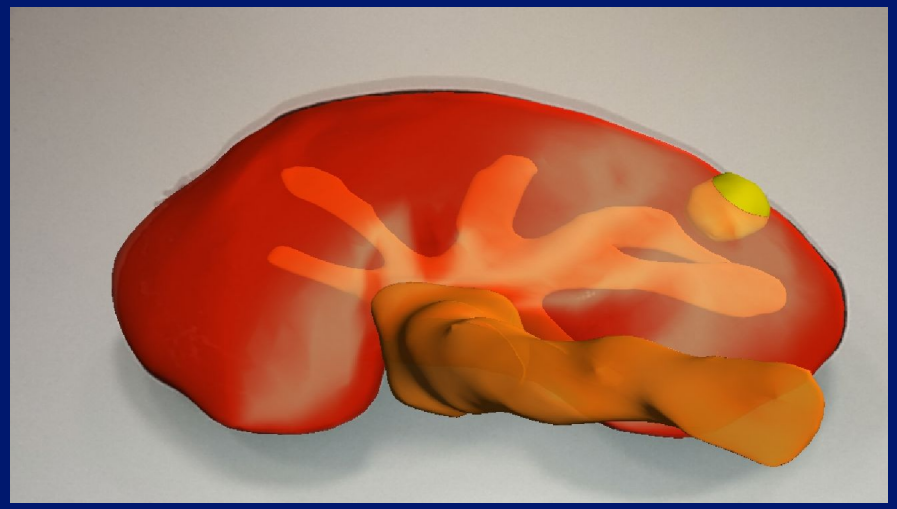
# Mobile-App to evaluate tumor visualization strategies in Augmented Reality

by Felix Meyer and Remke Albrecht



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Supported by:
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Carl Gustav Carus Faculty of Medicine, TU Dresden
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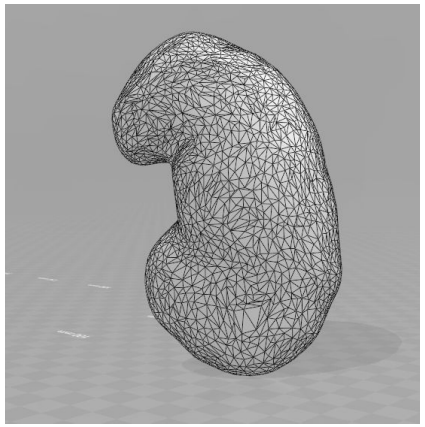
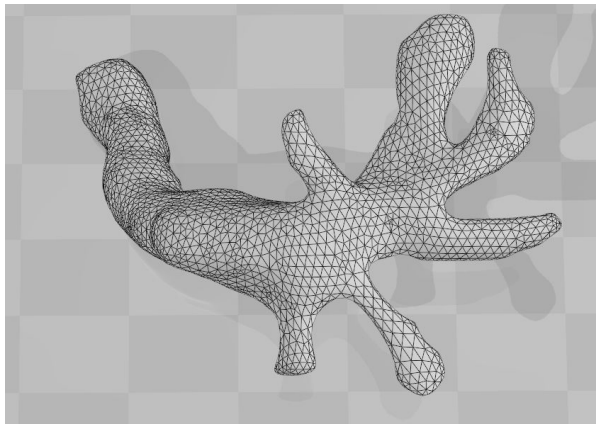
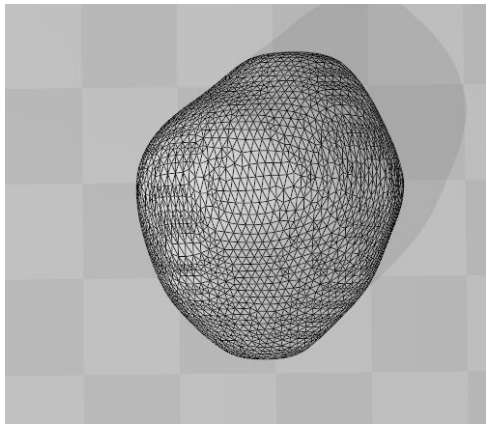
# Environment

- 3D printed silicon kidney of the phantom
- 3D models of the kidney, calyx and tumor
- The app should run on portable devices









