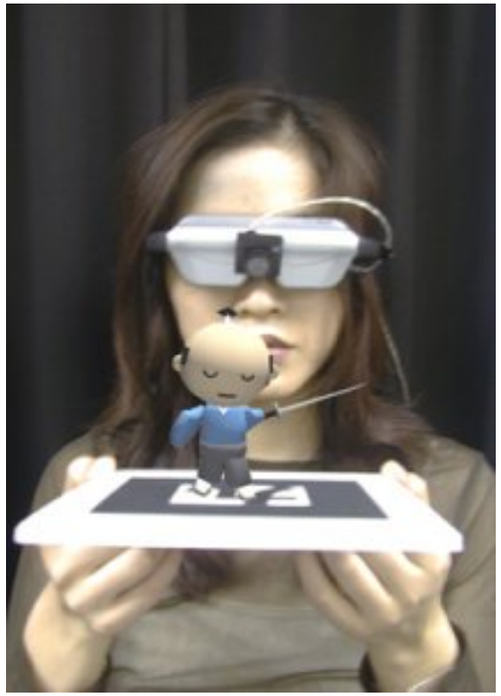
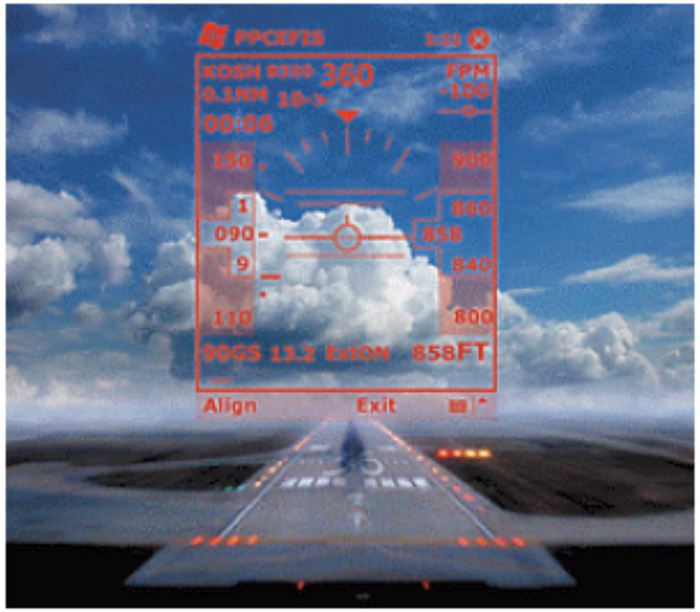
# Augmented Reality

**Modern Topics in Information Technology**
**4th Year – Semester 1**
**Lecture 02 - Part I**
**By Ishara Gamage**

# What is Augmented Reality?



# What is Augmented Reality?

- **Augmented reality** (**AR**) is a field of computer research which deals with the combination of **real-world** and **computer-generated** data.

- Ronald Azuma defines an augmented reality system as one that:
  - The overlay of computer-presented information on top of the real world
  - Combines real and virtual realities
  - Interactive in real time
  - Registered in 3D
  - Not the same as “virtual reality”

# Historical Background

- From 1957 to 1962, Heilig created cinema of visuals, sounds, vibrations, and smells called Sensorama.
- 1966 – Ivan Sutherland, head-mounted display
- 1975 – Myron Krueger, Video place
- 1989 – Jaron Lanier coined the term **Virtual Reality**
- 1992 – Tom Caudell coined the term **Augmented Reality**

