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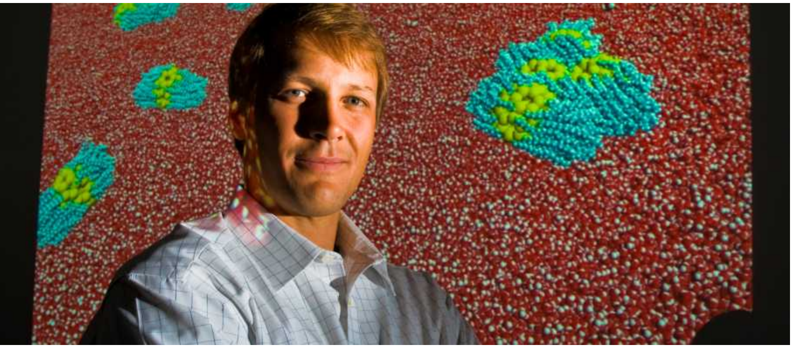

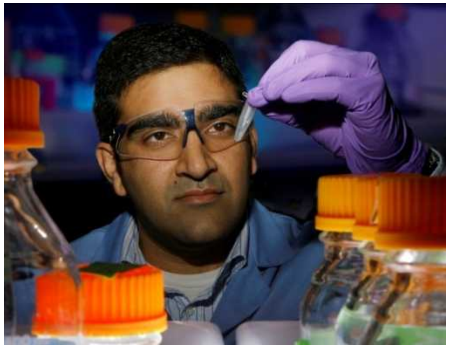

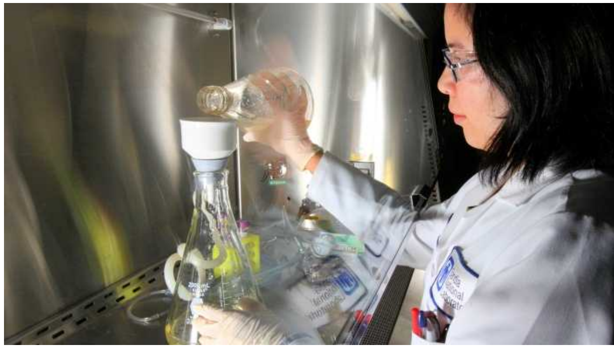

Game Development Engines as an Ideal Platform for Exploring 3D Virtual Reality Based Visualizations Constructed from Computed Tomography Data

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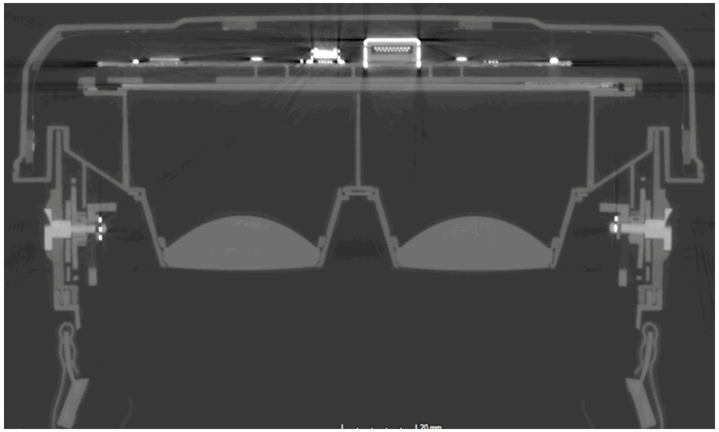
Overview

- Background: Virtual Reality
- Background: Game Development Engines
- Our Goals
- Approach
- Images
- Conclusion

Background: Virtual Reality

- Goals: "presence" and "immersion"
- A lot of new hardware recently developed
- Our work is based on the "Oculus Rift"
  - Goggles restrict vision, present separate images to each eye
  - Camera and sensors receive head position input
  - Applications use input to adjust images, best practices suggest 20ms or less motion-to-photon latency



