3D User Interfaces – Tutorial 3

Speaker: Linda Rudolph, M.Sc. (Teaching Assistant)

Responsible Professor: Prof. Gudrun Klinker, Ph.D.

Summer Semester 2023

09:00 – 10:00 time for individual questions

10:00 - ~11:00 lecture part

Topics Today

Debriefing Homework 1 & 2
- IMUs for 3DUI
- Image Marker Tracking
  - Affordances and Signifier
- Wireless Connectivity
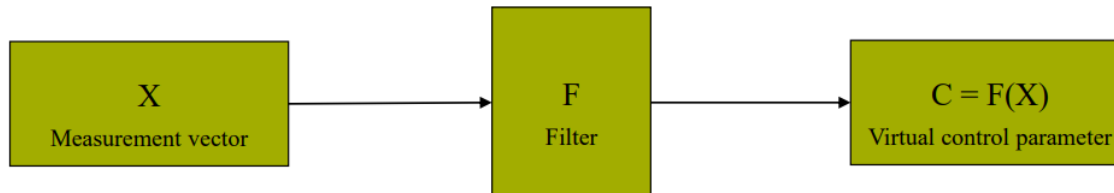
Ray casting methods in VR & AR
- In Unity
- Homework 3
- For handheld AR

Homework 1 - Debriefing

2. Interaction Techniques and Input Devices

2.3 Force versus Position Control

- *Isomorphic control*:
  - Absolute or relative **position** of the human hand (mouse, trackers, etc)

- *Non-isomorphic* (either *isometric* or *isotonic*) control:
  - Force applied to a device, speed of motion (**rate** of position changes) (joy stick)
  - ...

- For 6-DOF manipulation tasks: Position control usually better than force control [Zhai and Milgram 93]
- Force control better at controlling rates (speed of navigation).

```
┌──────────────────┐      ┌──────────┐      ┌──────────────────────┐
│        X         │ ───▶ │    F     │ ───▶ │      C = F(X)        │
│ Measurement vector│      │  Filter  │      │ Virtual control parameter│
└──────────────────┘      └──────────┘      └──────────────────────┘
```

检测力 ←

Isometric control
Device senses force,
but does not move

Isotonic control
Device is moved / displaced

Question: Which kinds of controls (Isomorphic/Non-isomorphic, Isometric/Isotonic) have you implemented in homework 1?

Homework 1 – Further Applications for IMUs

- Movement Patterns (Steps, Running, Driving a car)

- Posture control (https://mixed-news.com/en/head-up-huawei-unveils-tech-glasses-with-posture-control/)
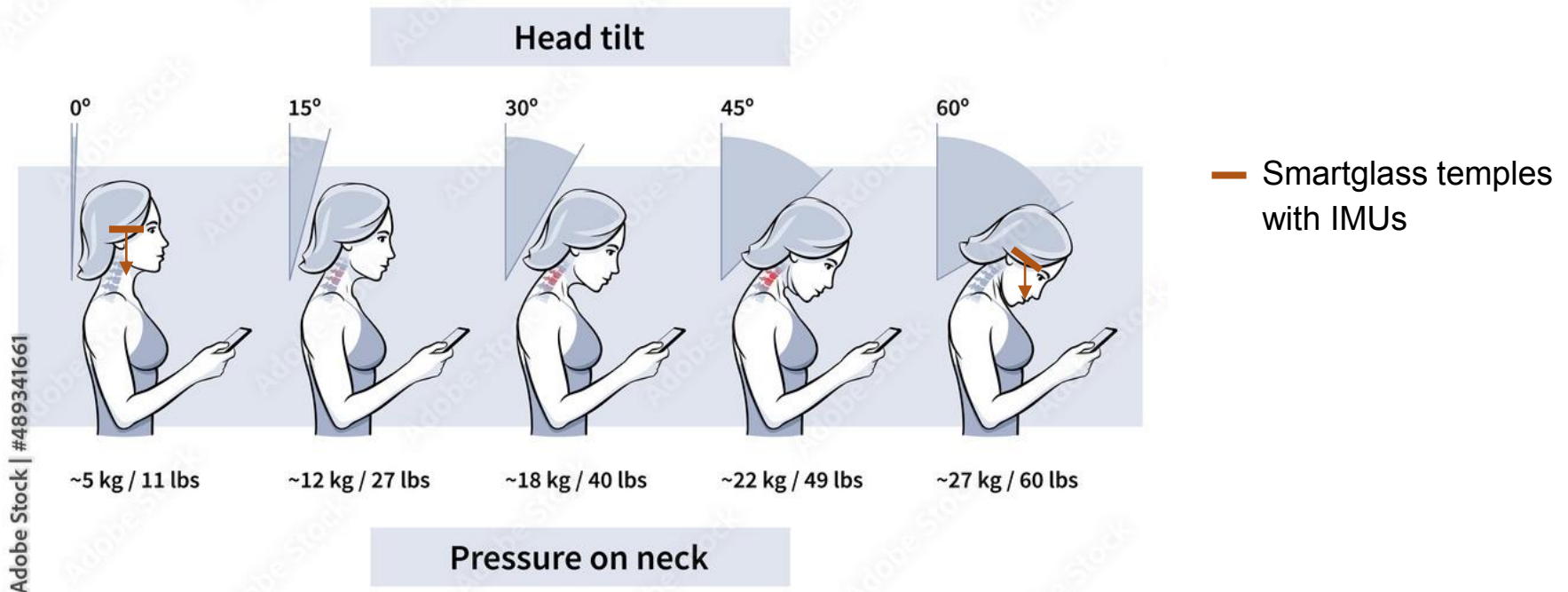

