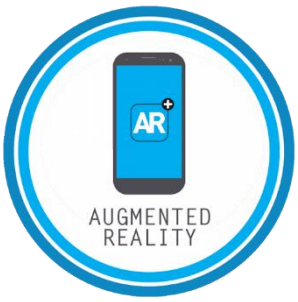
Goodyear Project

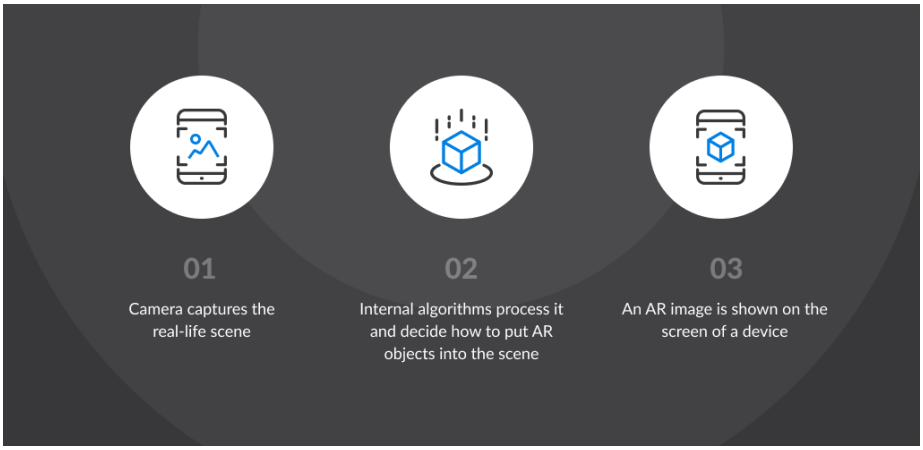
Augmented Reality Research

1. What is Augmented Reality?



Artificial Reality is a digital medium that allows you to **overlay virtual content into the physical world** in a way that makes it seem like the content is physically there. AR essentially allows us to merge the digital and physical worlds.

2. How does augmented reality work?



Step 1: Computer Vision processes the raw image from the camera to recognize the object.

First of all, AR uses a system of cameras and in some devices also 3D depth sensors to see and understand the physical world around you. This task is done with the help of **computer vision.** Your device will map your surrounding environment and build a model of it using hardware sensors and specialized software. This process is similar when we as human enter a room we've never been. You look around and make sense of your surroundings. Your mind builds a mental model of the space so that you can memorize it and recall it the next time you enter the same space. The processor in your head mapped the environment using images from the dual camera system on your face.

Step 2: Rendering module starts augmenting the original frame of the object with the AR system, making sure it will precisely overlap the whole object. Important information like 3D position and orientation of the object provided by computer vision will help the rendering task to be successful.

Now imagine this room again, when we move around the room, we can pretty accurately estimate our location within it. This is possible because we take into account our relative position to important features in the room, such as the wall, the desk and ultra-wide monitor. In AR this is referred to as tracking or localization. The research community has a fun word called **SLAM** which stands for Simultaneous Localization and Mapping. This is what your phone or glasses do many times in a second. They map your environment but also keep track of where you are in relation to it. This is so important to understand. Once mapping and localization are working well for a new environment, an AR experience can begin.

Step 3: Digital content will be display on the physical object.

When placing AR content, your phone or glasses really place them in the virtual map of the environment. The virtual map, however, is invisible. So that's why it looks like the digital content is placed in the physical world. It is therefore really important that our virtual map is accurate and aligned with its physical counterpart. In addition to **mapping** and **localization**, your AR device also senses other characteristics of the environment, for example the **light intensity** and **colour temperature**. To make things appear as realistic as possible, our AR devices sense the conditions of our environment and project that onto our digital content as well.
And that is how AR works. It maps your environment and tracks your location within it. By doing that, it allows you to place digital content into the physical world in a way that makes you and those around you believe that it is actually there.

Good to know: All of the above, since augmented reality is live, this process will have to be repeated every time a new frame comes from the camera. Modern phones work at 30 frames per second, that means it will give the device 30milliseconds to do all these tasks before repeating it over and over again.

