Augmented Reality (10 h)

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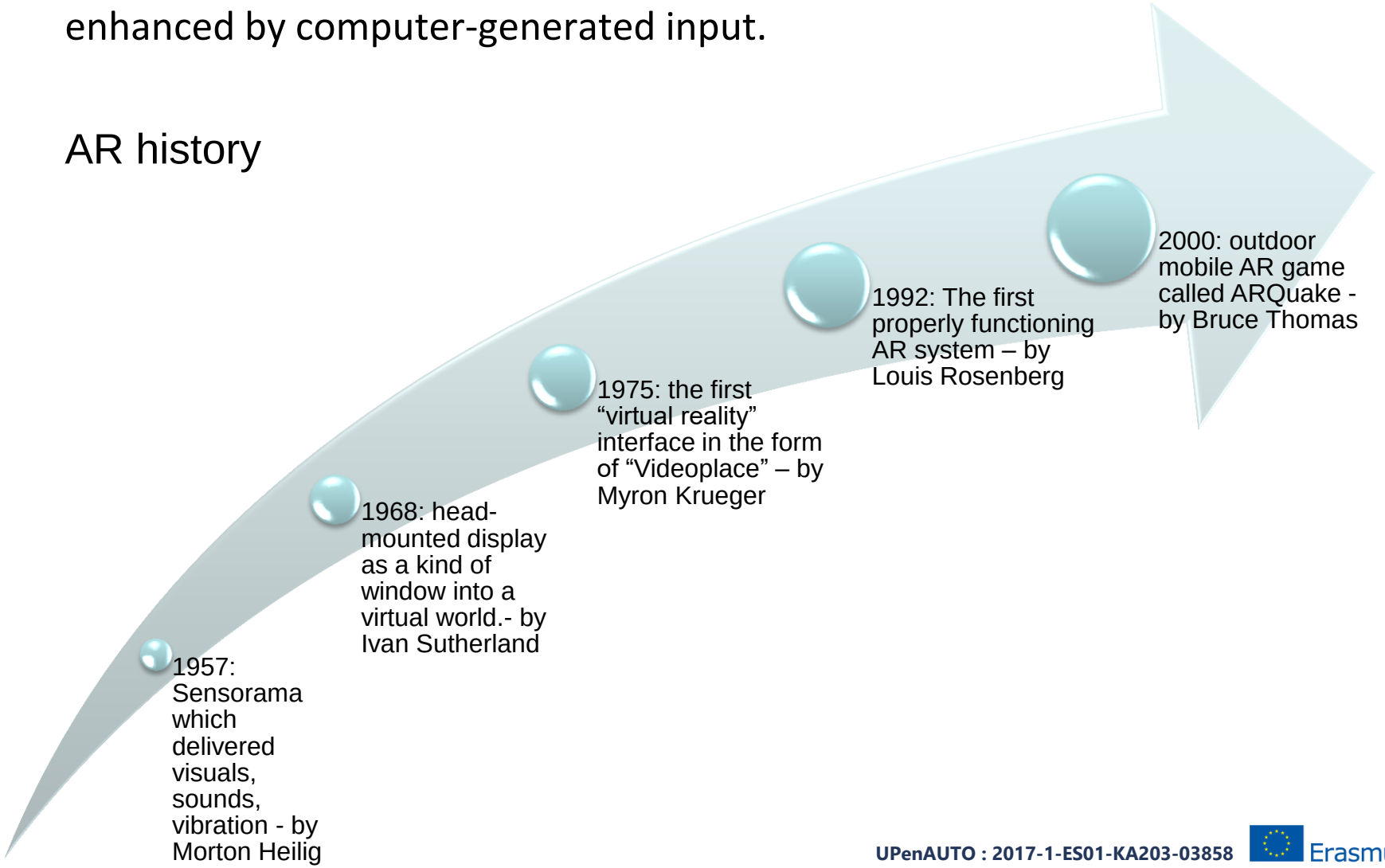
1. General aspects of Augmented Reality
2. What is Augmented Reality
3. Phases of Augmented Reality
4. Visualization technologies
5. Programs and Applications
6. Augmented Reality and its applications in industry
7. Educational uses of Augmented Reality

1. General aspects of Augmented Reality

Augmented reality is a view of the real world in which elements are enhanced by computer-generated input.

AR history

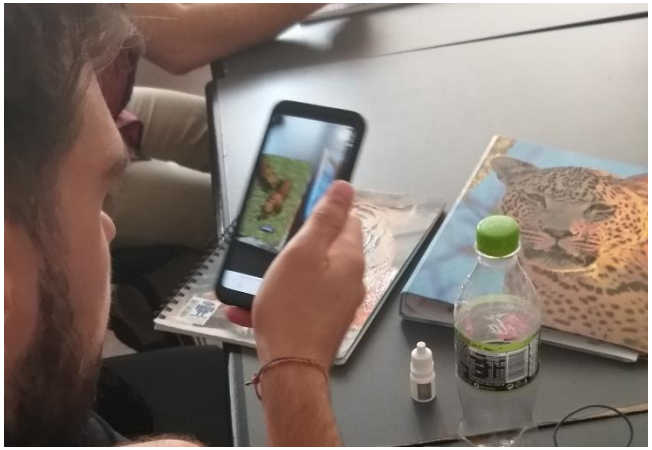


2. What is Augmented Reality?

Augmented Reality (AR) is a technology that involves the overlay of computer-generated perceptual information on the real-world environment.

AR is a system that can be described through three main characteristics:

- Overlapping of real world and digital world
- 3D registration of virtual and real objects
- Real-time interaction



Augmented reality terminology [1]

AR Overlay - An image or graphic superimposed over an Image Target

AR Video Playback - A video anchored in 3D space (typically superimposed on an **Image Target**) while maintaining the view of the physical environment as opposed to full screen playback.

Chroma Key Video - It is defined as video shot on a unique, brightly colored background (often called a “green screen”).

Extended Tracking – used to launch the AR experience with an **Image Target** in the camera’s view persist the experience even when you’re not tracking the image.

Hotspots - Tappable spots within the AR experience that reveal more content or options.

Image Target (also: trackable, trigger, marker, AR target) - The image recognized by the App, which launches the AR experience.

Markerless AR (also: dead reckoning) - Augmented Reality that maps the physical environment real-time.

Augmented Reality viewer app - An AR app such as Layar or Aurasma that is designed to provide Augmented Reality viewing experiences across multiple brands and content types.

Augmented Reality vs Virtual Reality

AR and VR are not competing technologies but are complementary technologies.

VR aims at offering a high level of a digital recreation of some real-life setting.

AR is aimed at delivering virtual elements as some kind of an overlay to the real world.

Augmented Reality vs Virtual Reality

Augmented Reality	Virtual Reality
Augmented reality uses the existing real-world environment and puts virtual information on top of it to enhance the experience.	Virtual reality involves users inhabiting an entirely different environment altogether, notably a virtual one.
EQUIPMENT AR: Head Mounted Display Camera	EQUIPMENT VR: Camera Array Controller VR Head Mounted Display For VR headsets such as Oculus Go, Google Daydream, Google Cardboard or Samsung Gear VR, a smartphone rather than a PC is the device that creates the experience.
TECHNIQUE: Marker Based Markerless	TECHNIQUE Pre-Render Six Degrees of Freedom Stitching Three Degrees of Freedom Volumetric Capture
Scene Generation – Minimal Rendering	Scene Generation – Requires Realistic Images
Display Device – Non-immersive, small field of view	Display Device- Full immersive, wide field of view
Tracking – High Accuracy	Tracking – Low to medium accuracy

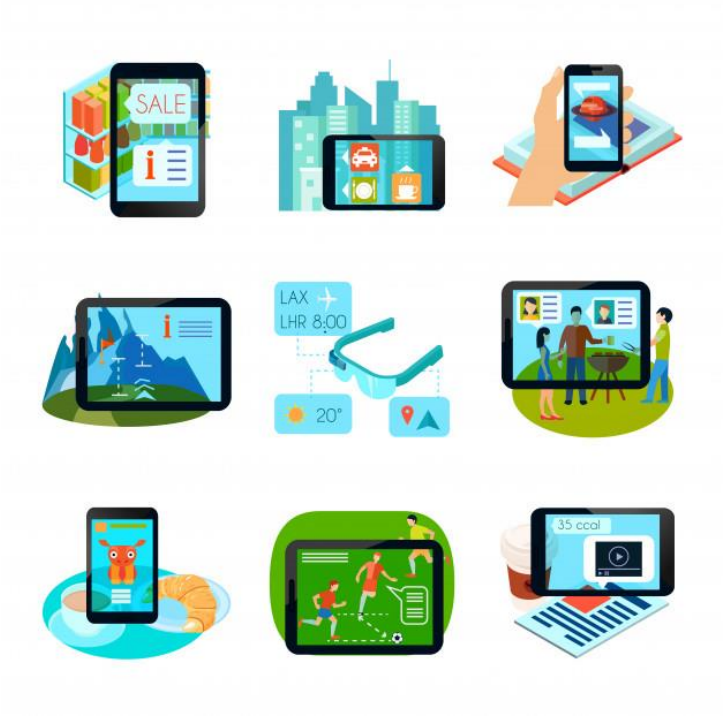
What elements are involved in AR?

AR components:

Hardware:

- processor,
- display,
- sensors and input devices

Software

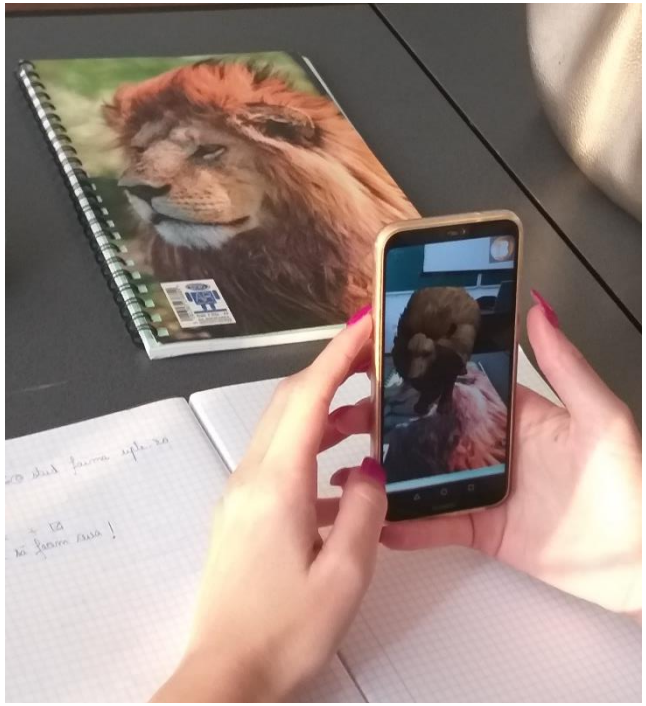


AR devices

The smartphone is an AR device because it contains all the hardware required by AR: processor, display, camera, microphone, sensors, GPS.

AR Devices:

- Optical SeeThrough,
- Virtual Retinal Systems,
- Video See-Through,
- Monitor Based AR
- Projector Based AR.