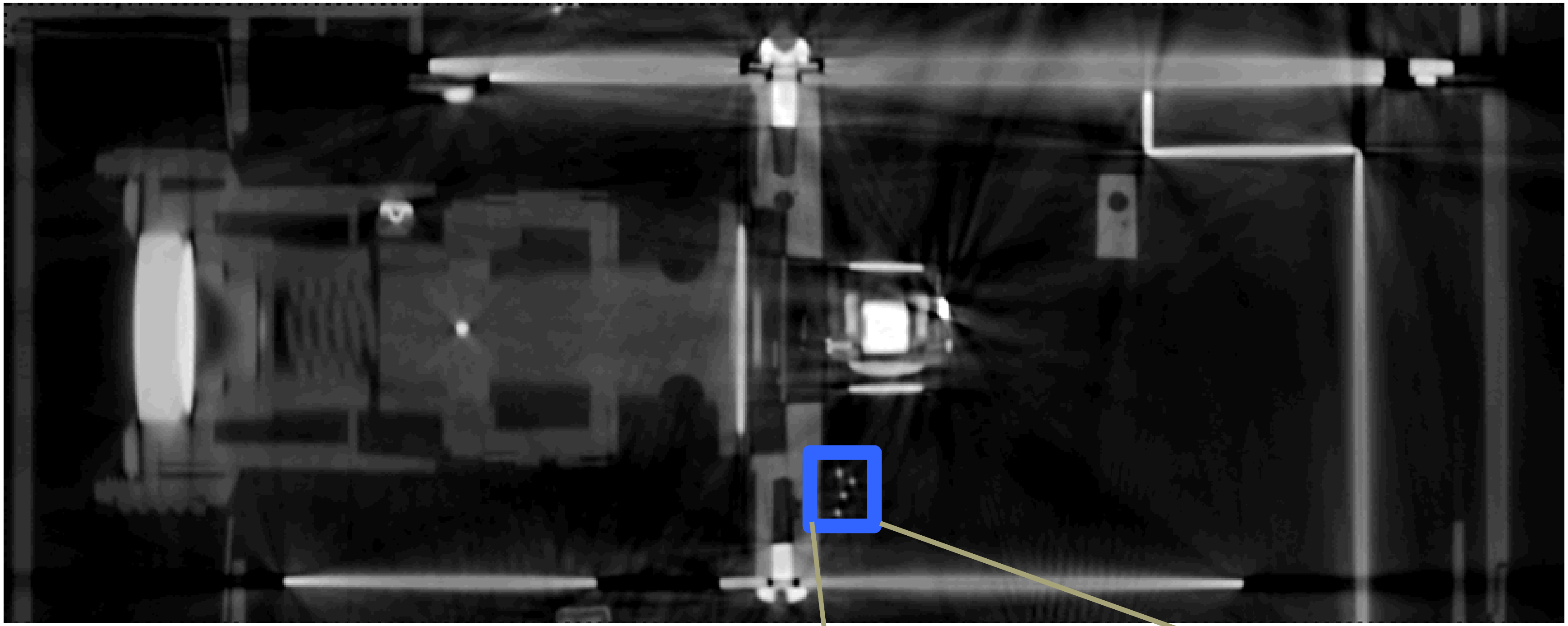
Background: Game Development Engines

- A powerful framework for creating virtual worlds
  - 3D rendering, physics engine, ‘game’ components
- Expose the power of modern Graphical Processing Units (GPUs) to novice ‘programmers’
- Built-in Support for Oculus Rift
- Our work is based on “Unreal Engine” though we likely could have used “Unity” or any other engines that support stereoscopic visualization.

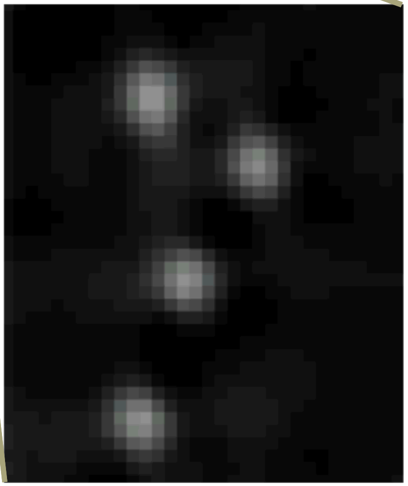
Our Goals

- A very small exploratory research project
- Can we use virtual reality and a game development engine to visualize CT data?
  - Users are immersed in a world containing the imaged object
  - 'Instant' navigation, i.e., as if they were playing a 3D game
  - Able to obtain views from the interior of the object
  - Other features to aid in diagnosis.
  - A familiar world (sky, ground, wall, object)
- Our dataset:
  - 2D reconstruction of a security camera
  - 341 volumetric slices (each 1018x404 16 bit grayscale)

