Engineering Design
GNG1103

Project Deliverable G: Prototype II and Customer Feedback

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1. Feedback from client

1.1. Feedback Received

- We need to make sure to have at least 20 frames per second video in order to ensure code detects ball well
- To improve ball detection use the phone camera instead
- Experiment with conditions and throw the ball around to see how well it works

1.2. How feedback will be implemented

- We will establish a phone camera connection with openCV in order to improve the frames per second of the video and thus improve the ball detection ability
- We will run multiple test in different conditions in order to test the capabilities of the code

2. Prototype developed

2.1. Why

- For prototype 2, the detection of the ball was improved and can provide accurate position of the ball in 3D space.
- Multiple cameras can be connected to the program, so that more accurate data can be gathered.
- The program has a higher detection rate and does not detect all circular shapes to avoid inaccuracy in data

2.2. What

- Prototype type:
  - Focused prototype where we test one attribute of the product.
  - Analytical prototype where we analyze the position of the ball through camera detection.
- The code masks all colors except green and contours green unmasked circular shapes
- The position in 2D space of the circle's center is recorded every 20 frames per second.

2.3. When

Testing will occur between November 7 and November 11. Will test if video quality is improved by using the phone connection. Will test if color detection along with circle detection improves detection of the ball. Will also test to see if X and Y coordinates given by the code are accurate compared to the actual position of the ball.

3. Analysis of critical components

The critical component of this prototype is the improvement of the OpenCv code compared to prototype 1. The code for prototype 2 first detects the color and then once color is found it detects the circle within the color found. An external app used to establish the phone camera connection between the computer. By adjusting the max and min radius value of the ball a more accurate detection can be made.

4. Documentation

4.1. Analysis

```
import cvzone
from cvzone.ColorModule import ColorFinder
import cv2
import numpy as np

cv2.bootstrap()
prevCircle = None
dist = lambda x1,y1,x2,y2: (x1-x2)*2+(y1-y2)*2
cap = cv2.VideoCapture(1)
cap.set(2, 1920)
cap.set(3, 1080)

myColourFinder = ColorFinder(False)
hsvVals = {'hmin': 43, 'smin': 60, 'vmin': 111, 'hmax': 98,
'smax': 255, 'vmax': 255}

while True:
    success, img = cap.read()
    imgColour, mask = myColourFinder.update(img, hsvVals)
```

```
    imgContour, contours = cvzone.findContours(img, mask,
minArea=5000)


    img_grey_blurred = cv2.blur(mask, (6, 6))


    circles = cv2.HoughCircles(img_grey_blurred,
cv2.HOUGH_GRADIENT,
                                        1, 99999, param1 =
100, param2 = 30,
                                        minRadius = 10,
maxRadius = 800)


    if circles is not None:
        circles = np.uint16(np.around(circles))
        for i in circles[0, :]:
            center = (i[0], i[1])
            # circle center
            cv2.circle(img, center, 1, (0, 100, 100), 3)
            # circle outline
            radius = i[2]
            cv2.circle(img, center, radius, (255, 0, 255), 3)
            print(center)


    imgStack = cvzone.stackImages([img, imgColour, mask,
imgContour], 2, 0.5)
    cv2.imshow("Image", imgStack)
    cv2.imshow("circles", img)
    cv2.imshow("blur", img_grey_blurred)
    cv2.waitKey(1)
```

4.2. Results

Circle is detected when moving slowly but detection is worse as the ball moves faster.

Video of test: https://youtu.be/iSebPg5TT6A

4.3. Feedback and comments gathered

- Detects ball accurately
- Only gives out X and Y coordinates
- X and Y coordinates seem to be fairly accurate
- Phone camera connection functions well
- To improve, we can make the program detect only a single circle. It will help to avoid multiple circles detection and therefore, avoid inaccuracy of the data.
- Calibration is needed for different light environment
- The system was trying to identify circles in surroundings as well

5. Updated target specifications, detailed design and BOM (if needed)

Our target specifications, design and BOM remain unchanged from deliverable F.

6. Prototype 3 test plan

Test ID	Test Objective (Why)	Description of Prototype used and of Basic Test Method (What)	Description of Results to be recorded and how these results will be used (How)	Estimated Test duration and planned start date (When)	Stopping Criteria

1	Open CV unity connection	The ball was recorded on the computer camera, moving the ball in unity in the same fashion	Open CV will work at the same time as unity. As the position of the ball is being recorded, the coordinates are transferred to the virtual ball which will move in the same position coordinate but scaled to virtual court.	Test duration: ~30min Start date: 11/17/2022	Position coordinates detected from Open CV will be transferred to the virtual ball in unity, so that it moves with the same position coordinates
2	Unity court render	The prototype will be tested on the padel court. The position of the ball on the court should match the position of the ball in unity court render	In unity, the court will be used to show the relative position of the virtual ball	Test duration: ~15min Start date: 11/17/2022	A virtual padel court is created and shows movement of ball in real-time
3	UI design	UI on the phone is a simple app that is used to connect a phone camera to the computer to record the data of the game. The prototype of the UI on the phone or computer will be given to the lab coordinator/ professor, client or friend for feedback	The good result is that the app is easy to navigate. It should look appealing to the athletes	Test duration: ~1h Start date: 11/17/2022	App that has all options and button needed

4	X,Y,Z coordinates	Two cameras will be used in order to gather 3D position data of the ball	Coordinates will be looked at compared to origin and accuracy will be determined	Test duration: 20 minutes Start date: 11/17/2022	With one camera X and Y coordinates are detected by placing a camera on a 90 degree angle while running similar code the Z coordinate of the ball can be obtained.
5	UI unity connection	To test the result the product will be given to the client as for feedback. Interface should connect the phone camera to the computer. The position and the motion of the ball should match the rendered image	The result will be used as a final step in our project which is what the client will use to analyze the game	Test duration: 30 minutes Start date: 11/19/2022	App is fully functional with unity and displays the 3D render as well has the ability to establish phone-computer connection

7. Wrike Link

Deliverable G - Wrike