Head tilt

— Smartglass temples with IMUs

0°	15°	30°	45°	60°
~5 kg / 11 lbs	~12 kg / 27 lbs	~18 kg / 40 lbs	~22 kg / 49 lbs	~27 kg / 60 lbs

Pressure on neck
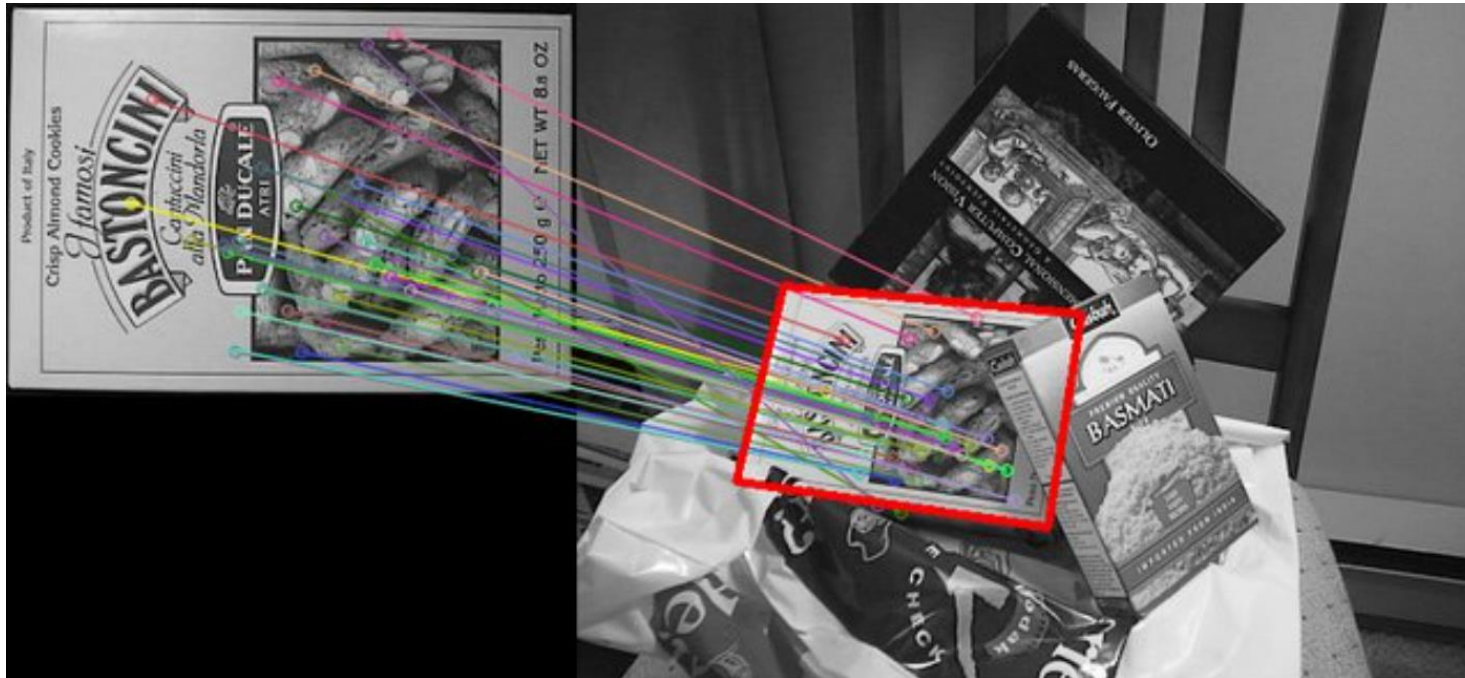
Adobe Stock | #489341661

