Team “ACES”

Deliverable D

GNG 1103

Group GO1-1

Team members

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Faculty of Applied Science (October 16th 2022)

Abstract

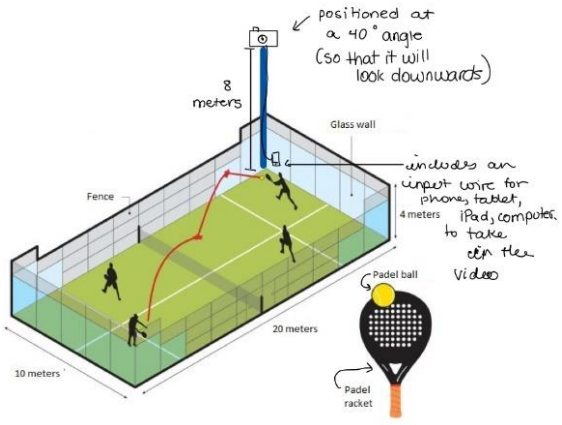
The intention of this deliverable is to develop a minimum of three subsystems, which have clearly labelled boundaries between the subsystems. The subsystems must also be inter-changeable for future use. Key concepts from the previous deliverable can also be used in the development of the three subsystems such as implementing the design criteria and ensuring that target specifications are highlighted from the client's needs.

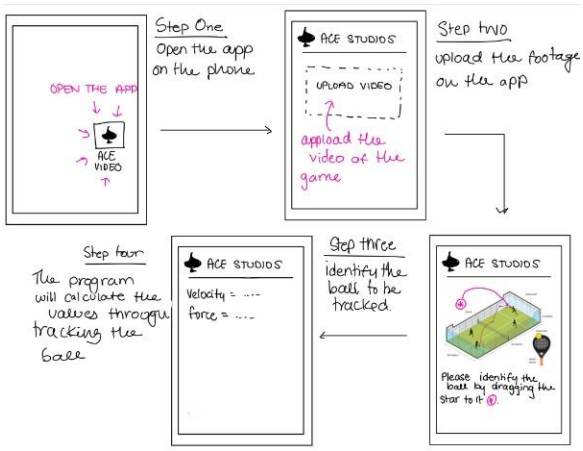
1. Introduction

In this report, each team member will develop a conceptual design based on our problem statement.

We will then discuss and compare our designs in order to develop a refined team design that incorporates all the best ideas of each team member's design. This report contains the designs of Tanvi, Hannah, Lucien, Max, as well as a team design.

2. Tanvi's Design





Tanvi's idea includes the use of one camera. It will be installed roughly 8 meters above the court. This camera will also be positioned in such a way that it will get the view of the whole court. The main idea of this design is to capture the game in its entirety. This camera will be plugged in to a smartphone, laptop, tablet, etc., at the bottom of the pole which will allow the video to be sent to the required location. From here, the users will open our app "ACES" and will upload the footage of the game. The app will have a tracking software installed in it. It will work via tracking the location of the ball.

The app will have built in dimensions of the Padel Ball court, dimensions of the ball, and various time measurements which will allow it to calculate the speed of the ball it is tracking through real time technology. It will also use various mathematical formulas to generate the force at which the players hit the ball.

