12-2021

Camera-based deep learning AI assistant system for basketball training

Guangkun Zeng
gz4641@rit.edu

RIT

Camera-based deep learning AI assistant system for basketball training

By

Guangkun Zeng

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Fine Art in Visual Communication Design

School/Department of Design College of Art and Design

Rochester Institute of Technology

Rochester, NY

December, 2021

RIT | College of Art and Design

Thesis Approval

Camera-based deep learning AI assistant system for basketball training

Thesis Title

Guangkun Zeng

Thesis Author

Submitted in partial fulfillment of the requirements for the degree of Master of Fine Arts

The School of Design | Visual Communication Design

Rochester Institute of Technology | Rochester, New York

Mike Strobert — Chief Thesis Advisor

Name — Title

Electronic Signature: Use Adobe Acrobat

Associate Thesis Advisor

Name — Title

Electronic Signature: Use Adobe Acrobat

--- select a Title ---

Name (Optional for some programs) — Title (Optional for some programs)

Electronic Signature: Use Adobe Acrobat (Optional for some programs)

--- select a Title ---

Name (Optional for some programs) — Title (Optional for some programs)

Electronic Signature: Use Adobe Acrobat (Optional for some programs)

Abstract

The YOLO, a Computer Vision Algorithms, is brought out to analyze the basketball player's status as a dataset. It can record the players' behavior on the court including dribbling, shooting, and running. In this way, the app could collect the field goal you made and missed. First, you should use this app to record a video of your shoot training. After that, the AI would analyze and brings out a 3d virtual diagram interpret your performance. This diagram will show the hot zone and cold zone for your field goal. Also, the track of your ball will be displayed on the video so that you can know if the angle of your shooting is too low or too high. In the end, the AI-based on machine learning will give out a plan according to your performance on shooting.

As a training mobile application supported by camera-based action recognition, the target audience is the basketball amateur players who don't have the resources as pro players do. This project will be designed as a new training experience and will be delivered as a promo video that shows how to use the application and also the scenario people use.

Keywords

MR, virtual environment, camera-based, training system, deep-learning, machine learning,

motion capture, AI

Critical Analysis and Summary

Context

Many basketball enthusiasts want to upgrade their skills to a far better level, but unfortunately, not everyone has the funds to hire professional coaches to train on the best court. And what's more, many amateur players do not even know how to practice in a proper way because the video tutorial is not as intuitive as the real coach or as the professional human coach is. What's more, it is almost impossible for the basketball player to quantify how good his/her shooting is. But people do need very good shooting form and technique to shoot consistently. How might we improve players' training experience?

Nowadays, MR (mixed reality) has changed our life. Research by Visual Capitalist projects that the XR market will be worth $209 billion by 2022, marking an eight-fold increase from 2018[1]. Furthermore, 63% of shareholders in XR technology companies believe the technology will be mainstream by 2024. At the same time, Mixed Reality is quite within the middle but also the longer term of the entertainment industry. [2]This type of technology could provide a customized and unique training experience even compared to the best court and trainers could do.[3]

The Mixed Reality is the technology that could provide an immersive experience and direct data visualization. I propose to bring out a Mixed Reality mobile application that can generate 3d virtual diagram of the basketball court to assist players to understand their shooting performance. At the same time, the app will collect the player's data and make the training plan according to the AI-based analysis system.

Methodology

To implement this system, multiple technologies will be integrated. The YOLO, a Computer Vision Algorithms will recognize the ball trace and collect data of your training.[4] The motion capture with 3D virtual environment technology will interpret the shooting gesture and movement. Then the machine learning will generate a specific training plan.

The phase of interview and user research will not proceed because this design puts more emphasis on conceptual design. This design focuses on 3 problems that players often meet. First, it's hard for amateur players to quantify their skill level. Second, not every player can make a precise plan as professional

[1] Emrich, T. (2020, February 25). 20 for 2020: Augmented Reality Trends and How They May Play Out This Year [Web log post]. Retrieved from https://medium.com/@tomemrich/20-augmented-reality-trends-to-keep-an-eye-on-in-2020-d2b0258edbb

[2] Terry, Q. (2019, July 23). AR is elevating the playing field for sports by creating smarter training methods. Retrieved from https://medium.com/futuresin/ar-is-elevating-the-playing-field-for-sports-by-creating-smarter-training-methods-77db01a84d64

[3] Lee, David. "Our First Shot(s)." Medium (blog). July 17, 2018. https://medium.com/nex-team/our-first-shot-s-272c67d0349d.

[4] Terry, Q. (2019, July 23). AR is elevating the playing field for sports by creating smarter training methods. Retrieved from https://medium.com/futuresin/ar-is-elevating-the-playing-field-for-sports-by-creating-smarter-training-methods-77db01a84d64

coaches can do. Third, players are not sure the practice is executed perfectly. People also sometimes forgot how many shots they've made.

Three solutions have been given out: First, A 3d diagram of your plays can help users to quantify their performance. Then AI Deep learning can give you advice as good as a coach does or even better. Finally, A smartphone camera-based real-time system can record your plays with no mistakes.

As the result of the problem solutions, HoopLab identified 3 specific design goals that are used to prototype：

1. Friendly to use
   Create an experience that users can enjoy. Users can customize their 3d avatar and pick up favorite cloth and haircuts for it. The avatar will be rigged and motion captured by users as a way to understand your shooting movement.

2. Easy to understand
   A 360 degrees 3D diagram will be generated according to the play recording. It is able to turn your still camera recording into 3d version environment. The AI will calculate the distance between objects (player-player, shooter-hoop, defender- ball)

3. Convenient to record
   The user only needs a smartphone camera to do the basic function. Using a smartwatch to unlock advanced features.

After three rounds of prototyping, the corresponding interface lo-fi wireframes are designed. Based on those interaction wireframes, the output of the UI visual wireframe is finally completed. A promo video that combined UI elements and application functions is also be made.
A game design theory is also brought in for this system. Users can earn coins by finishing the tasks. Then they can use game coins to unlock avatars and new advanced tasks. The circular economy is formed in this process.

I think there will be sustainable iterations to evaluate my proposal. At phase one, which is the initial state of a product, a large number of A/B tests will be given to the users. According to the A/B test results that we collect, it can be decided which feature is better for users. In phase two, the product starts to operate smoothly, then plenty of data can be analyzed by machine learning. Due to AI, we can decide what new features that may satisfy users should be built further.