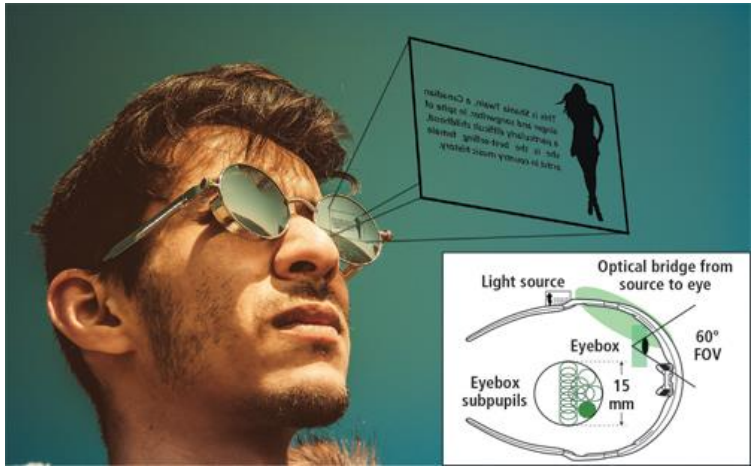
AR Display

Type of AR displays

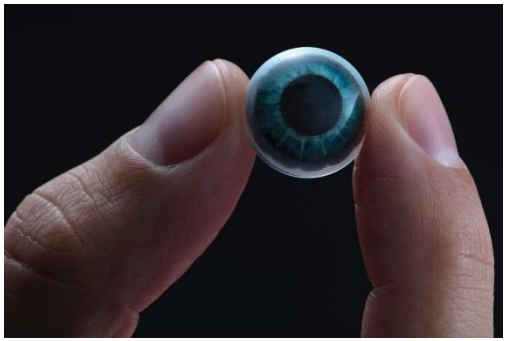
- **Had Mounted Displays -** is worn on the forehead used to place images of both the physical world and virtual objects over the user's field of view.
- **EyeTap -** a device which changes the rays of light captured from the environment and substitutes them with computer generated ones),
- **Spatial Augmented Reality** – uses ordinary projection techniques as a substitute for a display of any kind
- **Heads up display EyeTap -** a device which changes the rays of light captured from the environment and substitutes them with computer generated ones),
- **Spatial Augmented Reality** – uses ordinary projection techniques as a substitute for a display of any kind

Type of AR displays

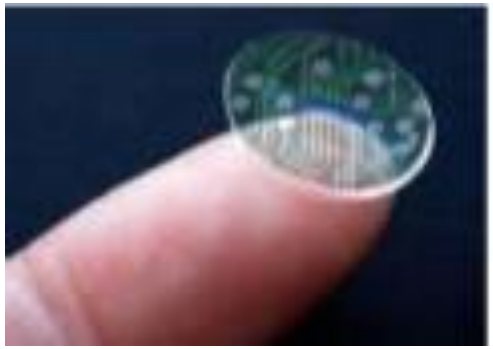
- **Eyeglasses-**
- **Contact lenses**
- **Virtual retinal displays**
- **Handheld displays**

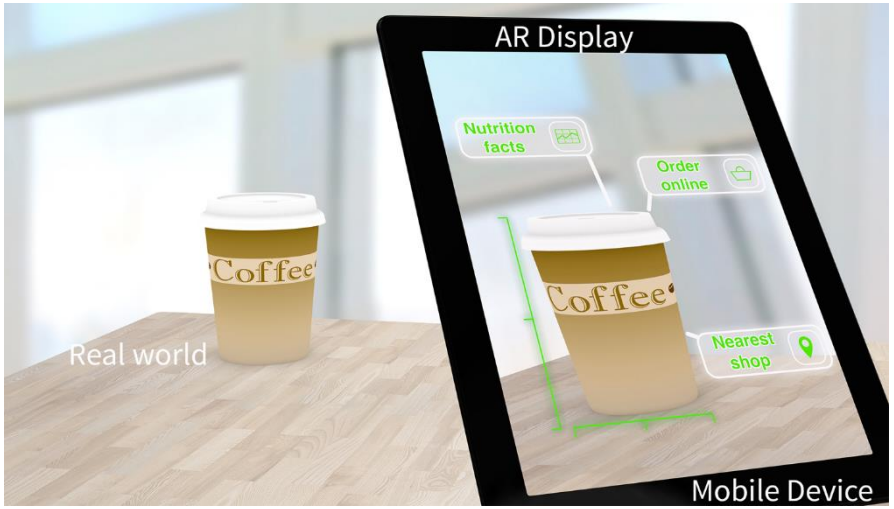


Source: Jannick P. Rolland/University of Rochester



Mojo Vision





Sensors and input devices

Sensors are very critical components for augmented reality.

Type of sensors used in AR: accelerators, optical sensors (captures visual image of user's environment in field of view), GPS receiver (to keep track of user's geographical location and movements) , compass (determines geographical orientation of the user) and gyroscope (determines rotational movement along with roll, yaw and pitch.

User input devices: microphone, touch screen and gesture devices.

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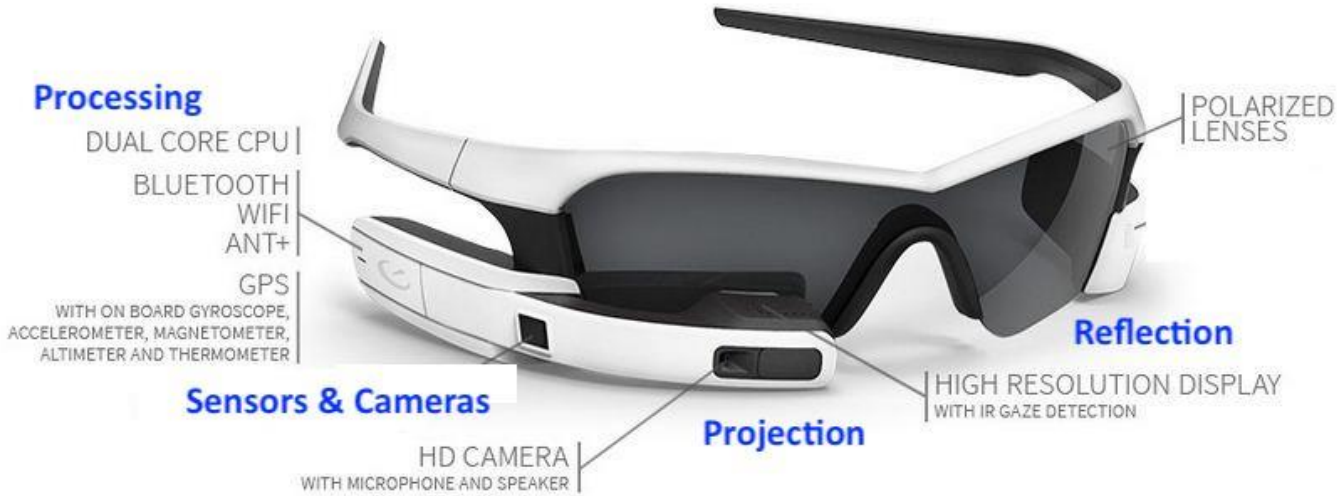


Augmented Reality Software

AR software works in conjunction with devices such as tablets, smartphones, headsets, laptops.

Types of AR software [3]:

- **AR visualization software** – enables organizations to create immersive experiences for consumers to interact with. AR visualization software users can upload 3D content and scale the image, adjust the color, and incorporate the additional details needed to give the best user experience possible.
- **AR content management system (CMS)** – lets users bulk upload raw 3D content that will eventually become the basis for AR experiences. This content can be managed and edited within the platform.
- **AR SDK** – allow users to build digital objects that will blend into the real world that will eventually become fully fledged AR experiences.
- **AR WYSIWYG editor software** – enables users with limited to no coding background to create customized AR experiences. These tools have drag-and-drop capabilities that let users upload 3D objects and drop them directly into previously designed scenes.
- **AR game engine software** – give game developers the framework for creating AR video game experiences. Using AR game engine software, users can create and edit 3D characters that can interact with the real world.
- **AR training simulator software** – leverages AR technology to train employees for certain jobs.
- **Industrial AR platforms** – are used by organizations in the industrial field. These tools include interactive AR content that improves these employees' productivity, effectiveness, and safety.

Augmented Reality

Top of Augmented Reality Software

ZapWorks	https://www.zappar.com/
BRIOVR	https://experience.briovr.com/
Vuforia Engine	https://developer.vuforia.com/downloads/sdk
ARCore	https://developers.google.com/ar
Powertrak CPQ	https://www.axonom.com/ar-product-configurator
Apple ARKit 3	https://developer.apple.com/augmented-reality/
Maxst	http://maxst.com
Wikitude	https://www.wikitude.com/

Types of Augmented Reality [2]

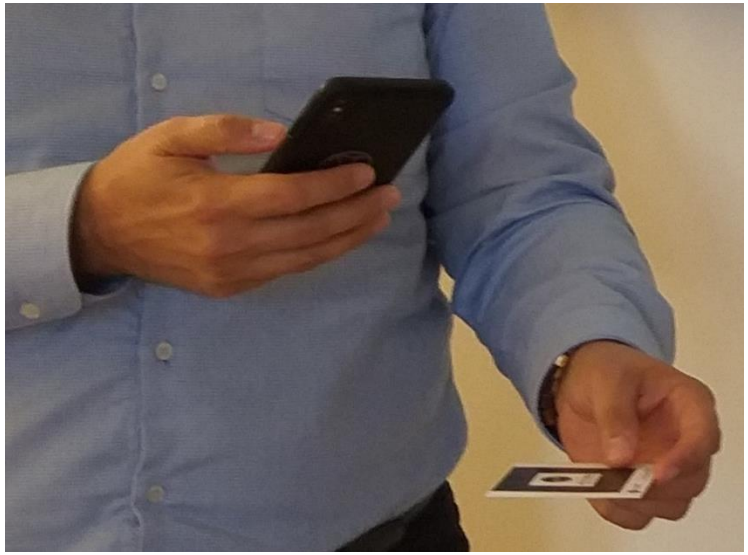
- **Marker based Augmented Reality:** Utilizes QR code scanning using mobile camera. The QR code pattern is recognized by software. It superimposes digital image on mobile screen and provides 3D image.
- **Location based Augmented Reality:** Utilizes smartphone and GPS app. GPS software recognises location of the device in the app. The digital information data is matched with real scene which is captured through camera of smartphone. Navigation is one of the application used here as per this method.
- **Superimposition based Augmented Reality:** In this type, augmented view is being superimposed on real view of the object.
- **Projection based Augmented Reality**: In this type, virtual images are projected onto physical objects. In this type, one can touch and feel the virtual image with the hands.

Marker based Augmented Reality

Augmented Reality (AR) markers are images that can be detected by a camera and used with software as the location for virtual assets placed in a scene [4].

Simple augmented reality markers can consist of one or more basic shapes made up of black squares against a white background [4].

More elaborate markers can be created using simple images that are read by a camera [4].

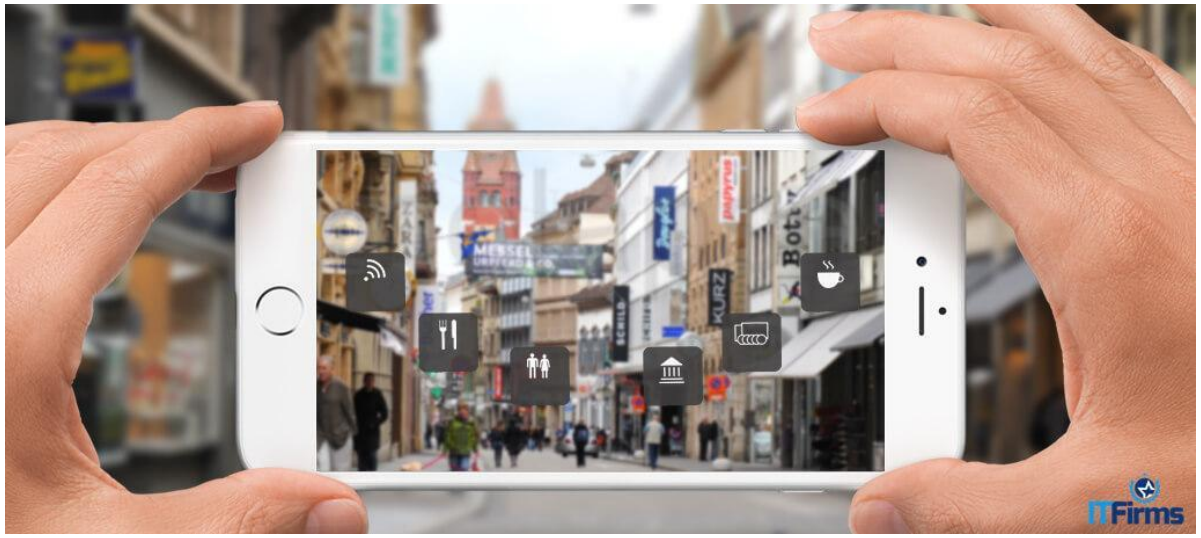


Location based Augmented Reality/ Marker less

In marker-less augmented reality, the image is gathered through the internet and displayed on any specific location (can be gathered using GPS).

The application doesn't require a marker to display the content.

