration of domain exploration starts exploring places where a food printer is likely to be utilised, for the team it was Food and Beverages businesses mainly, cafe businesses.

The research results of problems faced by cafe owners is the declining customer base, this problem leads the team into a term known as "Purple pound" which represents the spending power of people with disabilities in the UK.

Expanding from "Purple pound", the team looks towards the domain of disabilities scoping it down to people with dyslexia. However, the team had to reiterate back to domain exploration due to the lack of data supporting our claims that the solution for this problem was worth prototyping.

2.2 Early childhood education domain

The second reiteration of domain exploration starts by exploring use cases of a food printer in domains other than food industries, this led to an article describing a project conducted by the Big Bang researchers in the UK where a 3D food printer is implemented in a school canteen with the goal to encourage students to pursue a career in STEM(Science, Technology, Engineering and Mathematics)[1].

Additionally, total numbers of childcare enrollment has been increasing consistently, from 118,296 in 2018 to 152,634 in 2023, approximately a 5% increase annually. This increasing numbers shows that the team's target audience numbers and marketablility makes the solution worth prototyping.

2.3 Multi-sensory instructions

The team proceeds to do a market research onto existing solutions that enhances children's learning experience, this led to the team discovering multi-sensory instructions a form of education approach now most education toys or tools makes use of.

Multi-Sensory instructions is an education approach that engages more than 1 sense at a time incorporating the use of visual, auditory and kinesthetic-tactile modalilites, research has shown that this education approach improves memory retention of information[**2**] , makes connection between new information and what users already know[**2**] and it is considered to be a more engaging approach[**3**].

2.3.1 Conducted study

As further evidence, the team looked in to a study was conducted on fifteen 6^{th} grade students from a public school in the United States using large flashcards to present a 12-word sequence. Students were given paper and pencils to write down recalled information.

Participants were randomly assigned to three groups, representing different levels of sensory engagement. Group 1 heard the word sequence, Group 2 both heard and saw the words, and Group 3 heard, saw, and wrote down the words as they were presented. Afterward, all groups wrote down as many words as they could recall. The recall lists were collected and students were debriefed.

The results supported previous research on multisensory learning. Group 1 (auditory) had an average recall score of M = 6 (SD = 1.414). Group 2 (auditory & visual) had M = 7.8 (SD = 1.095). Group 3 (auditory, visual, & kinesthetic) had M = 9.2 (SD = 1.304). A one-way ANOVA showed a significant difference between groups, F (2,12) = 7.878, p ¡ .007. Simple effects t-tests indicated significant differences between Groups 1 & 2 (t (4) = -2.250, p ¡ .05) and Groups 1 & 3 (t (4) = -3.720, p ¡ .006), but not between Groups 2 & 3 (t (4) = -1.838, p ¡ 0.103). These findings suggest that using multiple senses enhances recall ability, with three senses being more effective than two, and both being better than using only one.

3 Prototyping

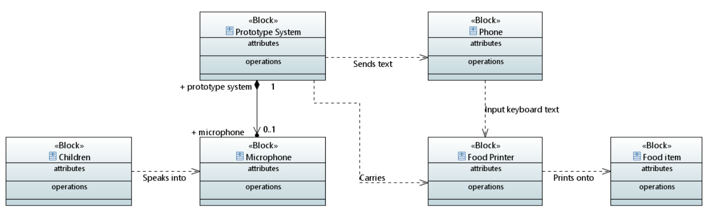

Figure 1: A concept model that shows the relationships between concepts in the prototype

3.1 Ideation

The domain exploration of early childhood education brought about information of enabling technology of multi-sensory instructions from existing solutions and benefits. The team starts by breaking down functionality of the 2D food printer or evebot printpen to determine which original functionality of it can be part of the solution of multi-sensory instructions, this will help to streamline what additional functionality we have to add to the current system to achieve our solution.