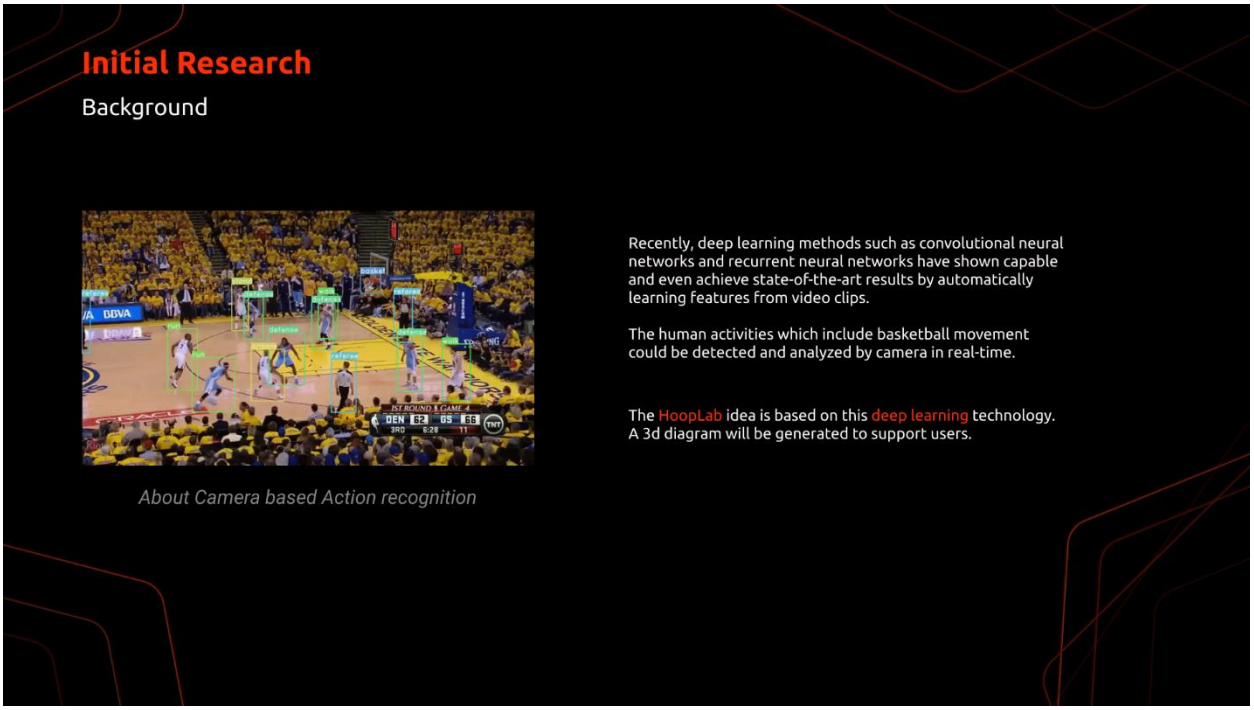
Conclusion

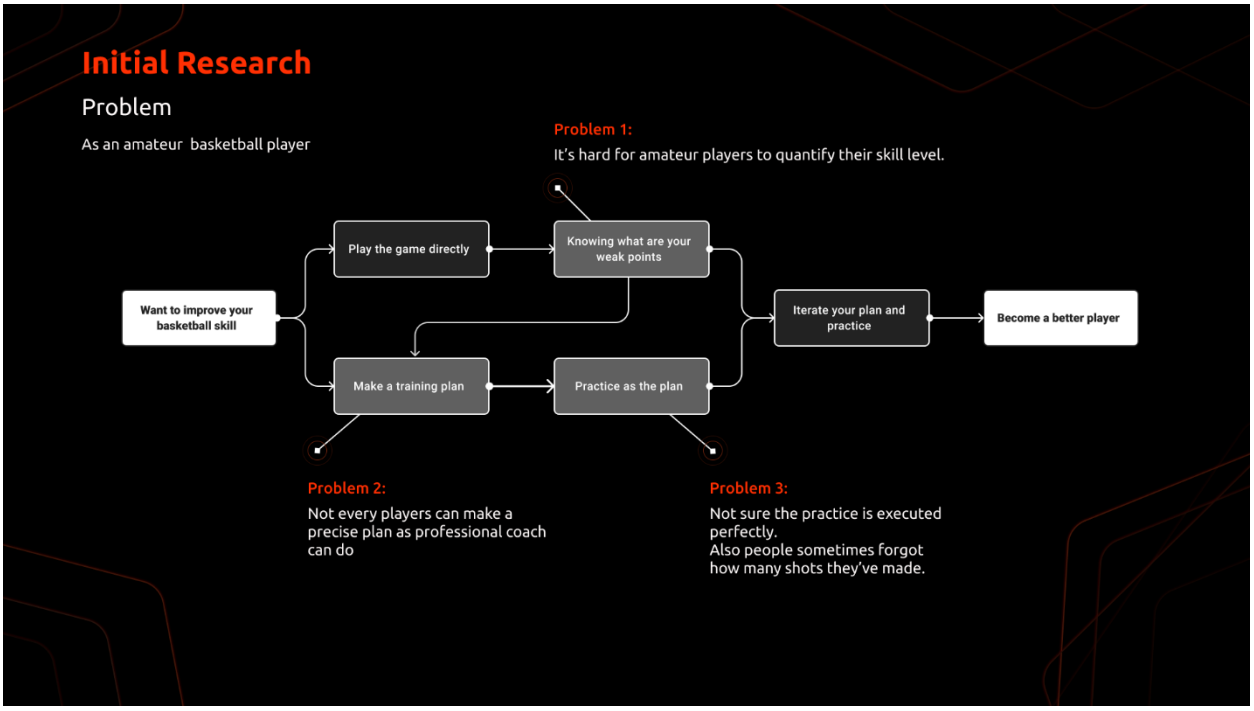
It's difficult to quantify the experience of the system. If the system could present a customized training plan for the user and create a virtual 3d environment of a real court that the player doesn't feel strange about it, this design will be a satisfied solution.

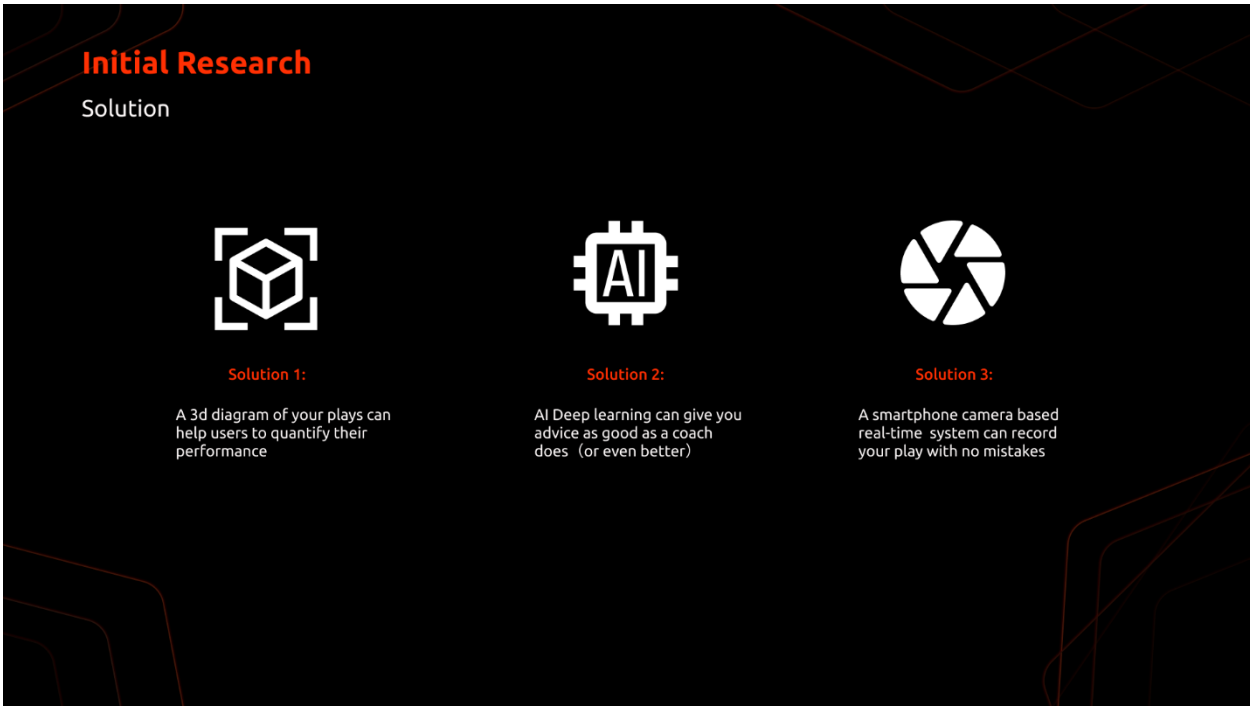
However, with the limit of real-time render technology and hardware hashing power, it is still impossible to implement an application like this in a mobile phone. This project is an approach that represents one possibility of what AI algorithms can do for sports games.

Appendix A: Expanded Thesis Defense Presentation

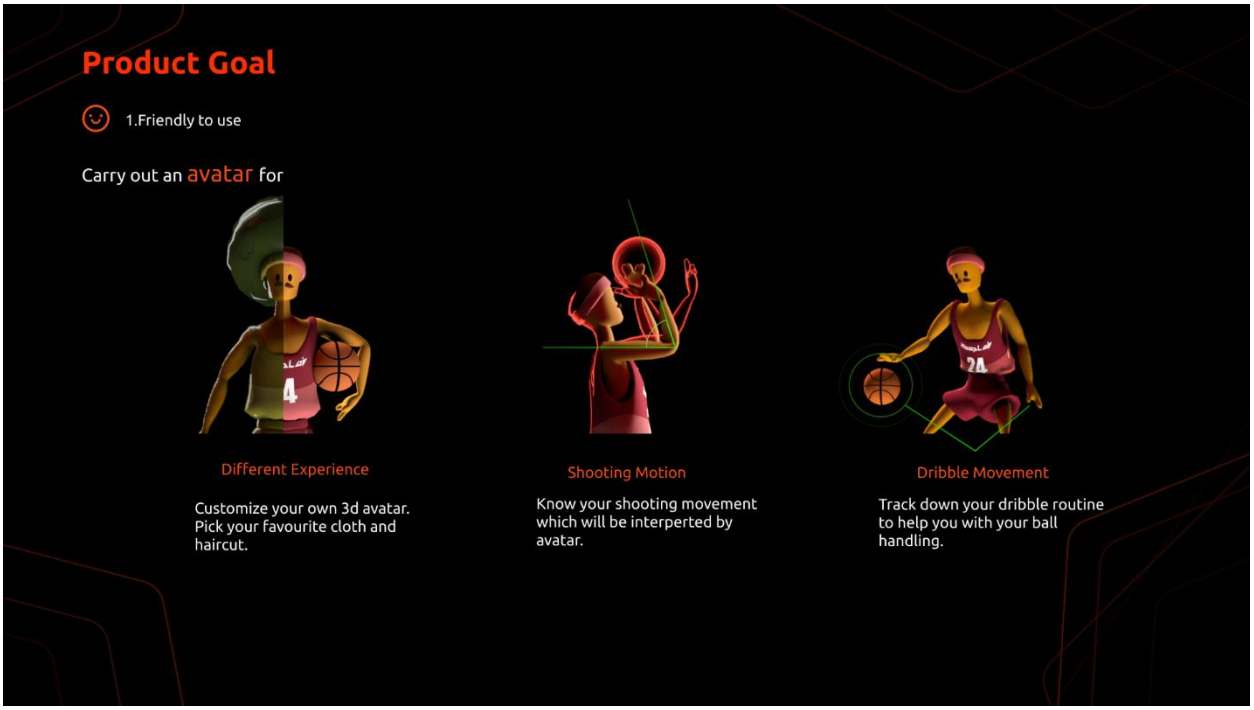
Initial design






Initial Research
Solution
AI
Solution 1:
A 3d diagram of your plays can help users to quantify their performance
Solution 2:
AI Deep learning can give you advice as good as a coach does（or even better）
Solution 3:
A smartphone camera based real-time system can record your play with no mistakes

Design intension



Product Goal

1.Friendly to use

Carry out an avatar for

Different Experience

Customize your own 3d avatar. Pick your favourite cloth and haircut.

Shooting Motion

Know your shooting movement which will be interperted by avatar.

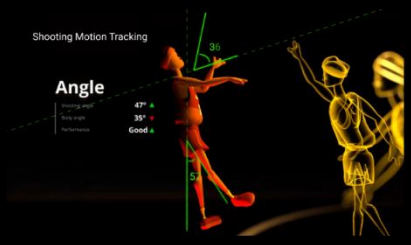
Dribble Movement

Track down your dribble routine to help you with your ball handling.