Slice 42



Close up of image

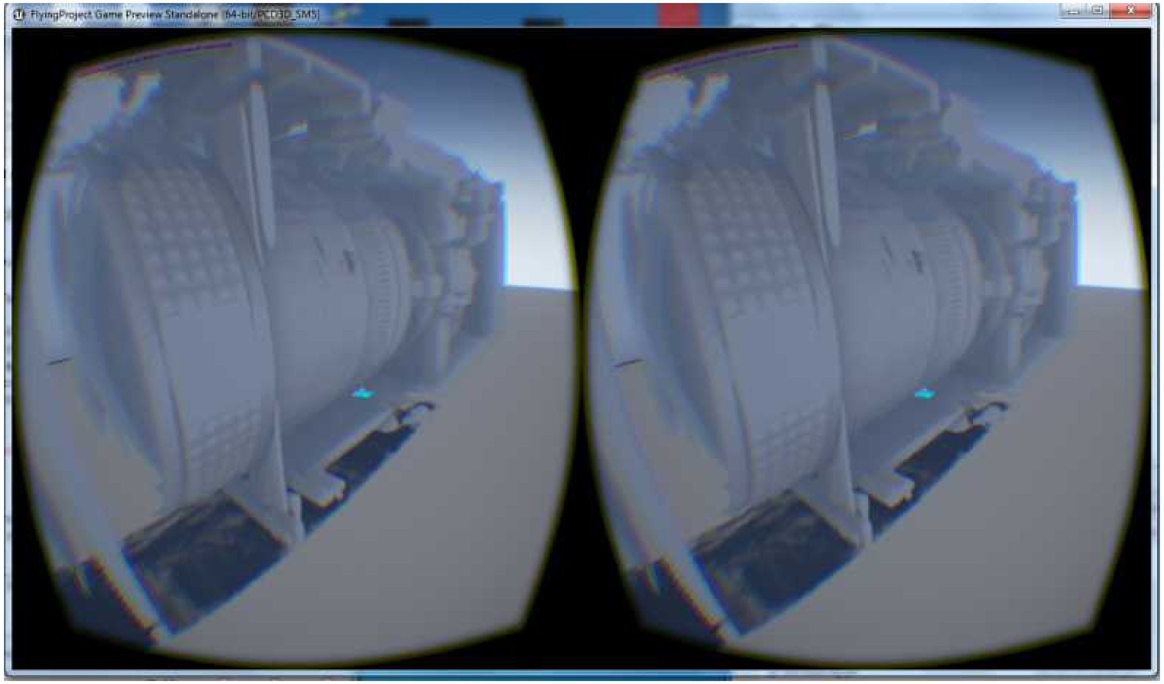


Approach

- Created and abutted 3D rectangular cuboids
  - one for each slice, width based on imaging parameters
- Each slice treated as a 2D texture
  - Applied to only one surface of each cuboid
- Utilized an opacity mask
  - Pixel shaders perform perspective projection to obtain pixel values based on the closest texture with a pixel value above a set threshold.
  - Empty (black) portions of the interior are thus ignored.
- Result is a 3D representation of the volume
  - On close inspection, object is constructed from slices.