As part of the ideation one of the team member contacted a preschool teacher whom is an acquaintance to him for some inputs that might help the ideation process, we learnt that incorporating multi-sensory instruction for food is an interesting solution and a possible potential, mealtime for a preschool lacks engagement and learning session. From these information, the team has agreed to make a solution that engages students during meal time with multi-sensory instructions.

3.2 Speech to text

As part of multi-sensory instruction, the team has decided to implement a speech to text function as evidence shows that using speech will have in memory retention of new words. Part of the functionality of the evebot printpen is that it enables user customizability by allowing users to input what word they want to print, so to integrate functionality the evebot printpen already had with speech in education the team decided to automate the input process using speech to text function.

```python
import serial
import speech_recognition as sr

r = sr.Recognizer()
mic = sr.Microphone()

print("Start talking!")

while True:
    with mic as source:
        audio = r.listen(source)
    words = r.recognize_google(audio)
    print(words)
```

Figure 2: This is the Speech Recognition code using Google Speech.

The figure above shows the Python code implementation for speech recognition using Google's speech recognition API. This code allows for continuous listening and transcription of speech input.

3.3 Audio word spelling

Research from existing solution has shown that most education toys spells out the word to provide audio learning, taking this functionality the team has implemented our own spelling algorithm that access the variable used by the speech recognition to contain the word translated as an array and do a conditional loop to identify each alphabet with its own respective audio av files.

3.4 Android Debug Bridge

Implementation of speech to text conversion is completed, however to be able to put the converted text into the evebot printpen application the team has to use the android debug bridge. Android Debug Bridge is a command-line tool to allow developers to communicate and control android devices, part of its capability is the ability to allow developers to debug Android applications. Due to the lack of API access from the evebot printpen's developer, Android Debug Bridge is used as a workaround to access android phone's keystroke which allows the team to send the translated text from the Speech Recognition code into the application directly.

```python
PHONEIP = sys.argv[1]


try:
    file_path = '/home/raspi6/output.txt'
    with open(file_path, 'r') as file:
        input = file.read()
        print(f"input:{input}")
except FileNotFoundError:
    input = 'hello'

client = AdbClient(host="127.0.0.1", port=5037)
device = client.device(PHONEIP)

#get width and height
phonesize=device.shell('wm size')
#print(f"Phonesize from python:{phonesize}")
width=""
height=""
for i in range(len(phonesize)): #extract ip address
        if(phonesize[i]=='x'): #24 is first \n
            width+=phonesize[i-4]
            width+=phonesize[i-3]
            width+=phonesize[i-2]
            width+=phonesize[i-1]
            height+=phonesize[i+1]
            height+=phonesize[i+2]
            height+=phonesize[i+3]
            height+=phonesize[i+4]
```

Figure 3: This is the Android Debug Bridge code snippet to access phone screen size.

```python
#Press the edit text button
pos1=str(((int(width))/6)*2)
pos2=str((int(height)/25)*11)
keyboard='input tap ' + pos1+ ' ' + pos2
device.shell(keyboard)
time.sleep(.5)

words = input.split()

for word in words:
    text='input text ' + word
    device.shell(text)
    device.shell("input keyevent 62")

pos1=str(int(width)-100)
pos2=str((int(height)/25)*11)
keyboard='input tap ' + pos1+' '+ pos2
device.shell(keyboard) #enter command into keyboard
pos1=str(int(width)/2)
pos2=str((int(height)/25)*22)
keyboard='input tap ' + pos1+' ' +pos2
time.sleep(1)
device.shell(keyboard) #press print button
```

Figure 4: This is the Android Debug Bridge code snippet to access keyboard input and commands

3.5 Fabrication of automated rig

The automated rig is the final part of fabrication to automate the entire solution, main function of the rig is to automate linear motion and apply pressure onto the printpen's pressure sensor to trigger the printing process, this will complete the goal of fully automate the entire solution.

