GNG 1103 [G]

Engineering Design

Deliverable D: Conceptual Design

Team 14

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Abstract

The deliverable D will aim to introduce our team's design concepts for the project. Our ideas will be divided into three parts and then we will bring them together to create the final product. Our first part will focus on the camera. The second will focus on the analysis of the ball during the Padel Ball game. Finally, the last part will focus on the interface display.

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1 Introduction

This document represents the brainstorming stage of our product. Therefore, our main goal with this deliverable is to come up with concepts for each chosen subsystem. Then, out of all the concepts provided, the best ones will be chosen for further development. Finally, our final solution for each subsystem will be supported by sketches and descriptions explaining functionality, and they will also be compared against the design criteria from the previous deliverable.

2 Concept Generation

The concept generation will describe our team member ideas, we divided our brainstorming into three parts. The first part will consist of ideas surrounding the camera. The second will discuss about the ball tracking analysis through platforms. The third part will talk about the interface display.

2.1 Scabency's Concept

2.1.1 Camera

A normal phone's camera should be chosen. Let's use an iPhone 14 as an example, the dimension and weight would be about 150.9 x 75.7 x 8.3mm and 6.84 oz respectively. Those iPhones can record resolution up to 4K and, nowadays, most people own an iPhone or a phone with a camera. Therefore, there will be no need to spend on a camera or to build one from scratch which would increase the cost of our product. We will have to test for the height at which the tracking of the squash ball will be most effective in case a specific camera mount is needed.

2.1.2 Ball Analysis

For the tracking of ball, OpenCV and Python should be used. Basically, a game of padel will be recorded. Then, with OpenCV and python, the code will read the videos and detect the players and the padel ball. Finally, it will track those different things and record the information of their movement.

2.1.3 Interface Display

The 3D simulation of the padel court should be created through Unity. Basically, a 3D environment of a typical padel court will be reproduced on Unity. Also, the ball and the players will be reproduced as well. Then, the information coming from the ball tracking program will be sent to Unity to reproduce the movement of the ball and players. In addition, information such as acceleration and speed will be always provided on the screen. The simulation will also run as a video recording meaning that pause and replays will be available. That way, a real-time squash game will appear on the screen just like an EA video game.

2.2 Abdel's Concept

2.2.1 Camera

Canon EOS Rebel T7 DSLR Camera should be chosen. Their video resolution is 1920 x 1080 (FHD). The dimensions for this camera (630$) are 10.13 x 7.76 x 12.9 cm, and the weight for this camera is 475g. The price for this camera might be high but it will take a high-quality video and that will help in analysing the game.

2.2.2 Ball Analysis

To track the ball Java is a good option to be used. The game of the pedal ball will be recorded with the camera then the code from Java will read these videos and can help in discovering the players movement and help the coaches in fame analysis. This information will be recorded on a USB.

2.2.3 Interface Display

The 3D simulation of this game will be created through an Unreal Engine. The information coming from the usb will be presented through Unreal Engine to recreate the movement of the ball and the players. The speed of the ball will be presented all time on the monitor as well as the movement of the players, so that coaches will be able to analyse the player movement and improve them.

2.3 Salma's Concept

2.3.1 Camera

The camera should be on the field, to capture the ball every second. In this case, a wireless and weather-resistant camera should be chosen. As an example, we can use security cameras, like the blink indoor camera. The size of the camera is 71 x 71 x 31 mm, and it weights 48 grams. The video resolution is 1080p HD during the day, and it uses infrared HD at night. This camera can capture quality images even at night, and it has a wide operation temperature (0-35 C), which is ideal for exterior games. In the future, it would also be easy to add more than one camera since it is a security system camera.

2.3.2 Ball Analysis

For this project, we should use other existing tracking programs, made on OpenCV and Python. We would have to modify the program, to adjust it to our criteria. In this program, we should be able to download multiple videos from the Padel Ball game. Once, the video is downloaded into the program, it should be able to recognize the ball and analyze its movement at every second of the game. The program should also output certain pieces of information like the position and the trajectory of the ball, as well as the time.

2.3.3 Interface Display

The 3D simulation display should be on Unity, with the help of OpenCV. It will display a simulation of a Padel Ball game. The program's ball analysis will be uploaded to Unity from OpenCV so it can recreate ball movement and game. Additionally, information such as ball position and time will be displayed on the screen. Furthermore, other information such as the speed or acceleration of the ball will be displayed, in the post-match analysis on Unity.