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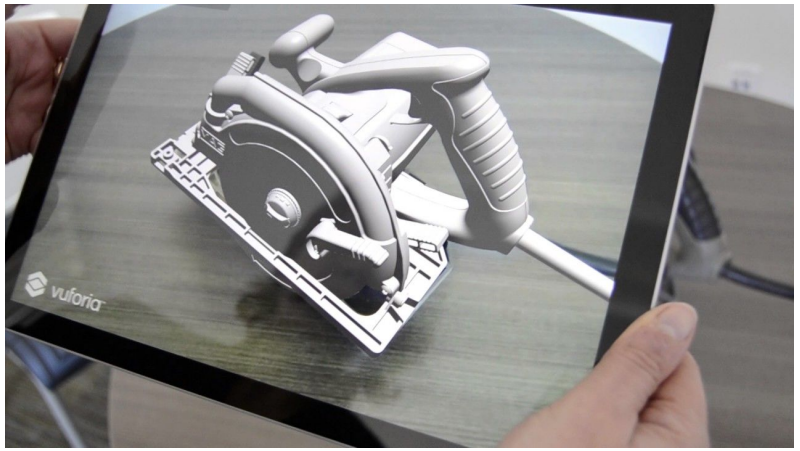
# Tasks

- Task 1 - Tracking
- Task 2 - Visualization
- Task 3 - Graphical user interface
- Task 4 - Track user input and used settings
- Evaluation of usability

# Task 1 - Tracking

- Vuforia Augmented Reality SDK

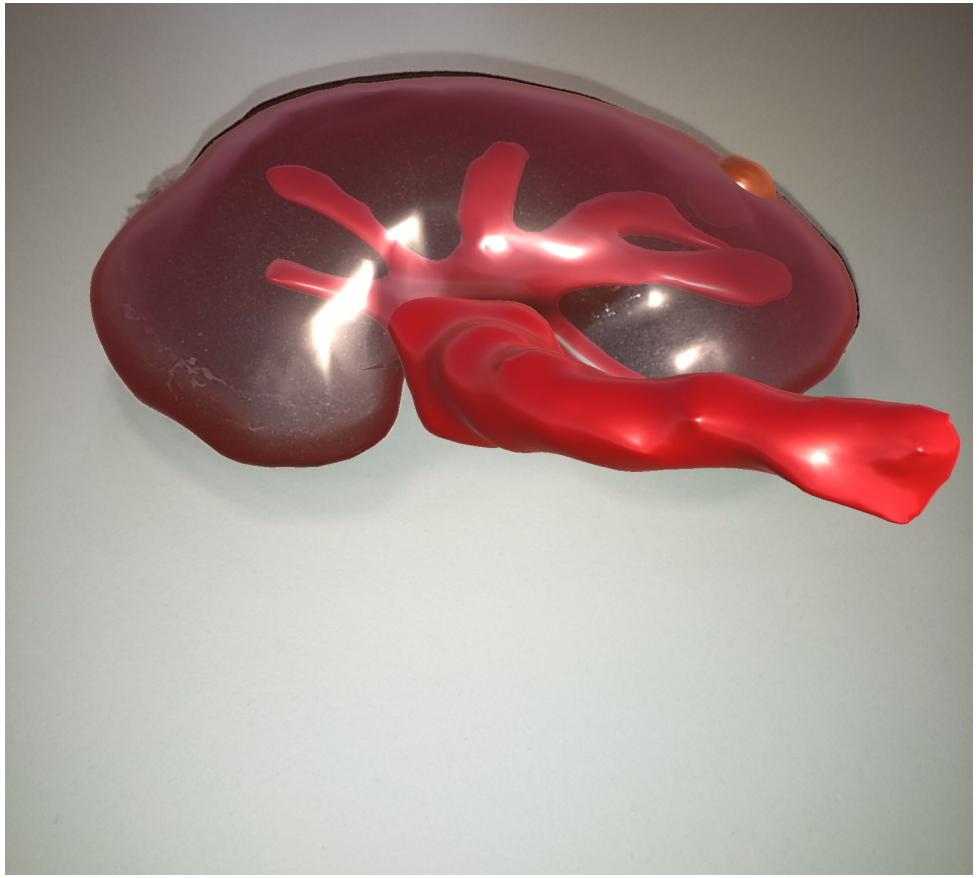



- Challenges:
  - Kidney with simple geometry (few possible feature points)
  - No texture information
  - 3D printing artefacts
- Solutions:
  - Use multiple hand picked target views for the object
  - Not too many to minimize performance overhead
  - Maximize visibility with external light sources or integrated flashlight
  - Interpolate tracking with acceleration sensor

# Task 2 - Visualization

- Unity as engine:
  - Integrated Vuforia support
  - Simple and adjustable render pipeline
  - Android deployment
  - Portable performance

- Big new problem with transparency:
  - Only tested with single transparent and multiply opaque objects
  - Multiple transparent objects require new rendering technique





