Augmented Reality for Visualization of Physics Experiments

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13th Collaboration Meeting of the BM@N Experiment at NICA

What is Augmented Reality?

Form factors

Smart glasses

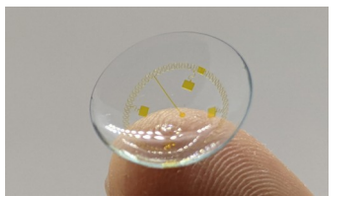
- AR headset

Mixed reality headsets

AR glasses

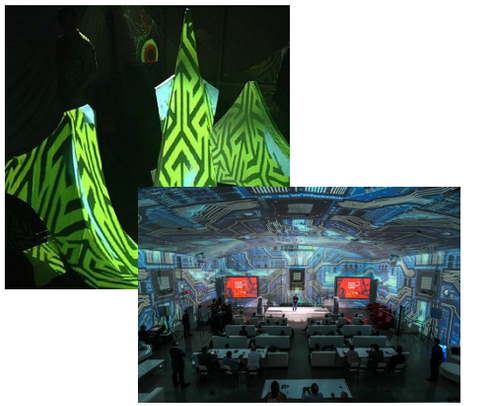
Mobile AR

hard



soft

AR contact lens



Projection mapping

… new to come?

What is Augmented Reality?

Implementation principles

Image formation technologies

- Laser projector
- Small LCD/LED displays
- Overlaying ocular for small screen
- Image projectors
- [Controllable] Beam splitters
- Liquid crystal deflectors
- Diffractive waveguides and reflective waveguides
- Special optical materials

Localization & reference to environment

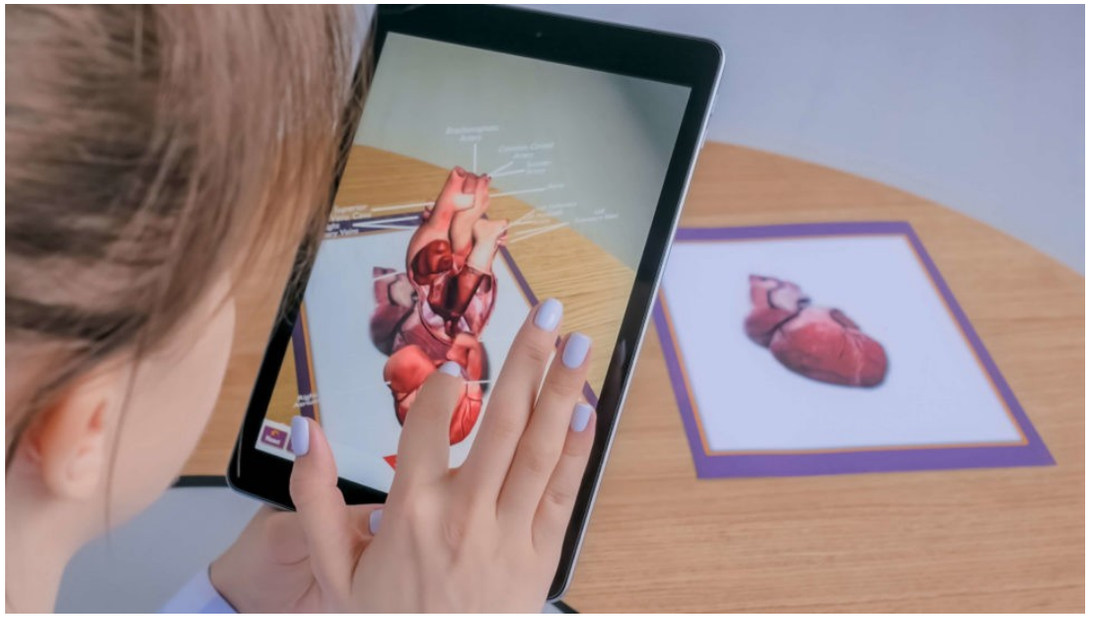
- Camera + SLAM algorithms
- Camera+fiducial markers (or fiducial images)
- Other optical sensors
- GNSS/DGPS
- Inertial sensors
- Radio frequency localization systems and RFID

User interaction principles

- Gesture recognition (camera)
- Hands pose estimation (camera)
- General and special (like micro) joystics
- Eye tracking
- Neural interface (?)

Devices

Smartphones and Tablets	Advantages	Disadvantages
• Phab 2 Pro, Lenovo ($499) • ZenFone AR, Asus ($699) • etc.	1. widespread use among the users 2. mature interfaces	1. cumbersome to use 2. small display 3. no stereoscopic vision 4. limited interactivity
Smart Glasses and Headsets	**Advantages**	**Disadvantages**
• DAQRI's Smart Glasses, (1000$) • DAQRI • HoloLens, Microsift (3500$) • Meta 2, • Meta ($429) • Google Glass ($1500) • etc.	1. Hands free interaction via gesture and voice recognition 2. wide field of view	1. comparatively bulky 2. narrow field of view 3. expensive