# Mixing of Realities

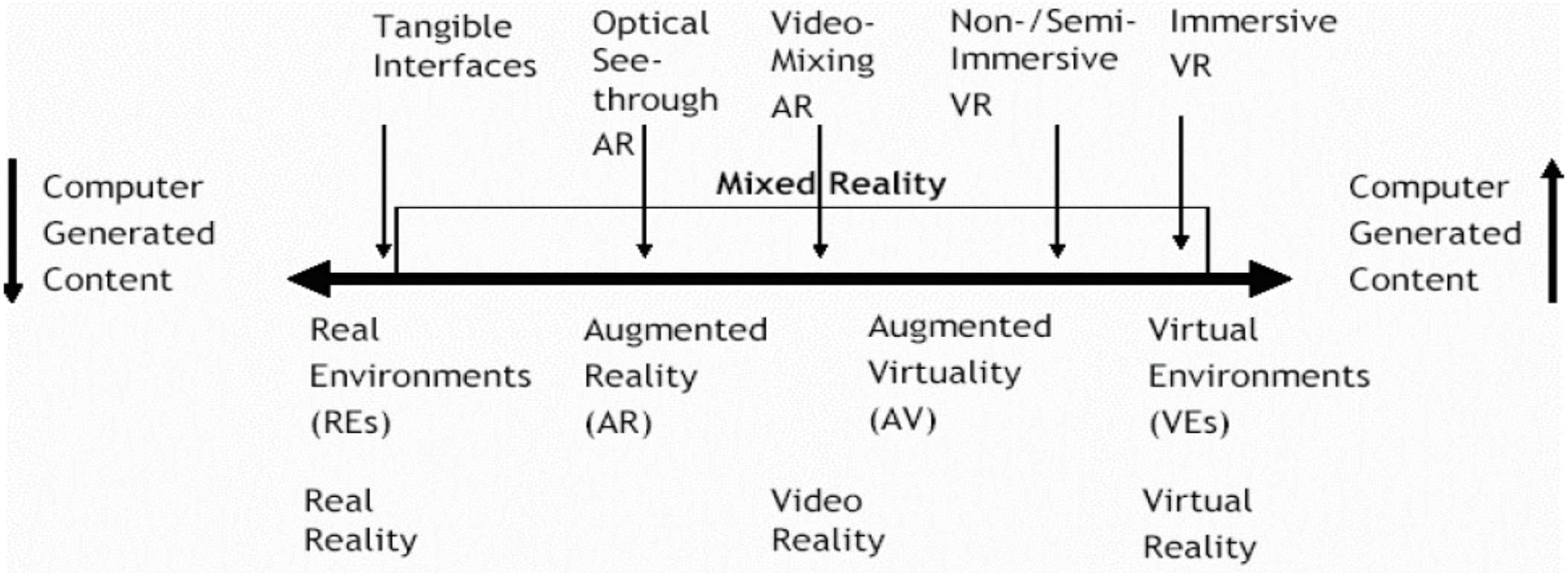
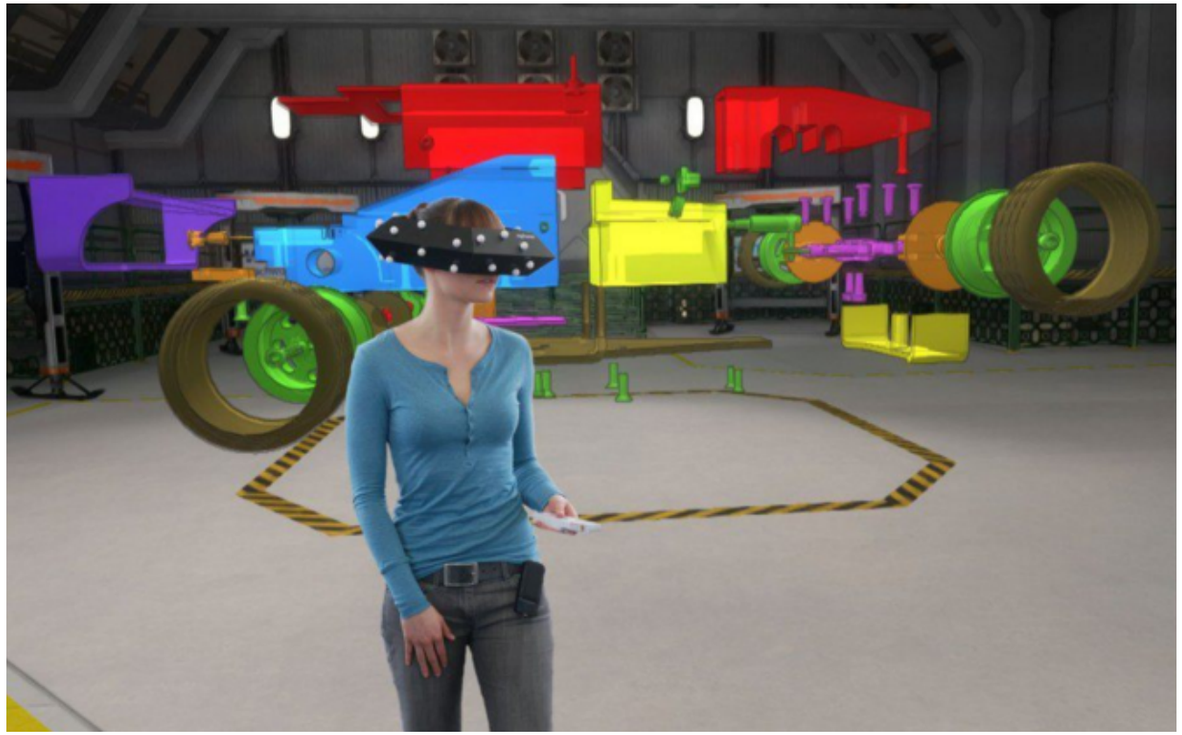



**Figure 1-3: Reality-virtuality Continuum (Milgram and Kishino 1994)**

# What is Virtual Reality



# Augmented Reality vs. Virtual Reality

- Augmented reality (AR) and virtual reality (VR) are fields in which the lines of **distinction are kind of blurred.**
- To put it another way, you can think of VR as the precursor to AR, with some parts overlapping in both. The main difference between the two technologies is that VR

- **Virtual reality**
  - Immerses the viewer into computer-generated environments
  - Requires equipment which completely obstructs visual view of physical objects in the real world
  - Does not use a camera feed.
  - All the things displayed in VR are either animations or prerecorded bits of films

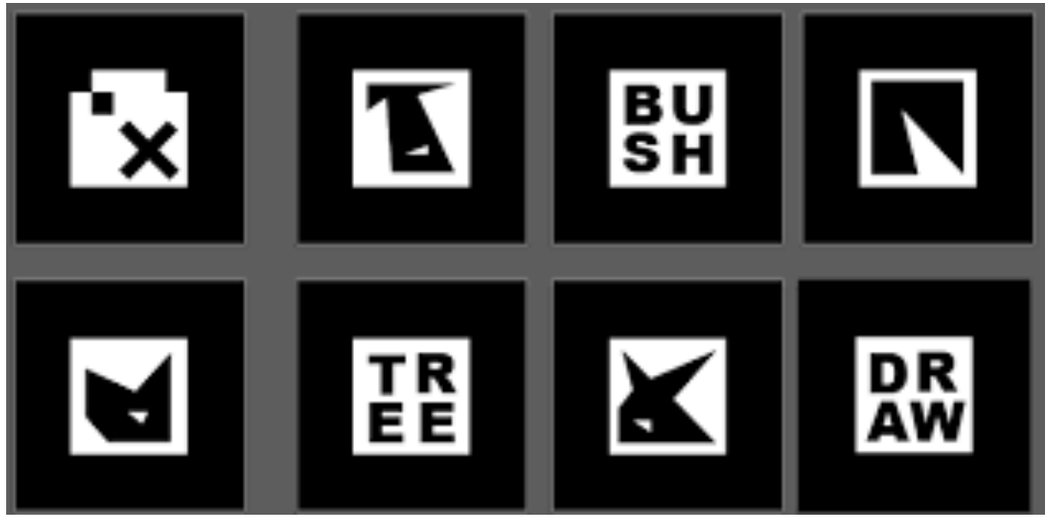
- **Augmented reality**
  - Augments or adds graphics, audio, and other sensory enhancements to the natural world as it exists.
  - Use Camera feed not Animations
  - System augments the real world scene
  - Needs a mechanism to combine virtual and real worlds
  - User maintains a sense of presence in real world

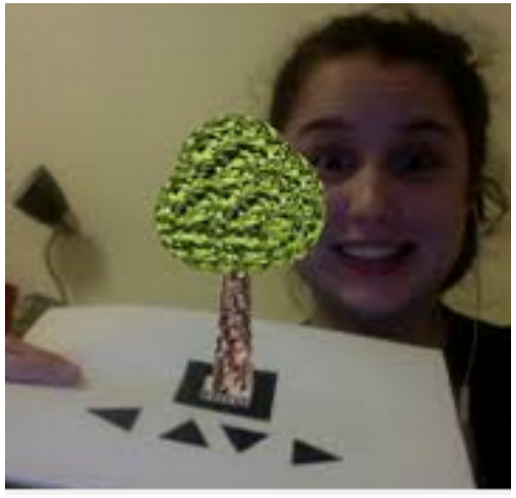
# What is needed?