Product Goal

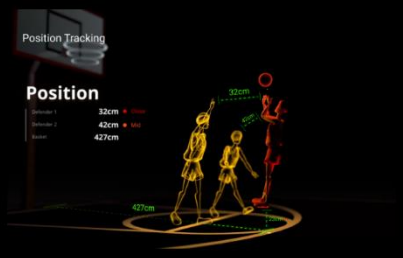
2.Easy to understand

360 degree 3D diagram



Shooting motion tracking

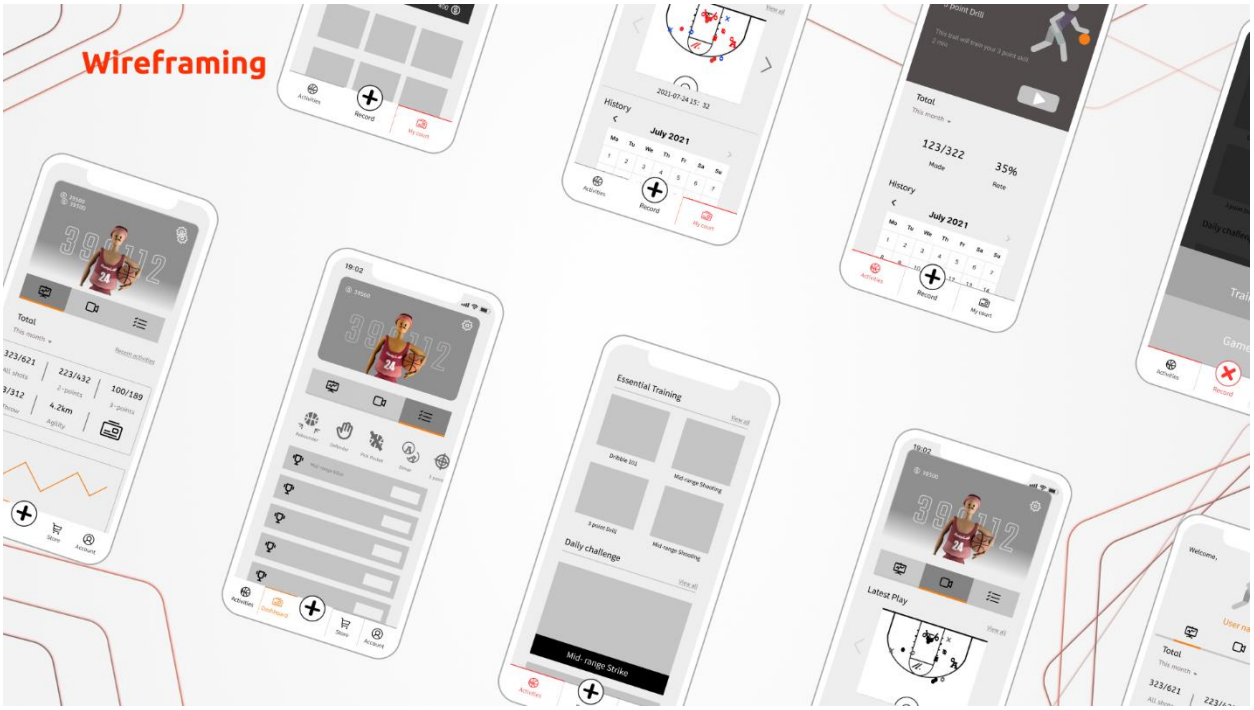
Turn your still camera recording into 3d version



