Virtual reality:
3D interactive environment

Multimodal Interaction course
Computer Science Master Degree
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Objective

- Track user position in space
- Using low cost equipment
- Create a 3D environment which responds to the user movements
- As a generic framework for Virtual Reality applications

Virtual Reality

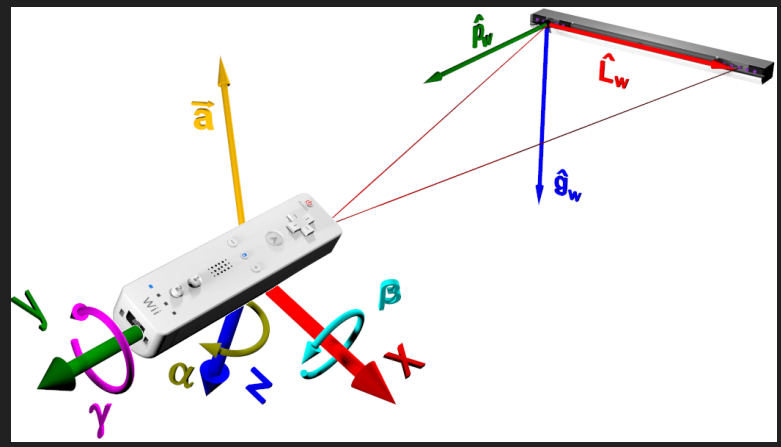
Virtual reality or **virtual realities** (**VR**), also known as **immersive multimedia** or **computer-simulated reality**, is a computer technology that replicates an environment, real or imagined, and simulates a user's physical presence and environment to allow for user interaction. Virtual realities artificially create sensory experience, which can include sight, touch, hearing, and smell.

(Wikipedia)

Virtual Reality

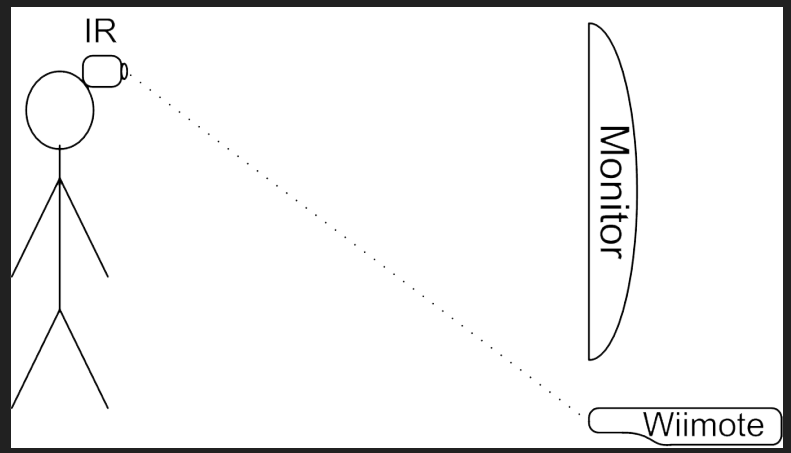
Wiimote & sensorbar

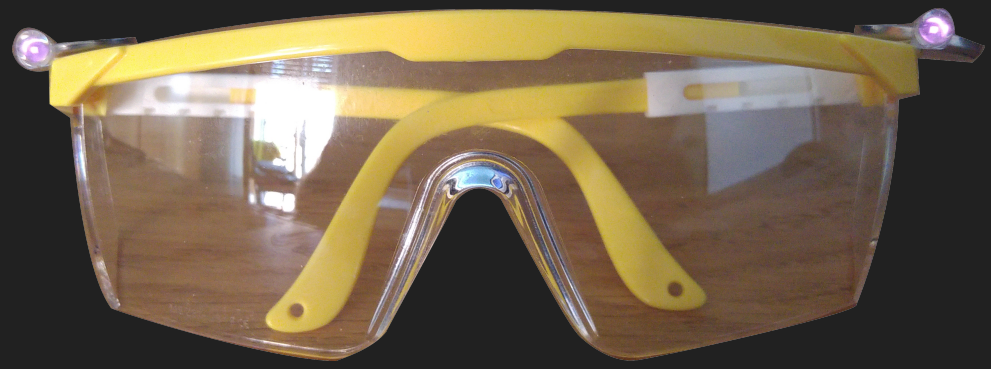
- In order to track user movements we used the Wiimote
- The Wiimote is a bluetooth game controller designed by Nintendo
- It is equipped with sensors and an IR camera
- Paired with the “sensorbar” its main use is as pointing device
- Reversing this paradigm we’re able to do head-tracking