3. Why does AR need computer vision?

Computer vision has the important task for the computer to understand the physical world around the user in order to use AR correctly. This computer vision technique involves to important terms such as semantics (Bedeutungslehre) and 3D Geometry.

Semantics: What object am I seeing? For example is that a physical object or a human face in front of me

Semantics has been progressing at a good rate thanks to **Deep Learning**. This technique help the computer to figure out what is in an image without worrying about its 3D geometry. It enables basic forms of AR

Geometry: Where is the object in the 3D world? Geometry is essential for the AR content to be display at the right place and angle in order to make it feel part of the physical world. Geometry is responsible so that the digital content stays anchored at the physical object while we move our camera aside.

With that information, the device will show digital content to the user which are relevant for him. These digital contents will be displayed in a way, so that it looks like being part of the real world. This process is also called **rendering.**

4. Hardware & Technologies behind Augmented Reality?

Depth-sensing camera: Camera that has the ability to record visual information and to add digital content on the physical object. The camera should also be able to figure out the subject's distance and angle from the object.

Registration tools: Tools such as motion sensors and accelerometer that allow the device to outline the space where it would superimpose the sensory information: /objects around the user

Computer Vision: Taking images with the camera from the physical world, the computer interprets them using machine learning algorithms as reference. Afterward it'll will render these data and create an output.

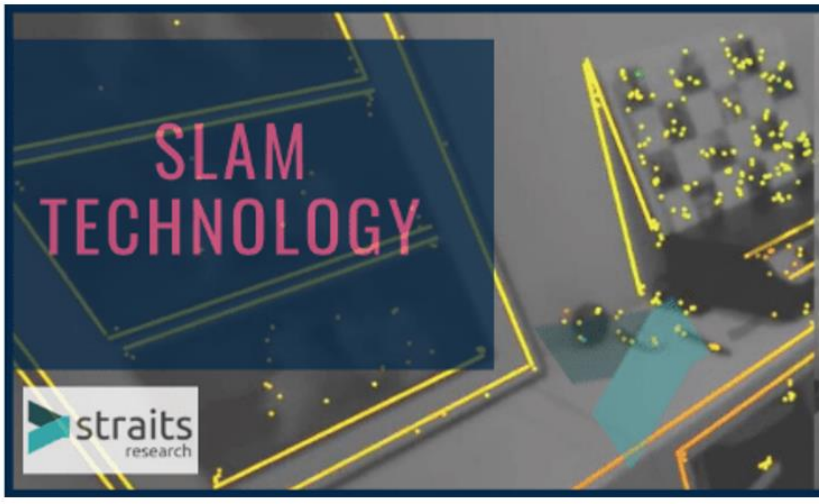
Output device: Device where the AR digital content will be displayed.

5. What are the Different Types of AR?

Currently there are 4 different types of Augmented Reality Technology:

1. Simultaneous Localization and Mapping (SLAM)

The Slam (Simultaneous Localization and Mapping) is currently the best way to render virtual images over objects in the physical world. The **SLAM technology localizes sensors with respect to their surroundings, while simultaneously mapping the structure of the environment.**



The SLAM system contains a set of algorithms aimed at solving localization and mapping problems simultaneously. That is also why the SLAM approach is often being used to solve complex AR simulation problems.

2. Recognition/Marker based Augmented Reality

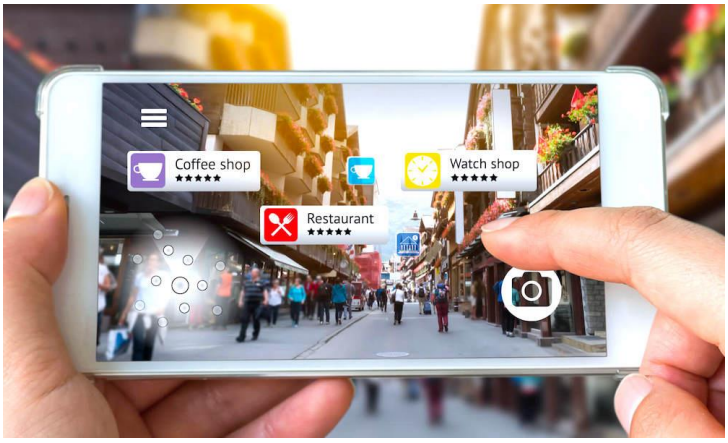
The Recognition/Marker based Augmented Reality uses a camera in order to identify **visual markers** such as a **OR/2D code** or **natural feature tracking (NFT)** markers. These markers will be used to showcase an overlay of the digital content, only when the marker is sensed by the device.