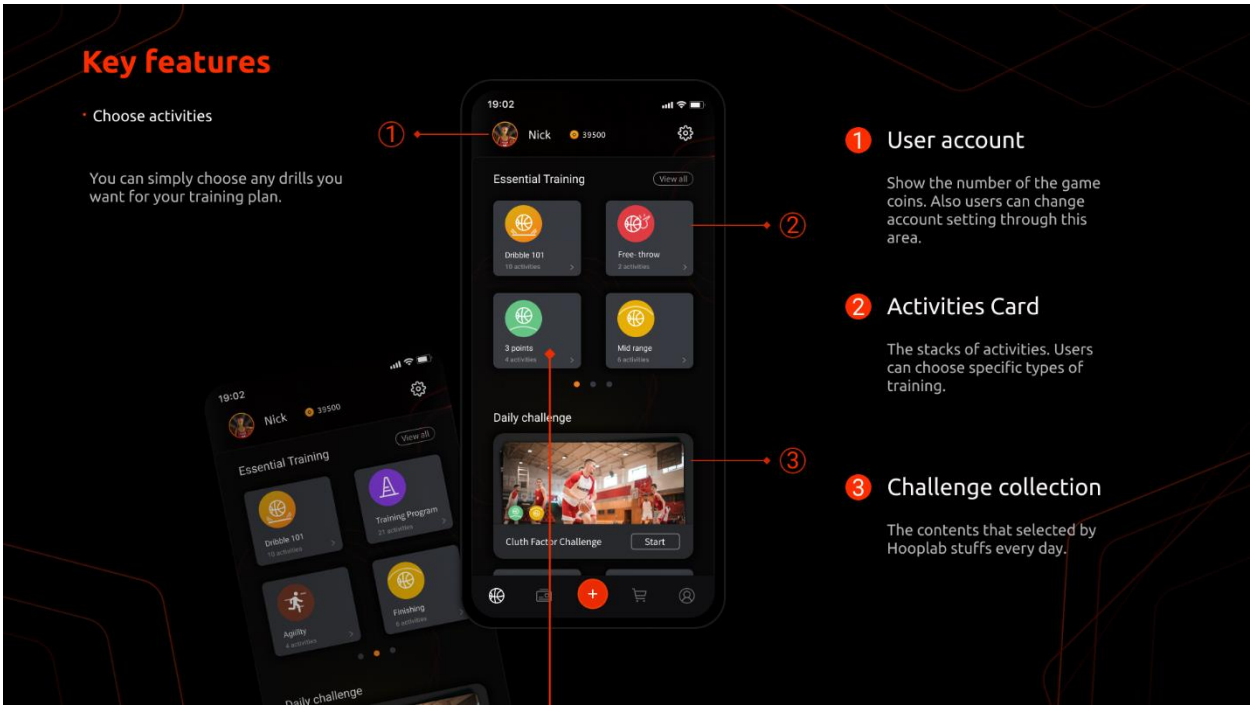
Position Tracking

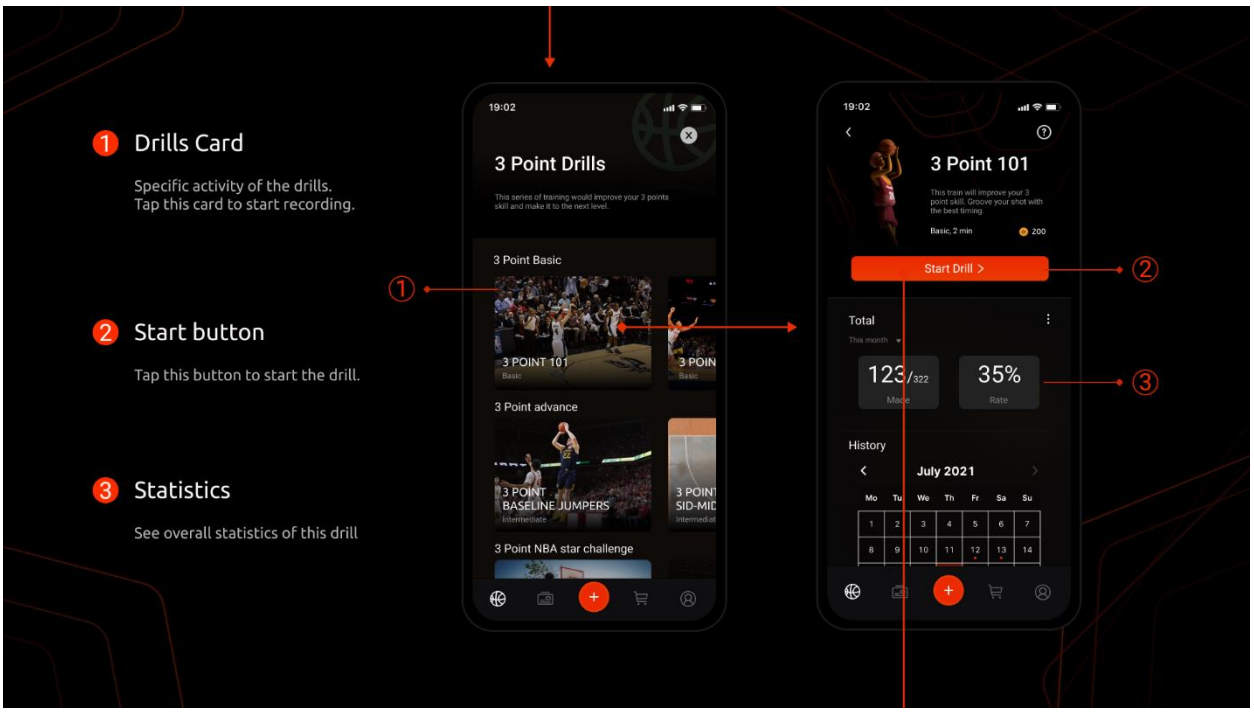
Calculate the distance of things

Wireframing

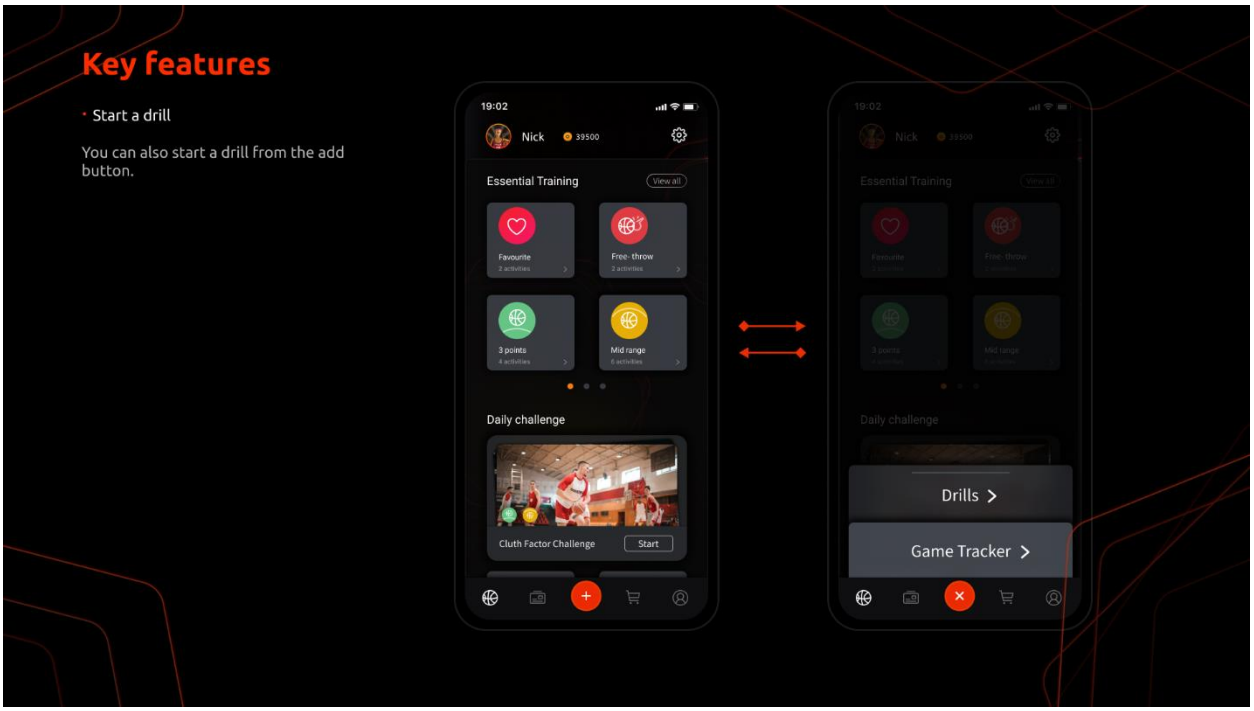


Key features

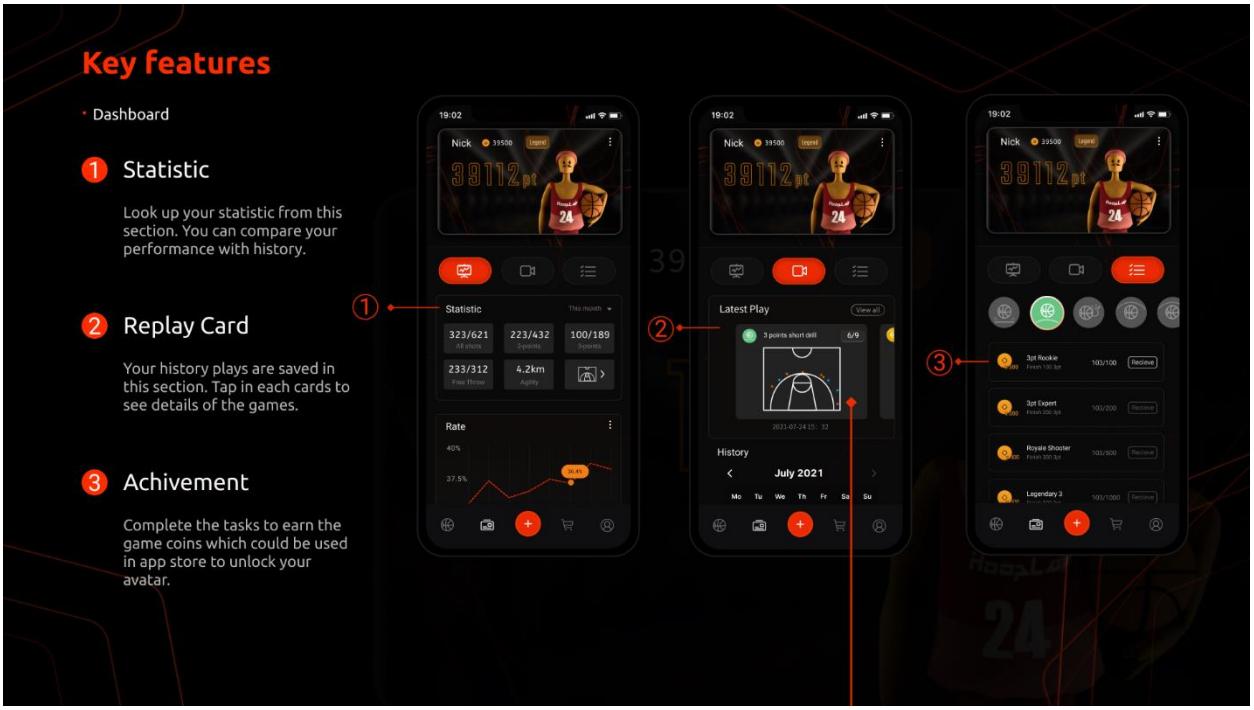




CAMERA-BASED DEEP LEARNING AI ASSISTANT SYSTEM FOR BASKETBALL TRAINING



CAMERA-BASED DEEP LEARNING AI ASSISTANT SYSTEM FOR BASKETBALL TRAINING



Appendix B: Bibliography and References

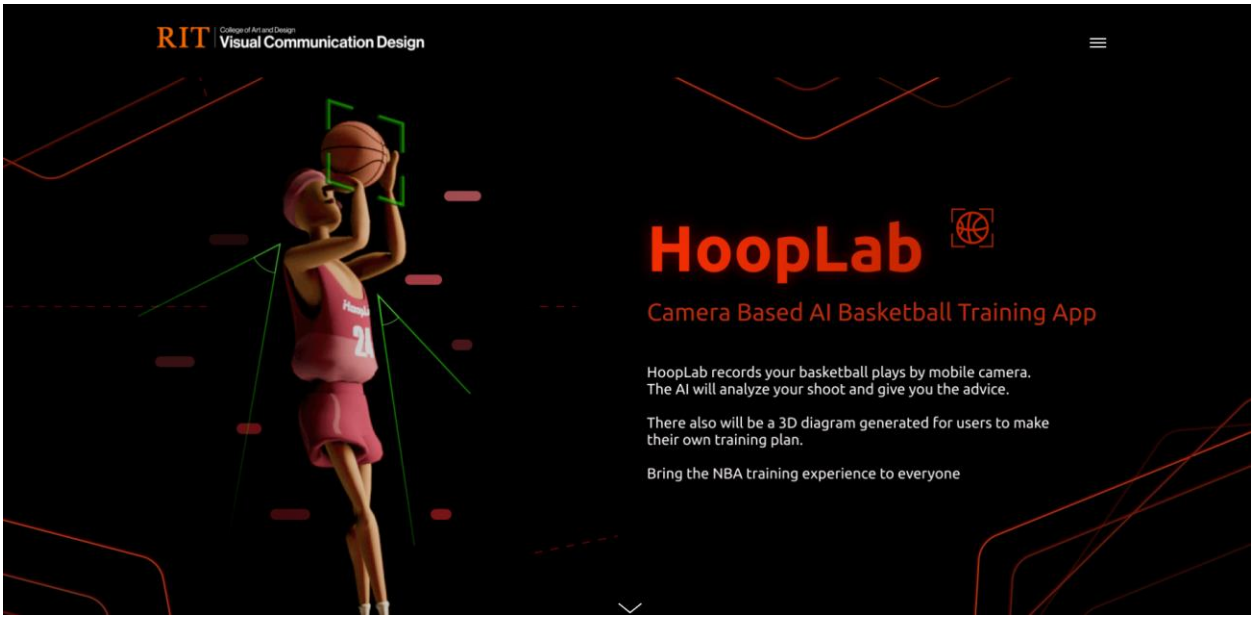
"Worldwide Spending on Augmented and Virtual Reality Expected to Reach $18.8 Billion in 2020, According to IDC." IDC: The Premier Global Market Intelligence Company. Accessed April 7, 2020. https://www.idc.com/getdoc.jsp?containerId=prUS45679219.