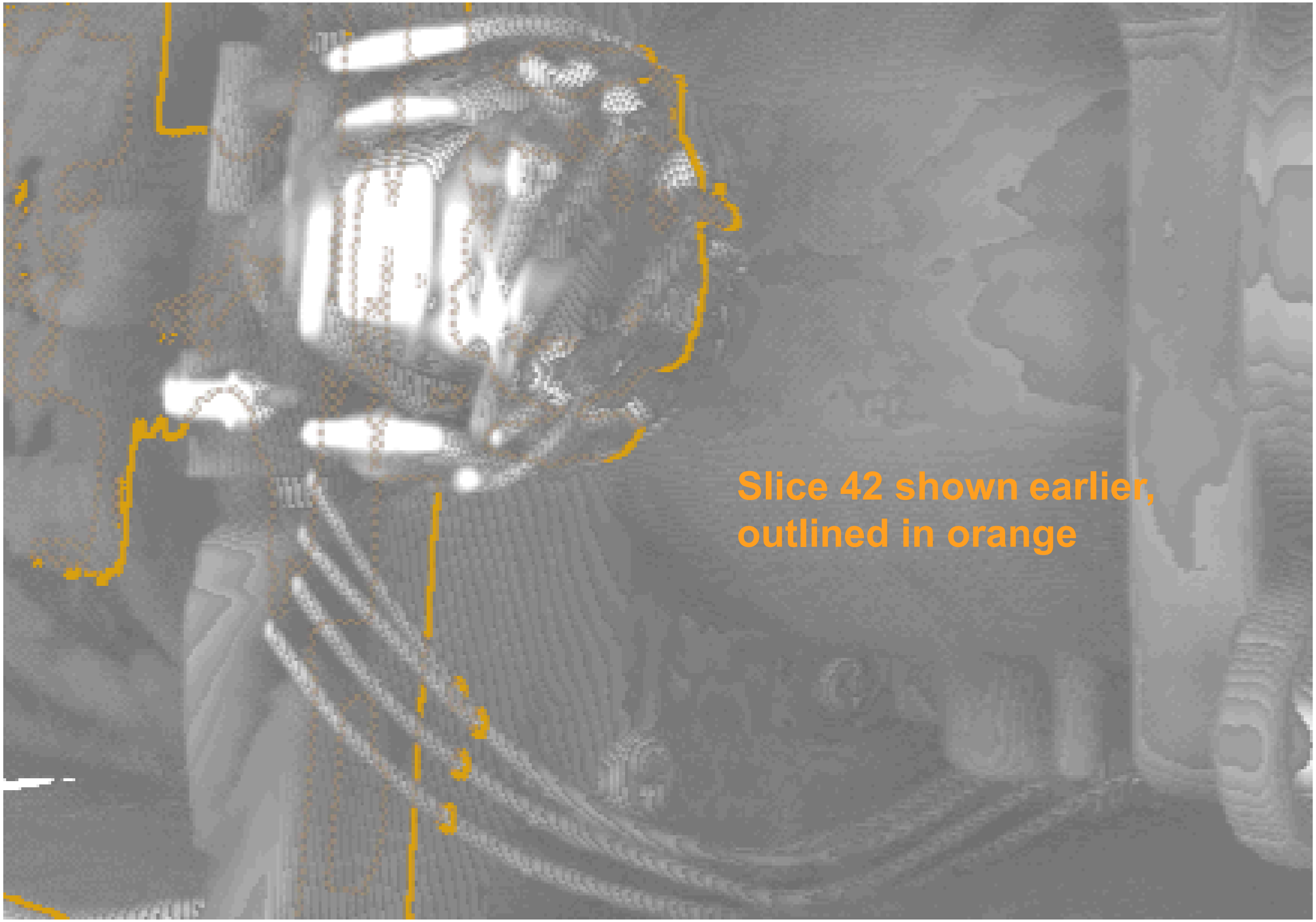
Images

- Produced an executable ‘game’ that renders separate images to the Oculus Rift

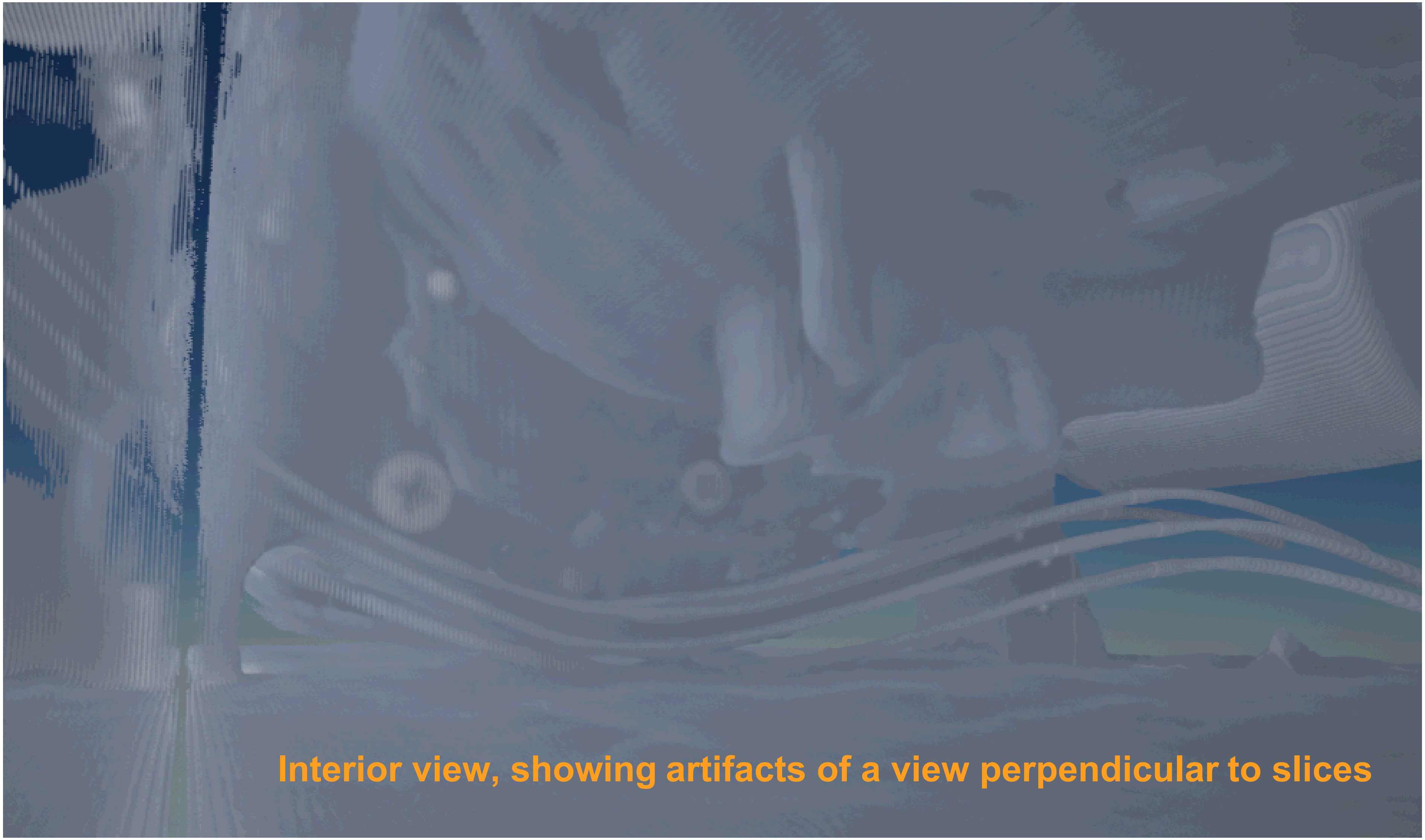


- Captured images (rendering to monitor) with
  - Different locations
  - Different settings
  - At various points in user controlled animations