Location-based augmented reality tools are based on position detectors or GPS to determine the current location and then adjust the environment and create objects accordingly.



Superimposition based Augmented Reality

Superimposition based augmented reality either partially or fully replaces the original view of an object with a newly augmented view of that same object.
In superimposition based augmented reality, object recognition plays a vital role because the application cannot replace the original view with an augmented one if it cannot determine what the object is [6].

source: Yamagata Europe

Projection based Augmented Reality

Projection based augmented reality works by projecting artificial light onto real world surfaces [7].

Projection on objects can be used to create deception about the position, orientation, and depth of an object. In such a case an object is taken into consideration and its structure is studied in depth [7].

Photo by Tanya on Mobile App Daily

3. Phases of Augmented Reality

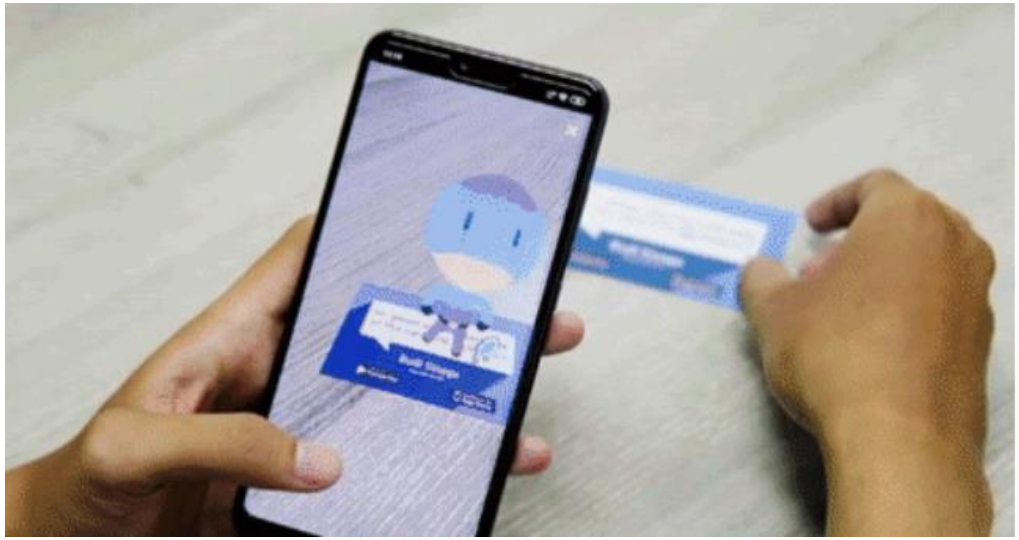
Image Recognition

Image Recognition and Tracking is the AR feature that enables apps to recognize and track specific images to properly superimpose digital content onto them.

Image Tracking relies on advanced Computer Vision technology to detect and augment images.

AR triggers – are known as Image Targets.

Source: https://www.wikitude.com/



Augmented Images in ARCore

https://developers.google.com/ar/develop/c/augmented-images

Tracking AR Technology

An augmented reality tracker is a specific pattern or image that an augmented reality app can recognise.

Type of AR trackers

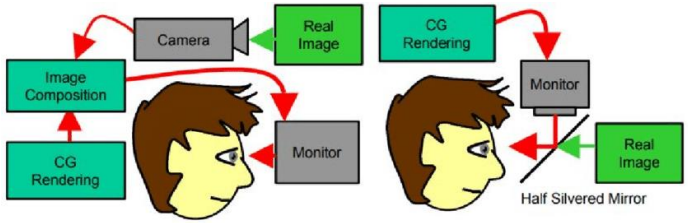
- targets,
- QR codes
- markers

Once the app finds the pattern, it constantly ‘tracks’ the position of the pattern in real world space so the app can accurately place a virtual object onto the tracker.

4. Visualization technologies

There are three basic techniques for showing visuals in AR which depend on the proximity of display mediums:

- **Optical see through [8]**
  In Optical see through glasses, the user views reality directly through optical elements such as holographic wave guides and other systems that enable graphical overlay on the real world. Microsoft's Hololens, Magic Leap One and the Google Glass are recent examples of optical see through smart glasses.
- **Video see through [8]**
  With these type of smart glasses, the user views reality that is first captured by one or two cameras mounted on the display. These camera views are then combined with computer generated imagery for the user to see. The HTC Vive VR headset has an inbuilt camera which is often used for creating AR experiences on the device.



1. Video see-through display. 2. Optical see-through display.

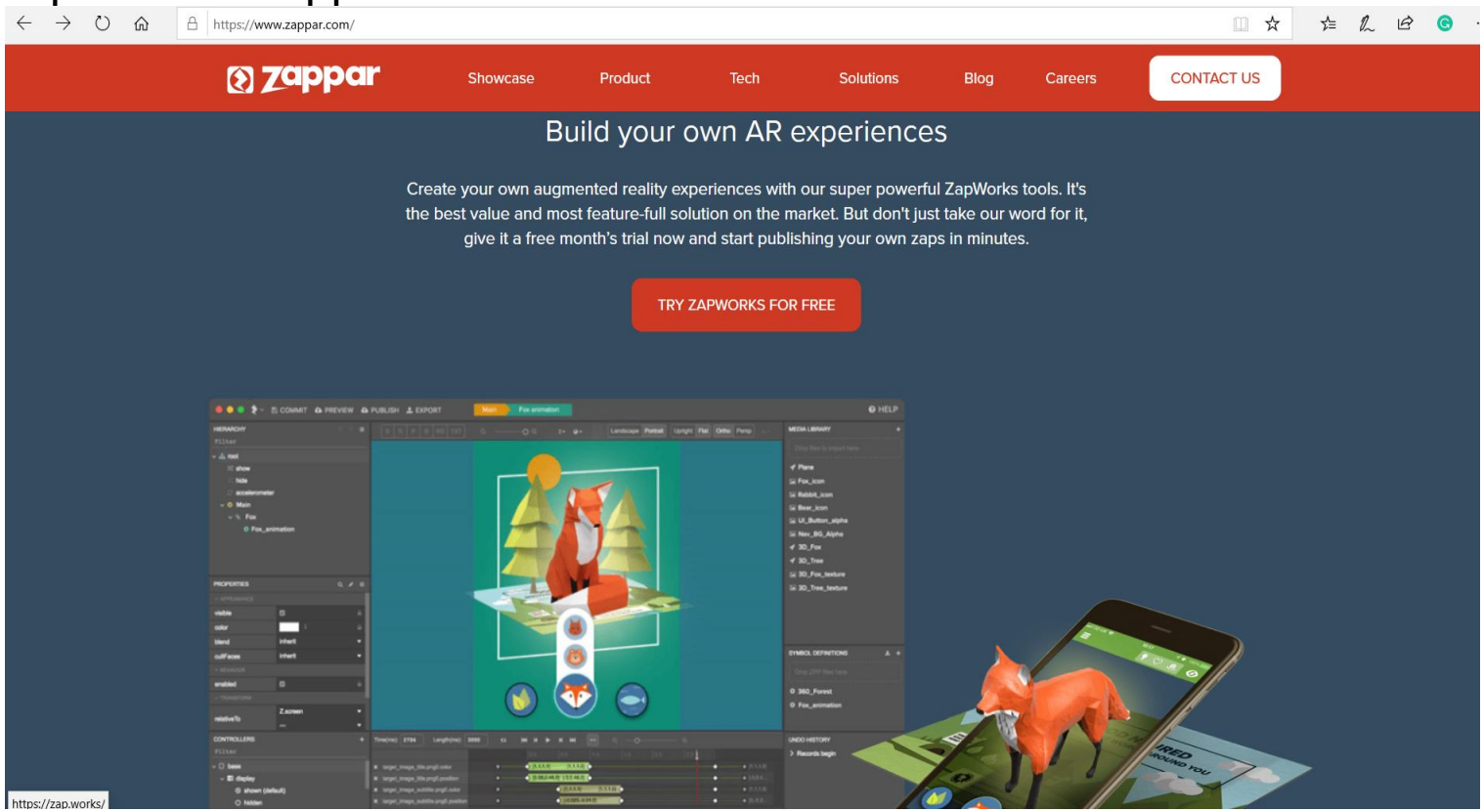
Visualization technologies

Optical see-through	Video see through
No eye offset Resolution Optical has only 1 stream of video to worry about (the graphics images), Optical - real world is seen directly through combiners with a time delay of a few nanoseconds while both delays in video are in 10s of milliseconds. Optical HMDs with narrow field of view combiners offer views of the real world that are basically undistorted,	Flexibility in composition strategies Wide field of view Real and virtual view delays can be matched Flexibility in composition strategies Basic problem with optical is the virtual objects do not completely obscure real- world objects because combiners allow light from both the virtual and real sources. Virtual objects appear ghost-like and semi-transparent, damaging the illusion of reality because occlusion is a strong depth cue. Video see-through is much more flexible about how it merges real and virtual - they are both in digitized form so compositors can do a pixel-by-pixel comparison

