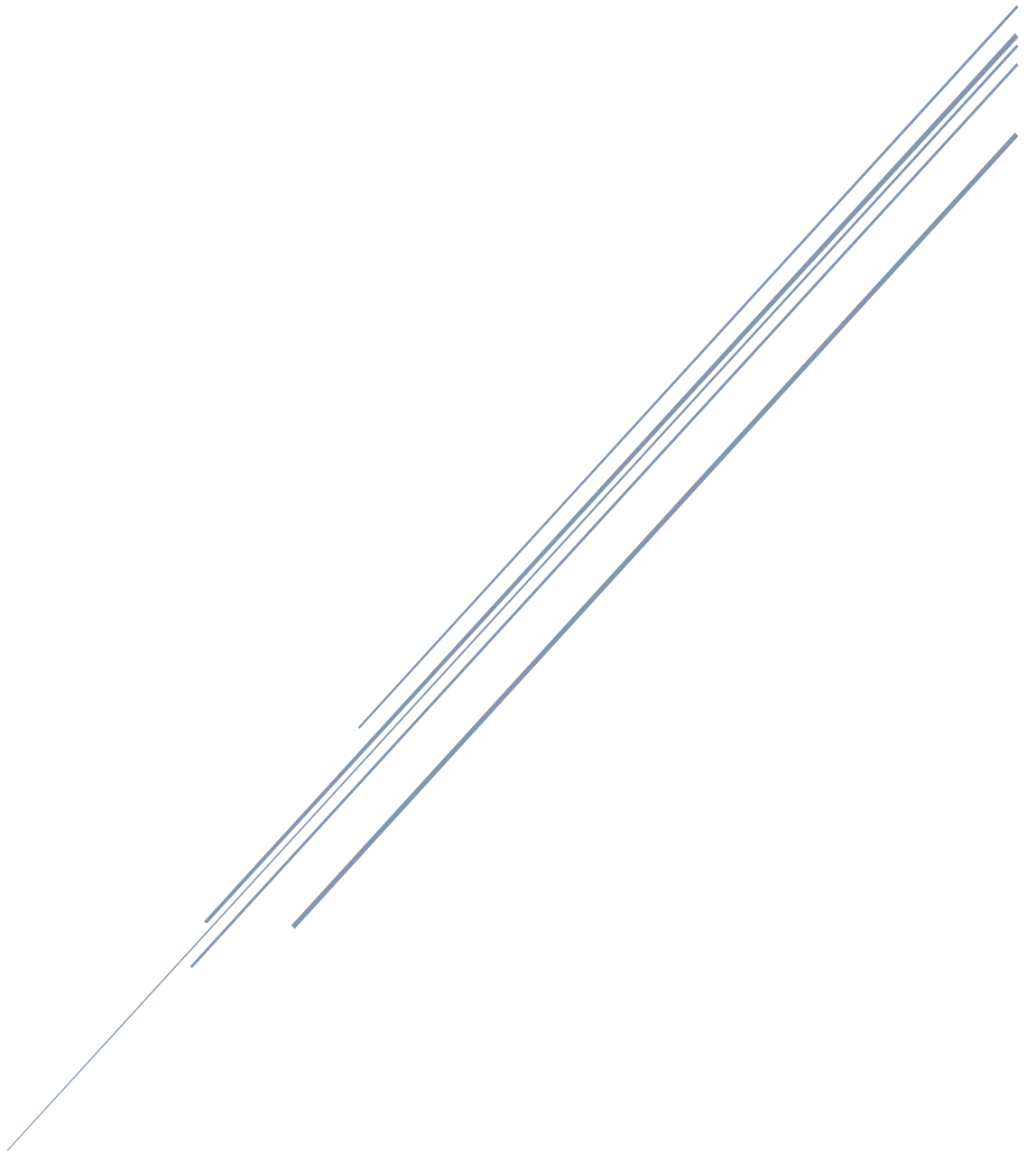


DRONE PILOT TRAINING IN XR

Digital Prototyping for AR and VR



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XR – AR + VR Drone Simulator for Beginners

The Problem

Agriculture is a very important field of work in India. I want to focus mainly on educating farmers, with new tools and technologies that can help them in doing better farming, and yield a better crop. Drones are being used widely in various tasks of farming such as

1. Sowing seeds
2. Spraying pesticides
3. Large scale Imaging the health of the crop
4. Picking samples for assessing the value of the crop

But it is very difficult to afford to buy an industrial level drone for a farmer in India. This is what started my research into the situation of drone flying training in India. So many rental companies have started, and many drone pilots have also emerged, most of who are self-taught comprising of photographers and engineers, charging very high rates on per day basis. There are many certifications, licenses one needs to acquire to fly a drone, but to start it all off, even after someone purchases such an expensive drone, some find it very worrisome to start flying the drone right away. Thus there is a need to help out whoever wants to at-least easily get a certificate from authorized schools, and this will be an entry point for that.



Proposed Solution

From this problem emerged the idea that, why not make an AR + VR drone simulator program, where user can both practice flying a drone in his physical surroundings using AR and be able to fly the drone in specific set conditioned environments such as beaches, farms, forests, urban areas in VR with a headset and a joystick.

This is a two level - AR+VR drone flight training module, which is aimed at empowering not just the farmers but drone enthusiasts who can, after playing these two levels multiple times, can be more confident to get their hands dirty with real drones. It's very similar to how and why flight simulator programs are used in training the pilots of helicopters and aircrafts.

LEVEL 1 – AR

Features

The Level 1 of this training will be in AR which gives the basic foundations of drone flying and has features

1. Taking off a drone
2. Checking battery status
3. Landing
4. Hovering
5. Yaw
6. Move
7. Record the flight video for future feedback
8. Cognitive understanding of various buttons and their functions in flying
9. A scoreboard that keeps a track of collisions and flight time.