3 Chosen Concept

We will discuss about the chosen concepts. Our decision was made based on our design criteria as well as our technical skills regarding the different platforms that will be used.

3.1 Camera

The concept design chosen for the camera is the phone camera. In this decade, majority of individuals has a phone, so there is no cost needed for a camera. In the figure 1, the sketch illustrated the placement of the cameras on the Padel court, however, a mount will be necessary to hold the phone in place. The tripod could be a solution, but if the ball hit the camera, it will interrupt the game which is not desirable. Therefore, the two other locations would be more convenient. It will just require a tennis mount as shown in the sketches. That way, the phone will be able to stay on top of the fence and record the whole game from a good view. The only problem is that the customer will have to acquire one of those camera mounts. In addition, in terms of the weather, it should not be a problem since it is not likely that players will practice or play and record while it is raining. A winding temperature might be a problem, but camera mount as shown should fix it. Finally, the phone's camera will be the primary solution to record the game. Yet, any camera that can be supported by the mount could also be used at the expense of the customer.

3.2 Ball Analysis

The best platform to use for a ball analysis in this case will be Python and OpenCV. The block diagram presented below, shows what we think about the general idea of what the tracking system is. It is our best solution simply because we are currently using python/OpenCV as a language in our lab. Thus, it will be easier to deal with it since we already have a bag of information about that program. Looking at the block diagram, we see that the main input will be a recording. Since our client wants to potentially add more than a single camera, more than one recording will become the input to our python/OpenCV program. That being the case, we will have to figure out how our program can simultaneously go through 2 & + recordings at the same time while giving accurate tracking information of our ball and players.

3.3 Interface Display

Unity would be the best platform to use for the interface display. Unity is a program used to create videos games and our goal is to have a simulation of a padel ball game. Since unity is known to work perfectly with OpenCV and Python, we will be able to establish an easy step-by step procedure. It and would also save us a lot of time, because we will be able to learn quickly and thus, we will explain it better to the customers and users.

4 Sketches

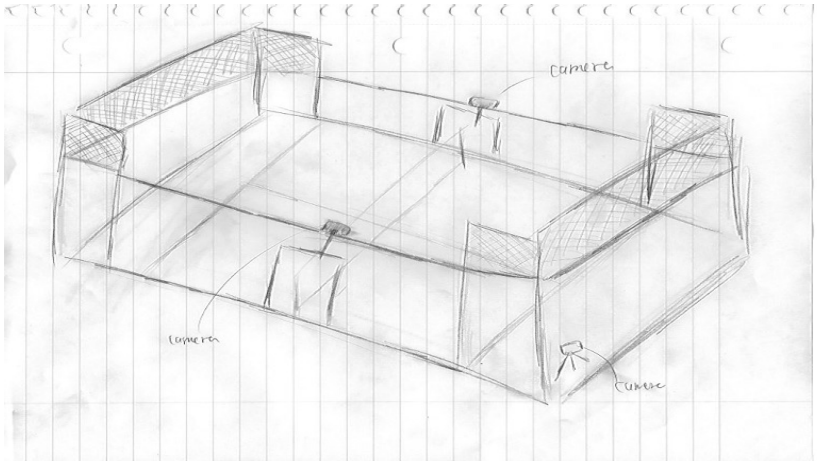

Figure 1- Sketches of the Padel Ball Court as well as the Placement of the Camera.

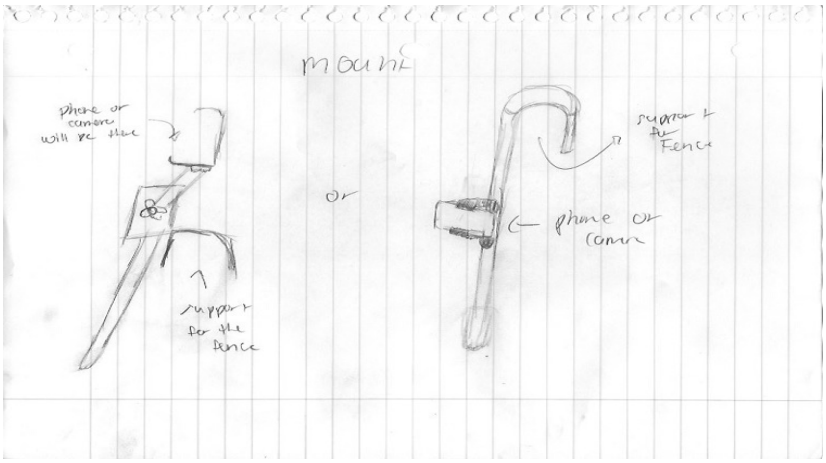

Figure 2- The Mount that Will be Used to Hold the Camera in Place.