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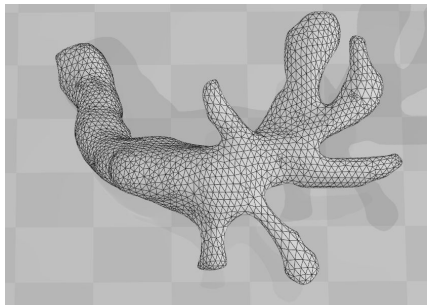
# Task 2 - Visualization

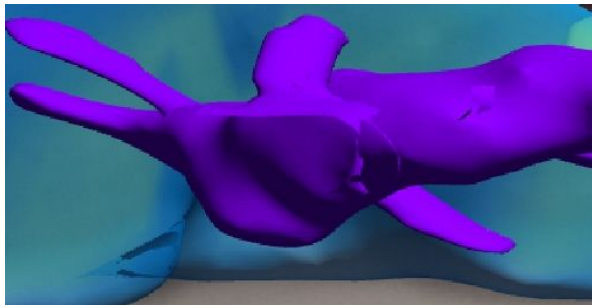
The Problem:

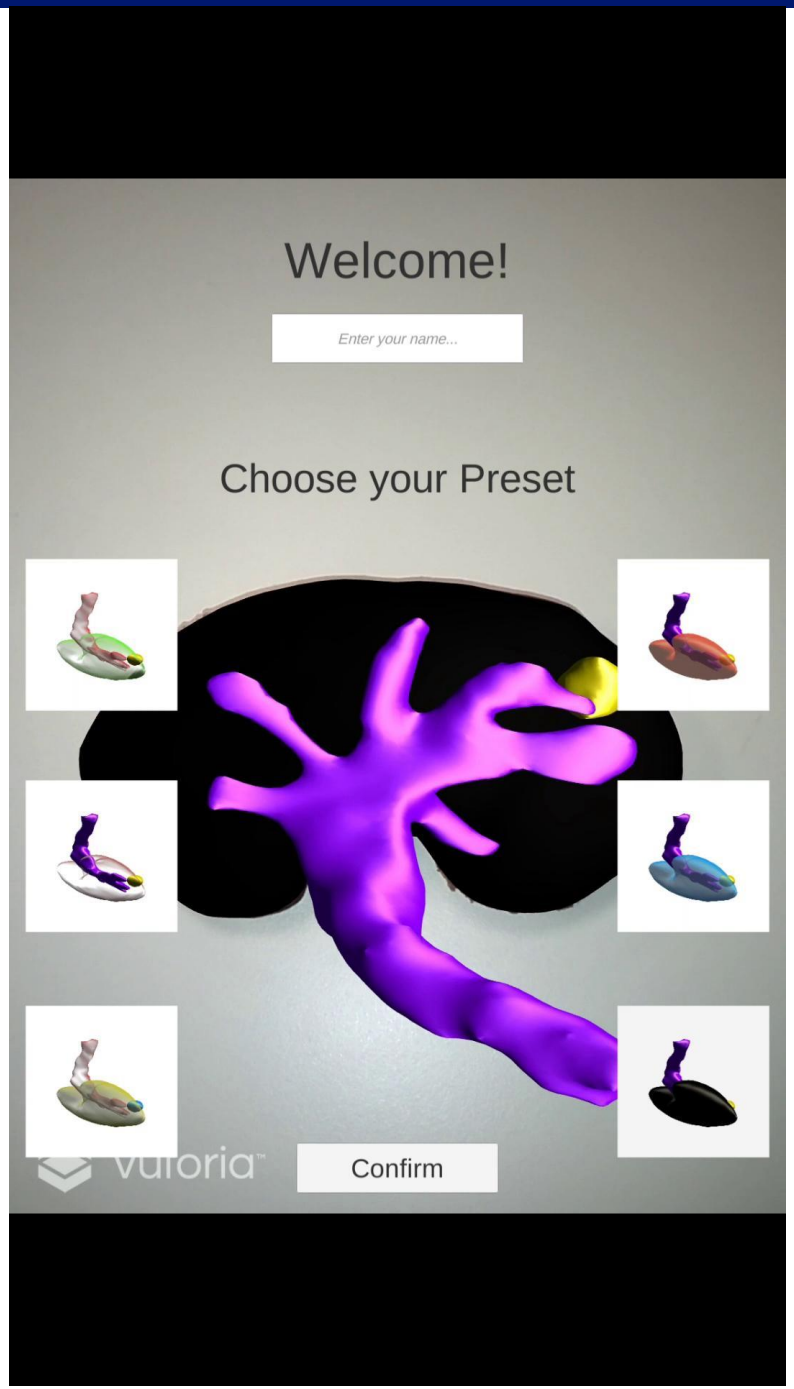
- Happens between transparent objects
- Happens with single concave transparent object