Digitally prototyping AR Mock ups

Strategy 1: Using marker placed in various locations to explain the interactions. Marker based AR using AR JS Studio is used, along with a custom marker

Process:

I tried figuring out ARJS studio for creating marker based AR, where I used the same marker placed at different points in my camera's field of view to understand how the user could move and scan surroundings, and also how the drone collisions with obstacles happen and cause reduction in the overall score.

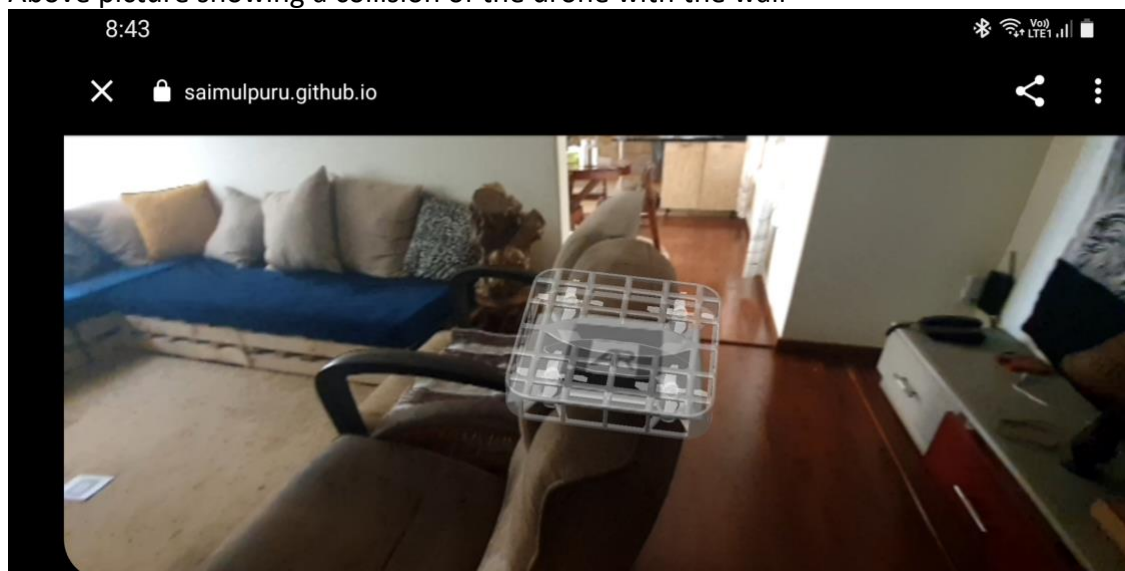
<https://saimulpuru.github.io/droneAR9rzex/>



Results:



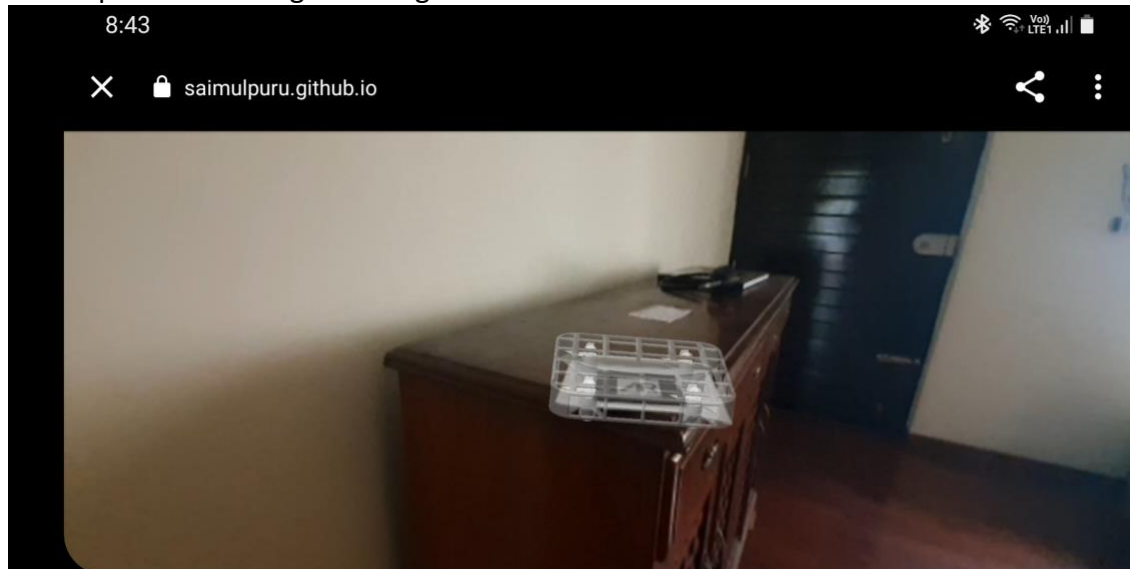
Above picture showing a collision of the drone with the wall