Image Marker Tracking (Natural Feature Tracking)

Img: Jakubović, A., & Velagić, J. (2018, September). Image feature matching and object detection using brute-force matchers. In *2018 International Symposium ELMAR* (pp. 83-86). IEEE.
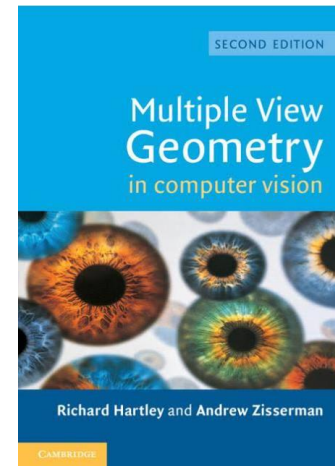
Further Information

Theoretical (Mathematical) Basis:

Prof. Cremers - Computer Vision II: Multiple View Geometry (also on Youtube)

Hartley, R., & Zisserman, A. (2003). *Multiple view geometry in computer vision*. Cambridge university press.

Practical Guide:

Baggio, D. L. (2012). *Mastering OpenCV with practical computer vision projects*. Packt Publishing Ltd.

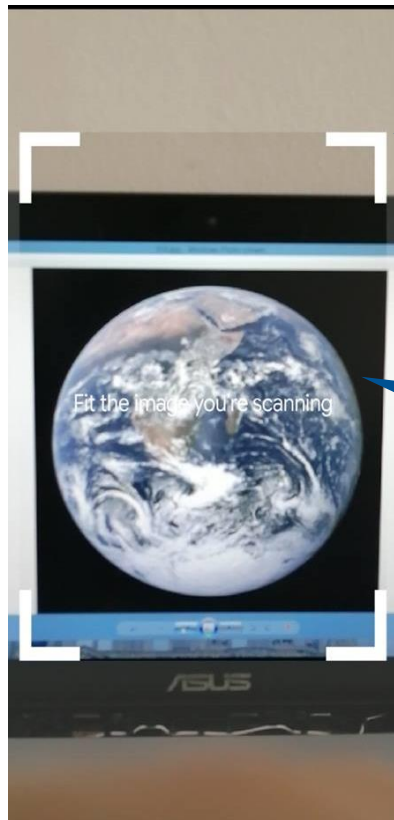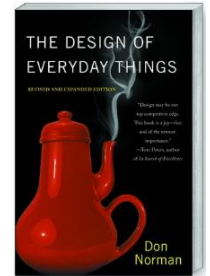# Homework 2 – Applications of Image Targets

Source: https://youtu.be/_qHY1qoIPOE Published by Youtube Channel Brick Finder, All rights by Lego, archived for educational purpose

https://www.youtube.com/watch?v=_qHY1qoIPOE

Affordances and Signifiers

Affordance = What a user can do with a device

Signifiers = Perceivable hints for affordances & constraints

Signifier: That visual frame on the screen

Affordance: "Scan" a specific physical image to see digital content

Affordance: Push the button to seal the coffee mug

Signifier: That little lock symbol

Homework 2: Device connectivity

- Several options for wireless connections
  - Bluetooth
  - WiFi / Mobile networks

- Several protocols
  - UDP/TCP
  - Bluetooth / ZigBee etc.