- There are three components needed in order to make an augmented-reality system work:
  - Head-mounted display
  - Tracking system
  - Mobile computing power

# Marker-based vs. Marker-less Augmented Reality

# Markers in Augmented Reality



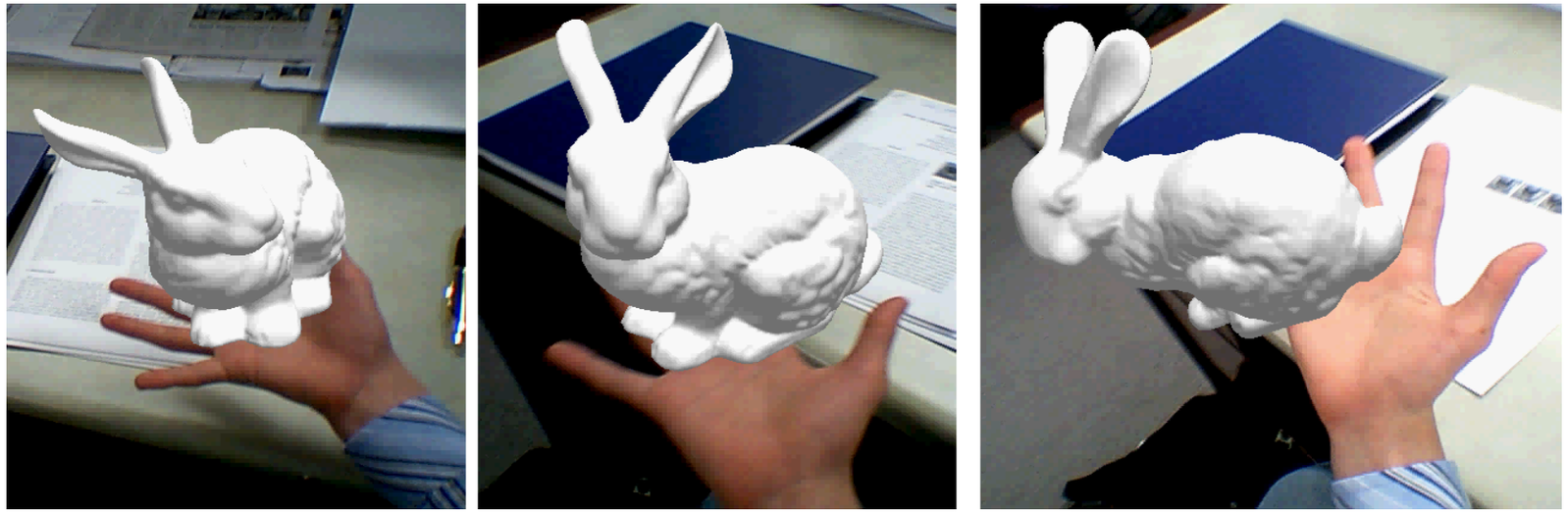



# Marker-based AR


- In a **marker-based AR** application the images (or the corresponding image descriptors) are provided beforehand.
- In this case you know exactly what the application should recognize while acquiring camera data.
- **Marker-based AR** application where image recognition is involved, the marker can be an image, or the corresponding descriptors (features + key points)

- **Marker-based** augmented reality is when the tracked object is black-white square marker. A great example that is really easy to follow shown.
- These are **easily recognized and tracked** not a lot of processing **power on the end-used device** is needed to perform the recognition (and tracking)

# Marker-less Augmented Reality



- **Marker-less AR** application recognizes images that **were not provided to the application beforehand.**

- This scenario is **much more difficult** to implement because the recognition algorithm running in your AR application should identify patterns, colors or some other "features" that may exist in camera frames.

# Marker-less Augmented Reality

- **Marker-less** AR typically uses the GPS feature of a Smart Phone to locate and interact with AR resources.

- **Marker less** augmented reality is when the tracked object can be anything else: picture, human body, head, eyes, hand or fingers etc. and on top of that you add virtual objects

- **Marker less** augmented reality systems are a better option for final applications, because they use normal images or objects as targets and they are no invasive like marker-based systems.

# Applications of Augmented Reality

# Applications of Augmented Reality

- Augmented Reality for Advertising Applications
- Augmented Reality for Marketing Applications
- Augmented Reality for Industrial Applications
- Augmented Reality for Scientific Applications
- Augmented Reality for Arts Applications
- Augmented Reality for Educational Applications