The automated rig's frame is initially fabricated using both metallic and 3D-printed components. It is designed to house the electrical components necessary for the solution and includes a baseplate to hold objects that needed to be printed on. The team uses a lead screw mechanism for linear motion, driven by a NEMA17 stepper motor, which allows for precise step control.

4 Outcome

Full integration of each portion of the prototype is completed with a master shell script to run all commands sequentially. The user now only has to press a input button to trigger the speech recognition recording and speak into to microphone, conversion to text, sending to evebot printpen and printing action will all occur automatically decreasing the need of human interaction to most activity in the system.

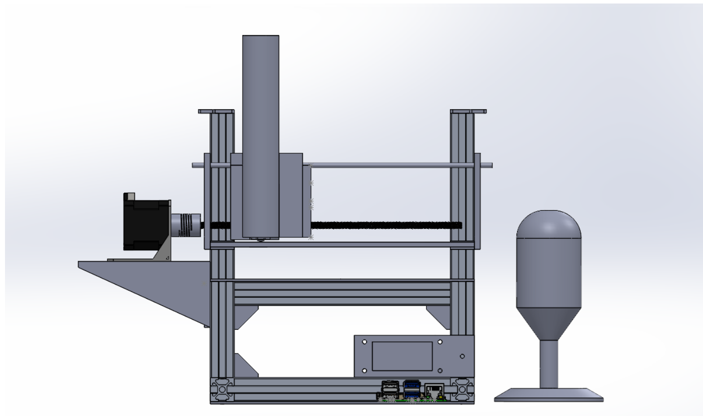

Figure 5: This is the CAD model of the automated rig drawn in Solidworks

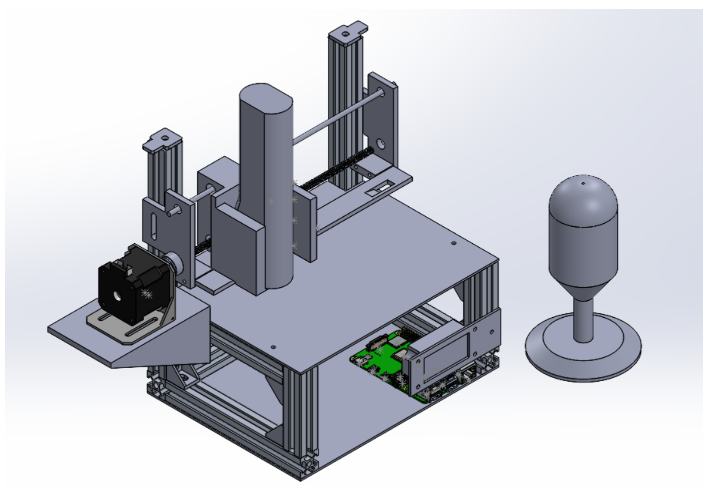

Figure 6: This is the CAD model of the automated rig drawn in Solidworks

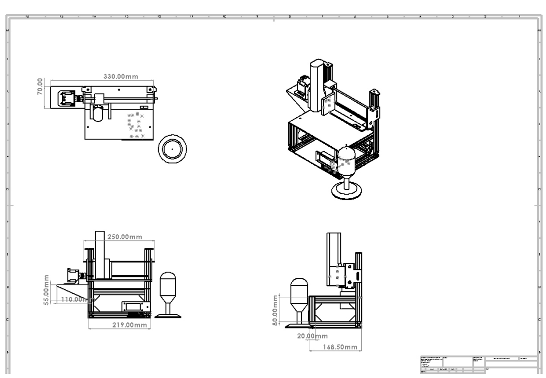

Figure 7: This is the sketch of the automated rig drawn in Solidworks

5 conclusion

This project aims to create an opportunity for preschool children to have a more engaging learning experience during meal time in the hopes that it will brings benefits such as better memory retention of food names, create a more engaging meal time and also create a more fun learning experience.