Wiimote & sensorbar

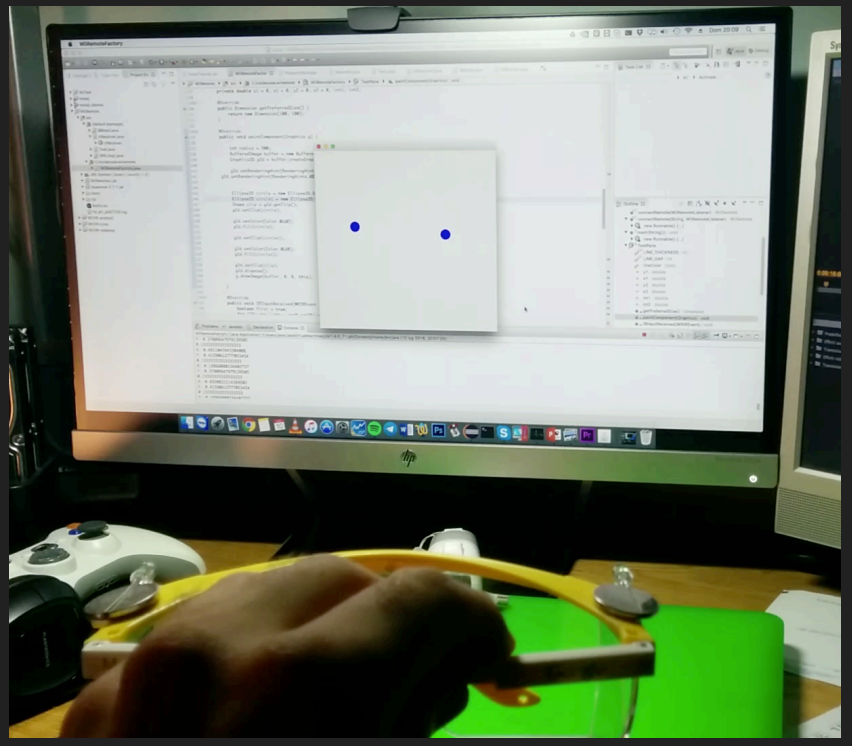
- We placed the sensorbar on the user's head
- For convenience and improve the usability we simulated the sensorbar mounting IR leds on glasses