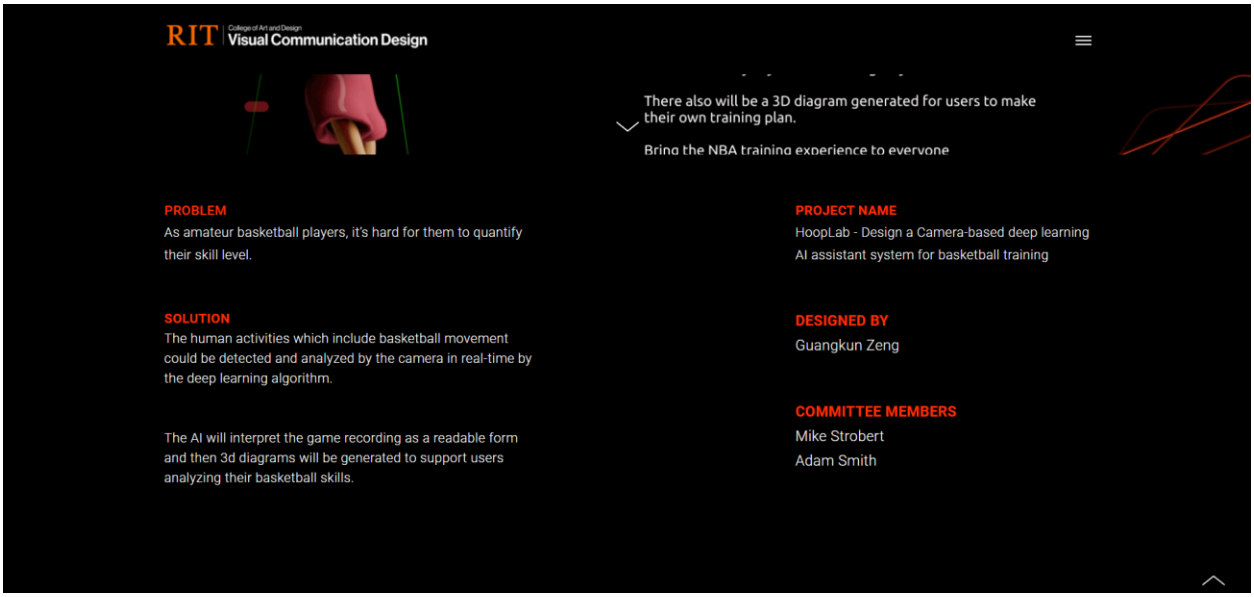
Emrich, T. (2020, February 25). 20 for 2020: Augmented Reality Trends and How They May Play Out This Year [Web log post]. Retrieved from https://medium.com/@tomemrich/20-augmented-reality-trends-to-keep-an-eye-on-in-2020-d2b0258edbb

Lee, David. "Our First Shot(s)." *Medium* (blog). July 17, 2018. https://medium.com/nex-team/our-first-shot-s-272c67d0349d.

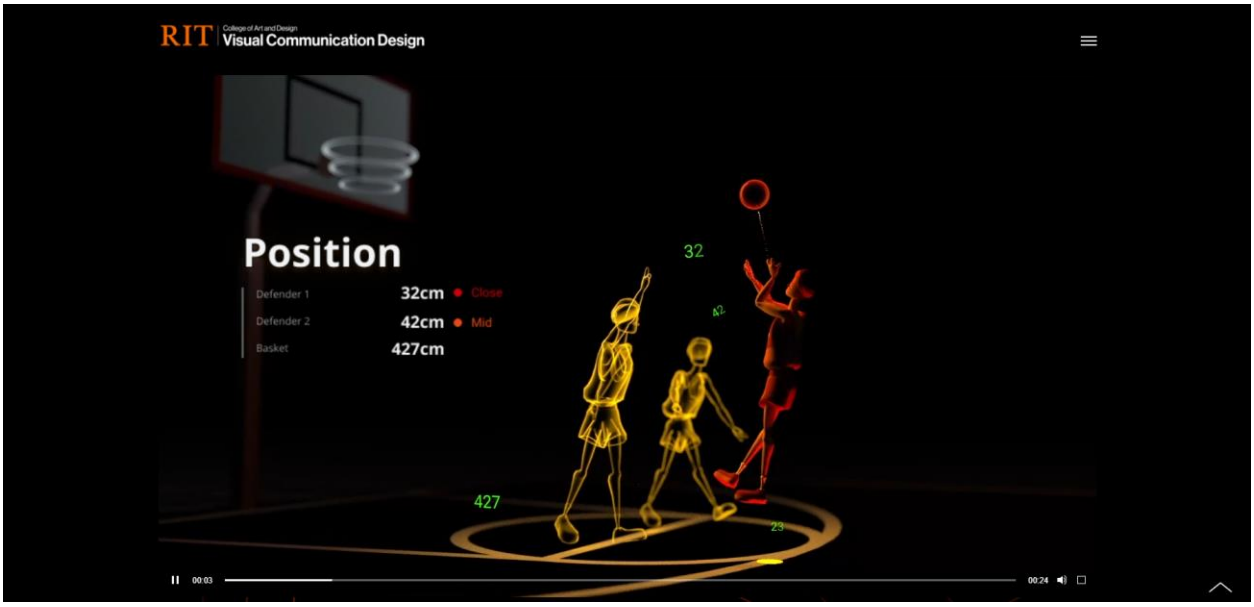
Terry, Q. (2019, July 23). AR is elevating the playing field for sports by creating smarter training methods. Retrieved from https://medium.com/futuresin/ar-is-elevating-the-playing-field-for-sports-by-creating-smarter-training-methods-77db01a84d64

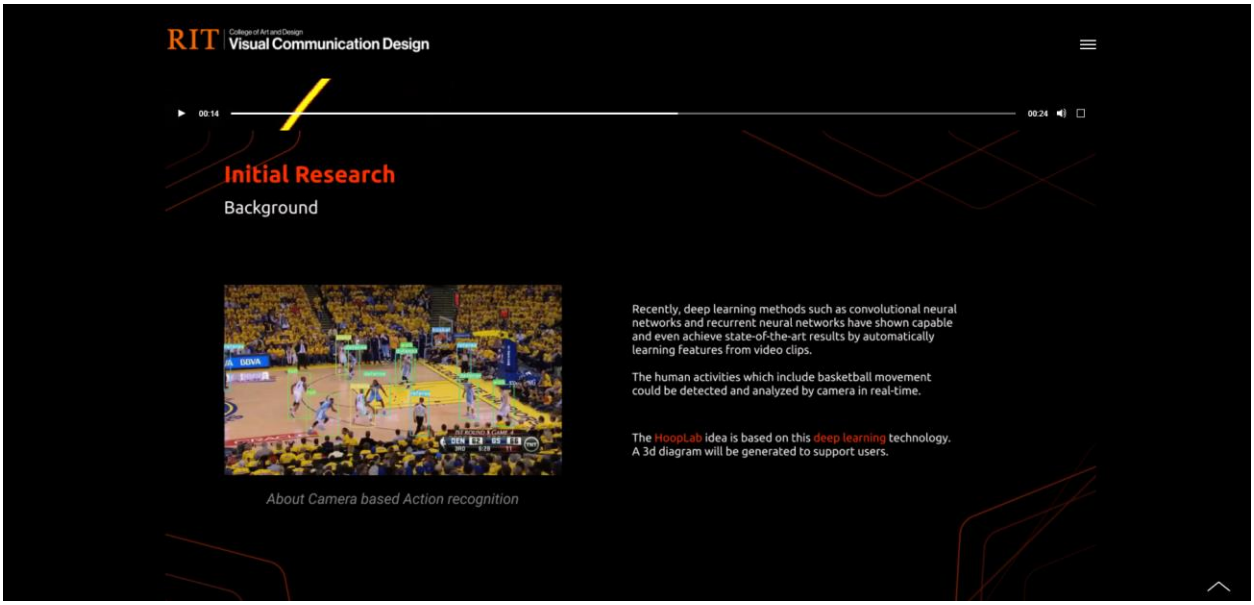
Appendix C: Screen Capture of Semplice Case Study Page and Optional screens of project or animation



