Project proposal for CIS II ——

Annotation Framework for Recurring Appointments in Medical Applications using Augmented Reality

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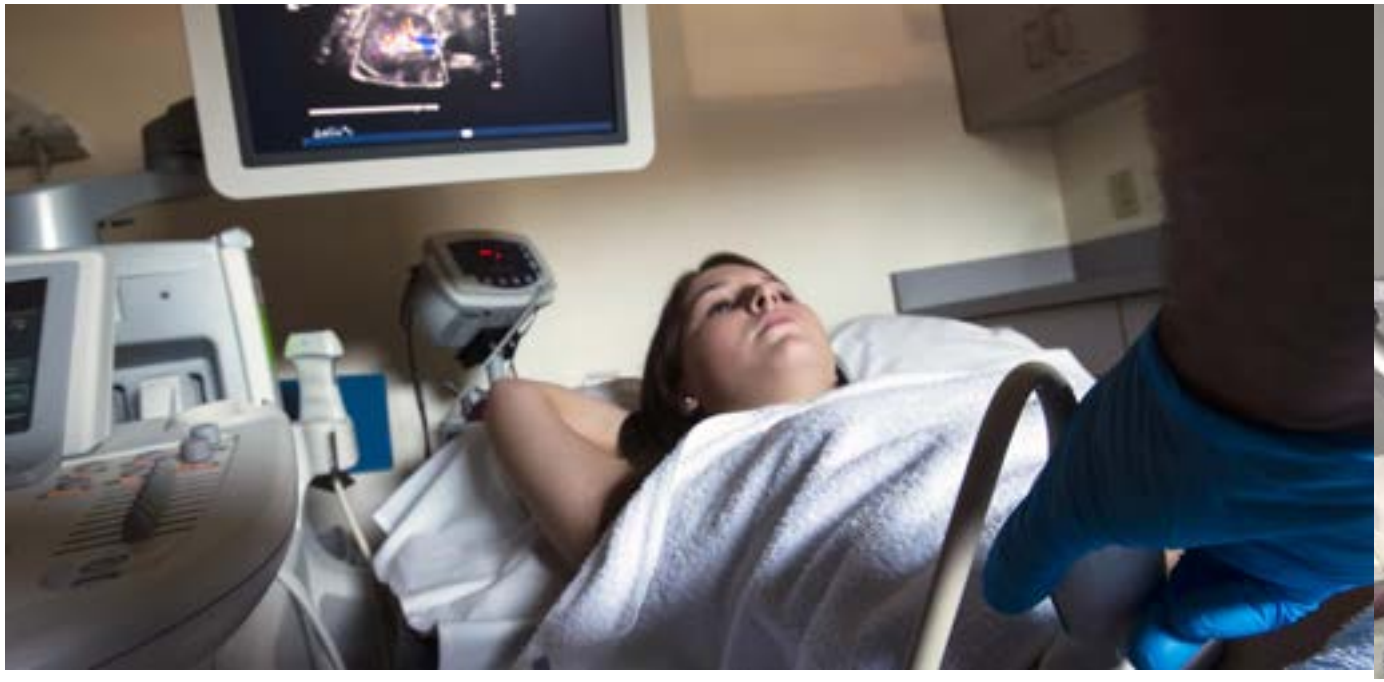
Background