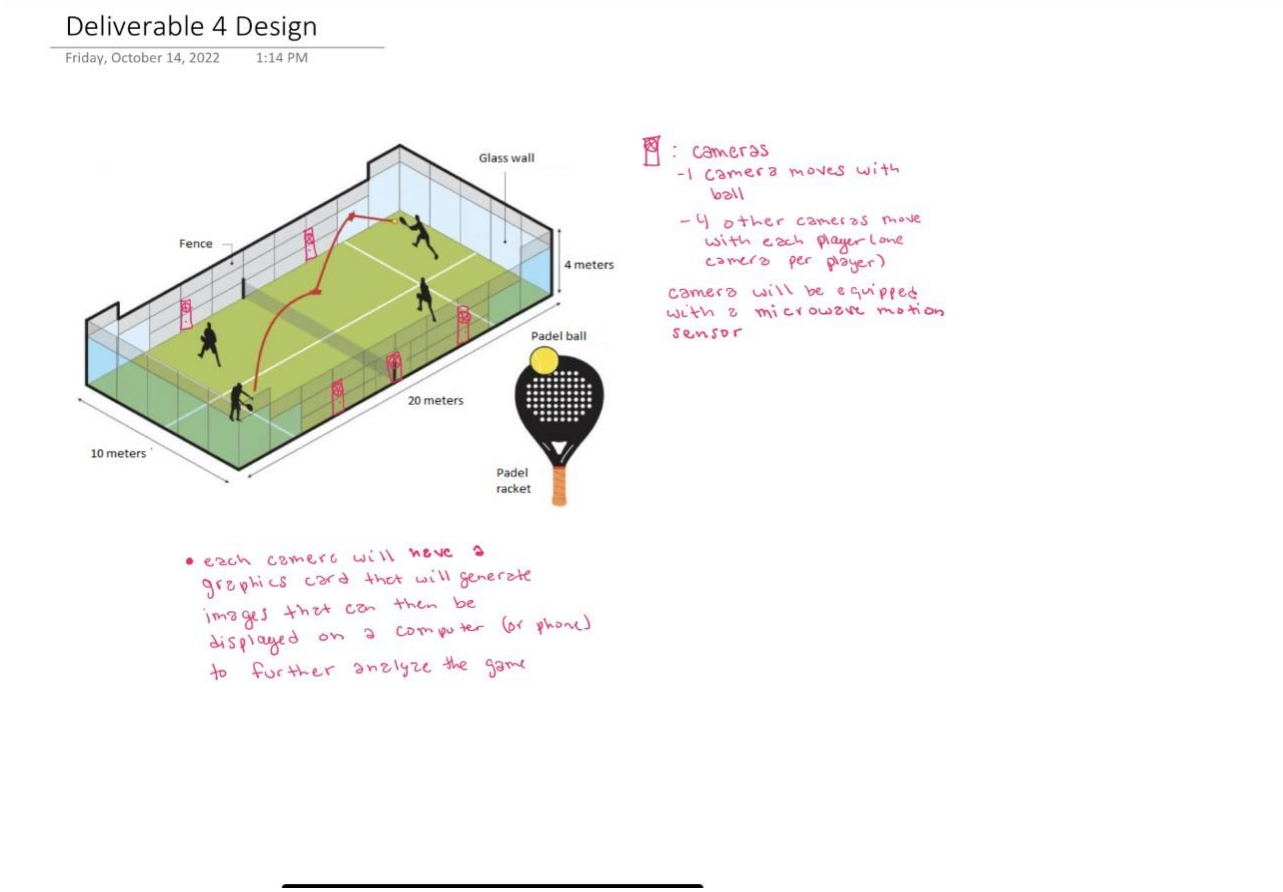
We will use pre-developed technology to calculate the speed of an object on screen by following these steps:

1. Calculate the distance the object moved

2. Know what the frame rate of the video recording is (*Frame Rate*: measurement of how quickly a number of frames appears within a second)

   - The app will view the video frame by frame and calculate the distance an object moves from one frame to the next. Therefore, you can calculate the speed of the object (by dividing it by time)
     - Example: if the ball moves 2 inches between each frame; the speed would be 4.2 feet/ second