Images



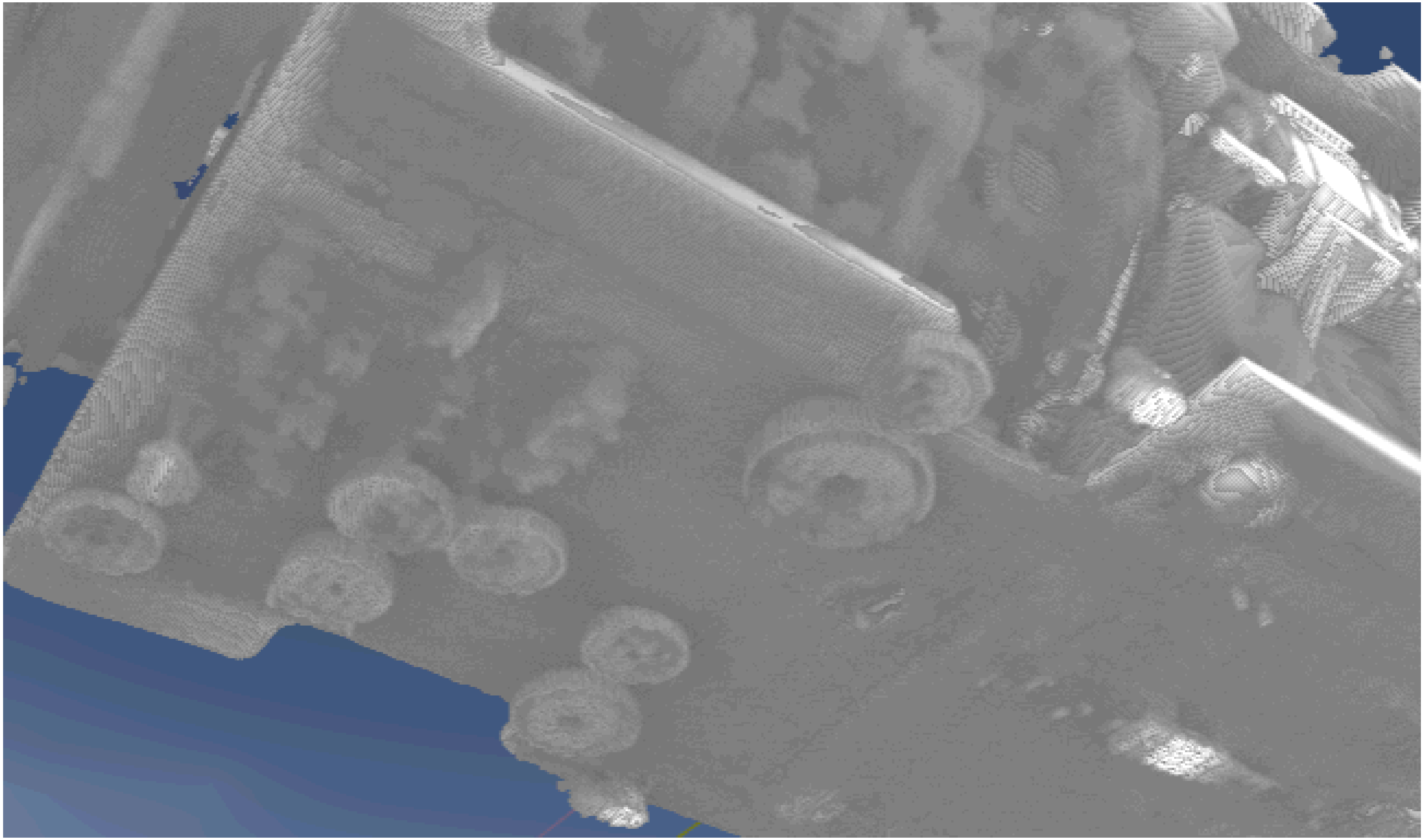
Images


Interior view, showing artifacts of a view perpendicular to slices

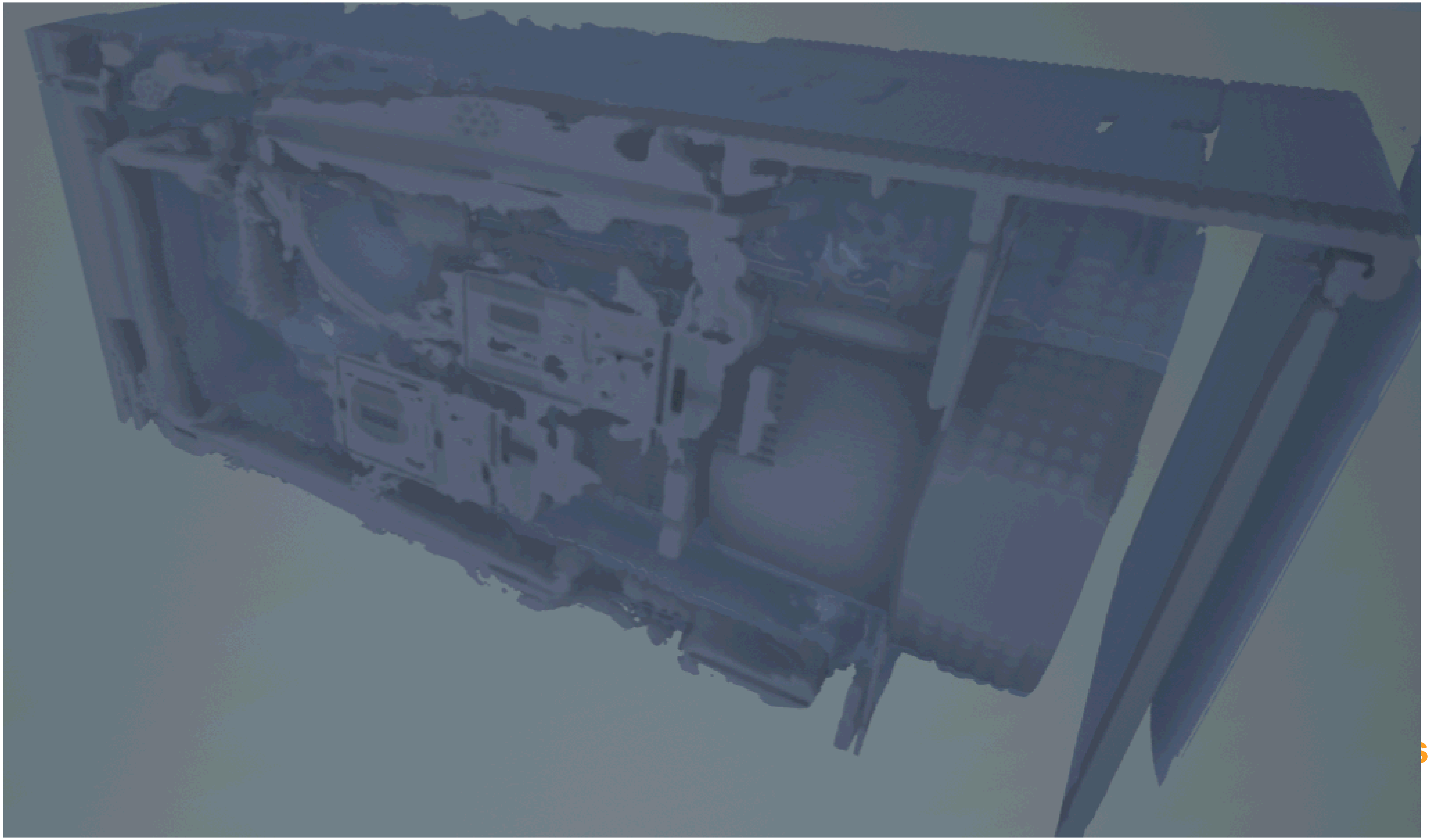
Images

Another interior view, looking at the lenses from the interior

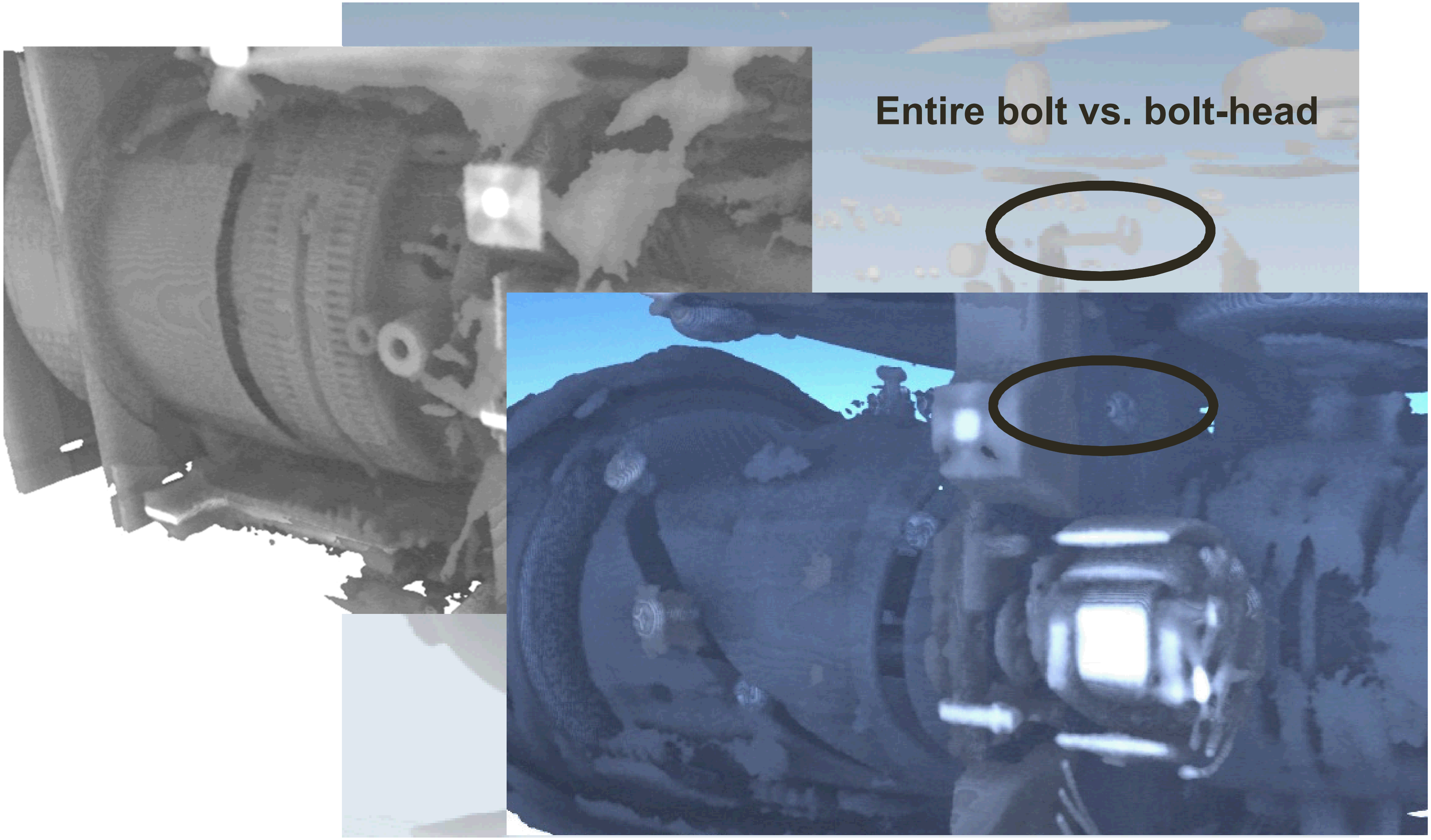
Images



Images



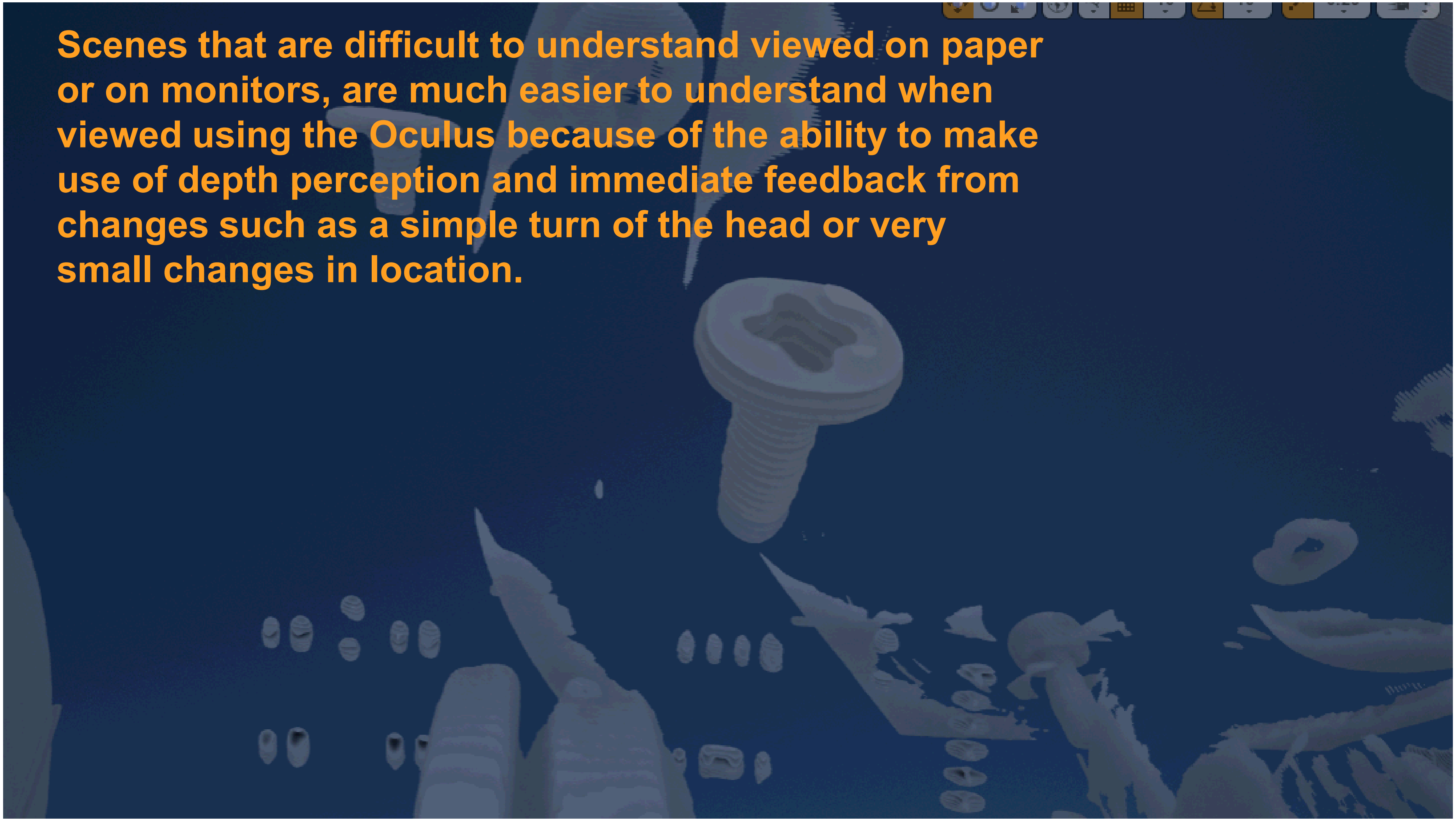
Images



By changing parameters, you obtain different insight

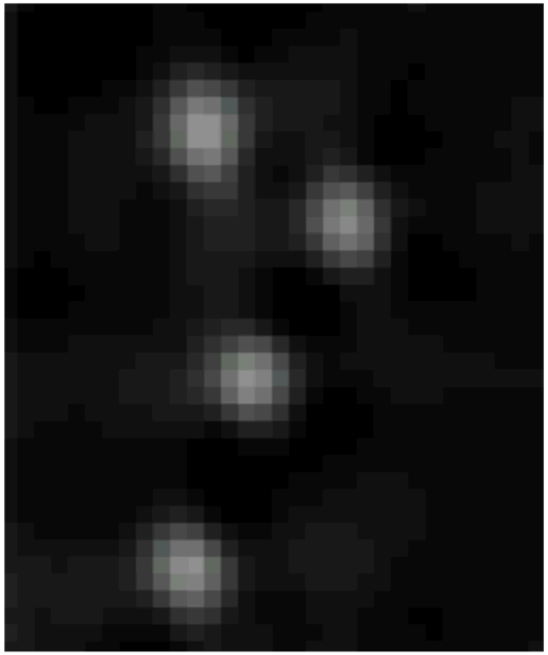