# Augmented Reality for Advertising Applications


- Movie character speaks to you when you pass her outdoor movie poster


City Sites Tour

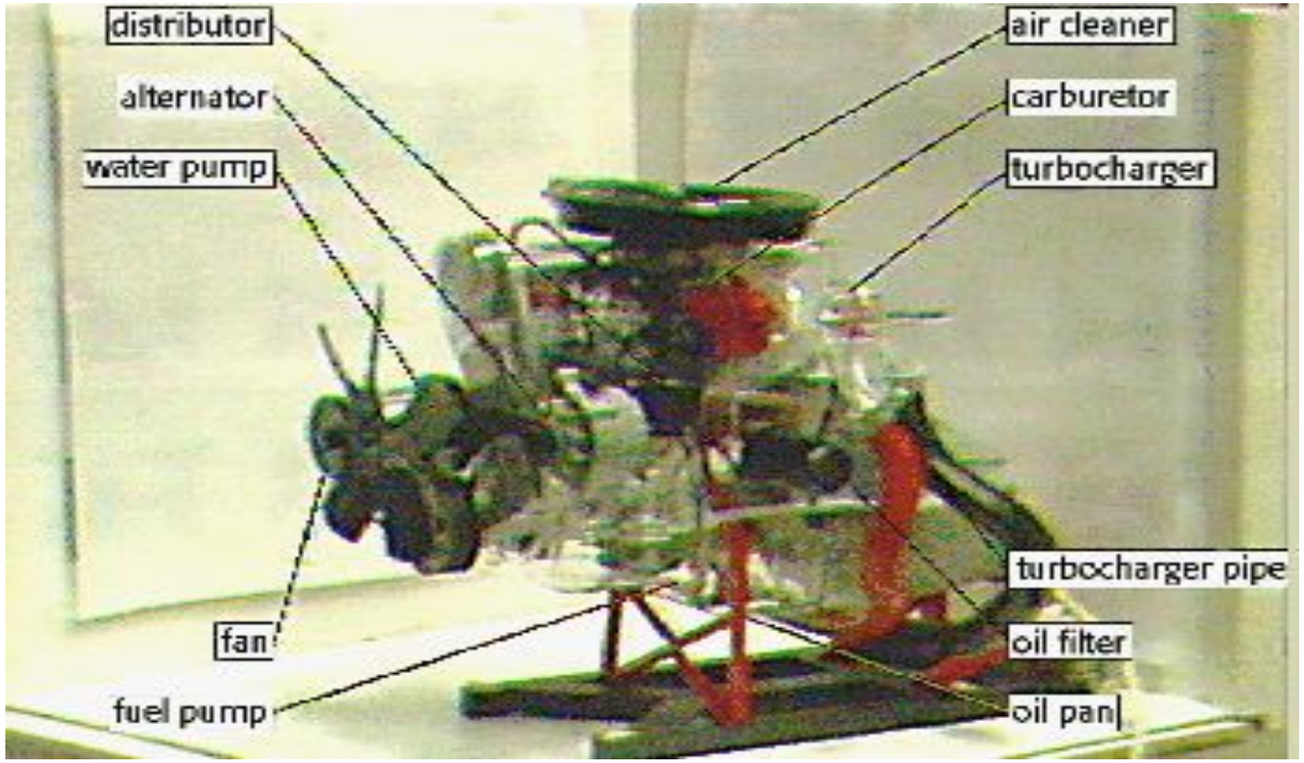
- The other example is a city sites tour available in most major metropolitan areas.

# Augmented Reality for Marketing Applications


Social shopper

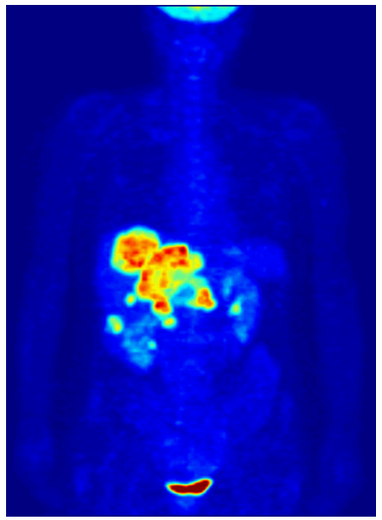

Restaurant search

# Augmented Reality for Industry Applications


- Compare the data of digital mock-ups with physical mock-ups
- Provide instructions, specs, and training for mechanics and machine operators

# AR for Scientific Applications



Whole body PET scan

Laser Scanned Patient

Terrain rendering

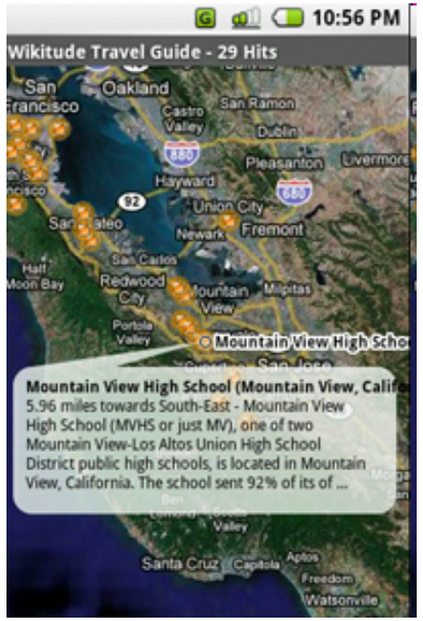
# AR for Arts Applications



# AR for Educational Applications

# Wikitude – Augmented Reality Travel Guide

- Mobile travel guide for the Android platform (open source OS for cell phones).
- Plan a trip or find about current surroundings in real-time.





# Braille Reader Application

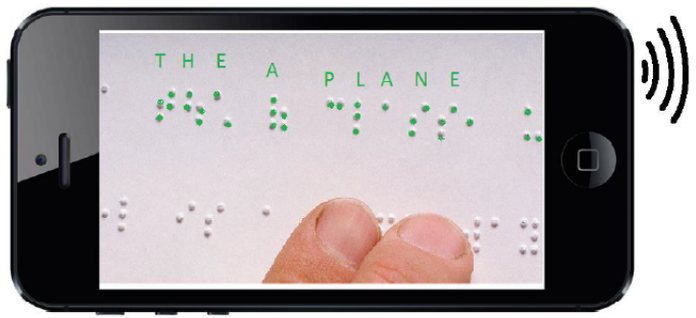



Figure 6: Braille Reader App Design

- The user would scan the braille using edge detection software to recognize the braille dots then the software would read out loud what the braille says to the user.