Above picture showing a collision of the drone with the chair



Above picture showing a landing and take off zone of the drone

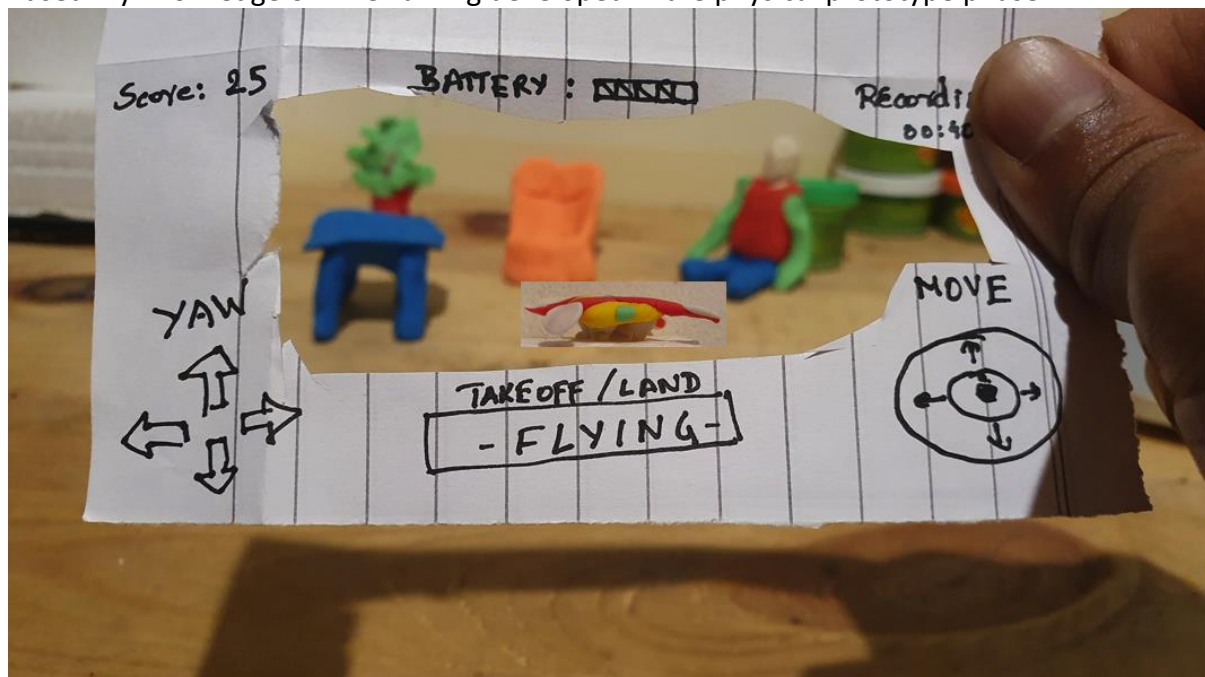


Above picture showing drone safe landing on a table

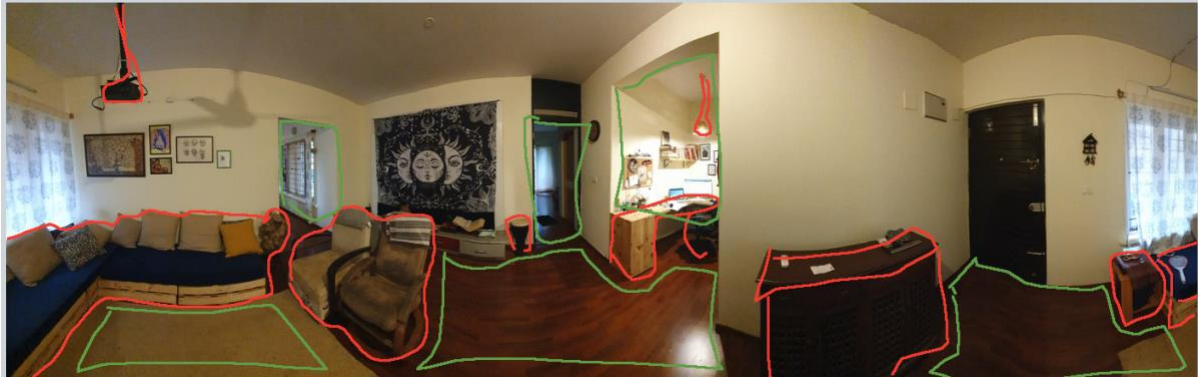
Strategy 2: Using Snapchat Lens Studio/ Spark AR to actually use a working interface and map the mesh of the room.

Process:

I used my knowledge of wireframing developed in the physical prototype phase.