The essential tasks of the Marker-based AR Technology depends on the camera to spot the difference of the marker from the physical objects in the real world. The position and the orientation will be calculated before processing the virtual 3D object on the marker.

This technology is being commonly used since it's easy to implement and unexpensive to create. The user usually has to download a custom app that recognizes these specific patterns

The user can observe the object from various angles while the object stays put on the marker. The user can also rotate the marker, which would rotate the virtual replication around itself as well.

3. Location based AR-Technology



The Location-based AR Technology relies on several tools such as **GPS, digital compass, velocity meter** and **accelerometer** to provide exact data about the location. This data is being used by the AR to visualize objects based on these inputs.

Common uses of location-based AR are mapping directions, finding nearby services,…

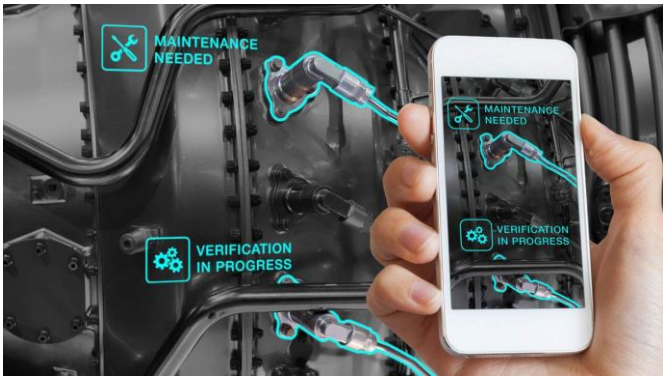
4. Projector based AR-Technology

The **Projector based AR-Technology** uses advanced projection technology with the goal to **simplify complex manual tasks** in a manufacturing company. This technology can also be used in the for training courses for workers. For instance, employees can follow a step-by-step guide on how to create a product. **Light indication** will be used to make each step of the task easy and comprehensible.

6. Advantages of this technology in manufacturing

There are many benefits which using augmented reality applications in the manufacturing sector can bring us. Here are several listed:

- **Production & Assembly**
  - Every product created need to properly follow a set of assembly instructions. AR Technology can help workers follow all these steps precisely and it's easier for them to understand these steps than reading it of a PDF. On top their work will be in a interactive way which will lead them to finish their tasks faster and smarter
- **Augmented Reality Employee Training**
  - AR can be used in the formation of new employees. They can learn difficult tasks and concepts easily with vivid representations.
- **Augmented Reality Machine Maintenance & Support**
  - Manufacturing companies can use AR to scan the problem on the machine and employees can follow a step to step guide to repair it. This process will be faster than trying to solve the issue using a manual.
  - Companies can offer to customer an interactive customer support via telecommunication. Technicians and experts can guide the customer with the help of AR to fix their issues by themselves. This service of customer support will be much more convenient for both parties.



7. Weblinks used for research

- https://www.youtube.com/watch?v=H7ZHemE2nRs&ab_channel=RyanKopinsky
- https://computer.howstuffworks.com/augmented-reality.htm
- https://www.blippar.com/blog/2018/08/21/what-is-augmented-reality-and-how-does-augmented-reality-work#:~:text=Augmented%20reality%20(AR)%20adds%20digital,the%20physical%20world%20around%20you.&text=In%20practice%2C%20this%20could%20be,the%20physical%20streets%20around%20you.
- https://www.newgenapps.com/blog/augmented-reality-technology-how-ar-works/
- https://www.techslang.com/how-does-augmented-reality-work/