# Augmented Audio

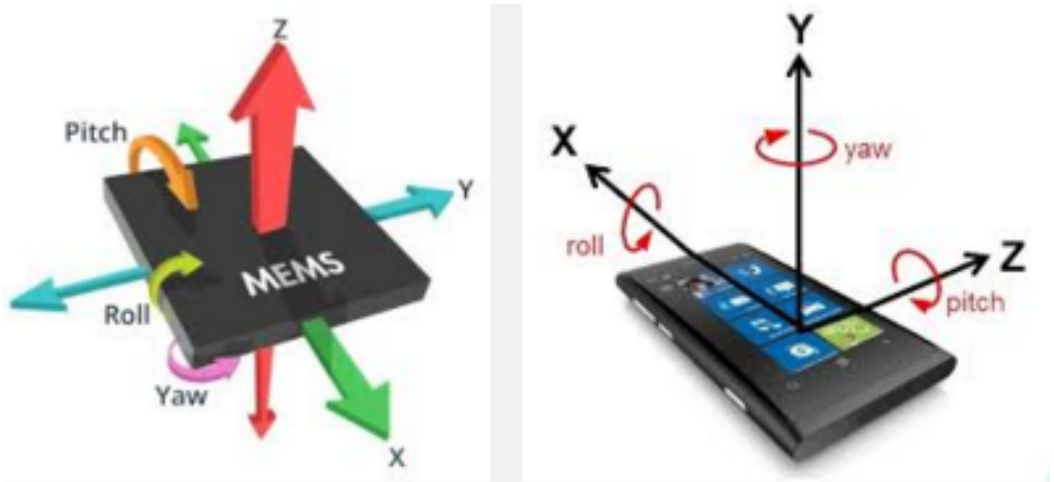

**Figure 7: Blind Maps Attachment (Designboom 2013)**

- The majority of AR apps create visible augmentation such as 3D objects.
- This app would focus on the audio possibilities of AR.
- The idea was created whilst reading Harma (2004) paper on augmented audio.

- Braille-like interface used to navigate the visually impaired around urban areas, would further extended the concept.
- The user would scan written/typed text translating it into braille, raising the dots on the attachment for the user to read.

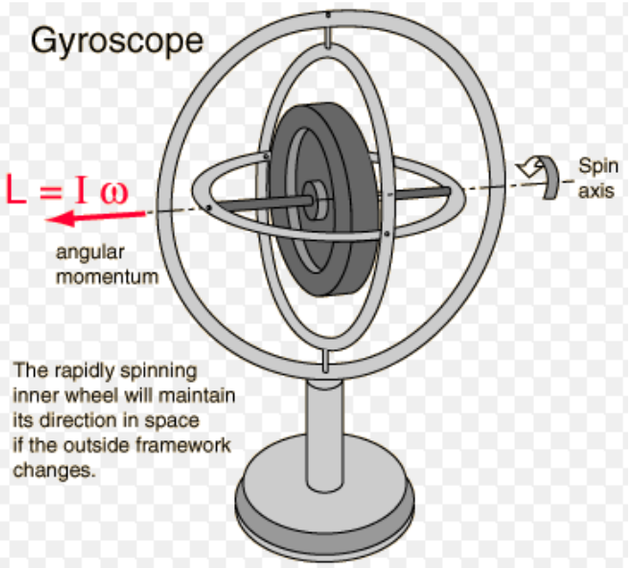
# How does Augmented Reality Work?

# Sensors support for AR




Accelerometer

Magnetometer




Gyroscope

- **Accelerometer** - Accelerometers in mobile phones are used to detect the orientation of the phone.
- **Magnetometer** – To identify the direction of which the camera is pointed and changes the Augmented 3D object direction to match.
- **Gyroscope** – To identify the orientation of the floor and the 3D objects camera.

# Classifications of AR Systems

- Hardware of the AR systems – (Type of tracking systems)
- Visualization approach – (ST, Video mixture) – most well known classification
- Distance – (Indoor, Outdoor)
- Communication – (Wireless, Hardwired)

# Components in AR systems

- There are 4 general components in AR systems
  1) Displays - Critical components where the level of immersion is concerned
  2) Tracking Systems - Responsible for accurate positioning and orientation in the real world
  3) Devises or Interaction – HMD
  4) Graphics Systems - Responsible for generating the virtual objects

- Setup of AR Systems
  1) MB_AR - (Monitor-Based AR Systems)
  2) ST_AR – (See-Through AR Systems)
  3) SAR – (Spatial AR Systems)

# Monitor-Based AR Systems (MB_AR)

- Allows the user to observe the real world and the superimposed virtual objects on a regular display, thus **without need to wear special glasses.**

- Widely used in laboratories for testing systems and creating low-cost demonstrations

- Real world are enhanced with the virtual scene (generated by a conventional graphic system) and visualized on the screen

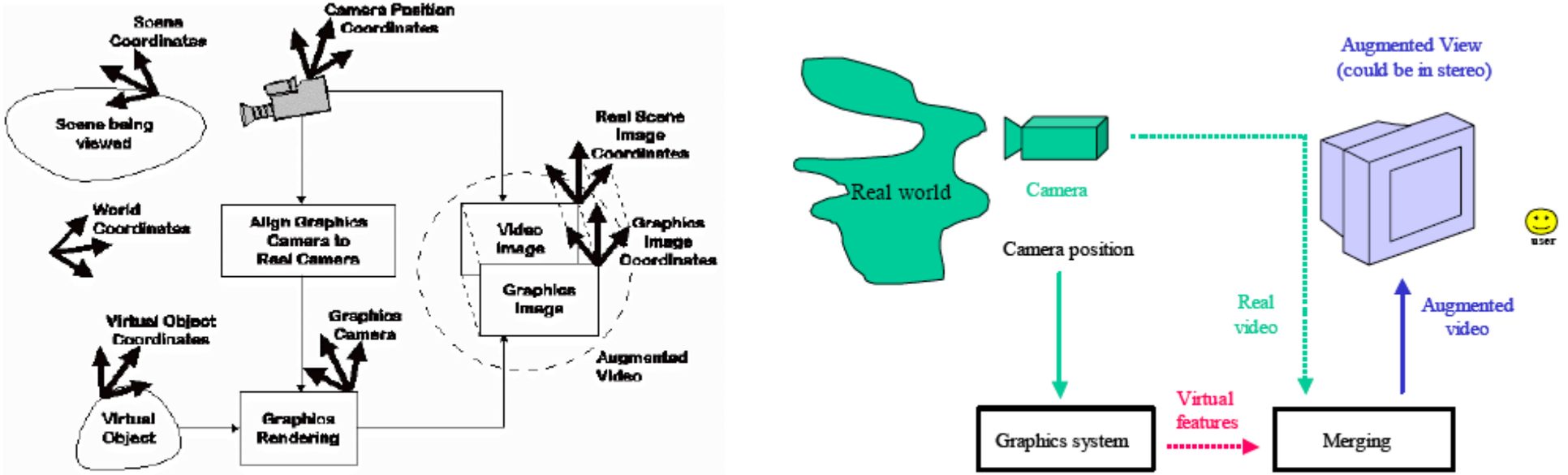



Figure 2-1: Basic components to achieve the augmented view (J. Valino, left) and Monitor-based AR (right)