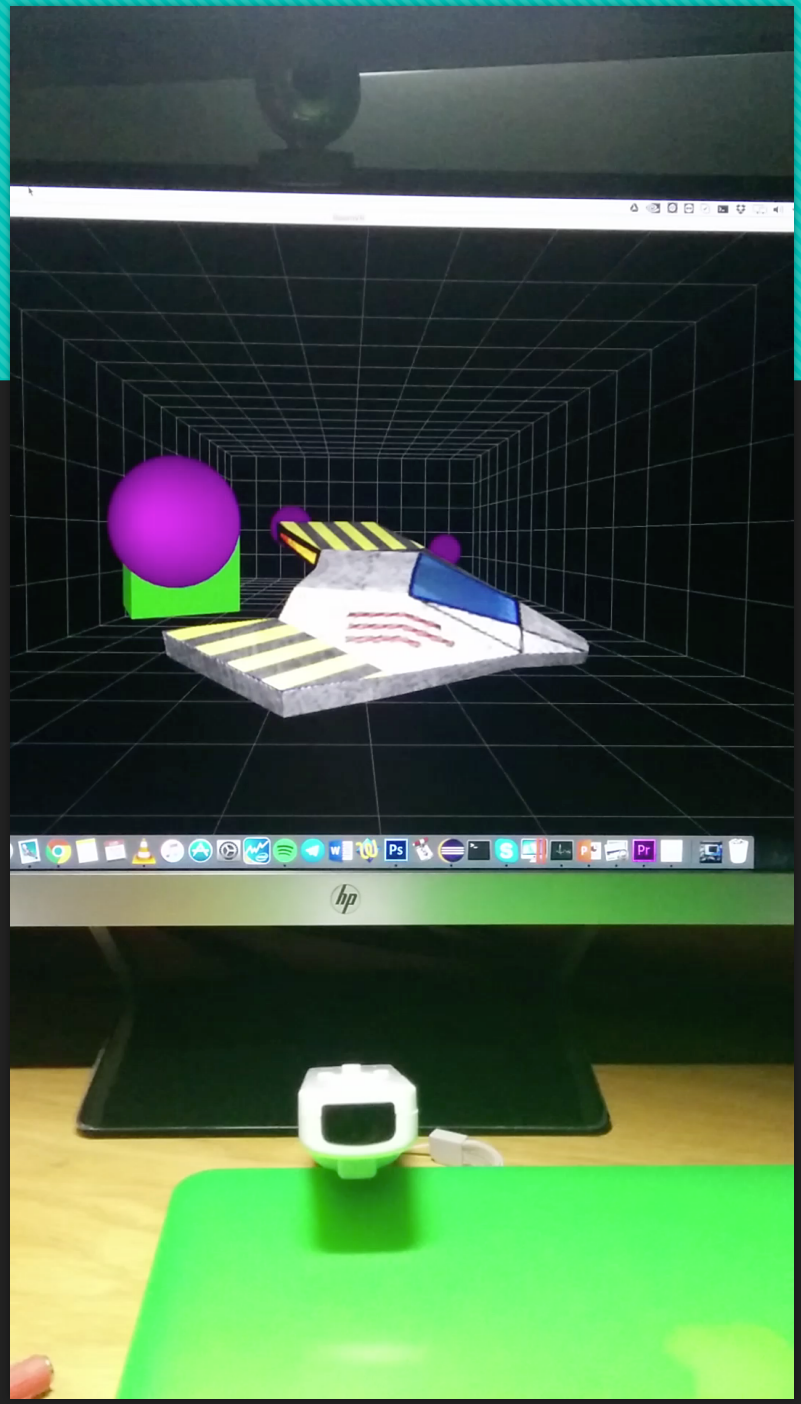


Wiimote

- The controller is provided with buttons, accelerometers, vibration and a frontal IR camera capable of hardware tracking up to 4 points