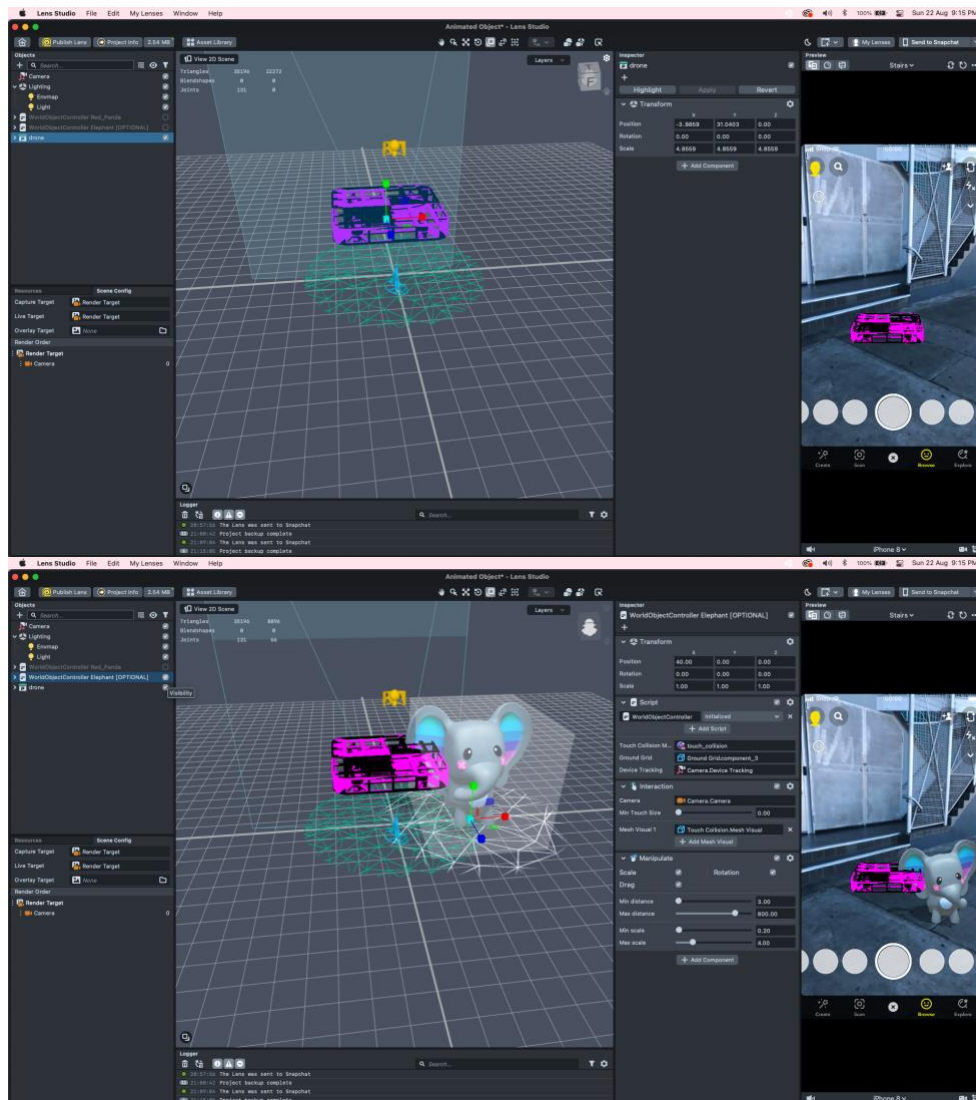


The picture above represents the mockup user interface for the AR app

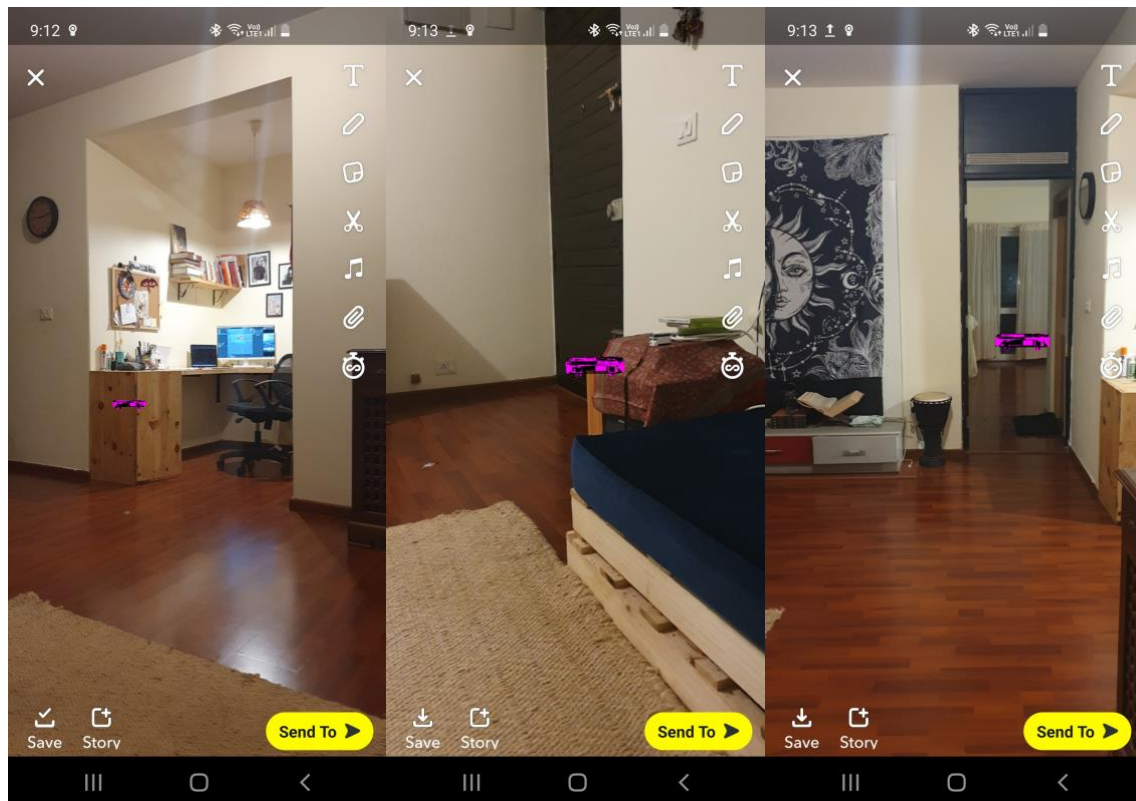


The above picture has green lines that are safe for drone to fly, take off and land. The red zones are mapped as rigid bodies for collision which cause reduction in points