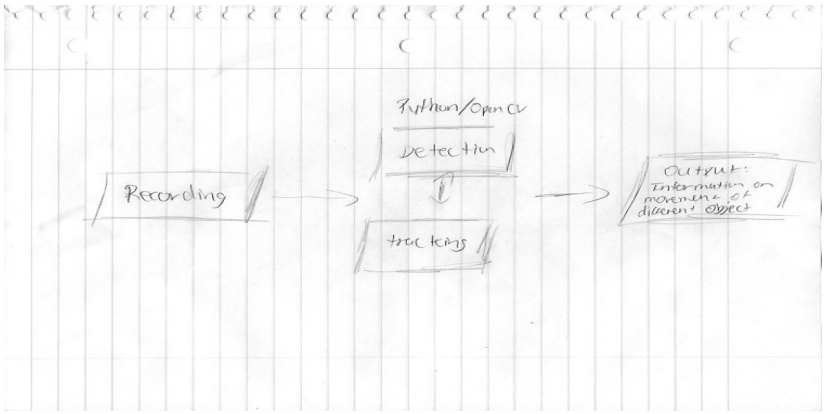

Figure 3- Block Diagram of the General Idea for the Tracking System.

5 Design Criteria

Design Criteria	Chosen Concept
Cost	Our chosen concept respects these design criteria because we will use an iPhone to record the padel ball game. Since most individuals already have a phone, there will be no cost associated with our camera or the different platforms used during this project.
Resolution	The iPhone resolution can go up to a 4K resolution, so it will above 1080p HD, which is the criteria.
Camera Weight	The weight of the average iPhone is about 0.194 kg. The expected weight in our criteria is about the same weight or less. It will be easier for the users to use since it is not heavy for repetitive use.
Operating System	Python, OpenCV and Unity are functional on Windows and MAC OS. There are also used for several games apps on IOS (apple product) and Galaxy store (Androids). Therefore, the customers and users could have easy access to our operating system.
Dimension	The dimension is respected since the iPhone 14 is smaller than 150.9 x 75.7x 45 mm.
Easy to Use	The overall product will be easy to use because we will use an iPhone to record. The phone is the most used thing on daily basis by most individuals, so they will already be familiar with it. Secondly, the platforms such as Python, OpenCV and Unity are used frequently to develop new games or apps, so the customers will also be familiar with them, and therefore, it will be easy to use them.
3D environment- Aesthetics	The 3D environment will be displayed through Unity. This program is used to develop multiple games and therefore, it will be easy for us to create an aesthetically pleasing court since the instructions are hugely available online.

6 Conclusions

In conclusion, this document demonstrated the steps taken during the team's brainstorming for the product. The main objective of this deliverable was achieved, and we were able to propose concepts for each chosen subsystem. We were also able to choose the concepts for the three subsystems, so for the camera, for the analysis of the ball and for the display interface. The best concepts were chosen for further development. Finally, our final solution for each subsystem was supported by sketches and descriptions explaining its functionality, and they were also compared to the design criteria of the previous deliverable.

7 References

"Blink Indoor – Wireless, HD Security Camera with Two-Year Battery Life, Motion Detection, and Two-Way Audio – 5 Camera Kit." *Amazon.ca: Electronics*, https://www.amazon.ca/Blink-Indoor-Wireless-Security-Camera 5cam/dp/B07X27JTM6/ref=sr_1_3?crid=2JY1NCV7U4AF9&keywords=security%2Bcameras%2Bwireless%2Boutdoor&qid=1665954021&qu=eyJxc2MiOiI2LjUxIiwicXNhIjoiNi43NCIsInFzcCI6IjYuMDUifQ%3D%3D&s=amazon-devices&sprefix=security%2B%2Camazon-devices%2C96&sr=1-3&th=1 (Oct 15, 2022)