3. Hannah's Design

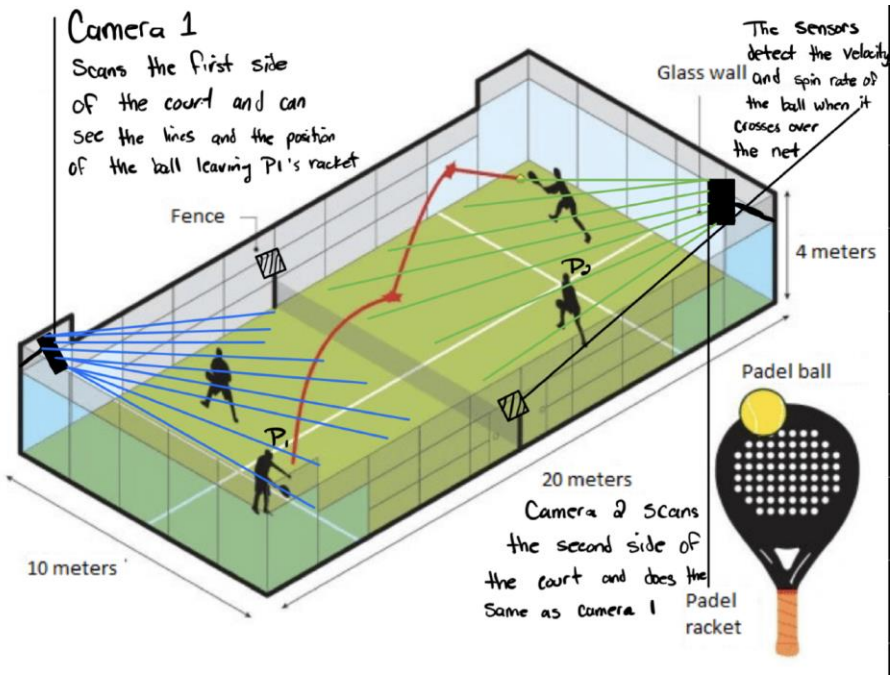


For Hannah's design, there will be 5 cameras installed on the padel ball court. There will be one camera for each person, which will move with them by tracing their movement. There will be two cameras on each of the longer sides of the court next to each player in order to trace their movement the best. There will also be a fifth camera placed on the side of the court, in line with the center line. The camera must also be higher than the net otherwise its view may be obstructed by the net.

Each camera will have a microwave motion sensor that detects the motion of the ball by continuously sending out microwave signals which then return to the sensors placed on the side of the court in regular intervals. This system is activated when it detects a frequency shift.

Each camera will have a graphics card that generates images that can then be displayed onto a computer or phone to further analyze the game. This graphics card will have a high-resolution (such as 300 pixels per inch) to display a lot of detail, as well as a high refresh rate which will make the image appear sharper because it will update more often every second.

4. Lucien's Design



For Lucien's design, there will be 2 cameras placed in the corners of the court protected by pixy glass. Each camera will cover half of the court and get the location of the ball and the players, as well as where the racket is when the ball makes contact and leaves the racket.

There will also be 2 sensors on each end of the net, these sensors will determine the velocity of the ball when it crosses the net, as well as the spin rate of the ball at that same moment.

Each camera will upload the entire match info to be looked at or reviewed in a high quality (720p) including the information on the location of the ball and the players (rackets included) and the sensors that gather the velocity and spin rate will upload the information directly to the user's phone and can be viewed in the same way when looking back through the match.

5. Max's Design

Class: game
- Game title/ info
- Playing field
- Ball paths[]

- Create new game()
- Load saved game()
- Edit game()
- View game()
- View game when()
- View game info()

Class: ball path
- Total time
- X path
- Y path
- Z path

- Create new path()
- Edit path()
- View path()
- Get ball speed()
- Get ball direction()

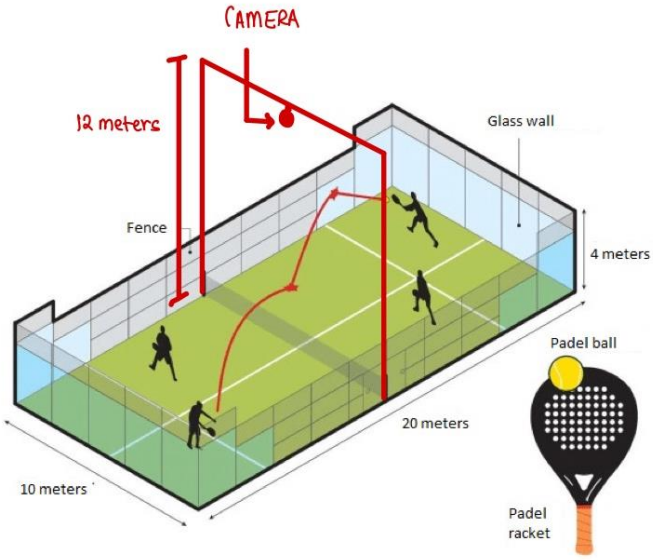
Max's design will feature one wide-lens camera centered above the court. As the game progresses the ball's position will be continuously logged in a text file along with the time. The stored positions are grouped each time the ball bounces off any surface.