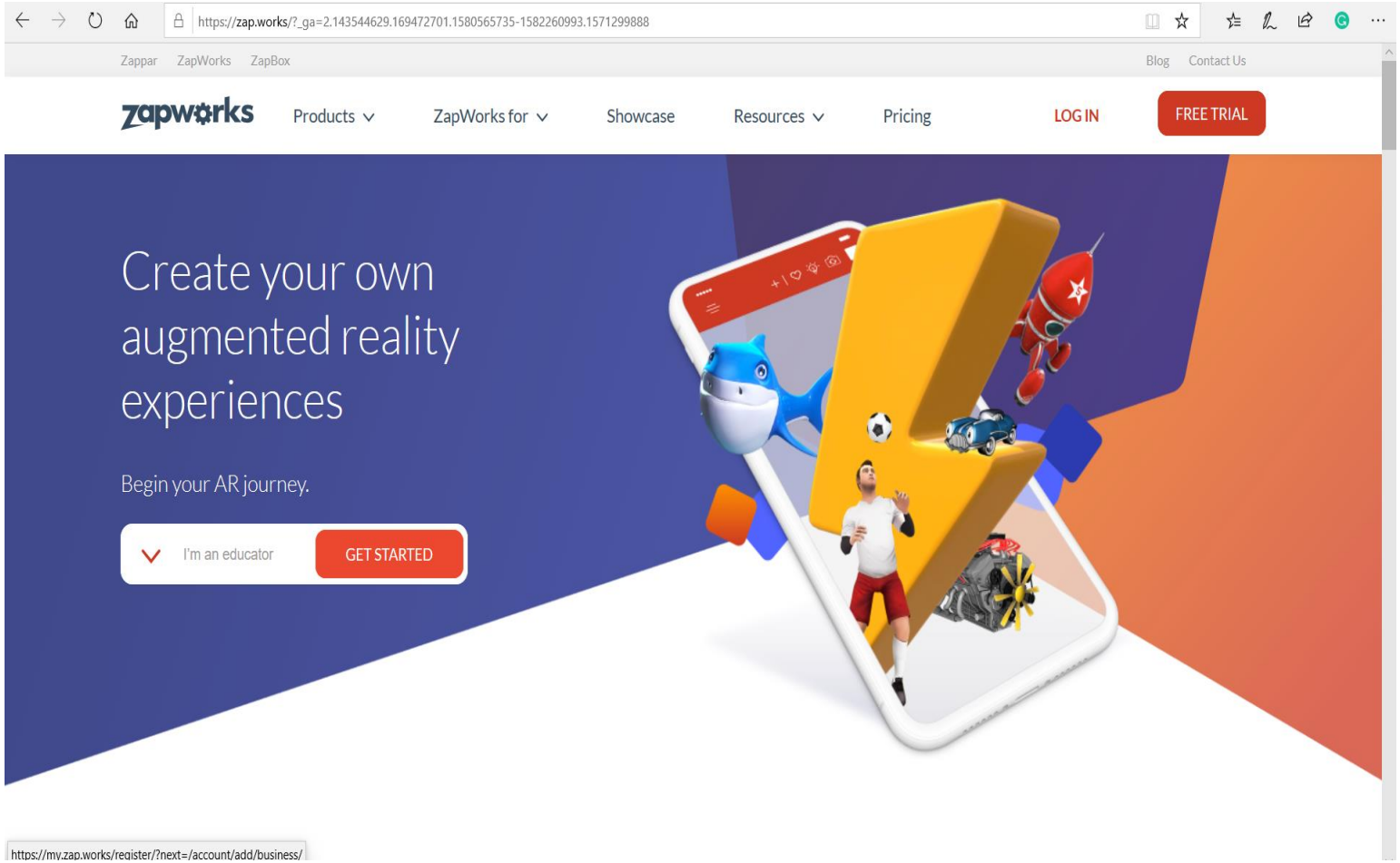
5. Programs and Applications

Program: Zappar
AR application using ZapWorks tools

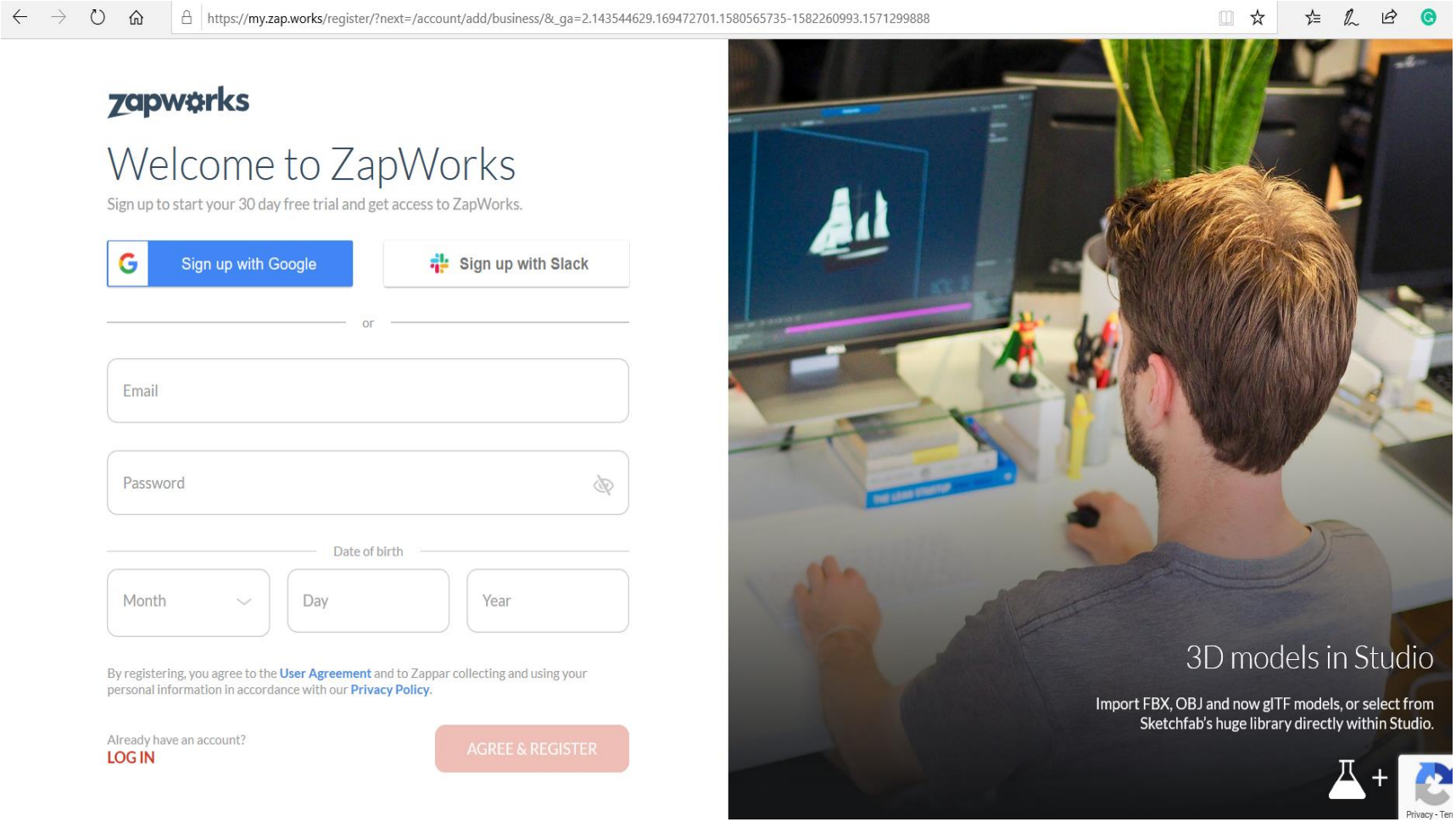
1. Open a new application



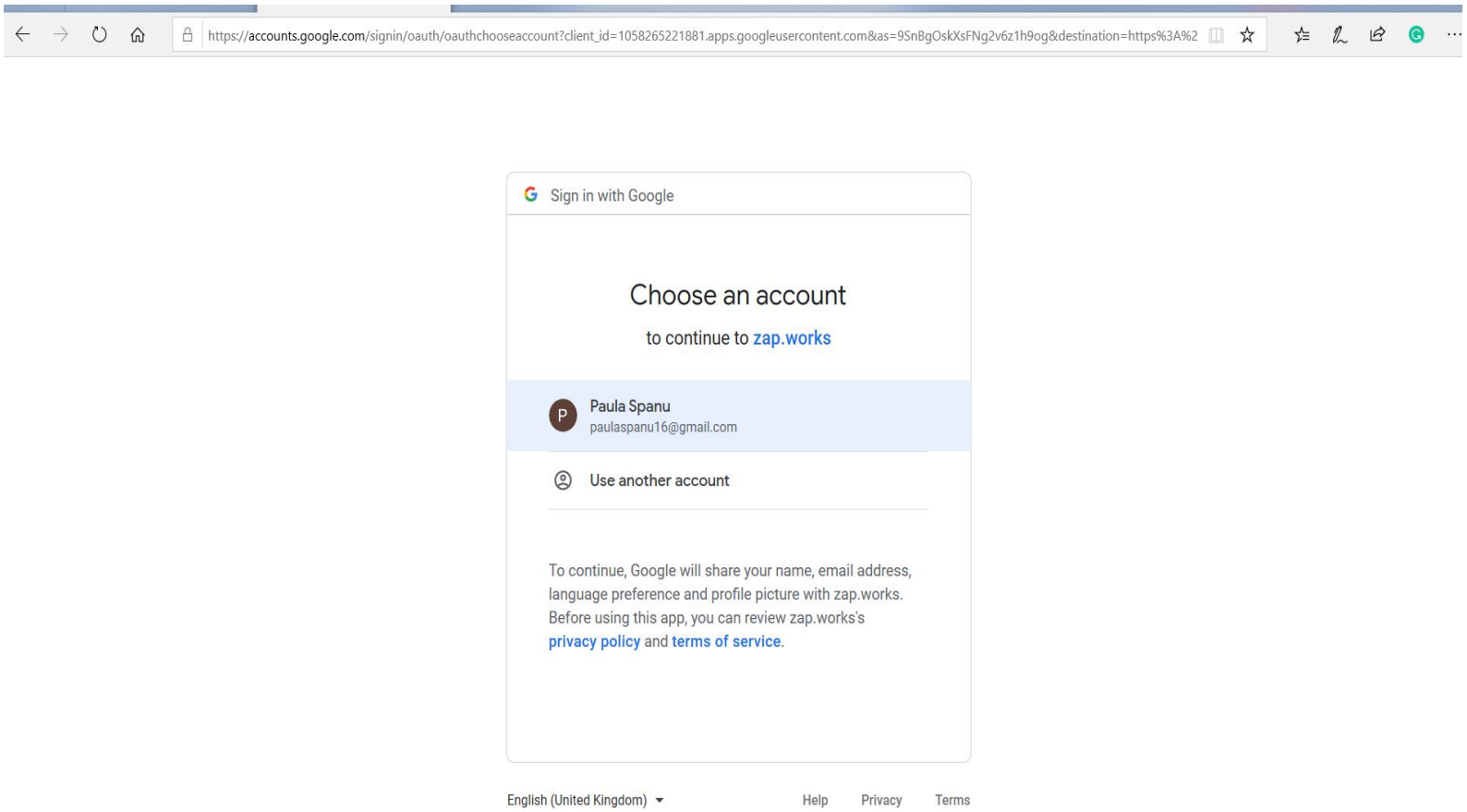
2. Get start page



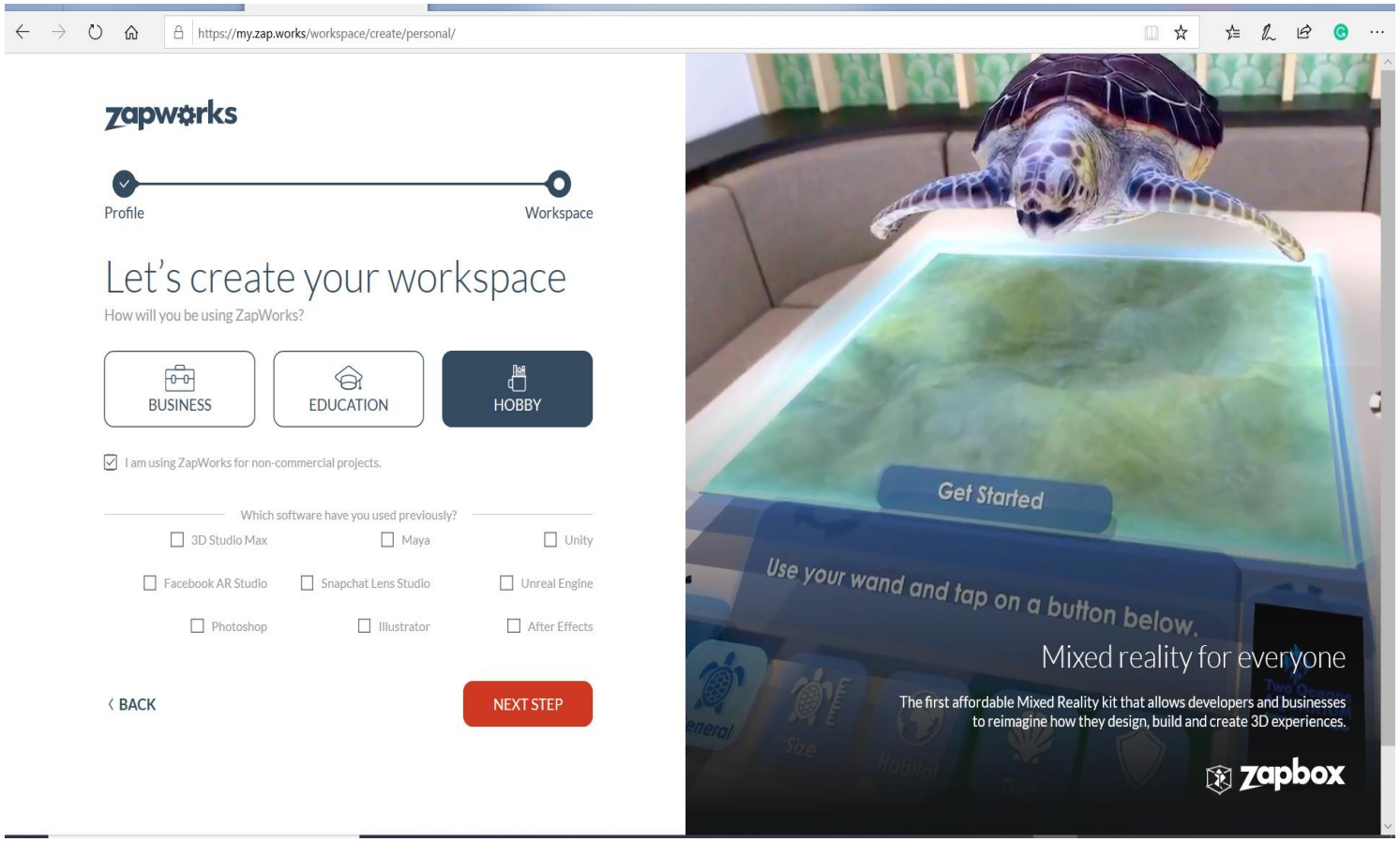
3. Create the account