And then I downloaded Lens Studio from Snapchat

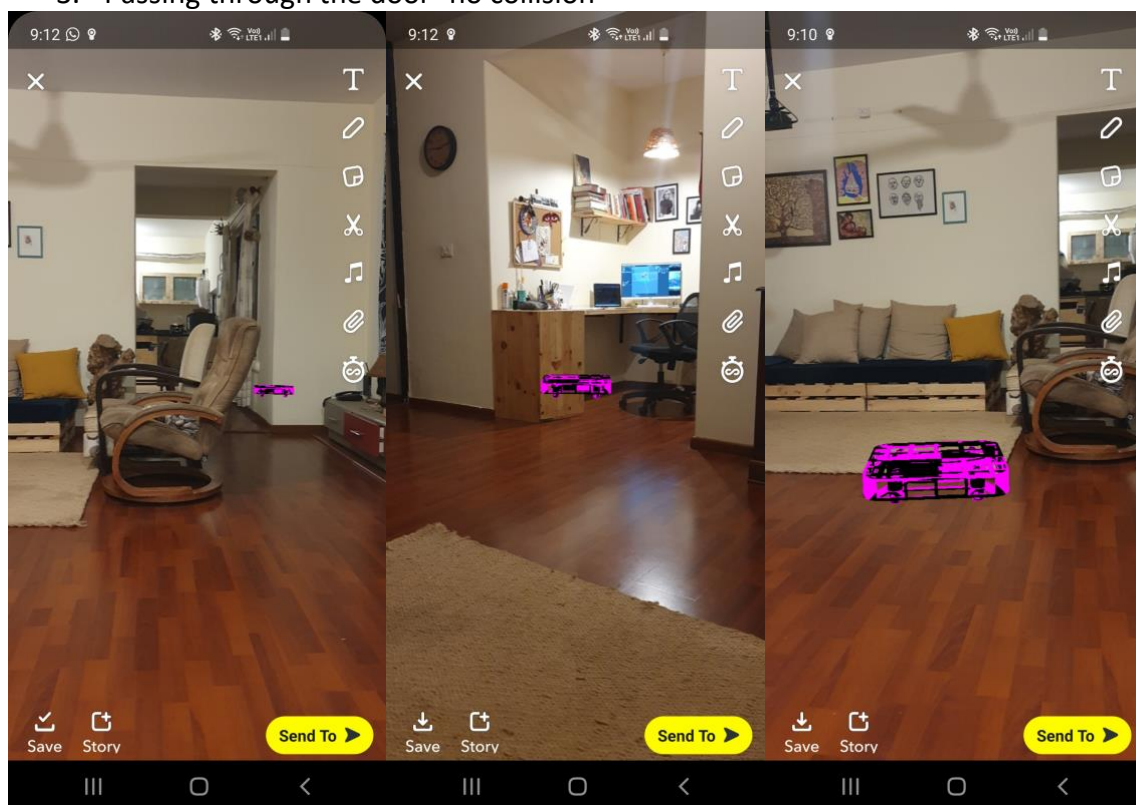


The next step was to test out various positions of the drone, and various points that could possibly count as collisions and those points that could count as good pass through points and ensure longer flight time.

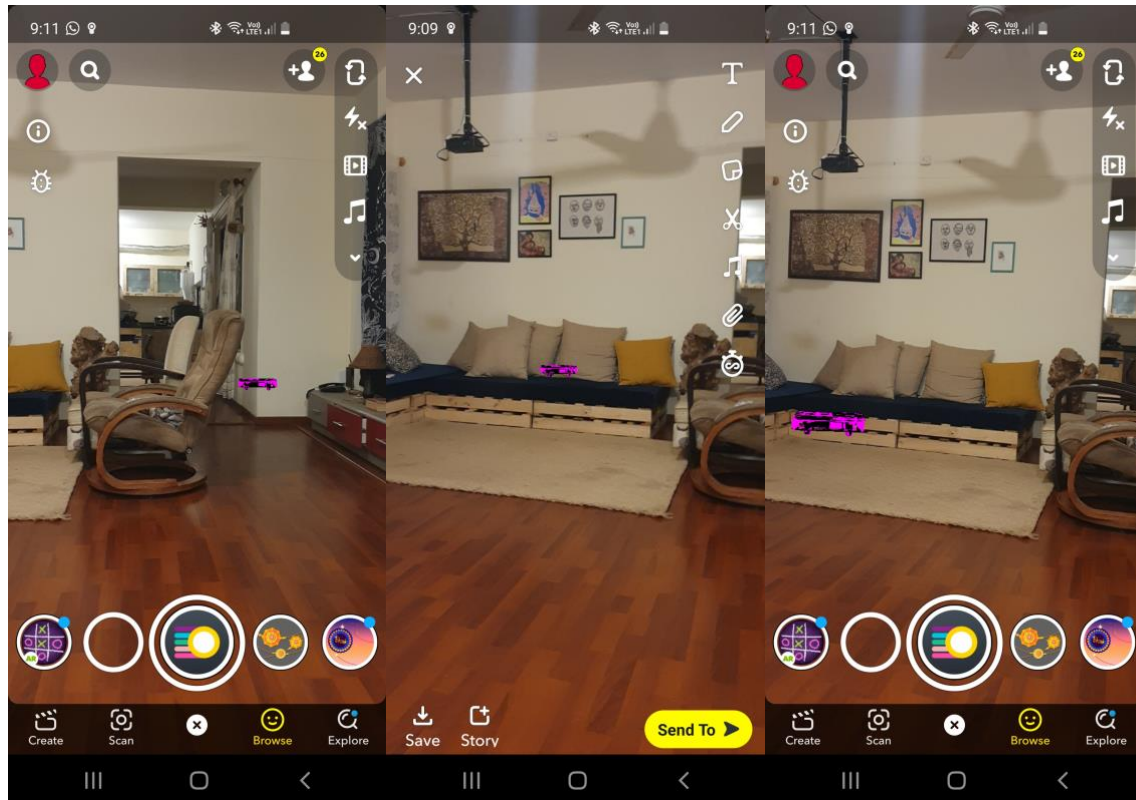


The above photos in order

1. Collision with the drawer desk - decreases 1 point from score
2. Collision with the side table – decreases 1 point from score
3. Passing through the door- no collision



The above 3 pictures show object being maneuvered safely without colliding with obstacles



The above 3 pictures represent object trying to land on surfaces of wooden floor, sofa/couch and carpet, respectively.

This strategy helped me understand how efficiently the 3D model needs to be designed, so that it looks a little different from all angles, as its confusing as to which is the front or the back. Also it helped me realize that my phone or lens studio doesn't support scanning everything around me. It did give a warning message that world tracking works best with a device enabled with LIDAR.

Advantages

The advantages of this foundation training app are

1. Web based training, no need to download an app
2. Play anytime anywhere on phones, no stress to purchase a drone
3. Record a video of drone flying in real surroundings and share with others
4. Understand basic physics and mechanics of the drones and interface controls
5. Affordable to use and design and development are also cost effective

Limitations

There are some limitations in this proposed idea such as

1. Collisions with certain objects might be inaccurately depicted, as its dependent on how good the phone and its sensors can form a mesh of the surrounding area in real time.