Question: Why are we using UDP and not TCP for the connection?

Last chance for questions about homework 1 & 2

Homework 2: Competition

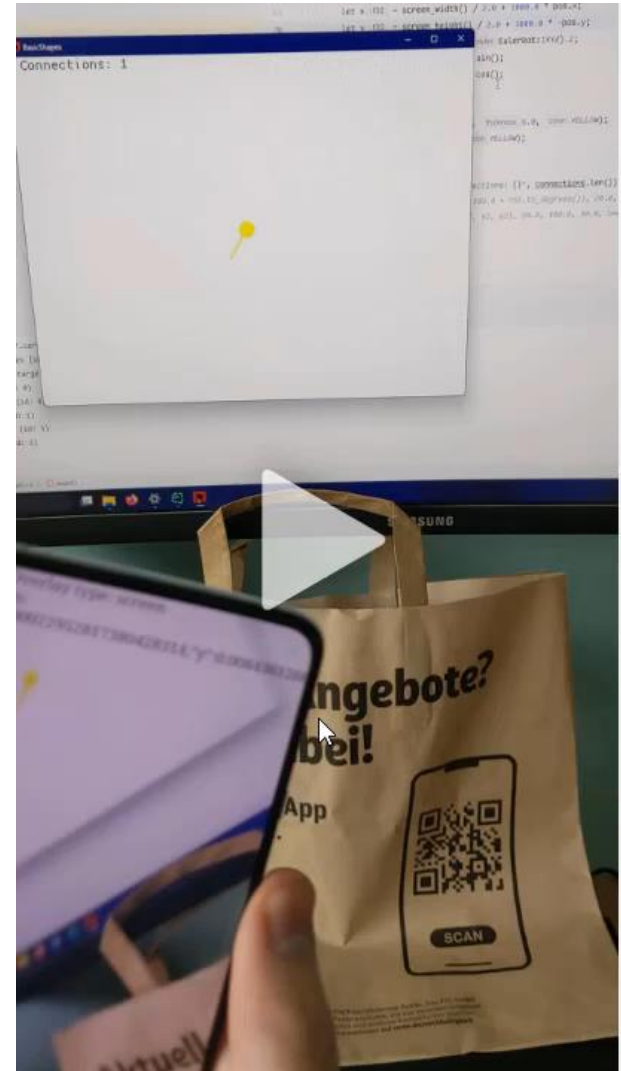Winner: Ao Gao & Michl Bayer

Special Price: Simon Dittrich (WebXR)

Wall of Honor (random order)

Tatev Tsokolakyan

Martin Hubert Schacherbauer

Paul Pernsteiner

Dhia Nouri

Ray casting

https://docs.unity3d.com/ScriptReference/Physics.Raycast.html

```csharp
using UnityEngine;

public class ExampleClass : MonoBehaviour
{
    // See Order of Execution for Event Functions for information on FixedUpdate() and Update() related to physics queries
    void FixedUpdate()
    {
        int layerMask = 1 << 8;
        layerMask = ~layerMask; //every layer except for layer 8 is selected

        Vector3 fwd = transform.TransformDirection(Vector3.forward);

        RaycastHit hit;

        if (Physics.Raycast(transform.position, fwd, out hit, Mathf.Infinity, layerMask))
        {
            print("There is something in front of the object!");
            if (hit.collider != null)
            {
                hit.collider.enabled = false;
            }
        }
    }
}
```

For Unity Beginners, also check: https://docs.unity3d.com/Manual/LayerBasedCollision.html

Virtual Hand Method

A Collider attached to the virtual controller intersects the desired object

• While intersected the object might change color or draw a bounding box around it to signal the user that it has been selected.

• A touch event selects the object.

Homework 3: Adding a ray cast functionality to the smartphone controller

Implement two 3D selection methods for the "server" scene in homework 2:
– Virtual Hand
– Ray-casting based selection

Step 1: In the server scene, add some virtual objects to select (like in homework 0)
Step 2: Implement the virtual hand and the ray cast based selection to the virtual controller
Step 3: change the color of virtual objects that are selected
Step 4: Add a touch event in the smartphone scene, publish it via UDP as well, use it to change the color of virtual objects in the monitor scene permanently

Reflect on:
• What happens if there are many "targets" close to each other?
• What happens with raycasting if the target is far away?
• What are the problems with each of these methods?