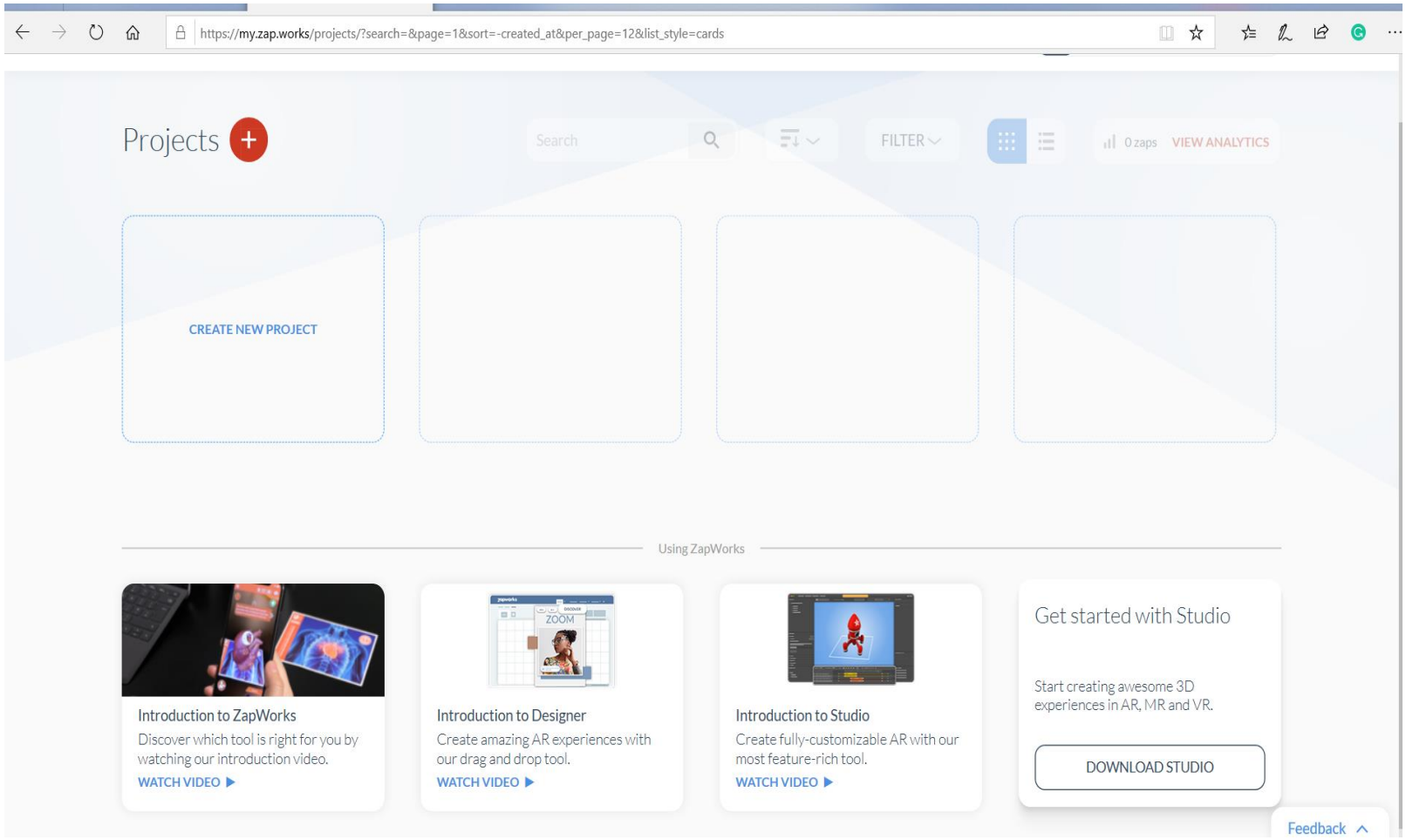
4. Choose an account



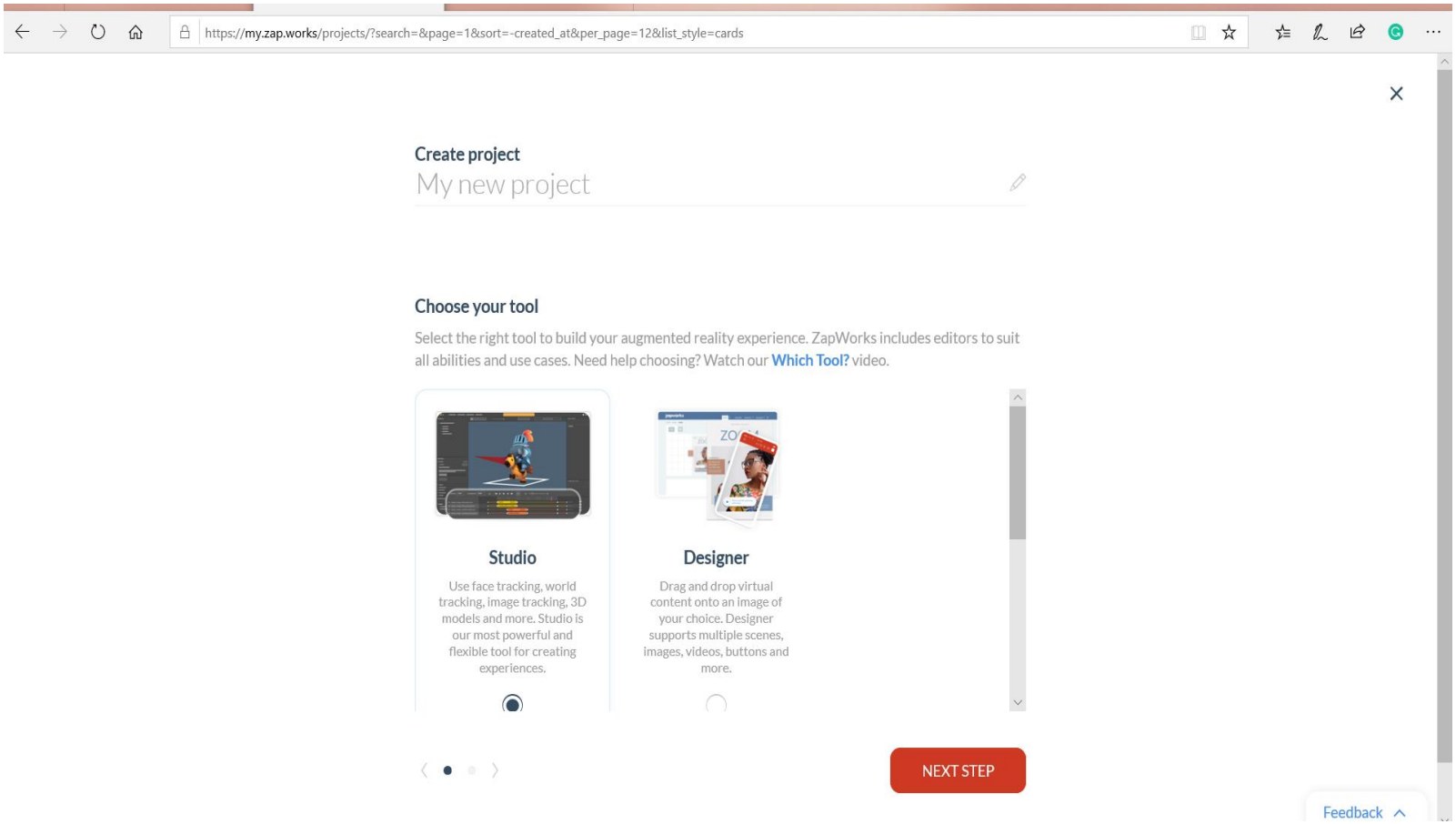
5. Select type of the workspace



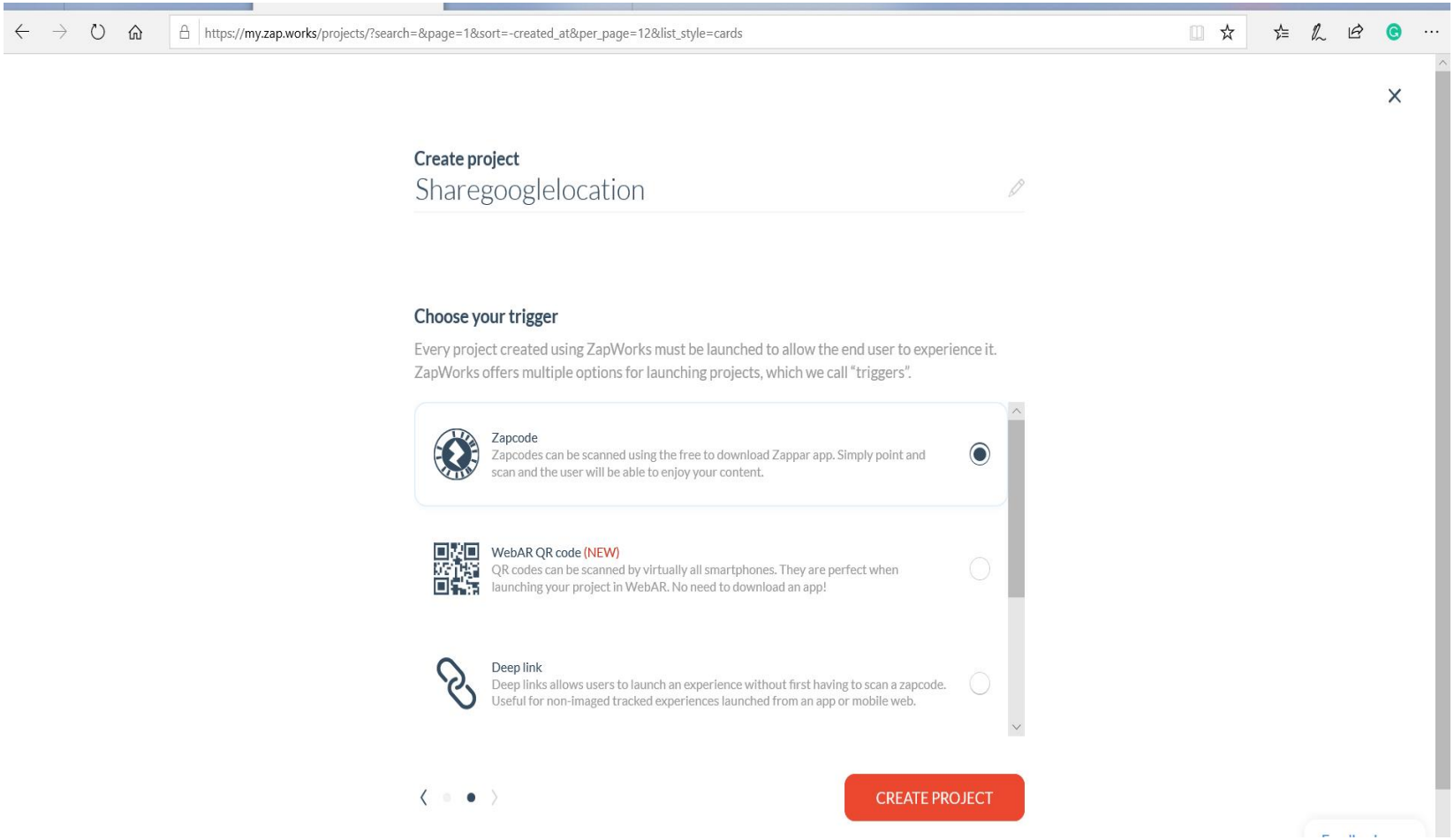
6. Create a new project



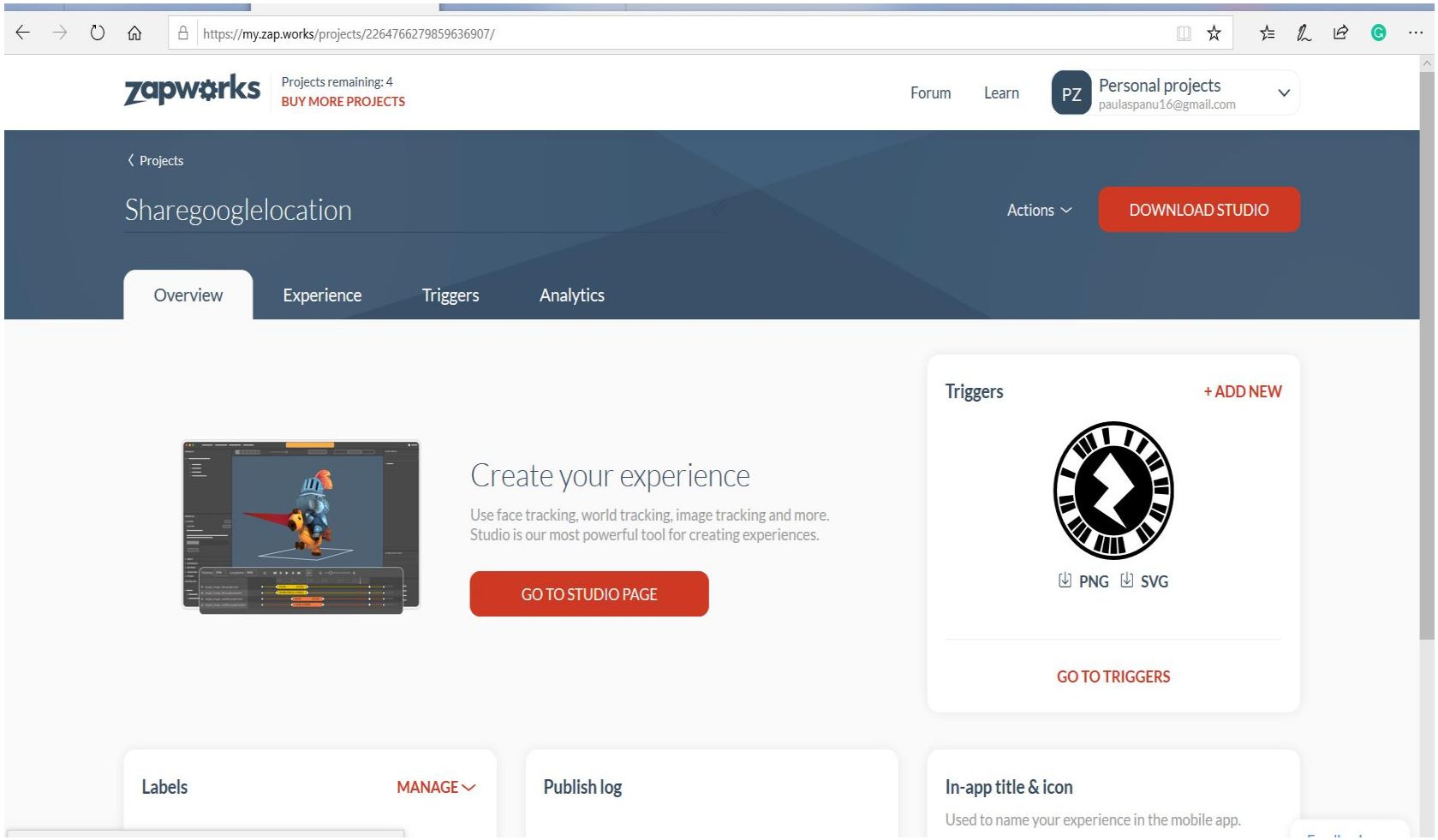
7. Select the type of tool for the new project