- Unitys solution for multiple transparent objects needs a clearly defined object order
  - Solves only transparency problem between objects and only if they don't intersect
  - We have concave objects and intersecting objects

→ Won't work for us







# Task 2 - Visualization

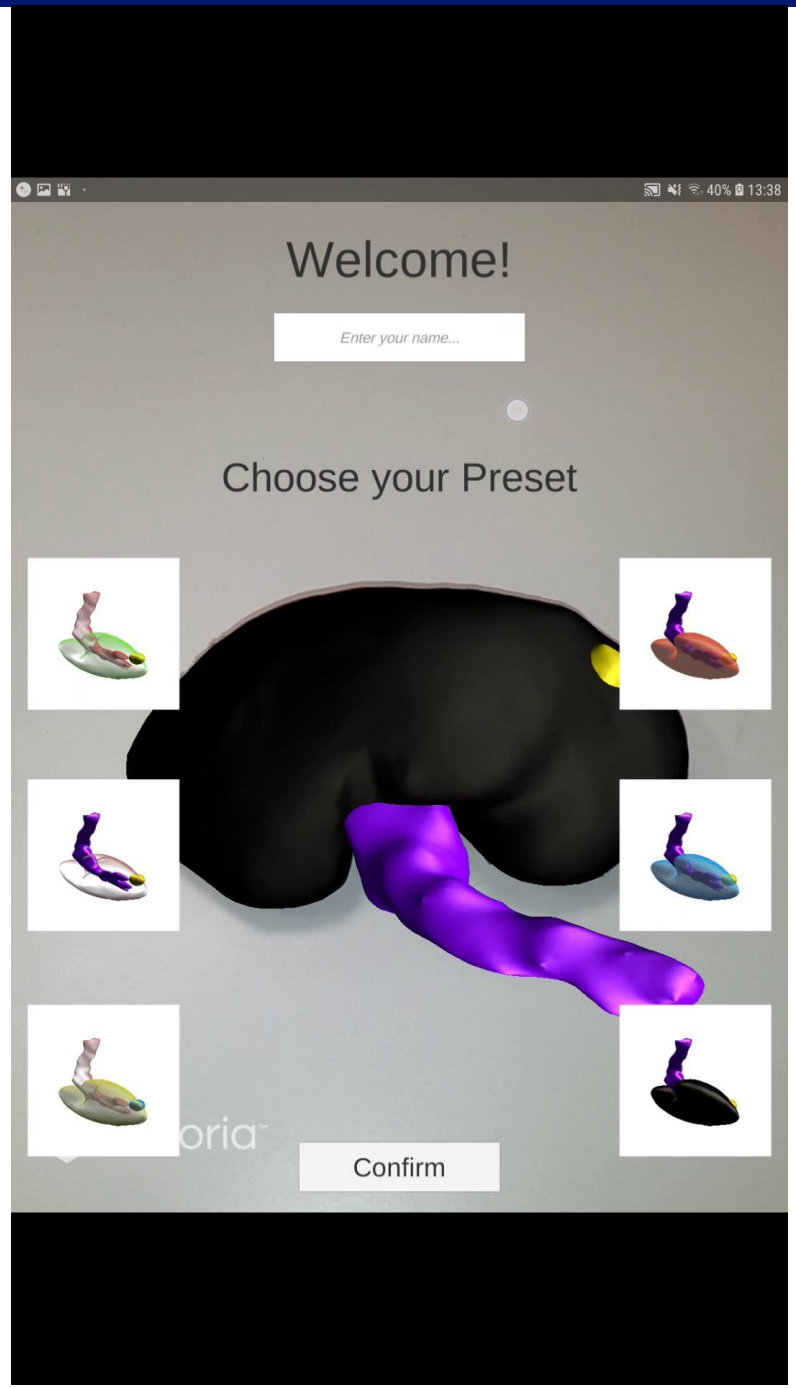
## Tested transparency solutions:

| Technique | Pro | Con |
|---|---|---|
| Order dependent transparency: | | |
| Object sorting | • Solves some transparency issues between objects | • Won't work with intersecting objects<br>• Concave objects still a problem |
| Vertex sorting | • Solves all transparency issues | • Difficult implementation<br>• Far to heavy for mobile devices |
| Order independent transparency: | | |
| Weighted transparency | • Works well with very transparent objects<br>• Average blend between transparent surfaces<br>• Fast | • intersections between surfaces are invisible<br>• falls apart for opaque objects |
| Depth peeling | • Trade-off quality and rendertime<br>• Solves all transparency issues<br>• works good on mobile devices | • Maximum number of overlaying transparent layers |