2. Usual drones have a separate remote control and a separate screen, so the viewing area is much larger, than in this case, as the user interface will be overlaid on top of the camera stream
3. Roofs in the area cannot be detected, so if the AR drone 3D model hits the roof, it will not really affect the scoreboard
4. Real time light information is not shined on the drone, and it can only use default or HDRs that are uploaded by the designer, which could create a disconnect.
5. In real scenario, you can both look at the drone in the sky and also your screen, whereas here, you are only looking at your screen
6. As it is a browser based, its dependent on the 3G/4G/5G signals or Wi-Fi which is not available in remote parts of India where primary source of income is agriculture.
7. The response time of touch could be slaggy, which might create a delay in the responses of the drone, which could cause a disconnect
8. When it's an analog or a tangible button/ interface, the user need not look at the button to actually press or use it, where, as in case of touch-buttons on a screen, the user will have to look at the button to touch it accurately.
9. The smart phone will need to be at least capable of creating a mesh of the surrounding features such as floor, wall, in order to play this game efficiently, and affording such phones also might be difficult at the current pricing of the phones in India. But gradually, these phones with all the sensors needed for marker-less AR will be available at cheaper rates.

LEVEL -2 VR

After the user gets comfortable with the basic controls in the AR app, and play it, let's say 100 times, they will unlock the VR simulator experience. They will be required to purchase a mobile VR cardboard headset, and a Bluetooth joystick that's similar to those used for XBOX or PlayStation.

Features

The VR drone simulator will be the next stage of cognitive learning of hand motor control while being in an immersive VR environment. The features of this level will be

1. Choose between environments: Farmland, Urban area, Forest, a large music event
2. Taking off a drone
3. Checking battery status
4. Landing
5. Hovering
6. Yaw
7. Move
8. Record the flight video for future feedback
9. Cognitive understanding of various buttons and their functions in flying
10. One extra button control to Spray seeds/ control camera shutter/ spray water on fire
11. Score board that keeps track of collisions and flight time

Digitally Prototyping VR Mockups

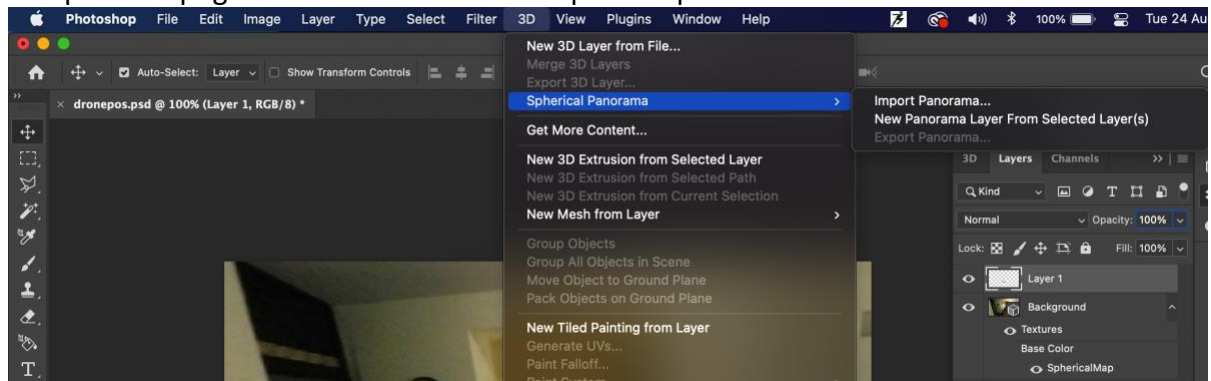
Strategy 1: Design and create a 360-degree photo storyboard with different instances of the gameplay

Process:

First, using a 360 camera Samsung gear 360, I captured a 360 photo of my room.