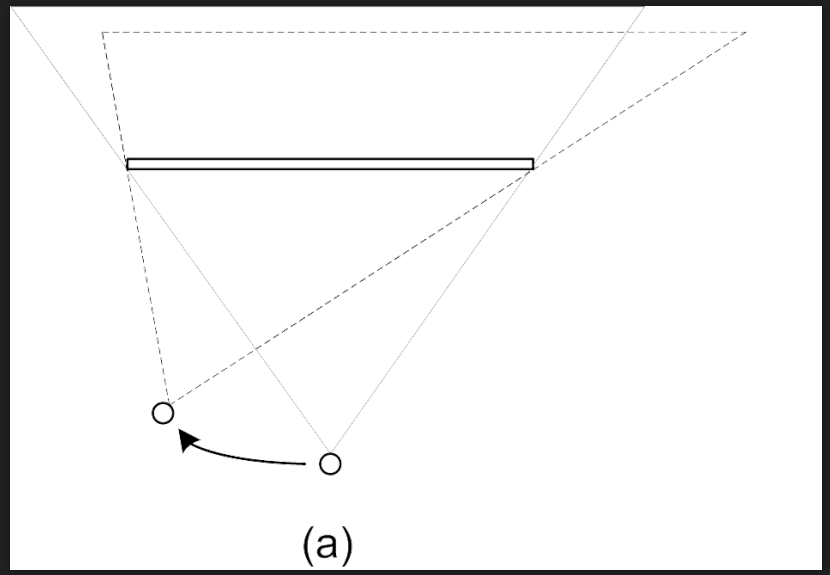


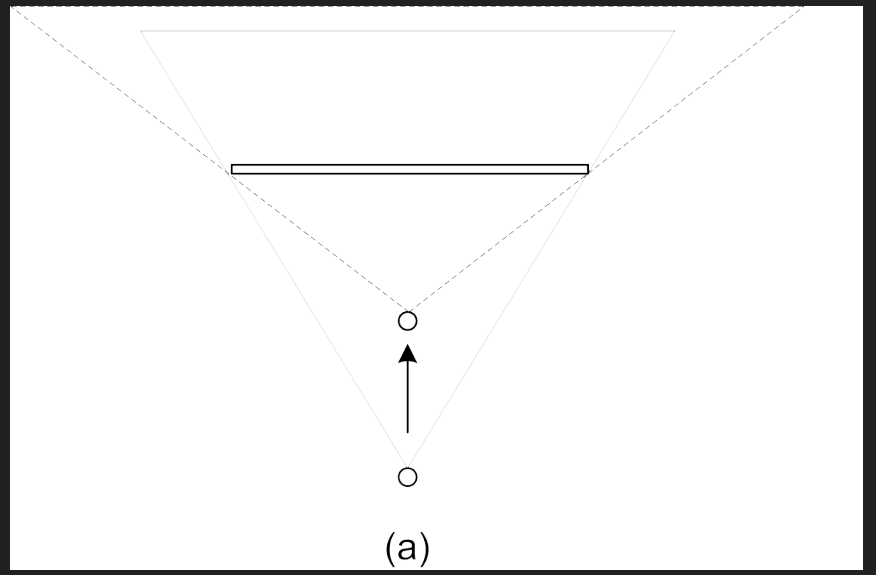
Final Result



Movements

- The main goal is to reproduce the effect of looking out of a window on a flat monitor





Headtracking

- In order to do this the system needs to know the relative position of the user's head wrt the monitor
- This problem is knows as head tracking
- Wiimote IR camera provides easy and precise solution even in low light settings

Headtracking

- The system tracks the user in a 2D space
- Calculus are needed to derivate the user position in 3D
- From the coordinates of 2 points we are going to calculate
  - Position in z axis
  - Position in x axis
  - Position in y asix

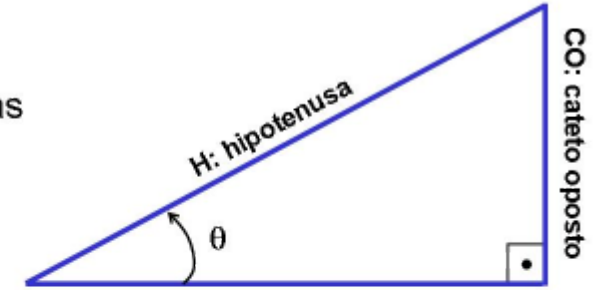
Computing position

- Computing the position in 3D requires few additional parameters
  - The physical distance between the LEDs
  - The physical monitor size
  - The radians per pixel camera constant (for angle measurements)