# Task 2 - Visualization

Final solution: Depth peeling

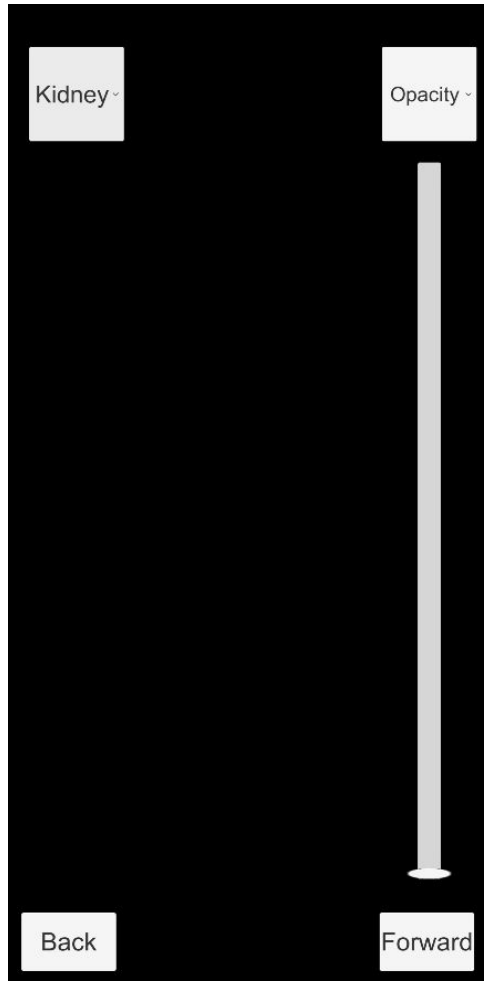
- Gives best control over performance and quality
- Object intersections are visible even on transparent objects
- Currently use 6 transparenty layers
  - after 6 overlapping transparent vertices, artefacts are theoretically visible (not visible in practice)
  - gives acceptable performance on tested tablet and phones (Renders scene 6 times)



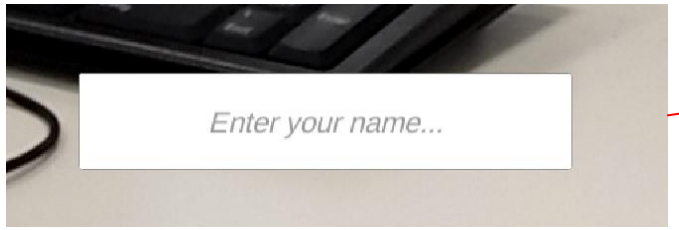
# Task 3 - Graphical User Interface

- Previous solution
  - Select Object
  - Select visual channel
  - Select value the visual channel should take

- New solution
  - Enter name
  - Select one of six presets
  - Reselect until user is satisfied
  - Fine tune visual channels
  - Submit