Ray cast methods for handheld AR
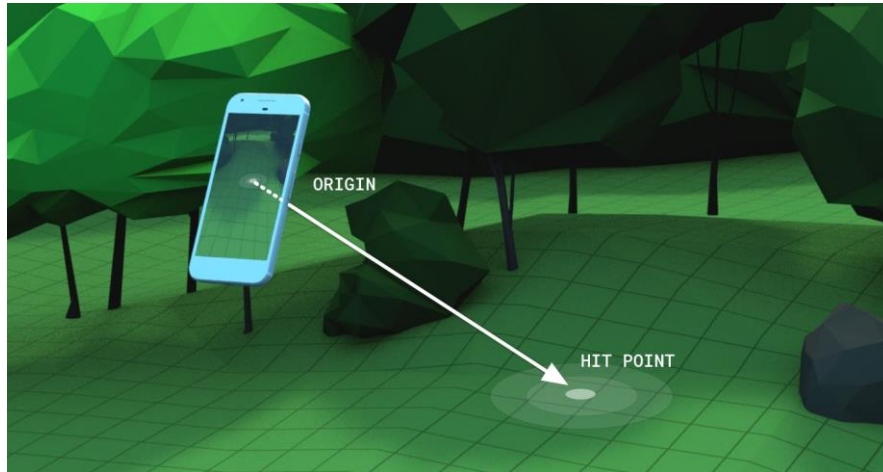
Source, image and video: https://developers.google.com/ar/develop/hit-test?hl=en (video archived for educational purpose)

Ray from the touch point on the screen to a collider

- Colliders can be…
  - Planes / objects in the "physical" world (Based on your tracking method)
  - Virtual objects

- Two methods: Either use center point of screen or touch position

Ray cast methods for handheld AR – Unity Vuforia

```csharp
using UnityEngine;

public class ExampleClass : MonoBehaviour
{
    // See Order of Execution for Event Functions for information on FixedUpdate() and Update() related to physics queries
    void FixedUpdate()
    {
        if(Input.touchCount > 0 && Input.touches[0].phase == TouchPhase.Began)
        {
            Ray ray = Camera.main.ScreenPointToRay(Input.GetTouch(0).position);
            RaycastHit Hit;
            if(Physics.Raycast(ray, out Hit))
            {
                ...
            }
        }
    }
}
```

Ray from the touch point on the screen to a collider

- Colliders can be…
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  - Virtual objects

- Two methods: Either use center point of screen or touch position

Homework 3 – Expert challenge (Optional)

The phone as a laser pointer (or mouse equivalent):