# See-Through AR Systems (ST_AR)

- Much more complex - Allow the user to observe the surrounding environment.
- Most of the research and development efforts are toward development of ST-AR systems

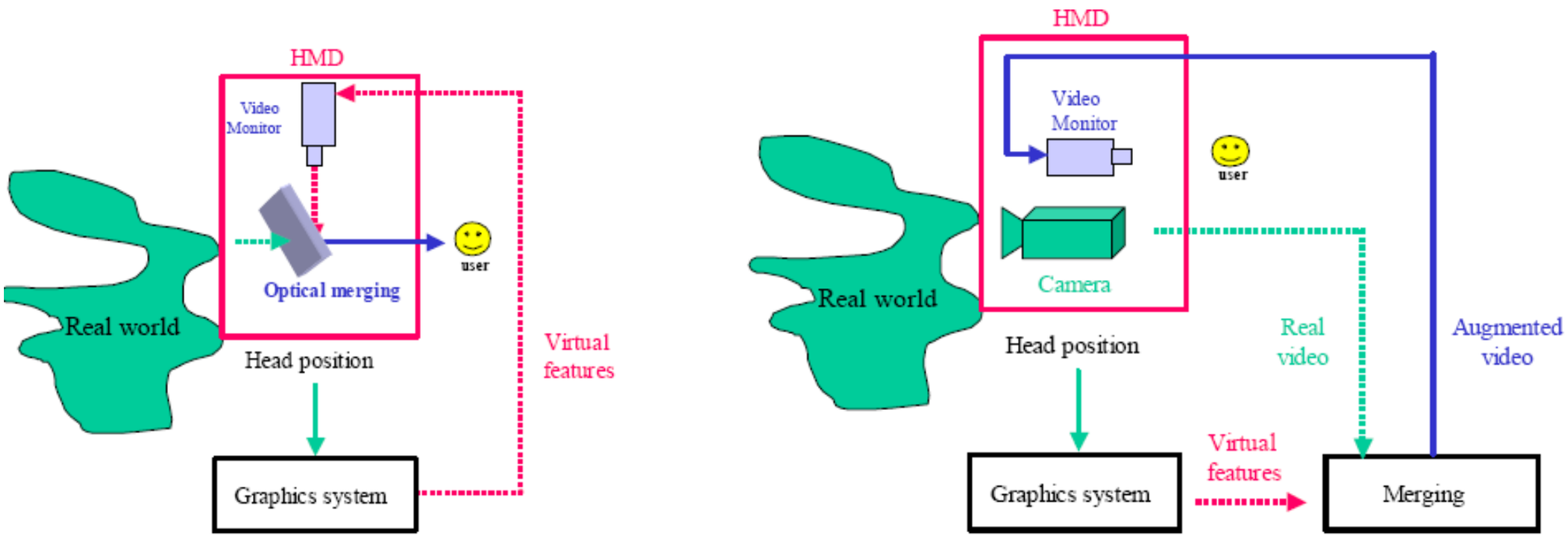
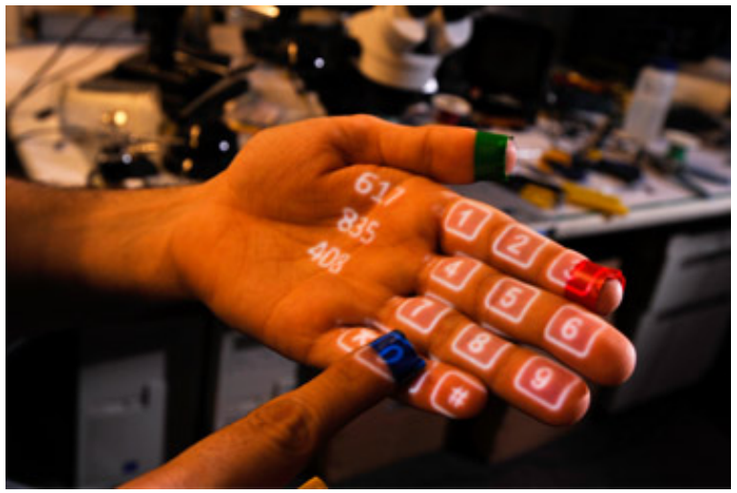



Figure 2-2: ST-AR systems: optical see-trough (left), video see-trough (right)

# Spatial AR Systems

- Spatially Augmented Reality (SAR) systems is also gaining popularity
- Projecting the view in the real world and thus avoiding the use of HMD.
- Virtual Object projected onto physical environment.