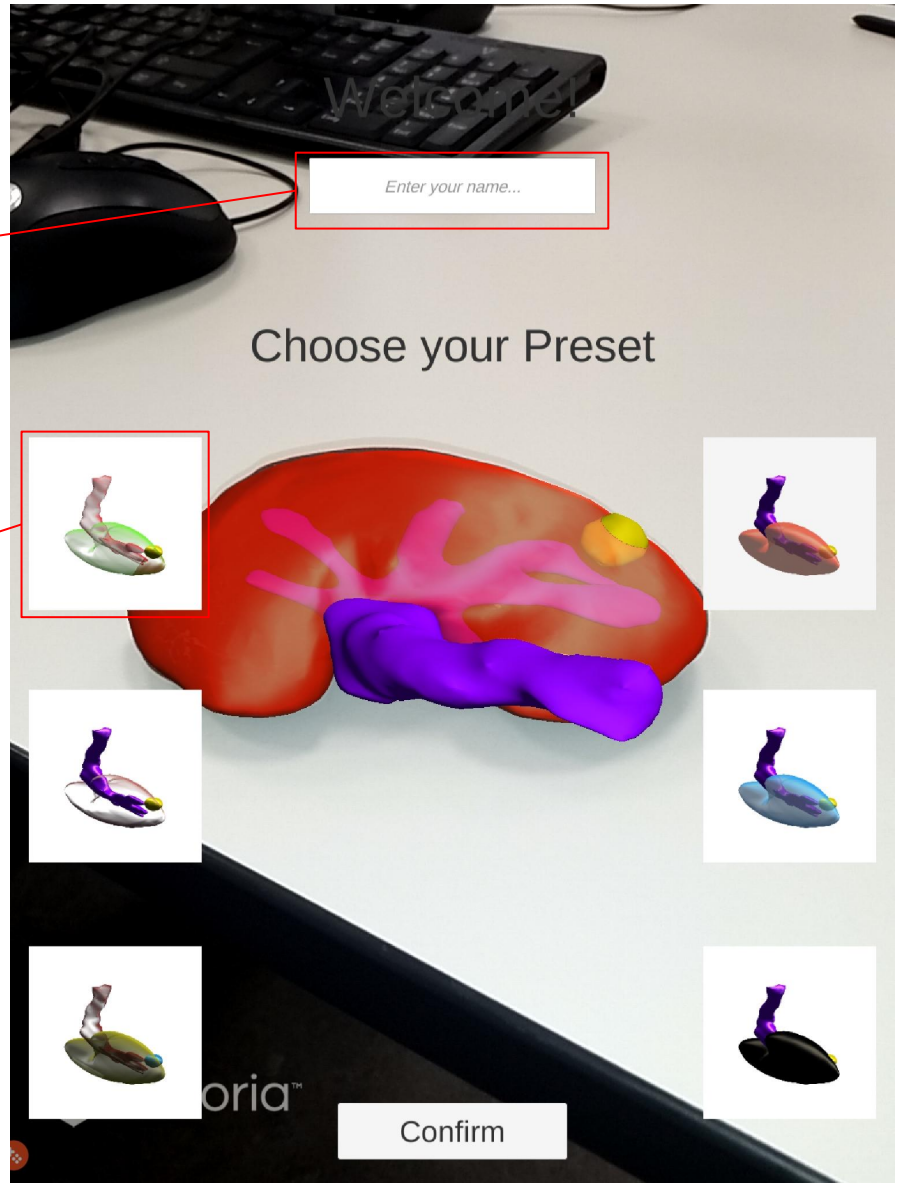


Step 1: Enter name




Step 2: Select Preset

Step 3: Confirm

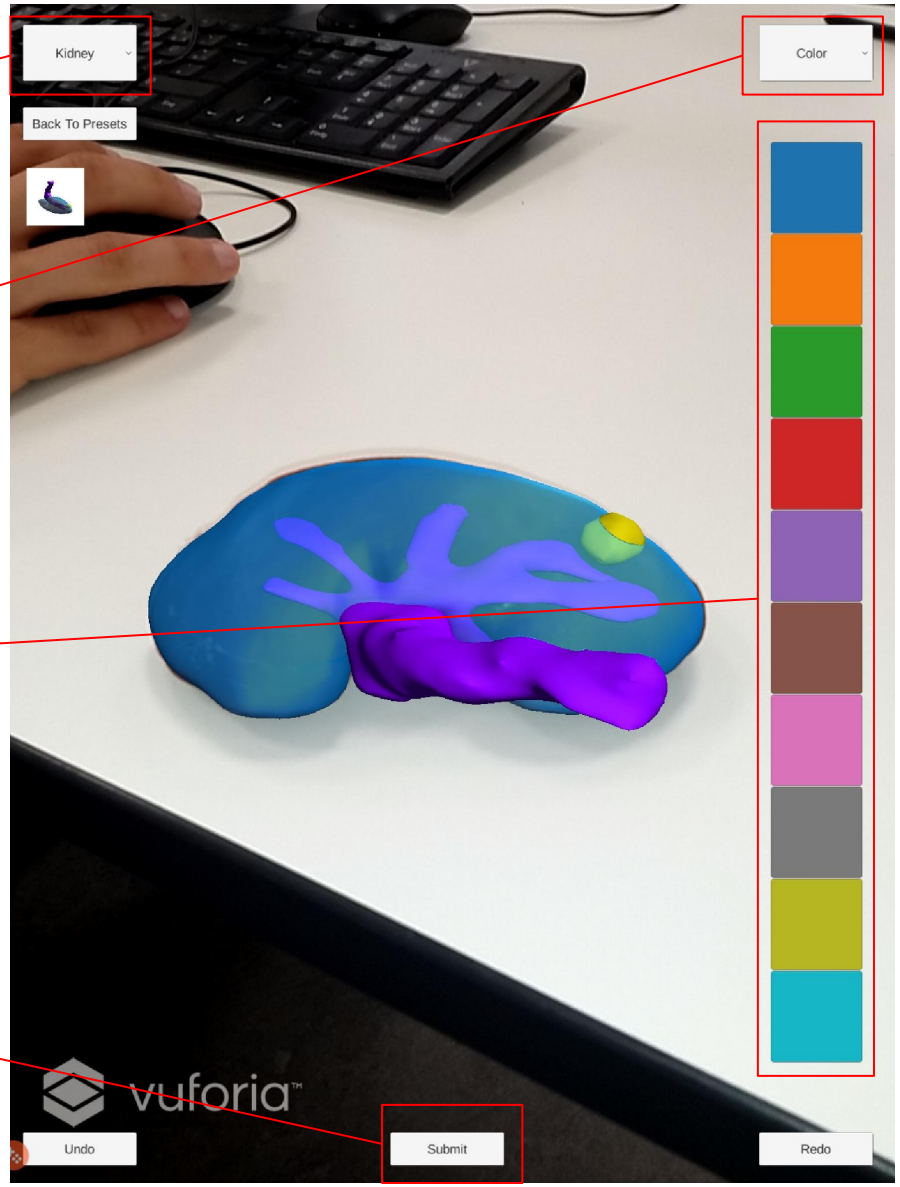


Step 4: Select Object