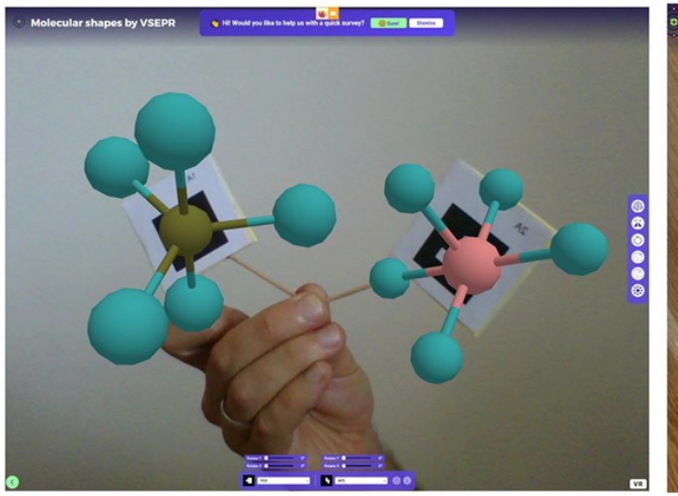


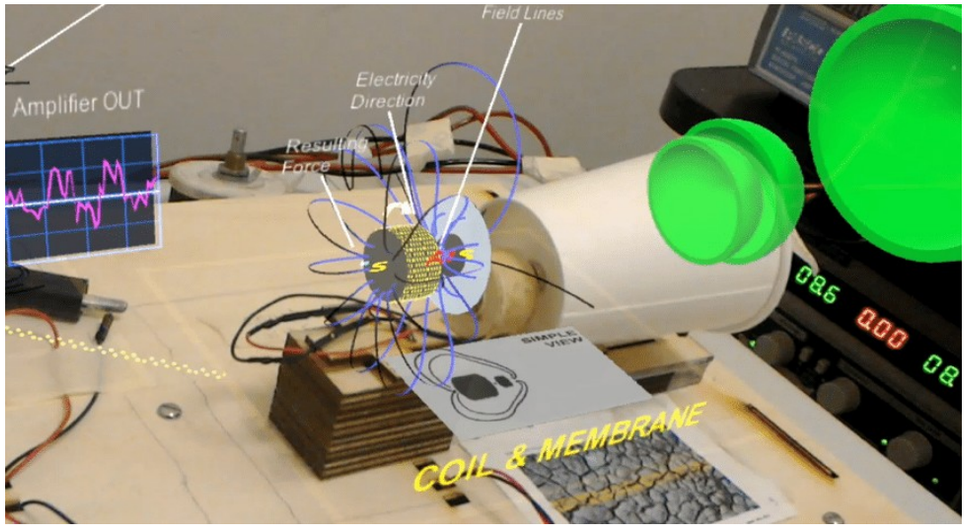
Trends in science and education

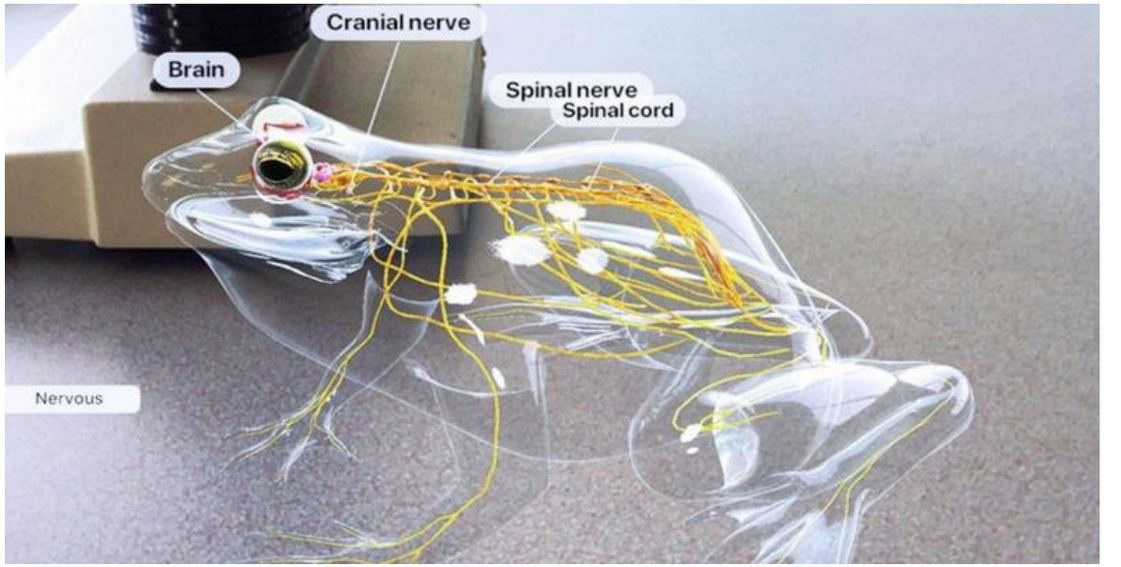
- Engineering
  - Visualizing and designing: using AR in CAD
  - Demonstrate
  - defect detection
  - Stuff training and practice
- Medicine: practice and education
  - Assisted surgery
    - spinal surgery int 2020, Johns Hopkins University, with using headset projecting images from X-rays or CT scans
  - Improving diagnosis using symptoms visualization
  - Training nurses and doctors:
    - Learn human anatomy
    - AccuVein technology to “see” through your skin and into your veins