z-distance

- Computing the z-distance is quite easy and requires few trigonometric notions

Relações trigonométricas

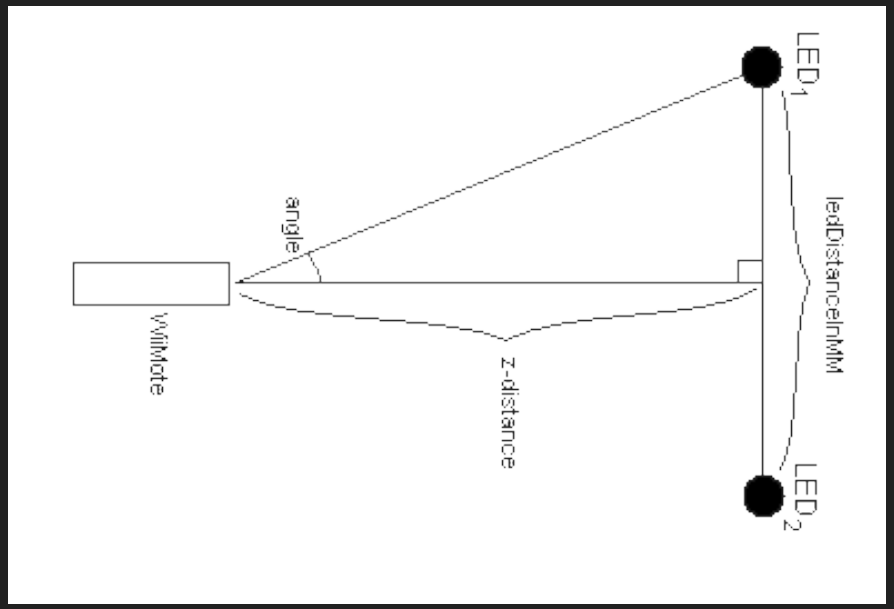


$$\cos\theta = \frac{CA}{H}$$

$$\text{sen}\theta = \frac{CO}{H}$$

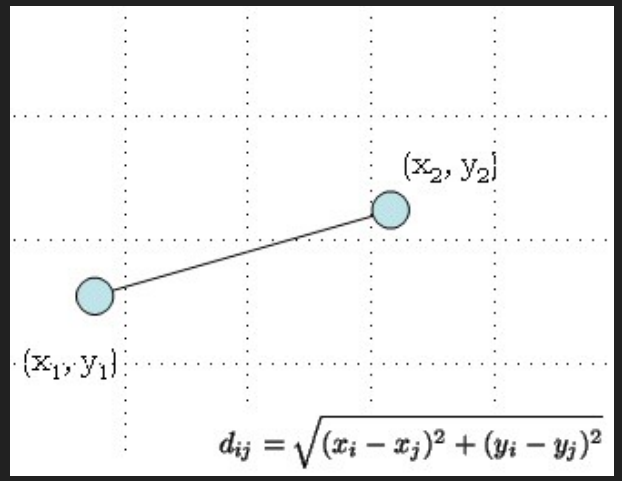
$$\tan\theta = \frac{CO}{CA} = \frac{\text{sen}\theta}{\cos\theta}$$

	0° 0 rad	30° π/6 rad	45° π/4 rad	60° π/3 rad	90° π/2 rad
cos	1	$\sqrt{3}/2$	$\sqrt{2}/2$	0,5	0
sen	0	0,5	$\sqrt{2}/2$	$\sqrt{3}/2$	1
tan	0	$\sqrt{3}/3$	1	$\sqrt{3}$	-



z-distance

- In the first step we're going to compute the angle between the middle point and the center of the view angle
- We use the pixelRadians constant computed knowing the camera definition and the view angle range
- The distance between LEDs is computed in the euclidean way



$$angle = pixelRadians \times \frac{ledDist}{2}$$

z-distance

- Using the trigonometric equations we can compute the z-distance
- The distance is also proportional to the screen size

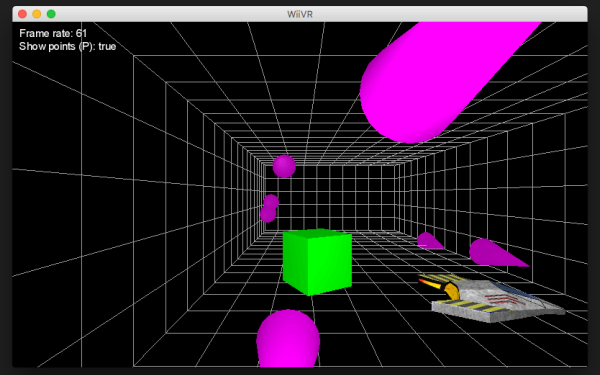
$$zDistance = \frac{ledDistanceInMM}{2} * \frac{1}{\tan(angle) * screenSizeInMM}$$

Software

- VR software realized in Java
- Two main components
  - Wiimote data elaboration system
  - 3D rendering engine
- Wiimote data parsed using Bluecove together with WiiremoteJ libraries
- LibGDX videogame framework as 3D platform

Software

- The application creates a 3D room represented as line grid
- A 3D model, a 3D figure and some targets are present in the room
- The user can navigate into the room and observe the objects reflecting the light depending on the current point of view
- In the up left corner there are some stats about the system and some configuration the user can choose to customize the view



Possible applications

- 3D model viewer
- Support platform for 3D artists
- Artistic live performance application (tracking dancers)
- Videogame VR framework

DEMO