Step 5: Select Visual Channel

Step 6: Select Value

Step 7: Submit



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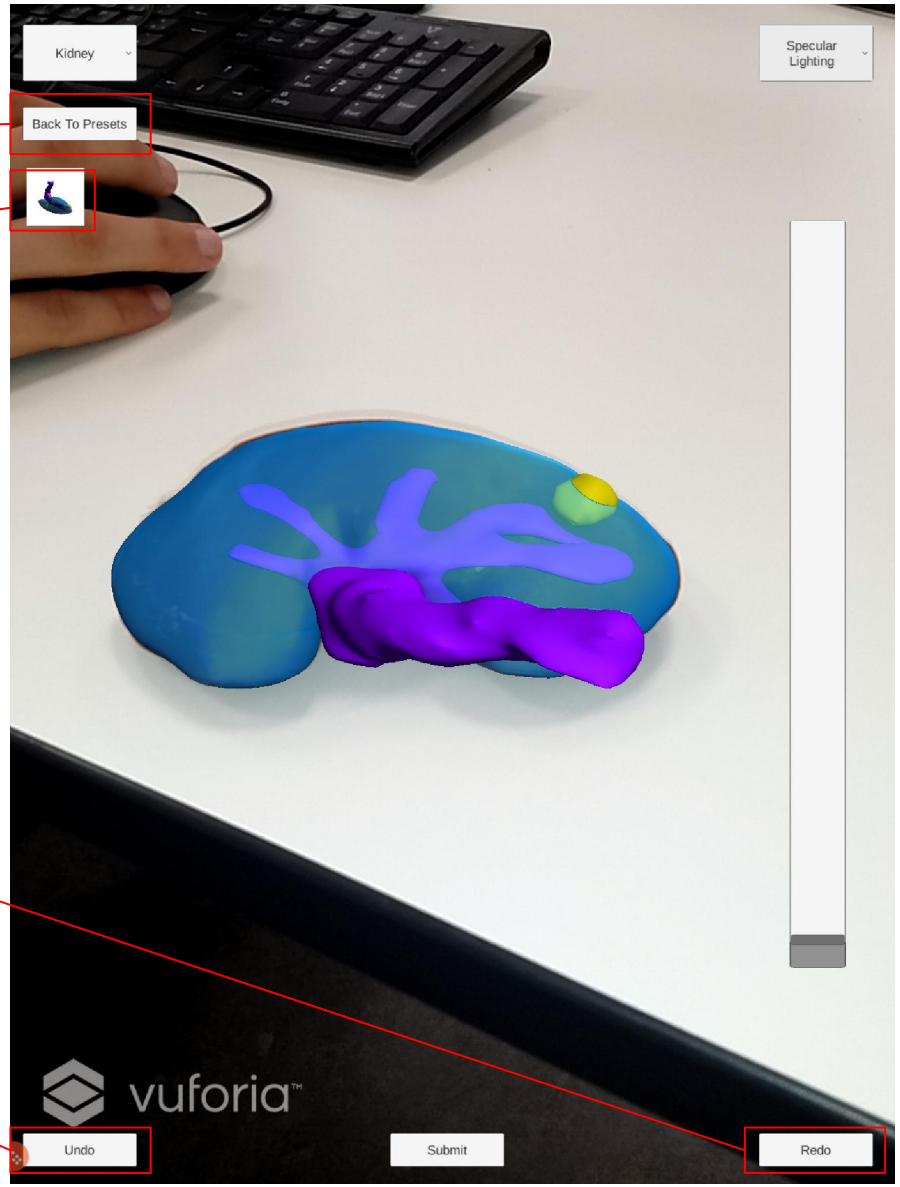
Back to Presets