When using the well documented software each data group is then used to create a ball path object consisting of 3 time dependent equations that represent the ball's position in space with respect to time and the length of time it takes for the ball to complete the path.

The game class will store basic info the user may choose to input such as game location, date, players, final score, penalties, weather or other notes. A game object can be created from a saved file or made as a live game progresses. The game object will also store the dimensions of the playing field. A game object can then be viewed in 3D space by calling the View game function.

The final product will come preset with the playing field object being the official Padel ball court and the create game method assuming the camera is pictured as seen in figure 4. The advantage to this design is that the object-oriented programing will allow for ease of further development in the future. For instance, if more cameras are added for better accuracy only one new game method will need to be added. If you wish to use this software for a different sport only the playing field specification will need to be changed. If the 3D environment is not as expected only the view game method will need to be altered. Storing the balls location as an array of equations will also save precious processing power and computer memory and allow stored gamed filed to be easily transferred. While this design may be basic it is based on fundamental programing principles that allow future development.

6. Group Design



Class: game
- Game title/ info
- Playing field
- Ball paths[]

- Create new game()
- Load saved game()
- Edit game()
- View game()
- View game when()
- View game info()

Class: ball path
- Total time
- X path
- Y path
- Z path

- Create new path()
- Edit path()
- View path()
- Get ball speed()
- Get ball direction()
- Get position()

For our group design we decided to use a wide lens camera placed over the center line of the court. The combination of the wide lens camera and the elevation of the camera will allow the camera to see the entire court. Ideally, the camera would be placed 12 meters above the court and have 720p.

OpenCV will use what the camera captures and store it as groups of coordinates in order to track the position of the ball. Using the grouped coordinates, we can then create ball paths. All the balls paths will then be stored in an instance of class game. This means that in the future if the client wishes to add more cameras or move the camera only the method of creating the coordinates needs to be changed. This also allows any other desired feature to be easily added.

7. Comparison to current market solutions

	price	Tracking of ball	Replay view	Replay quality	Ease of further development	Detect ball in or out of play	Interference with game
stat cast	$15000	Arm strength / exit	Overhead/ from	100FPS	no	Yes	no

		velo/ launch angle/ etc...	behind home plate				
Hawkeye		Judge where the ball landed	Line /court view from ground	340FPS	no	Yes	no
In/Out	$275	Judges where the ball lands on the court	Overhead 2-D view	N/A	no	No	no
Aces	50$	Tracks ball at all times	3D space	4k retina	yes	maybe	no

As you can see our company, Aces has the best product outcomes compared to the other three. This benchmarking was done in the previous deliverable to further optimize our understanding of what the client and user will want out of our product.

8. Conclusion

Group members provided a variety of different solutions to meet the design criteria, with careful review a group design was selected that best fit the client's needs and design criteria. This design is now ready to be presented to the client for feedback.

9. Bibliography

What is a graphics card? - definition from Techopedia. Techopedia.com. (n.d.). Retrieved October 14, 2022, from https://www.techopedia.com/definition/7465/graphics-card

Admin. (2020, July 27). *How does microwave sensor work?* Short. Retrieved October 14, 2022, from https://short-fact.com/how-does-microwave-sensor-work/

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Calculating speed using video analysis. (n.d.). Retrieved October 15, 2022, from https://www.topendsports.com/biomechanics/video-analysis-speed.htm

10. Wrike Link

https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=AtfUqJ09tiT1Rdbrr7fTQCbvAX2DeAkh%7CIE2DSNZVHA2DELSTGIYA

Or this link because it shows more detail

https://www.wrike.com/workspace.htm?acc=4975842#/folder/968841774/timeline3?viewId=109685302