Trends in science and education

- Biology:
  - Visualize and manipulate anatomy, microscopy, life processes
    - Biologia RA app
- Chemistry and physics:
  - Demonstrate chemical structures
    - AR Chemistry Lab app
  - Visualize physical processes
    - AR Physics app
  - Provide experiments not acceptable in current environment

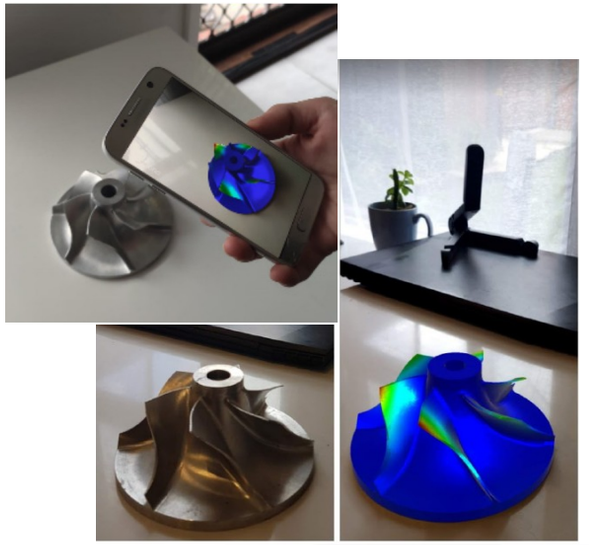


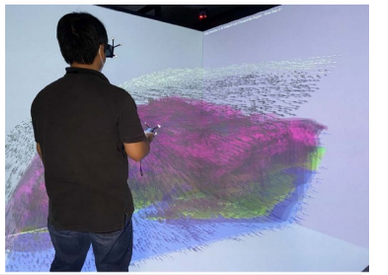


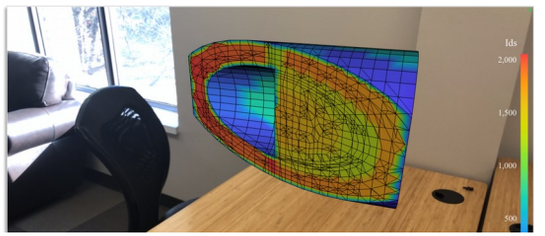


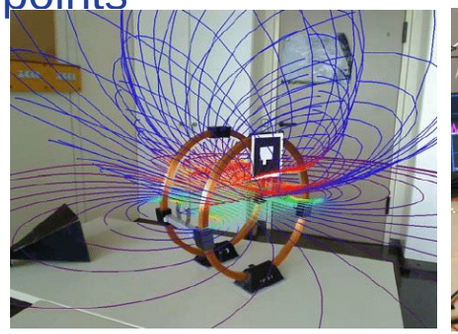
Important capabilities of AR for scientific/engineering data analysis

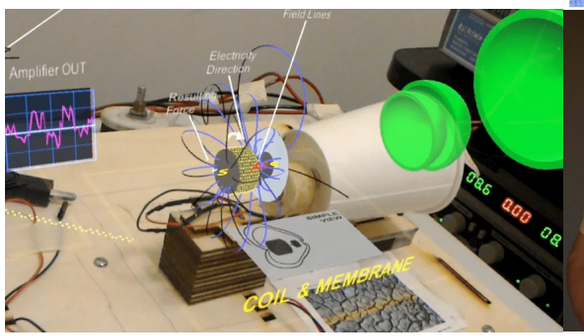
- Visualization of object properties (invisible state)
- Visualization of non-observable processes (like electromagnetics, flows, vibrations)
- Aid in finding correlation between observable and non-observable processes/effect by
  - Superimposing non-observable onto observable
  - Spacial or time magnification/modulation of observable
  - Numerical representation as overlay for observable
- More than 2D data charts: 3 and more axes are hard to visualized in 2D
- Aid in finding anomalies (in data/effects/processes) by:
  - Time or space scaling/highlighting/removing/adding information
  - Multiple repetitions with suitable variation (if needed)
  - Looking from different (or multiple) view points
- Keeping attention focused (highlighting)
- Other?

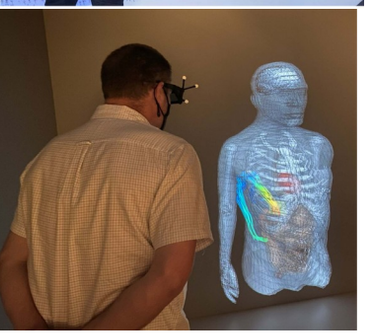












AR drawbacks

- Not any data can be effectively represented in 3D
- No direct guidelines on how to design data representation (more art than science)
- Expensive equipment
- For abstract data or in absence direct observation of the process at hand VR is enough

Thanks for your attention

References:

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