AR Phone Keypad

AR Keyboard

# Head-mounted display

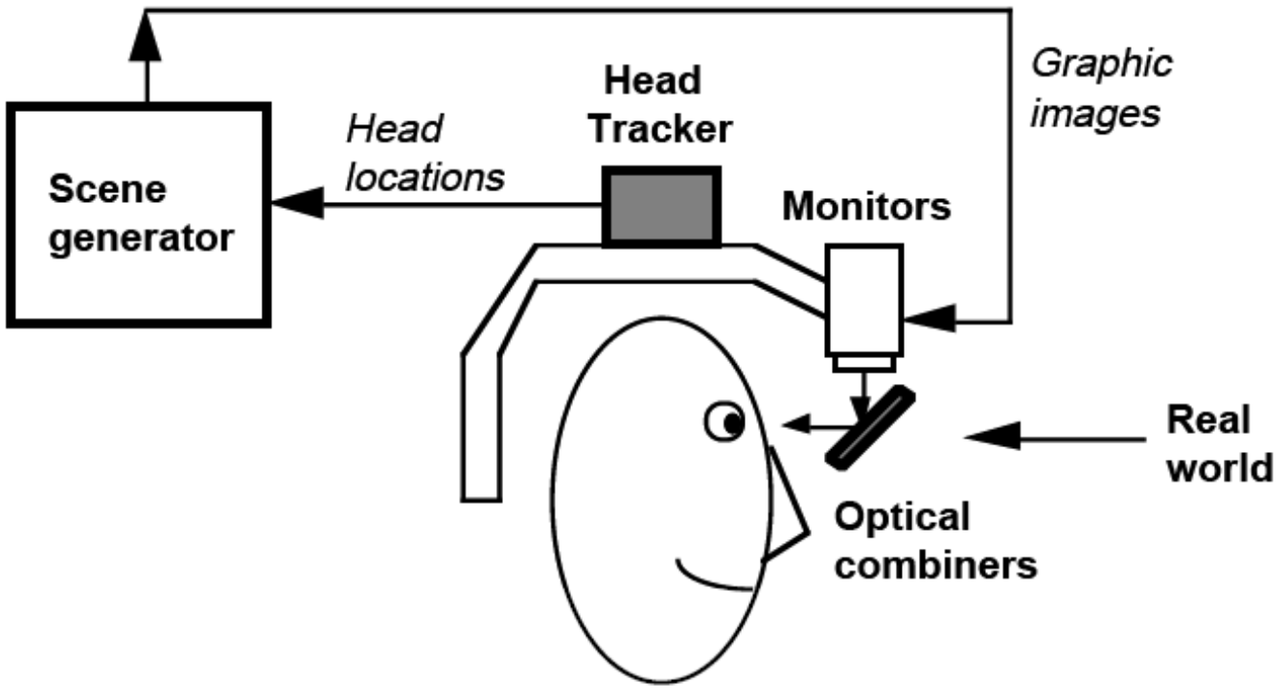



Figure 11: Optical see-through HMD conceptual diagram

Two optical see-through HMDs, made by Hughes Electronics

# Monitor-based AR Concept

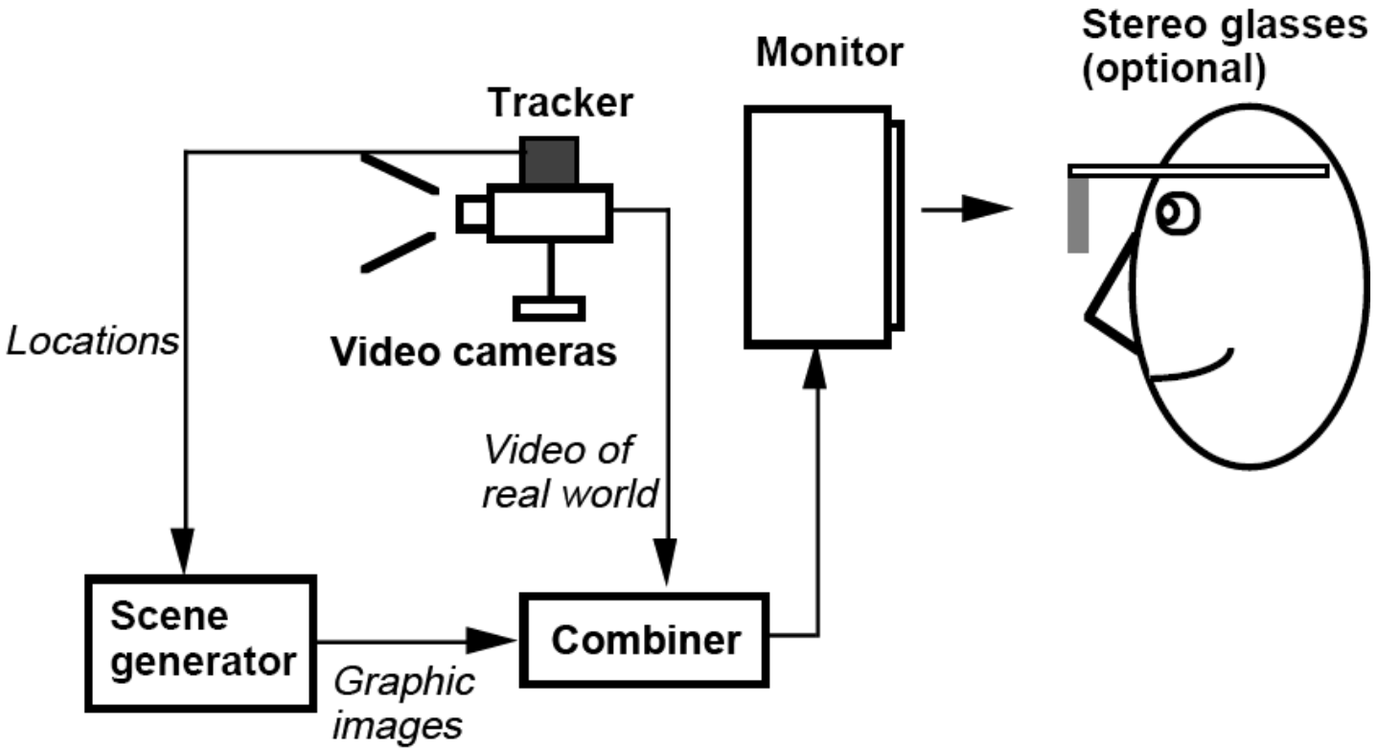



**Figure 15: Monitor-based AR conceptual diagram**

# Scale identification of Real-world objects

Mapping and 3D object placement component Flow