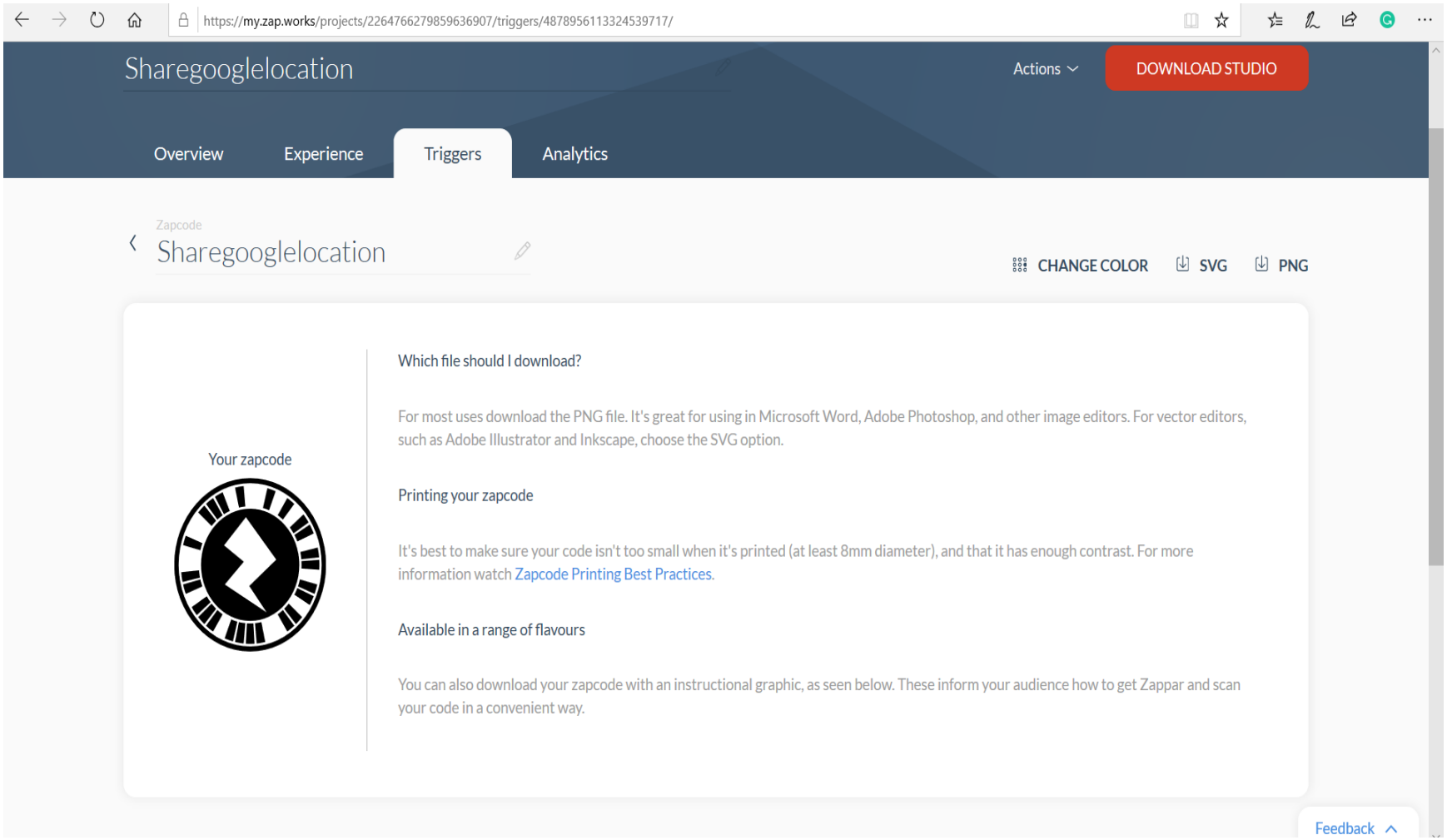
8. Select the trigger



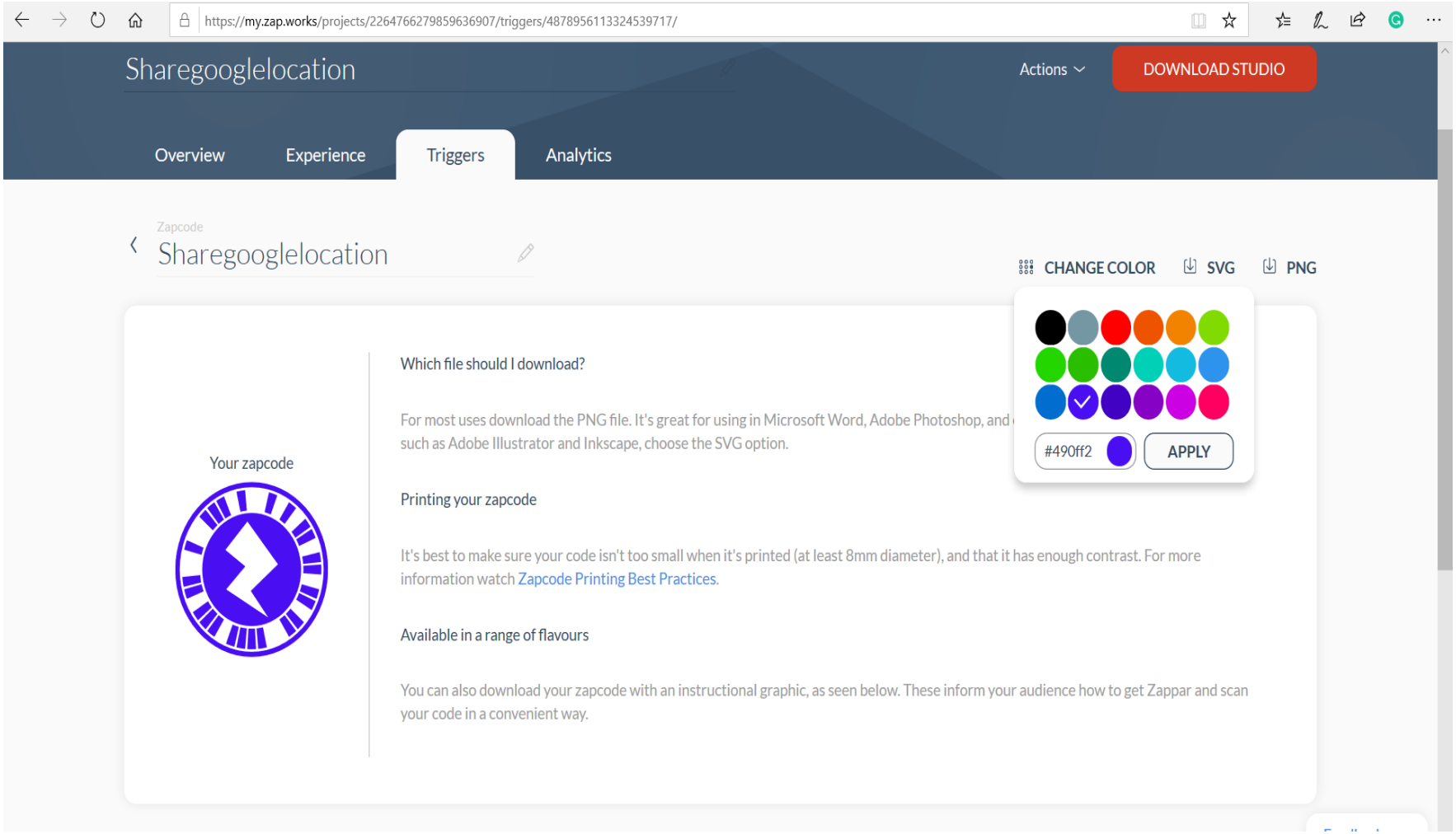
9. Studio page overview



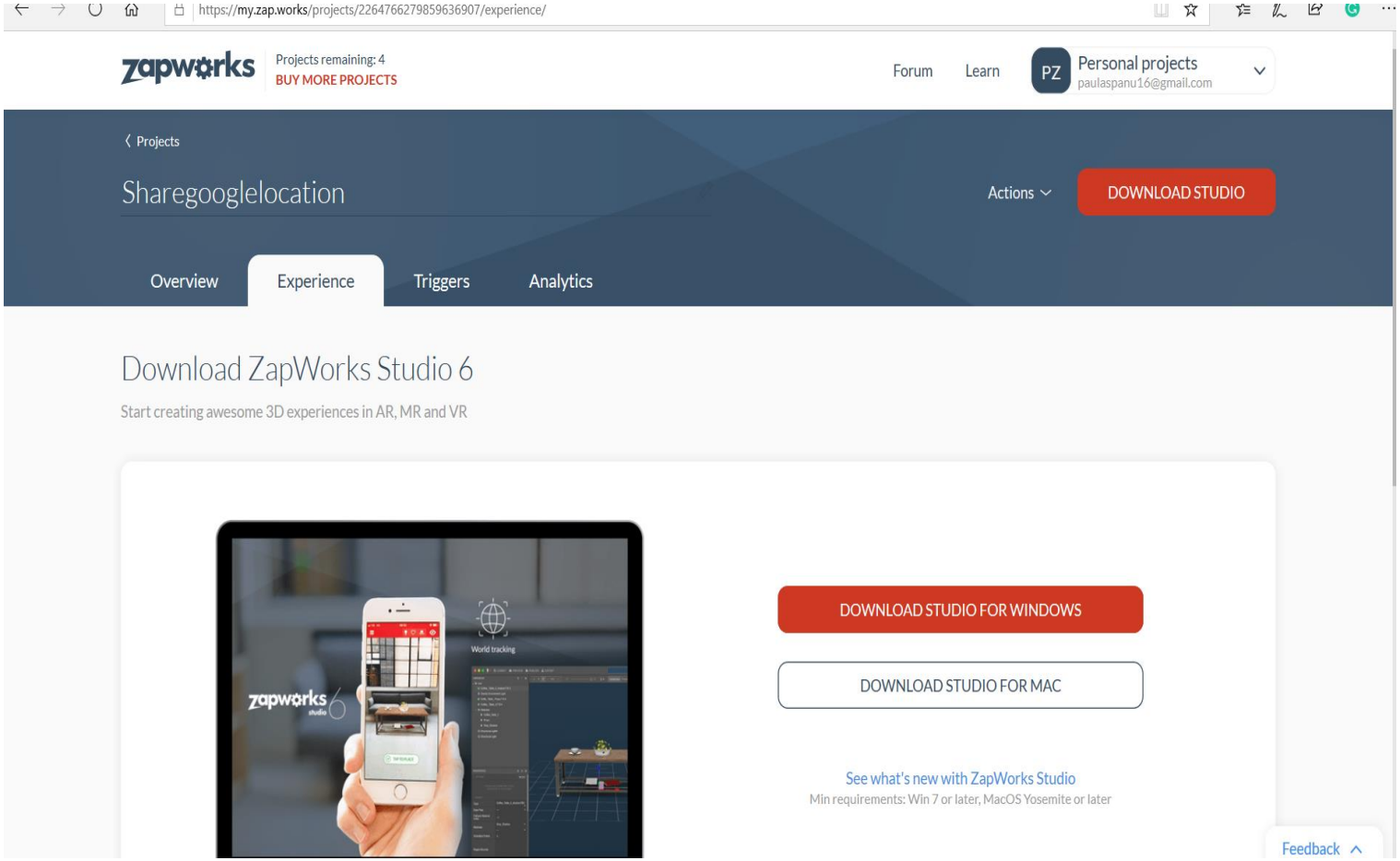
10. Edit zappcode



11. Change the trigger color

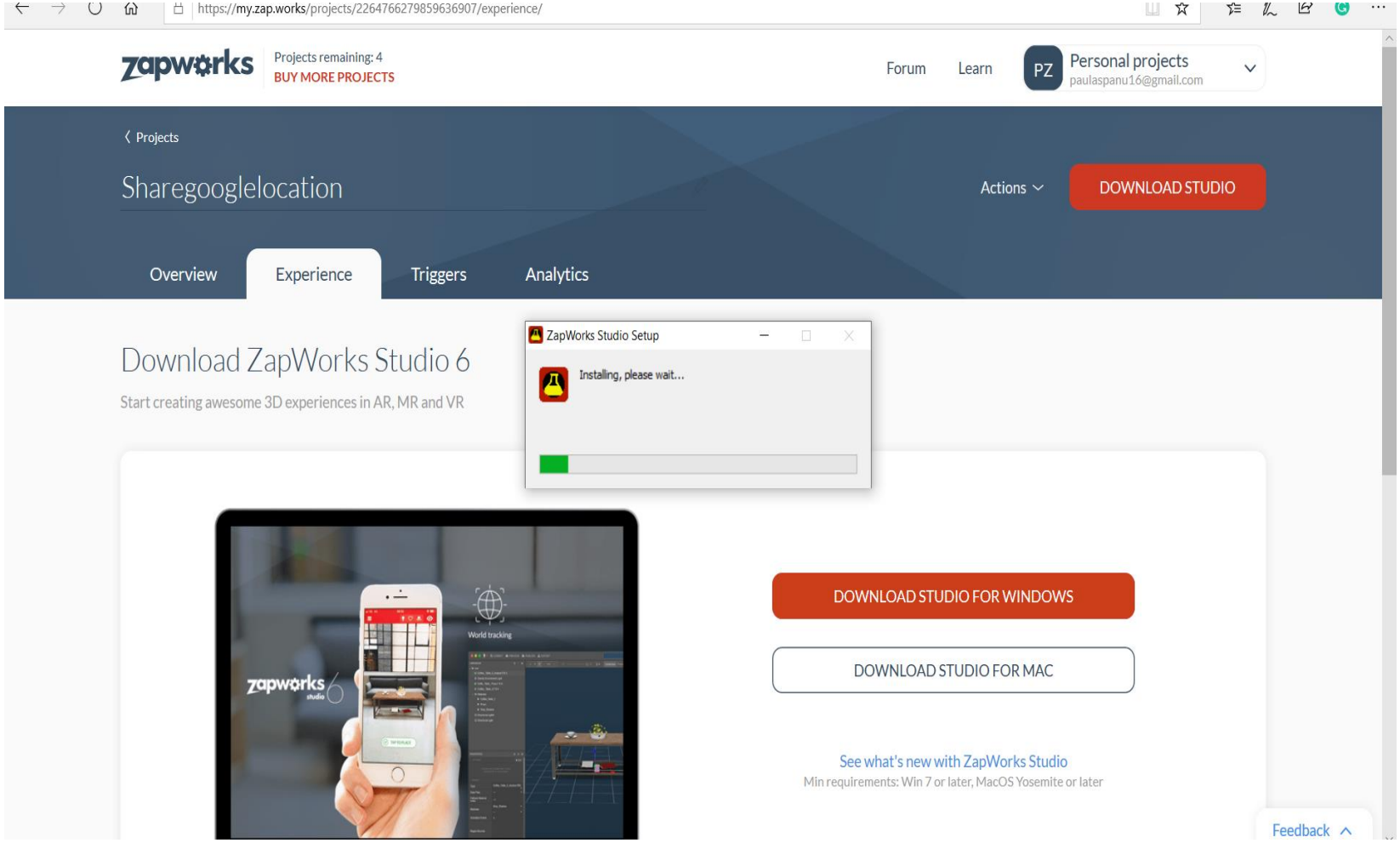


11. Download ZapWorks Studio

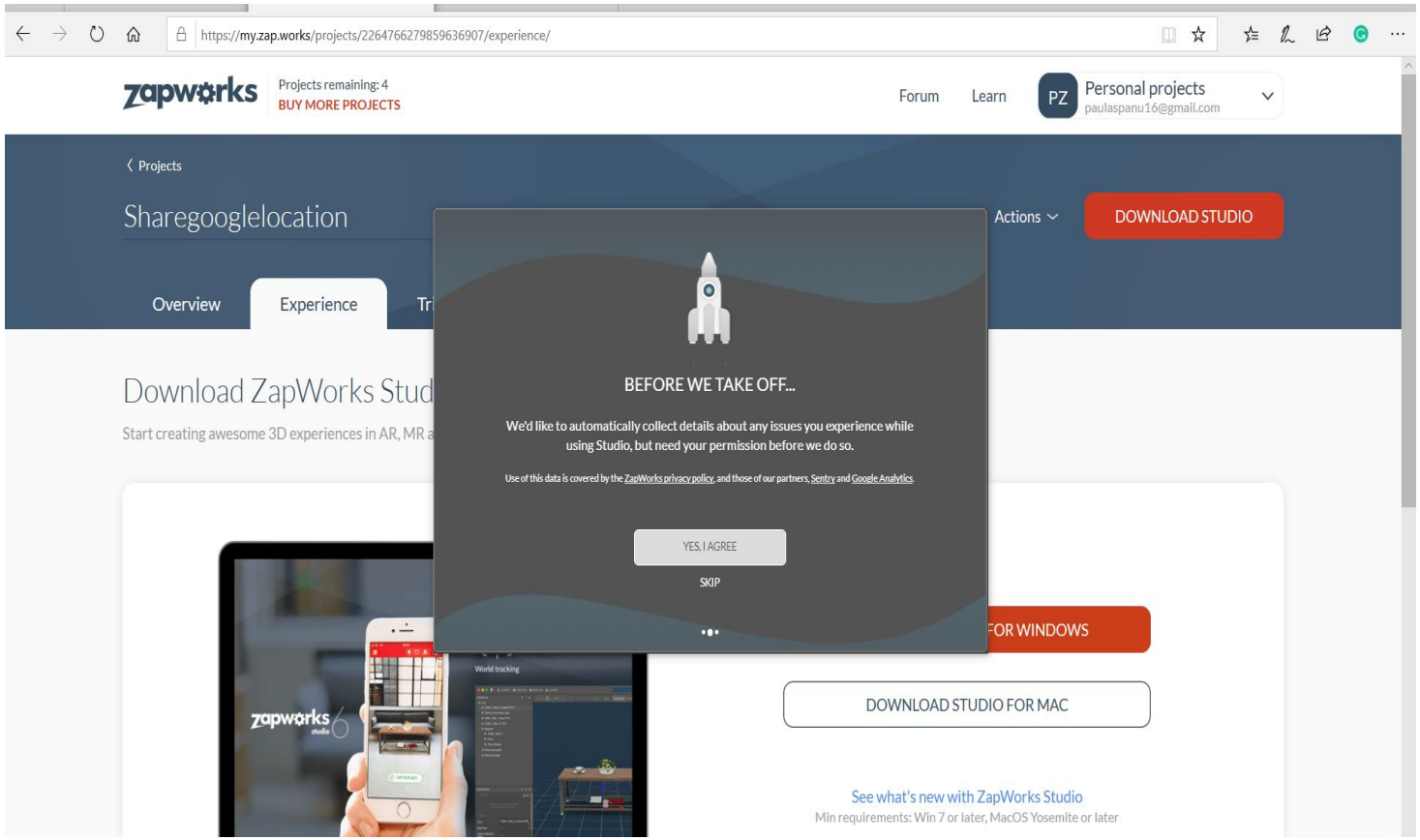


Augmented Reality

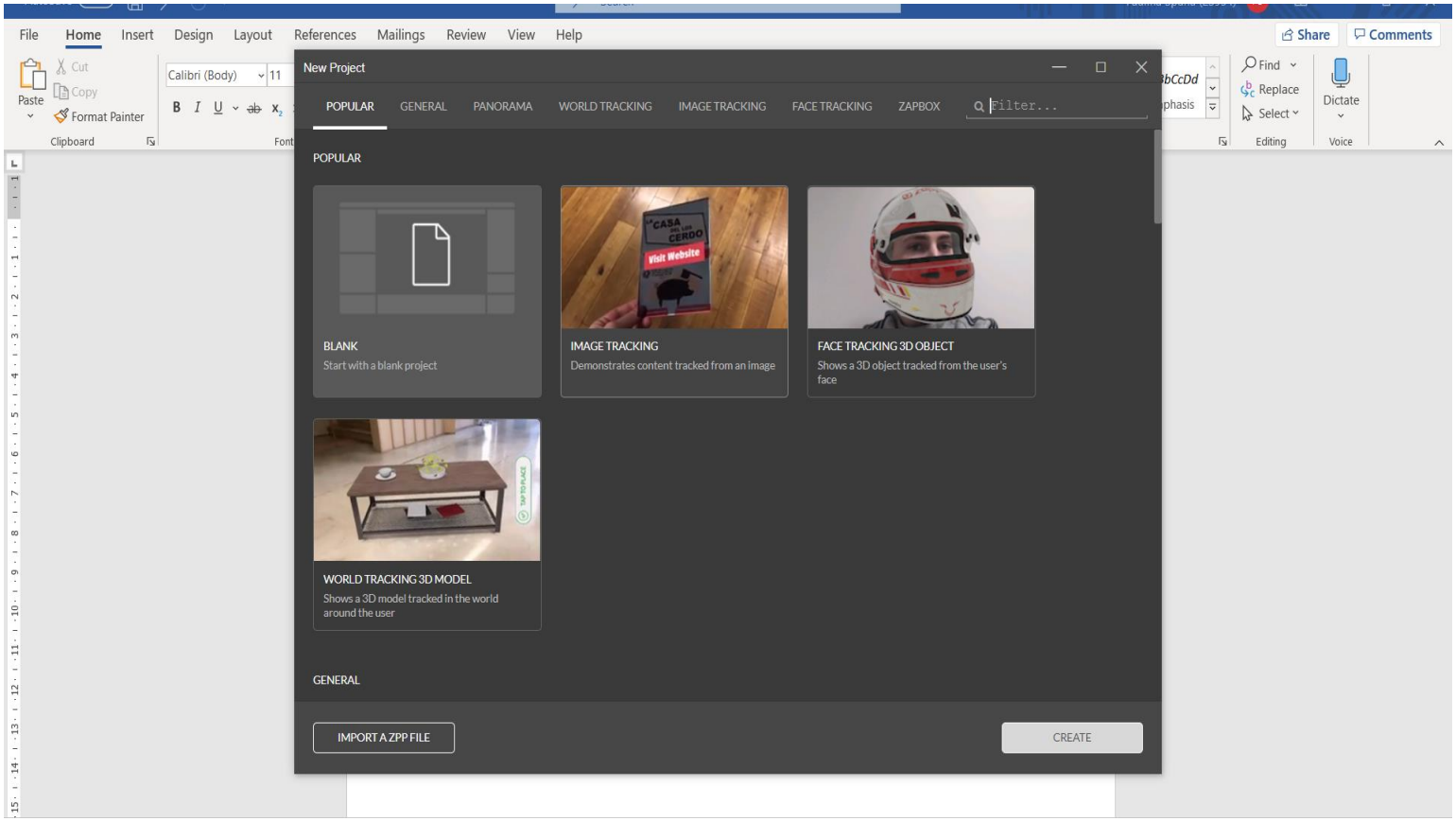
12. Run the program



13. Confirm the agreement

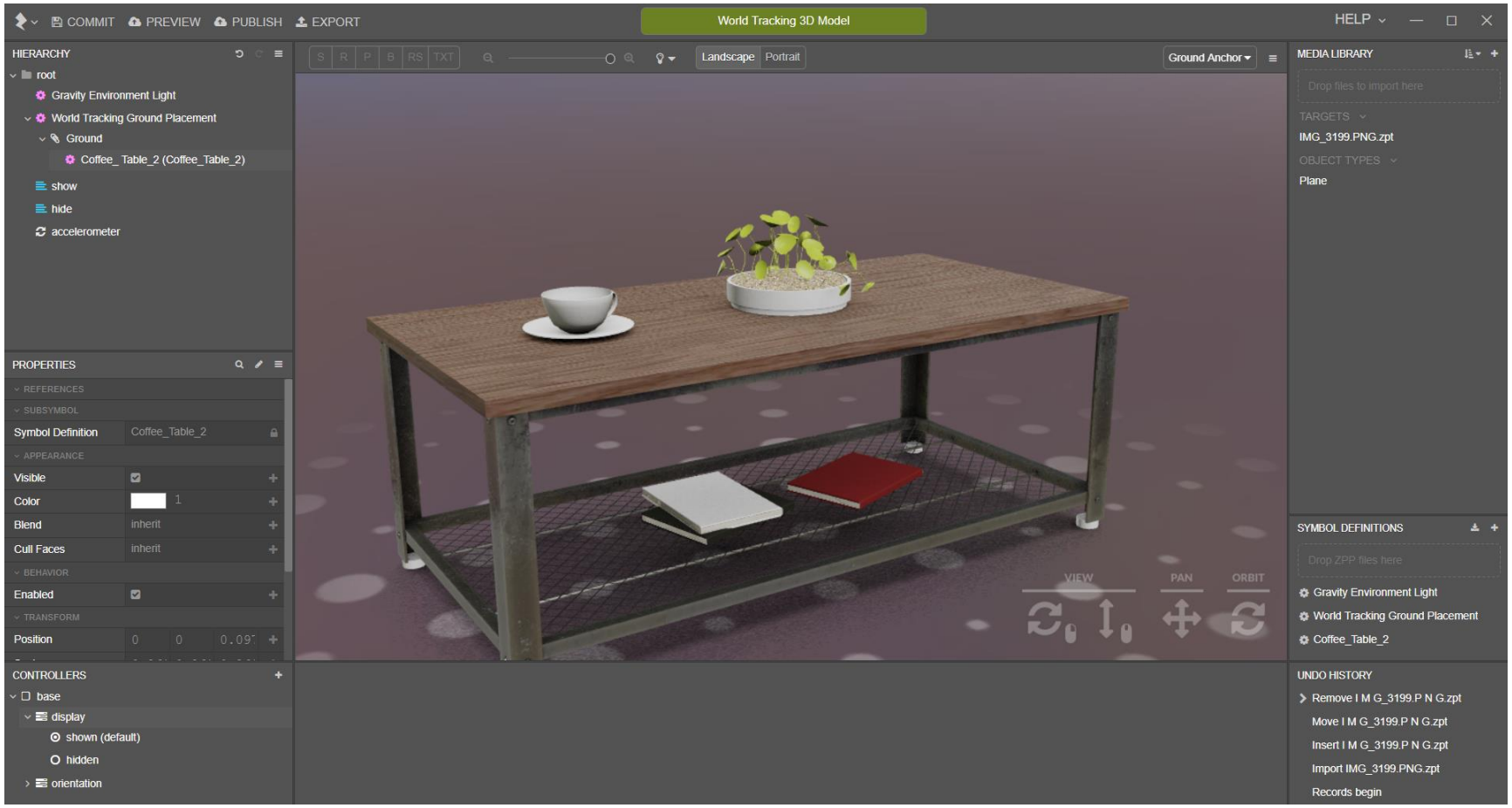


14. Select the blank project

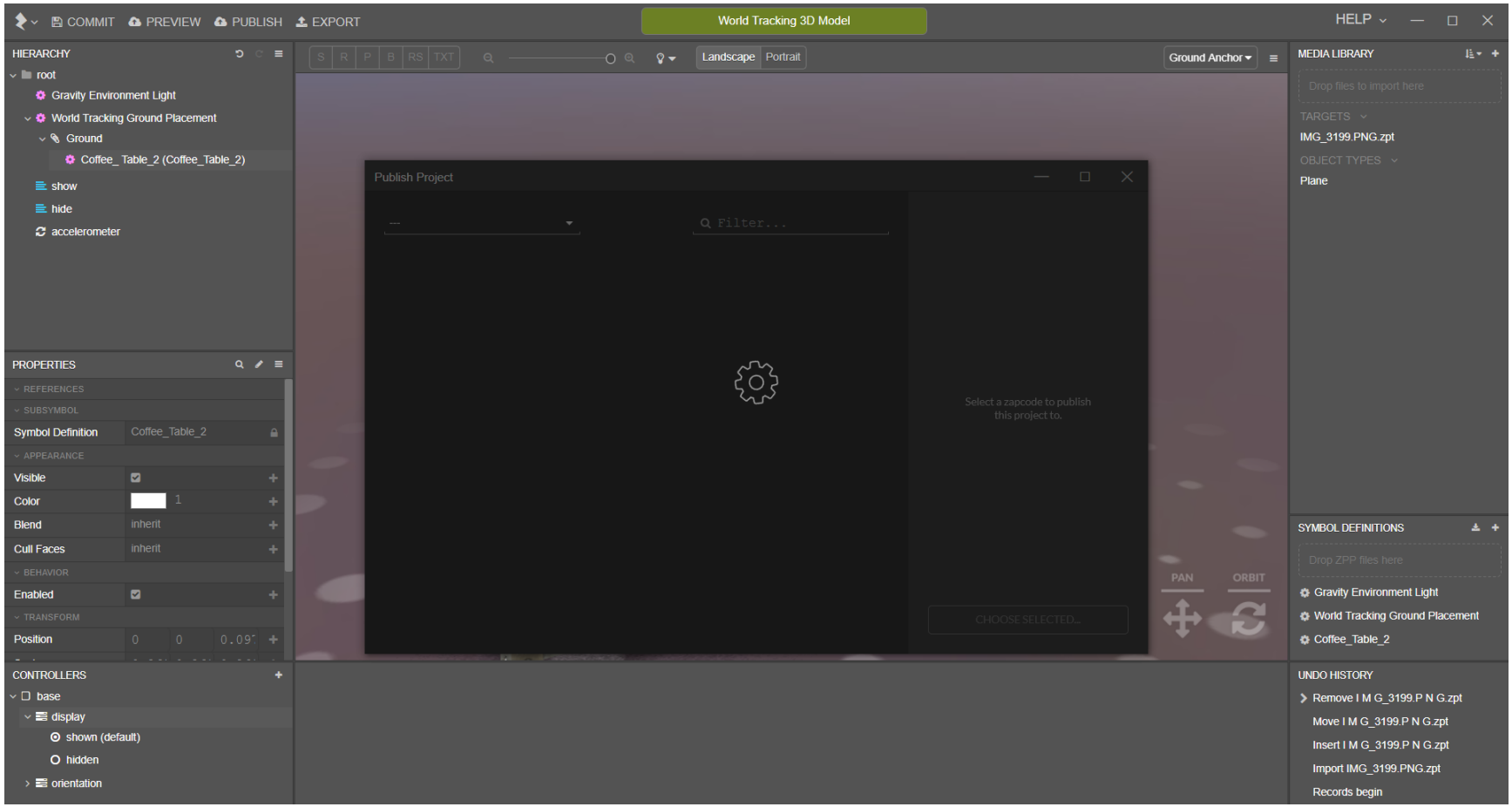


Augmented Reality

15. Create a new design



- 16. Preview and publish



6. Augmented Reality and its applications in industry

Industrial Design Applications.

https://www.youtube.com/watch?v=VIIWzlweWvw
https://www.youtube.com/watch?v=Yxqj44Rutuc
https://www.youtube.com/watch?time_continue=1&v=csk_3zNi2bQ&feature=emb_logo