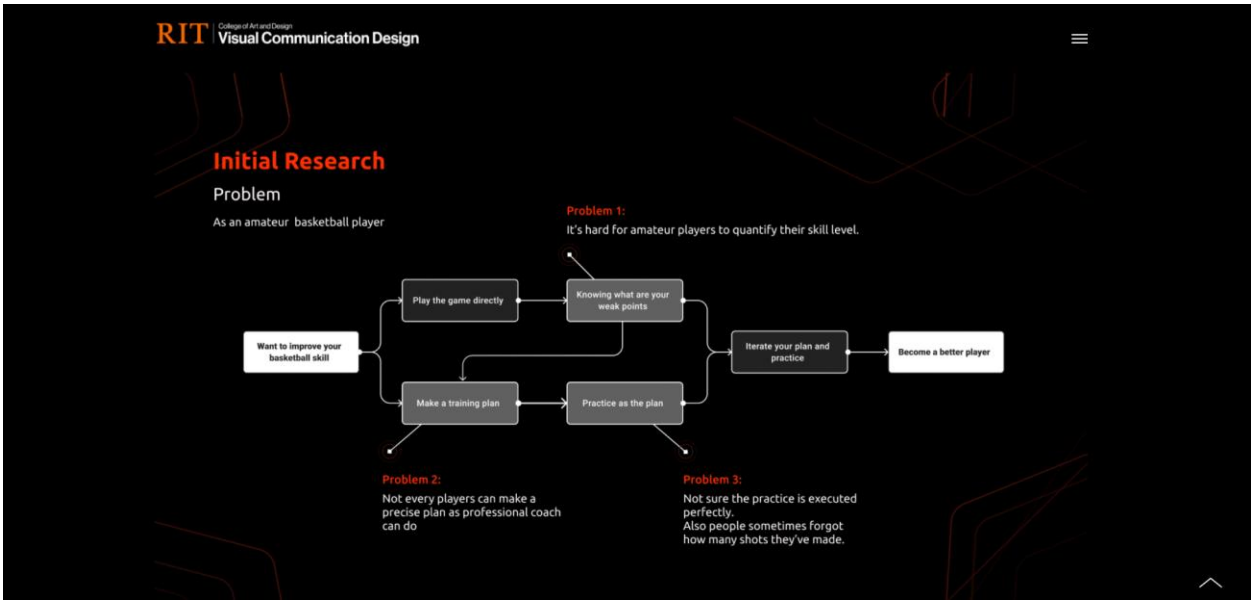


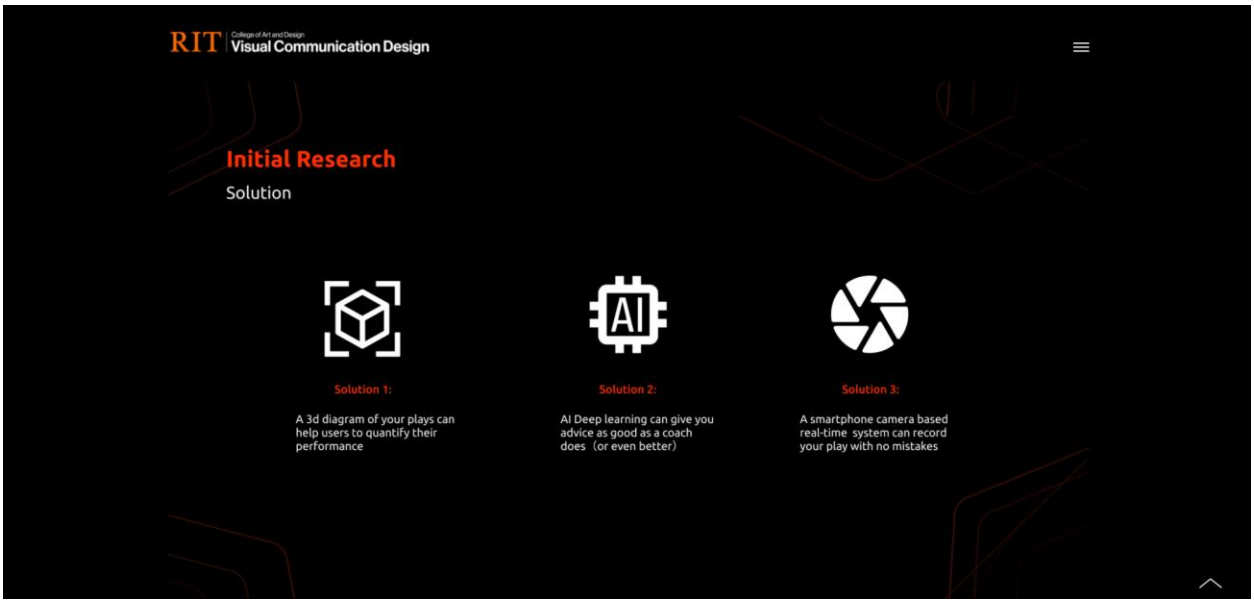
CAMERA-BASED DEEP LEARNING AI ASSISTANT SYSTEM FOR BASKETBALL TRAINING



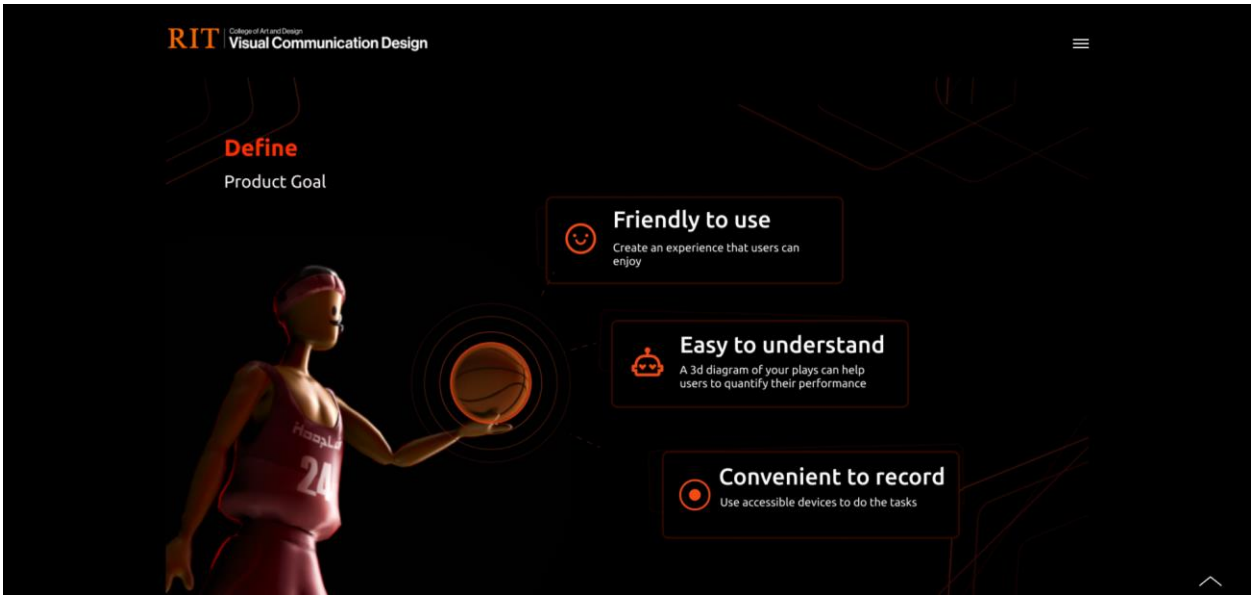


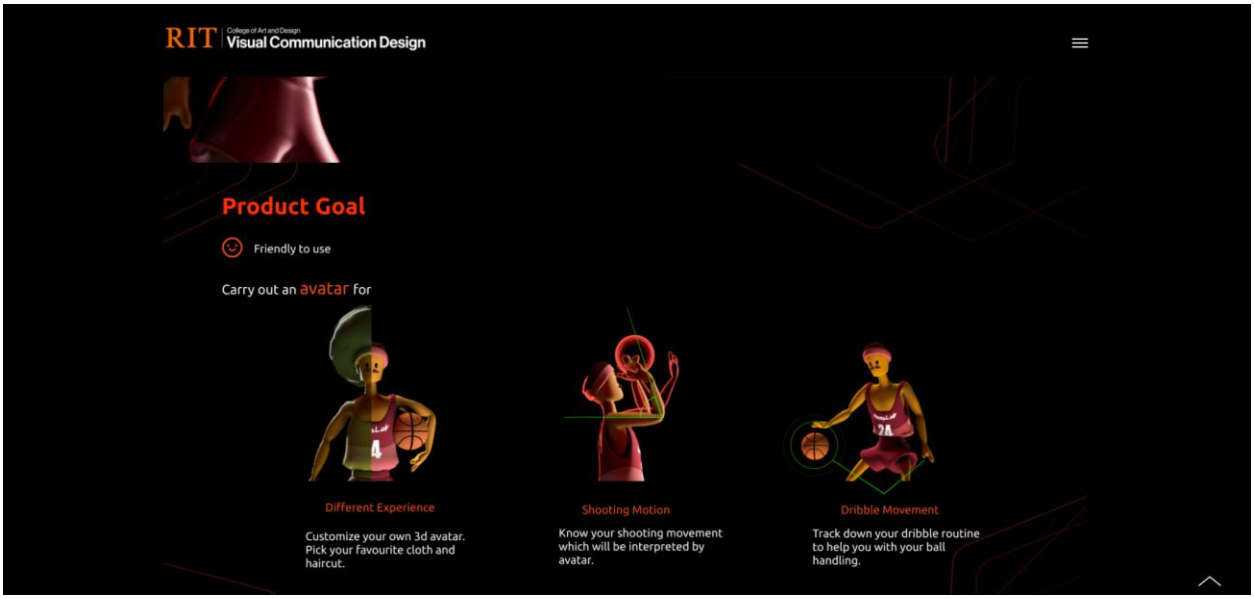
CAMERA-BASED DEEP LEARNING AI ASSISTANT SYSTEM FOR BASKETBALL TRAINING



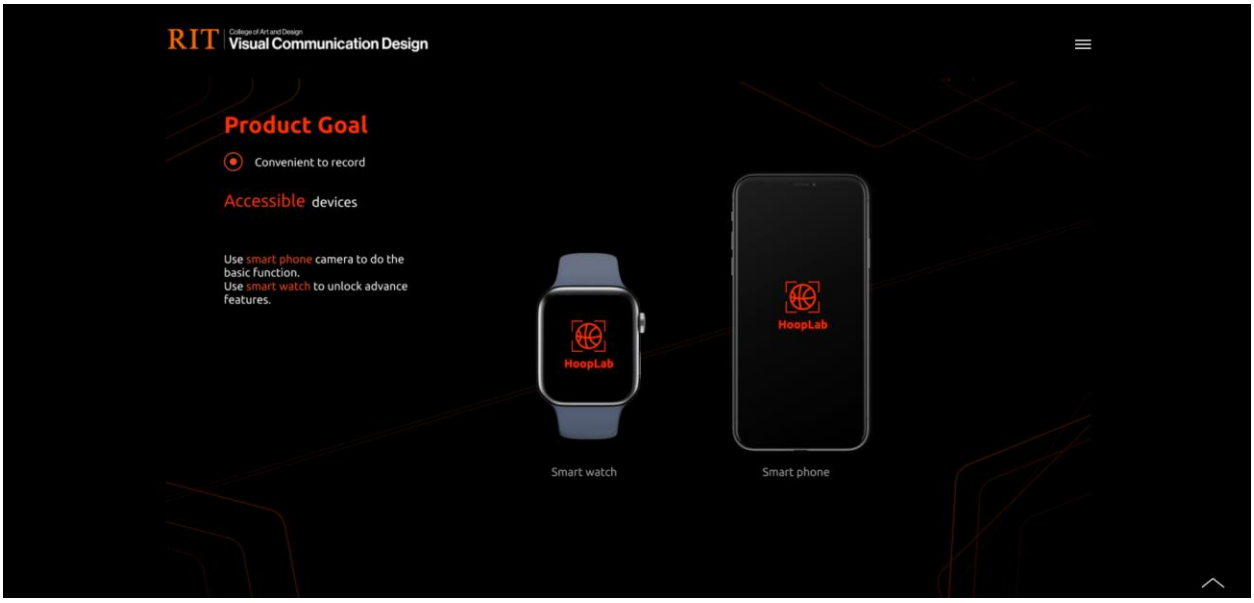


CAMERA-BASED DEEP LEARNING AI ASSISTANT SYSTEM FOR BASKETBALL TRAINING

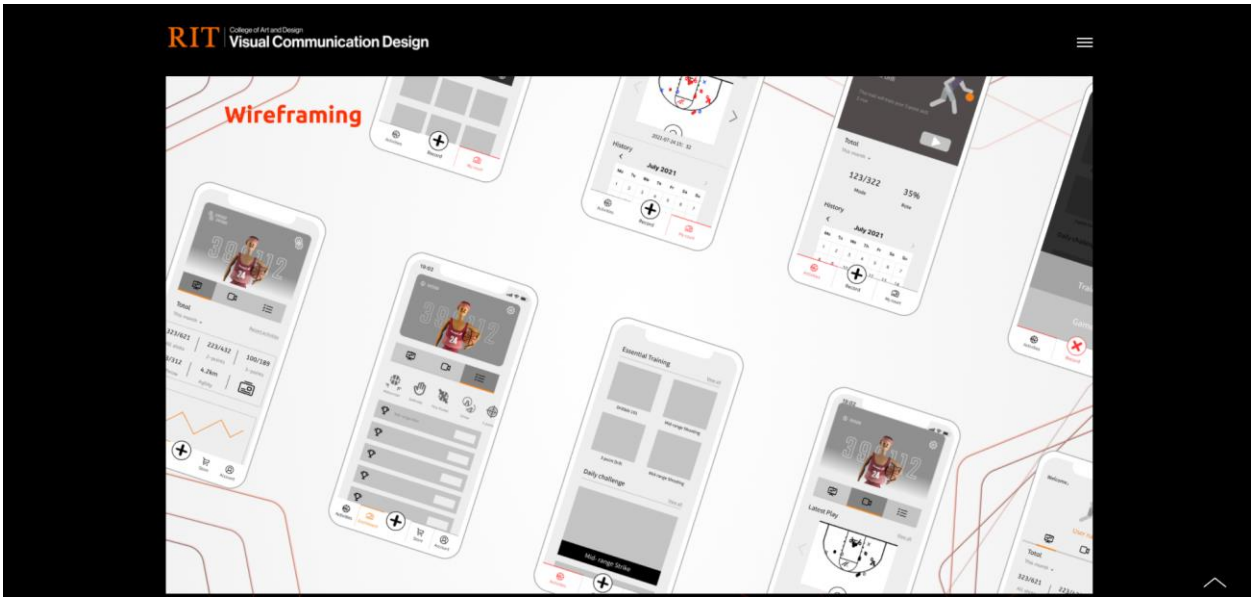


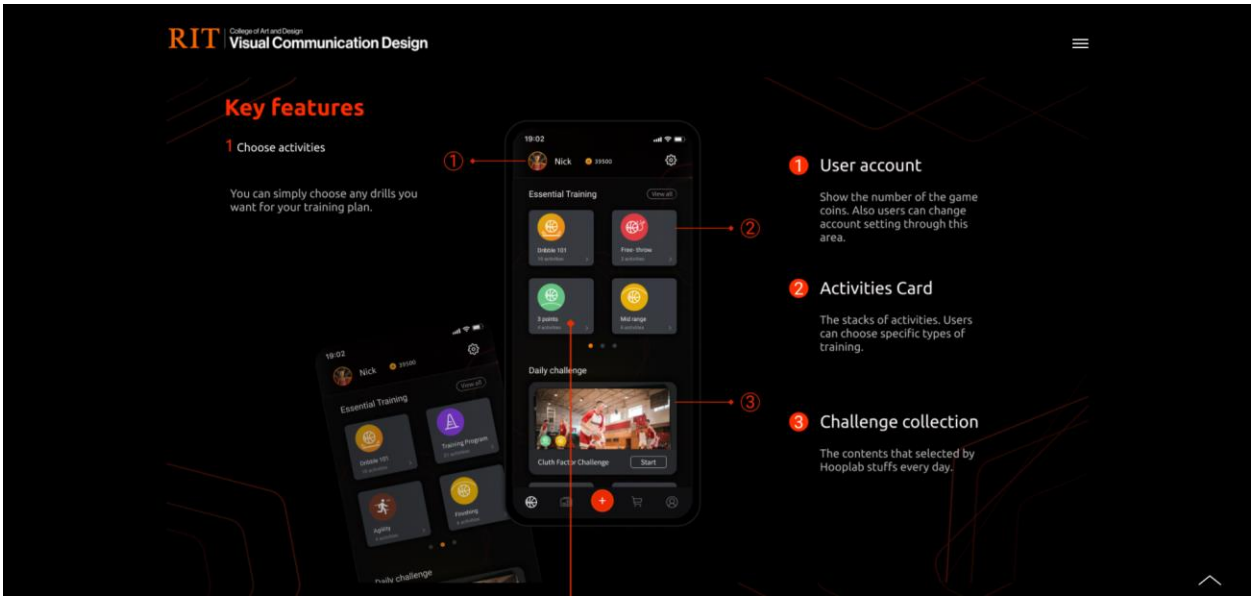


CAMERA-BASED DEEP LEARNING AI ASSISTANT SYSTEM FOR BASKETBALL TRAINING