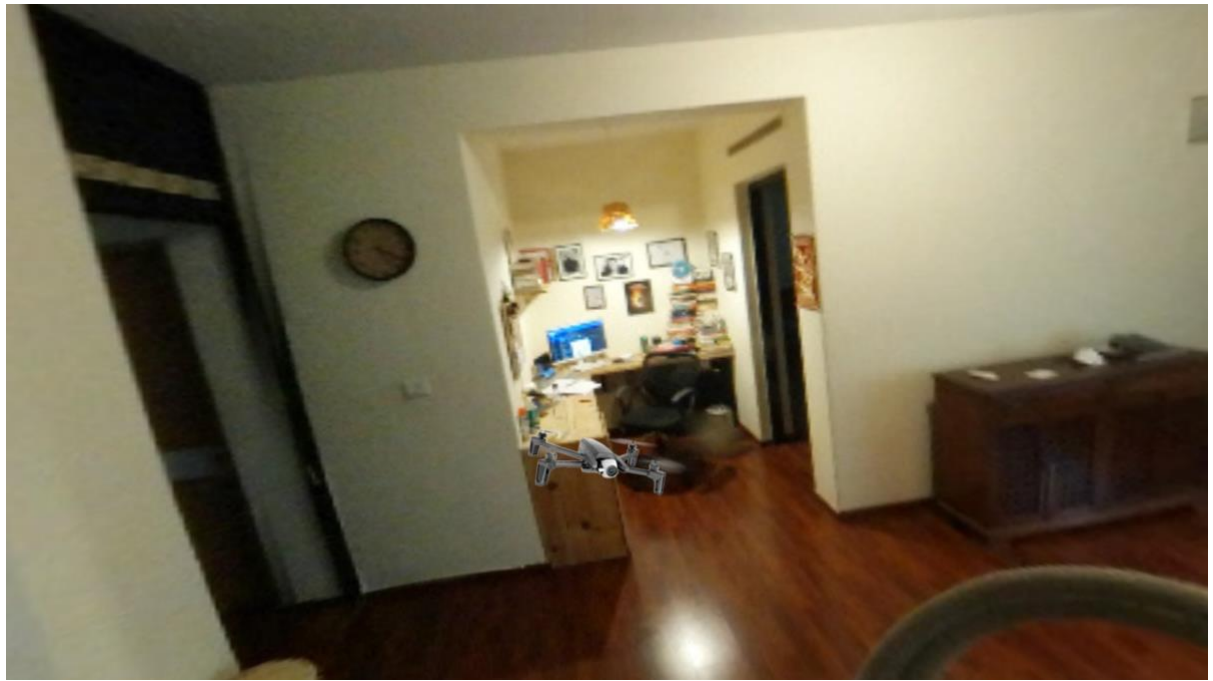


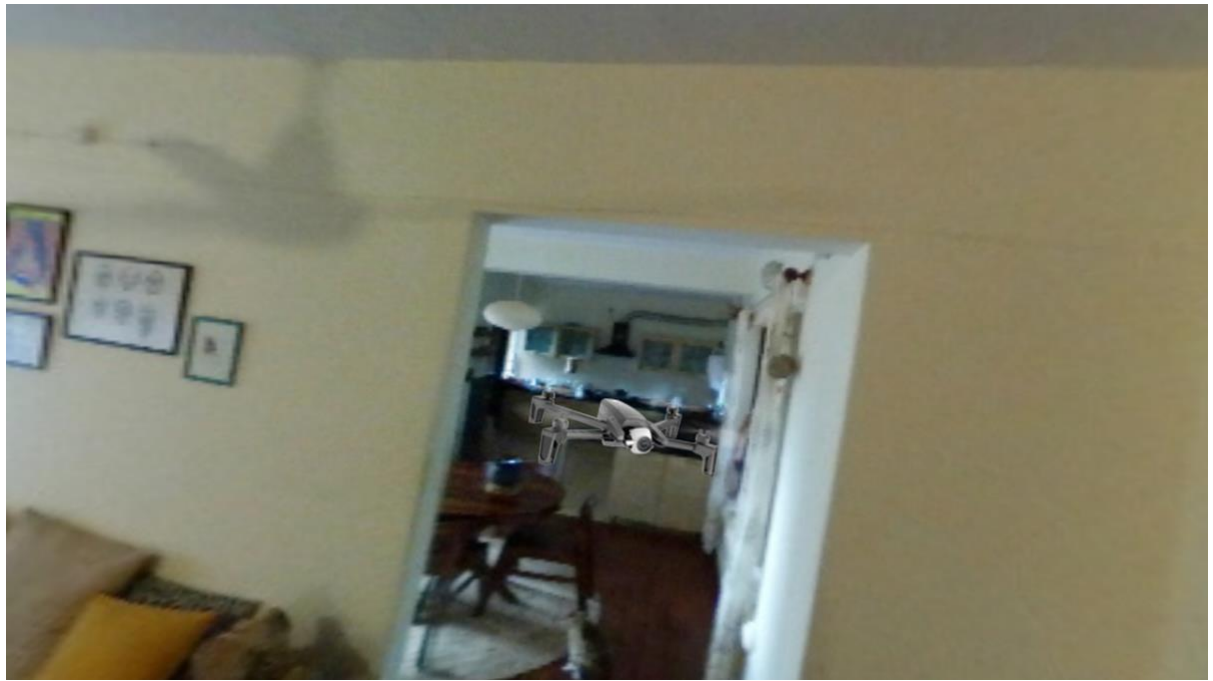
Next, I imported this photo in photoshop, and used a 2D to 360 panorama converting tool, and placed a png of the drone in various important points in the 360 scene



Results:

The potential screens where the drone can land, or collide are below







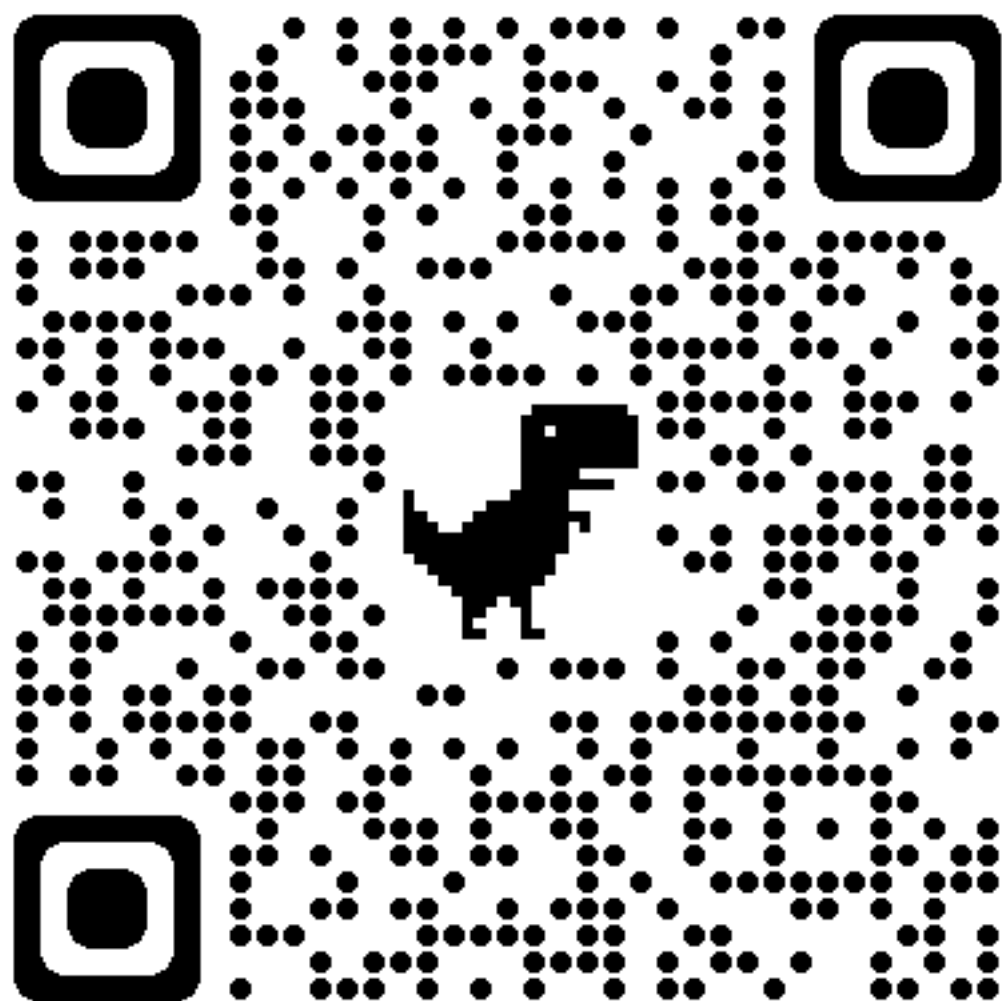
Strategy 2: Design and create a VR experience using A Frame, with basic movement of drone and showing collision touch points