Preset Comparison

Redo

Undo



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Thank you for participating!
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# Task 4 - Track user input and used settings

- Save user name
- Track every action with timestamp
- Save last set settings

*E.g. History_User1.csv*

| Object | Effect | Value | Time |
|---|---|---|---|
| Niere | _Alpha | 0,6091537 | 23,88399 |
| Niere | _Glossiness | 6,119171 | 27,31732 |
| Tumor | _Glossiness | 9,075993 | 32,00634 |
| Tumor | _Alpha | 0,819171 | 36,37442 |


Kidney
Transparancy Falloff
Back To Presets
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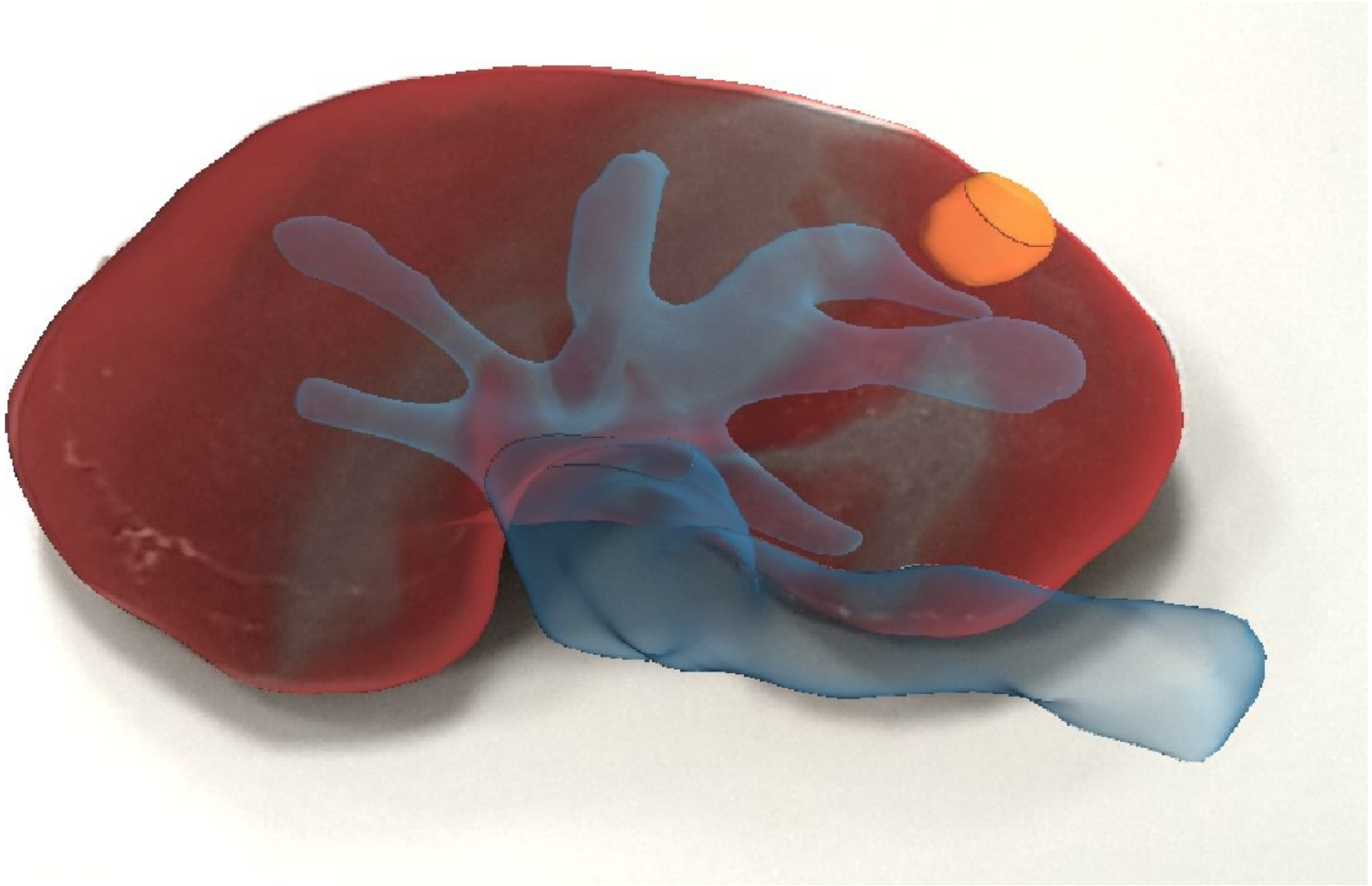
Undo
Submit
Redo



# Thank you for your attention!