Images

Scenes that are difficult to understand viewed on paper or on monitors, are much easier to understand when viewed using the Oculus because of the ability to make use of depth perception and immediate feedback from changes such as a simple turn of the head or very small changes in location.

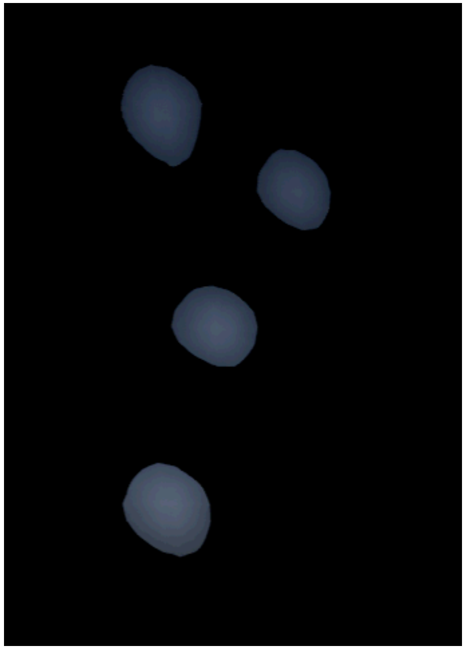


Quality

- High quality visualizations, even from lower quality data
  - When number of pixels being rendered exceeds number of pixels in texture, linear interpolation is used for enhanced quality.



Pixel close-up from slice



Rendered using Unreal

Conclusion

- We are unaware of previous efforts using texture based volume rendering founded on a similar approach.
- "Future" data visualization tools will use techniques and tools exposed in "today's" game development engines.
  - Engines allow users to construct sophisticated visualizations without requiring extensive GPU or programming experience.
- Our techniques allowed us to achieve presence and immersion when viewing commercial data sets.
  - We believe that virtual reality is a 'game changer' that will allow scientists to obtain better insight and make discoveries more quickly.
  - We believe much more is possible and hope to engage in additional research soon.