Process:

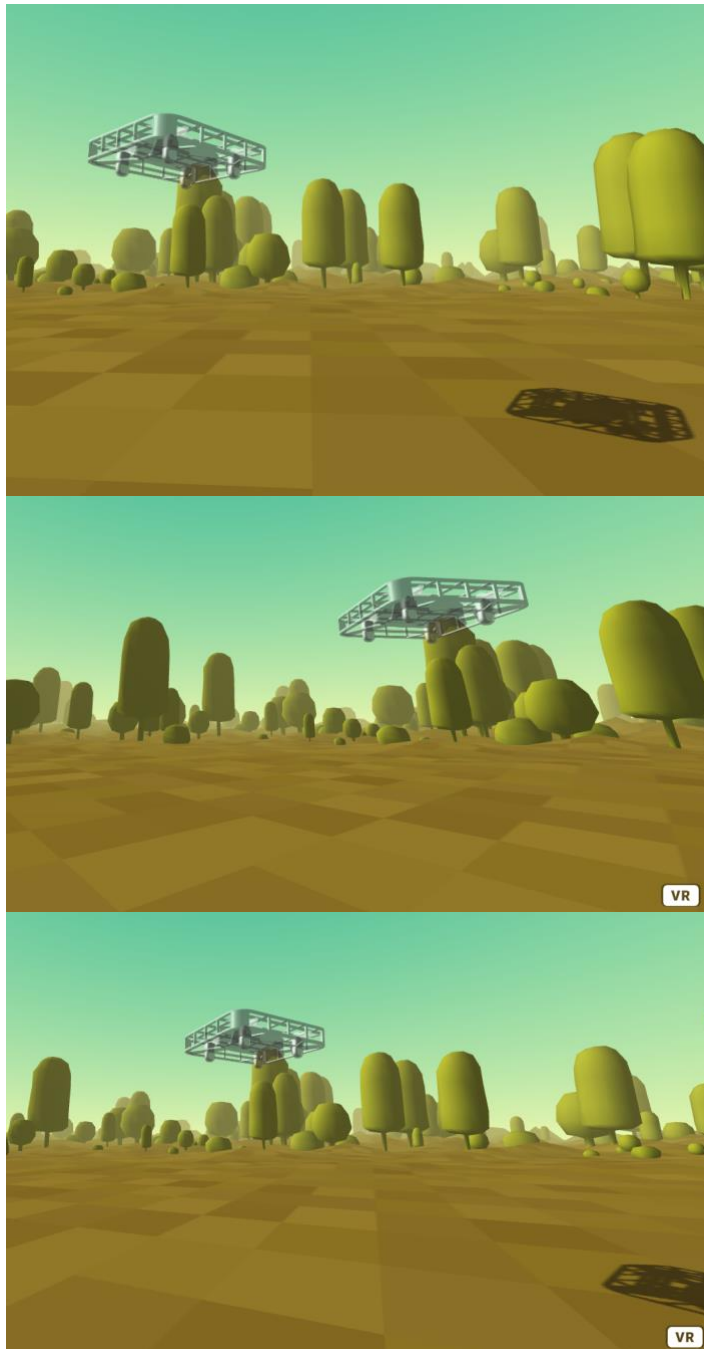
I was able to place a 3D GLB model of a drone in a 3D scene, without animations, that I found for free online, and take snapshots of it from various locations. This was quite challenging, as the mesh tracking was being repeatedly lost by the phone sensors. This is my attempt at understanding scenarios in mixed reality.

The link to my prototype can be found here:

<https://caterwauling-spark-heart.glitch.me>



Process images of placing drone in VR using A Frame library



Results: More higher level coding knowledge was required, for moving drone as we require, especially when coding in Unity and WebX.

Advantages

The advantages of this application would be:

1. Joystick tactile tangible control is a step closer to real drone flying
2. VR is much more immersive than AR, as the environments is in control of designer

3. Scoring, collisions will be very accurate, as designer and developer will have full control of defining the mesh and rigid bodies in the VR environment
4. There is no risk of losing or spoiling the drone, as it's a virtual object and you can play it any number of times.
5. It is browser based, so there is no need to download a dedicated app.

Limitations

Some of the limitations of the VR app I could think of were

1. In a real scenario, the user has two things to look at, the drone flying in the sky, and another screen showing what the drone is looking at from its perspective, and also a joystick with various control, but, in this app, the user can only look the drone in the sky or in the virtual environment as a first person view, and not see his joystick. Although this could all be integrated into the view of the user, it might get cumbersome as an interface
2. The Bluetooth enabled joystick for the google cardboard might not be similar to the one used by professional drone pilots, so the buttons and knobs might have to be learnt again when flying the actual one. But the idea here is to understand the tactile control of joystick and map it to drone movement.
3. VR could be uncomfortable for long periods of usage, so I am trying to keep one level of flight to be around 3 minutes or less, which also corresponds to the battery of the drone. The user can take multiple flights if they are comfortable with this mode of learning.

Lessons learnt

I learnt that paper prototyping and clay modelling are great start points for UI and UX research, and stay with the developer and designer till the end of the project. I also learnt that such tasks form the foundations for digital prototyping and human centric design

Experience gained

I gained experience in paper prototyping, without the need for any digital tool, which makes me confident to work on any digital design from scratch. I also gained a lot of experience in design critiques and peer reviews of augmented and virtual reality.