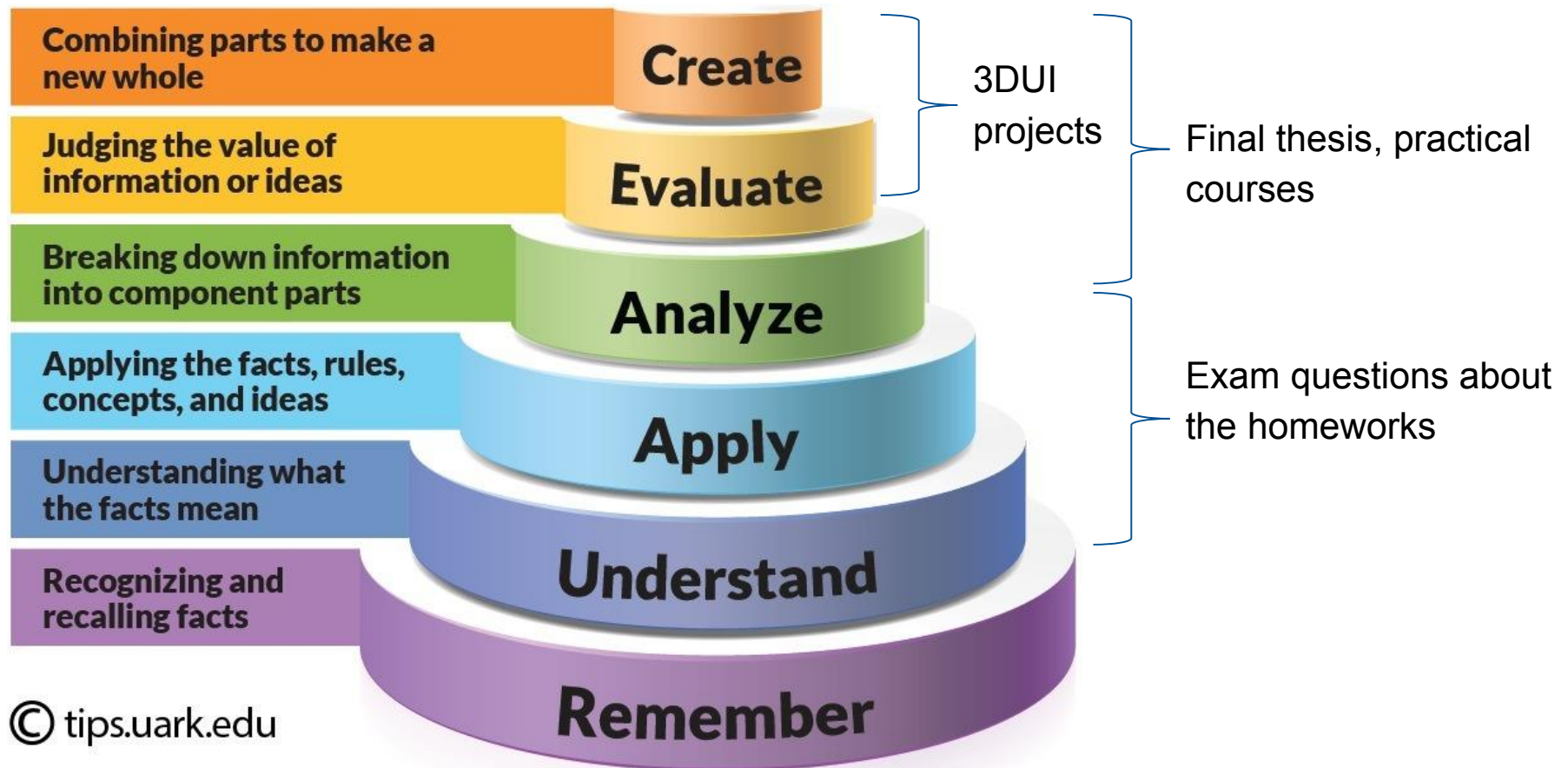Register the screen space to your image target, so that you can get the 2D-Screenposition

Hint:
- use a second (virtually shown) image target on your screen as a helper to get the monitor plane and use raycasting // hit testing

- then, anchor the screen corners to your "mouse pad"-image target (so that you can hide the virtually shown marker later)

- Send "just" the projected x,y coordinates to the server scene

Award
honor and a fancy input mechanic, useful for projector screens and big displays

For the exam, you do not need to memorize exact Unity Syntax!

Combining parts to make a new whole — Create

Judging the value of information or ideas — Evaluate

Breaking down information into component parts — Analyze

Applying the facts, rules, concepts, and ideas — Apply

Understanding what the facts mean — Understand

Recognizing and recalling facts — Remember

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3DUI projects

Final thesis, practical courses

Exam questions about the homeworks

Discord /
WhatsApp …
channel

Printed Targets

whoami

Coffee for the
challenge-
winners

Misc. topics

Who is standing there in front of you?

Linda Rudolph, M.Sc. (Doctoral Candidate)

What I do

Industrial Applications for Immersive Media
- Esp. construction industries & chemical industries

Virtualized Reality (V*R) and immersive Digital Twins
- Esp. 3D reconstruction, image based rendering & CAD (BIM) Models

Where I came from

Master of Applied Information Technologies – Computer Graphics and Media Technology
- Handheld devices
- Optical and Inertial Tracking technologies
- 2D/3D Data formats

Bachelor in Computer Science

What I also love to do

Teaching

- Games History (EIGE)
- Game Analysis Seminar, Augmented Reality Seminar
- Final Theses, Practical Courses…

Mushing

- "Sleighing with dogs"