Isolate Objects

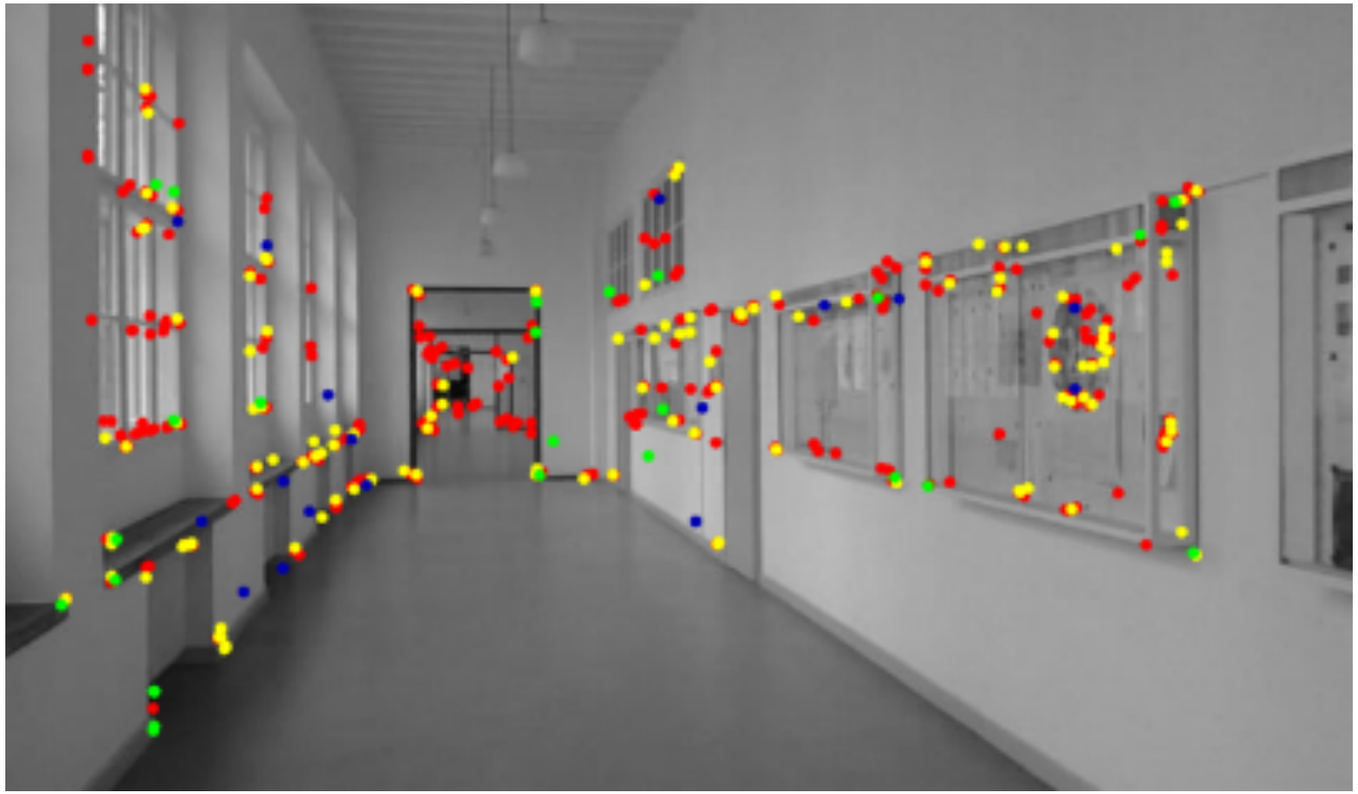
Get accelerometer readings, and Camera Focal Length

Derive Pitch angle, Height of the camera(respect to ground)

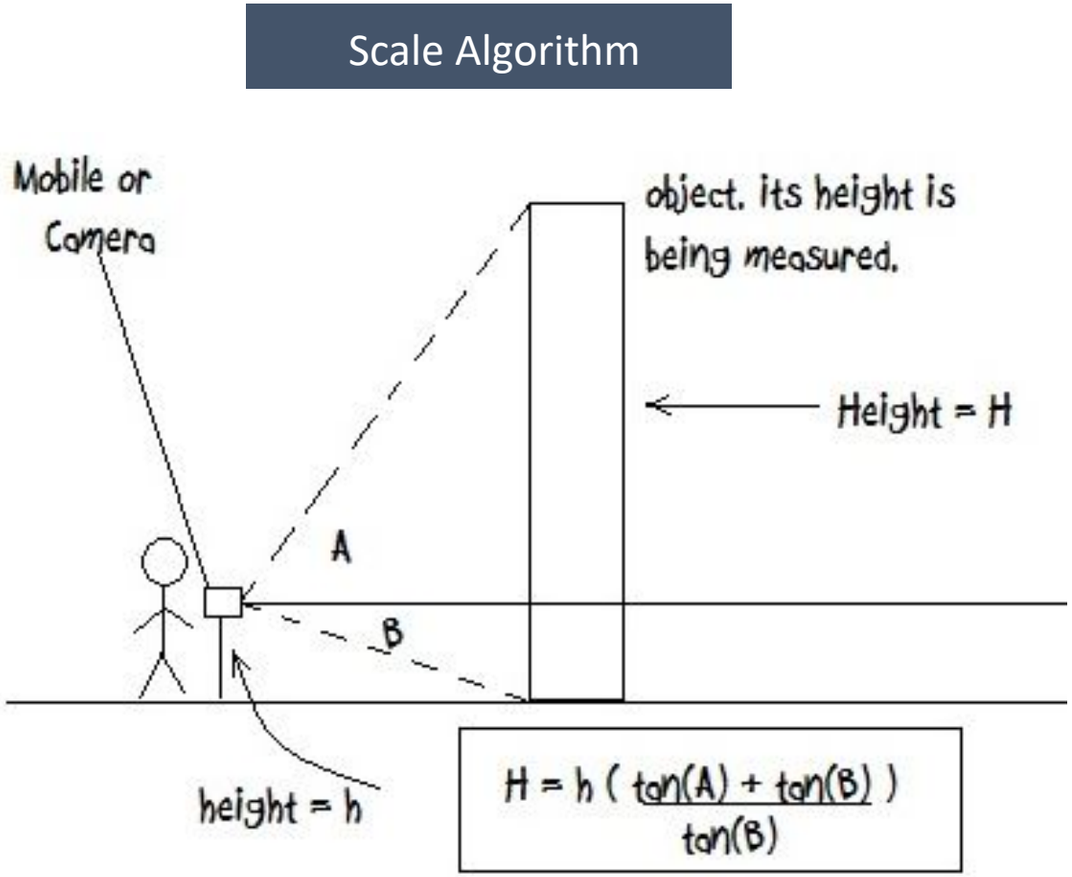
Estimate Height of the object

Calculate Other Dimensions

# Scale Algorithm



Initiate Scanning & obtaining tracking features




Calculate Dimensions through inputs from accelerometer , focal length of camera.

# Thank You