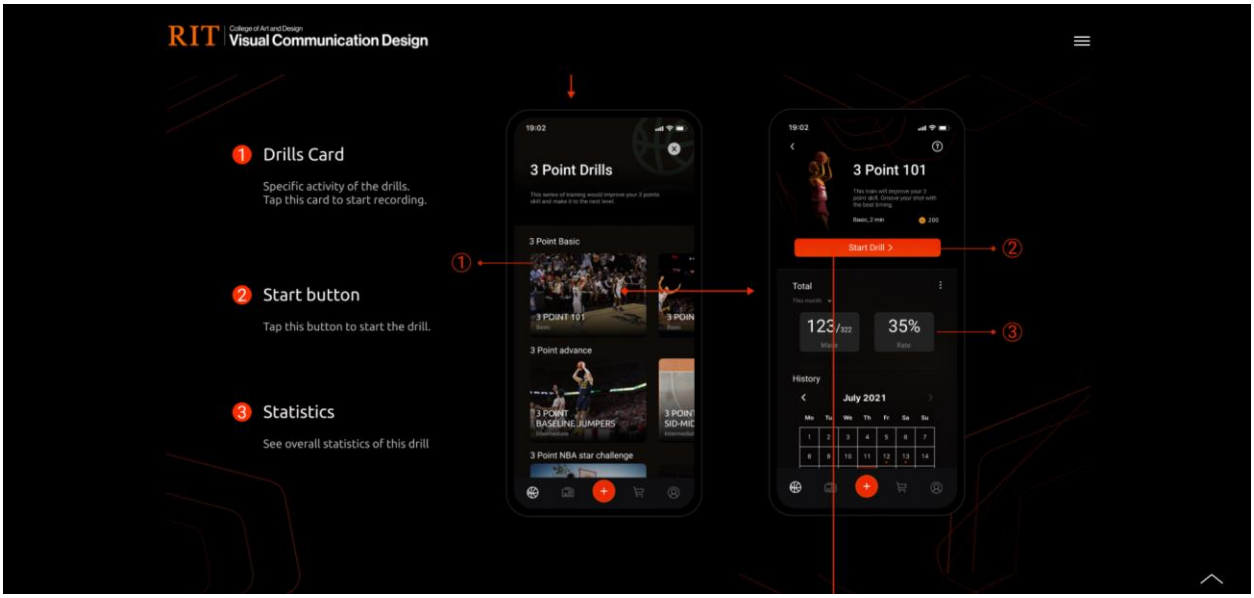


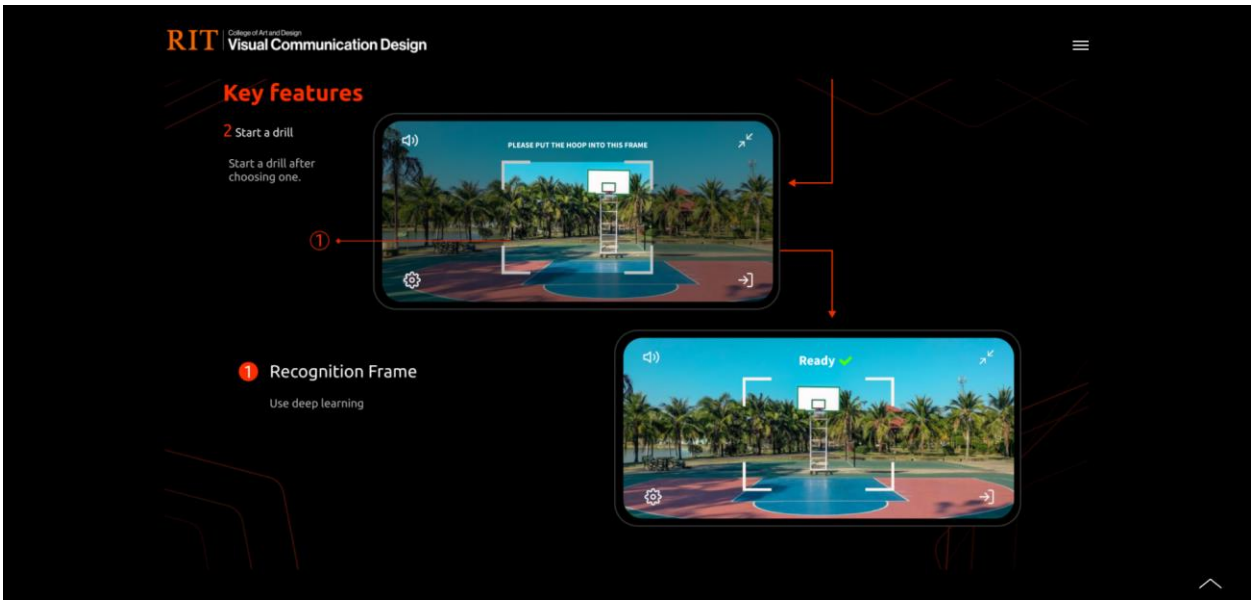
CAMERA-BASED DEEP LEARNING AI ASSISTANT SYSTEM FOR BASKETBALL TRAINING



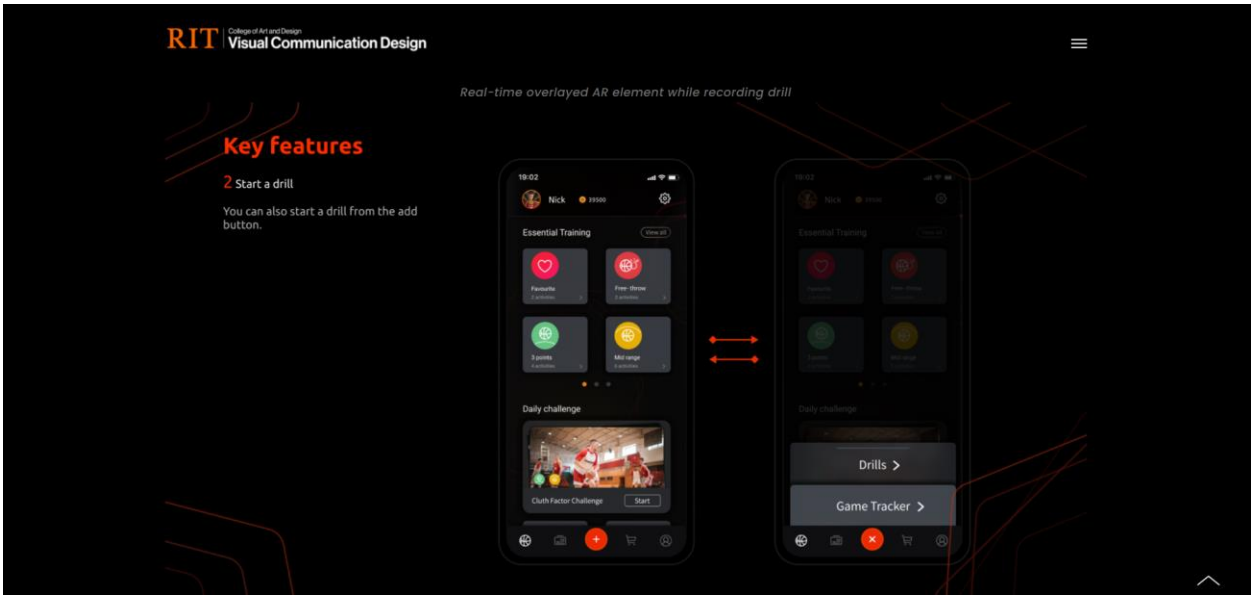


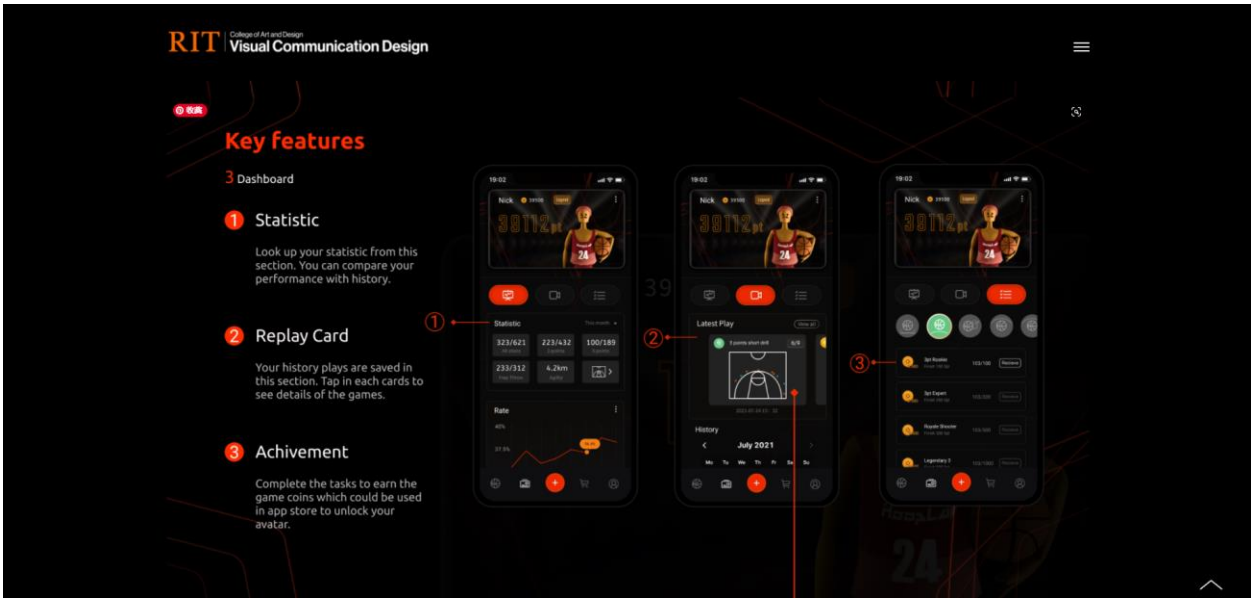
CAMERA-BASED DEEP LEARNING AI ASSISTANT SYSTEM FOR BASKETBALL TRAINING





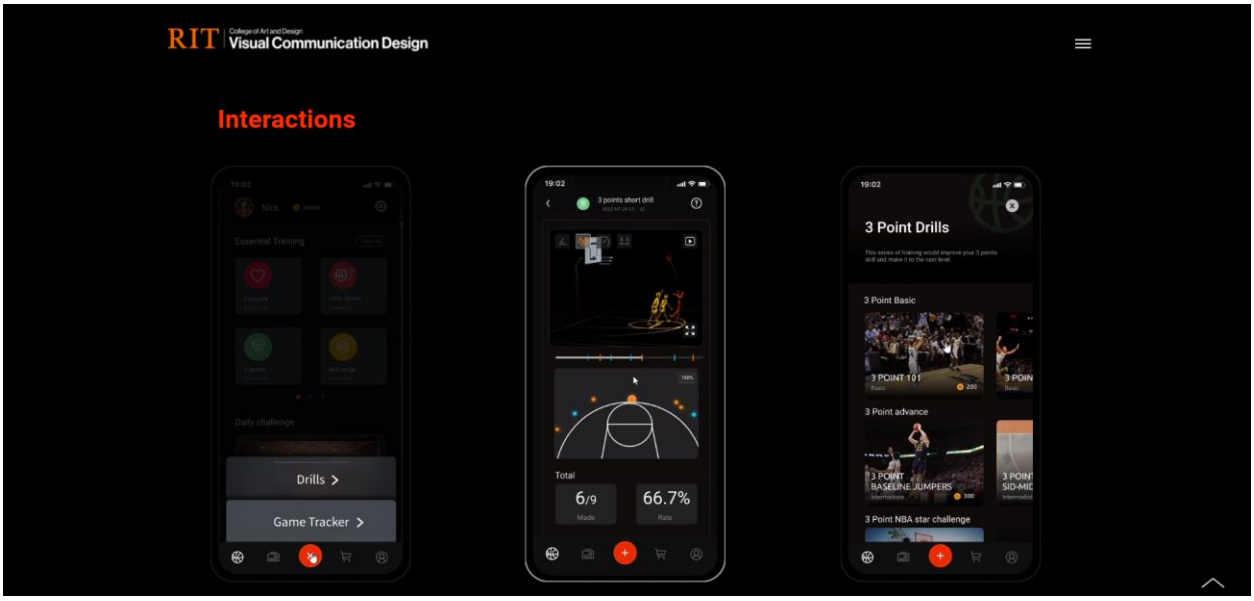
CAMERA-BASED DEEP LEARNING AI ASSISTANT SYSTEM FOR BASKETBALL TRAINING




RIT
College of Art and Design
Visual Communication Design
Key features
3 Dashboard
1 Statistic
Look up your statistic from this section. You can compare your performance with history.
2 Replay Card
Your history plays are saved in this section. Tap in each cards to see details of the games.
3 Achivement
Complete the tasks to earn the game coins which could be used in app store to unlock your avatar.
Statistic
Latest Play
History
July 2021


RIT
College of Art and Design
Visual Communication Design
Key features
3 Dashboard
In detail page, you can see your shoot motion in 360° in 3D mode
1 Video HUD pannel
2 Video play controller
Total
6/9
66.7%

CAMERA-BASED DEEP LEARNING AI ASSISTANT SYSTEM FOR BASKETBALL TRAINING



CAMERA-BASED DEEP LEARNING AI ASSISTANT SYSTEM FOR BASKETBALL TRAINING