https://www.youtube.com/watch?time_continue=6&v=g7uhOSMaCEg&feature=emb_logo
https://www.youtube.com/watch?v=tLCxYI7-v5I

Applications in Production.

https://www.youtube.com/watch?v=MDKbYbMgCL4&feature=youtu.be
https://www.youtube.com/watch?v=lIkbhJ2Fz6g&feature=youtu.be
https://www.youtube.com/watch?v=0m67O1Em7dY
https://www.youtube.com/watch?v=UhW12bILH7U
https://www.youtube.com/watch?time_continue=11&v=ZWsBHISOqjA&feature=emb_logo

Maintenance Applications.

https://www.youtube.com/watch?v=nHfY56lHZjU
https://www.youtube.com/watch?v=mn-zvymlSvk
https://www.youtube.com/watch?v=TQjz06LQjPA
https://www.youtube.com/watch?v=Q2FP-PLZhIY
https://www.youtube.com/watch?v=1A1gQyebX_0

7. Educational uses of Augmented Reality

https://www.youtube.com/watch?v=MuVGdBKHQfI&feature=youtu.be
https://www.youtube.com/watch?v=I30XR6VmBRU&feature=youtu.be
https://www.youtube.com/watch?v=kLMk5ke_01w&feature=youtu.be
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https://www.youtube.com/watch?v=Np3ucOnWL9g&feature=emb_logo

References

1. https://www.marxentlabs.com/what-is-augmented-reality-glossary
2. https://www.rfwireless-world.com/Terminology/Augmented-Reality-System-basics.html
3. https://www.g2.com/categories/augmented-reality
4. Anuroop Katiyar1, Karan Kalra2 and Chetan Garg3, *Marker Based Augmented Reality* , Advances in Computer Science and Information Technology (ACSIT) , Volume 2, Number 5; April-June, 2015 pp. 441-445
5. https://instabug.com/blog/augmented-reality-tools/
6. https://www.bunnypub.net/en/technology/topics/113692
7. Sanni Siltanen, *Theory and applications of marker-based augmented reality*, JULKAISIJA – UTGIVARE – PUBLISHER, 2012
8. https://uxdesign.cc/augmented-reality-device-types-a7668b15bf7a
9. https://blog.prototypr.io/understanding-display-techniques-in-augmented-reality-c258b911b5c9