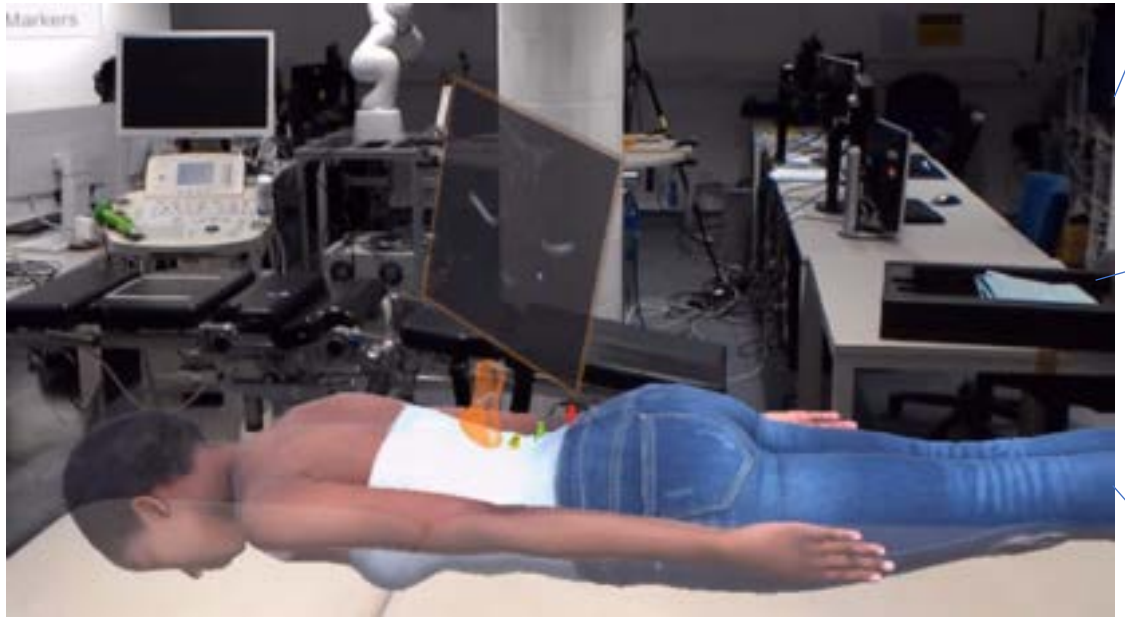
- Inappropriate medical image display.
- Unintuitive presentation of ultrasound images
- Difficult to control the pose and position of the ultrasound probe



https://www.cooleydickinson.org/programs-services/radiology-imaging/treatments-services/ultrasound/

https://www.radiology.ca/article/how-does-ultrasound-work

Goals:



Provided by mentor

To indicate the pose and position of the observation areas.

To display the ultrasound image saved on different time of a same patient whenever visits.

To design a human-AR device interaction system.

Expected results

- Minimum: Design an augmented reality user-interface to:
  - Save the pose of the tool with respect to the patient's body.
  - Record images from the desired poses.
  - Show the recorded images during future patient visits.

- Expected: Make experiment on a human body phantom.
  - Use 3D scanner to create a virtual replica of the phantom.
  - Evaluate the performance of the user interface.

- Maximum: **Add body tracking function** to automatically identify the patient's body pose. Visualize the human body anatomy evolution with Hololens display.

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Maximum: **Add body tracking function** to automatically identify the patient's body pose. Visualize the human body anatomy evolution with Hololens display.

Technical Approach

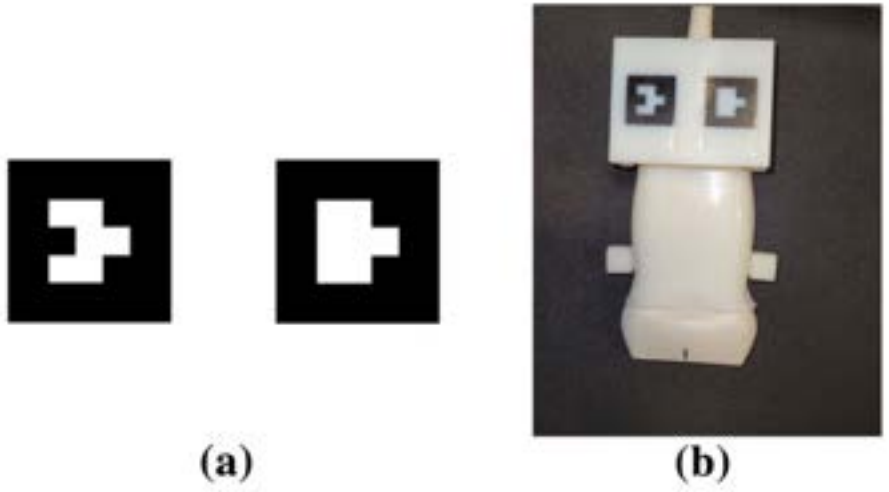
Tool Tracking:

https://www.emedicinehealth.com/ultrasound/article_em.htm

- Track the ultrasound probe
- Track the patient's body
- Identify the ultrasound probe's pose with respect to the human body

Technical Approach: Ultrasound Probe Tracking

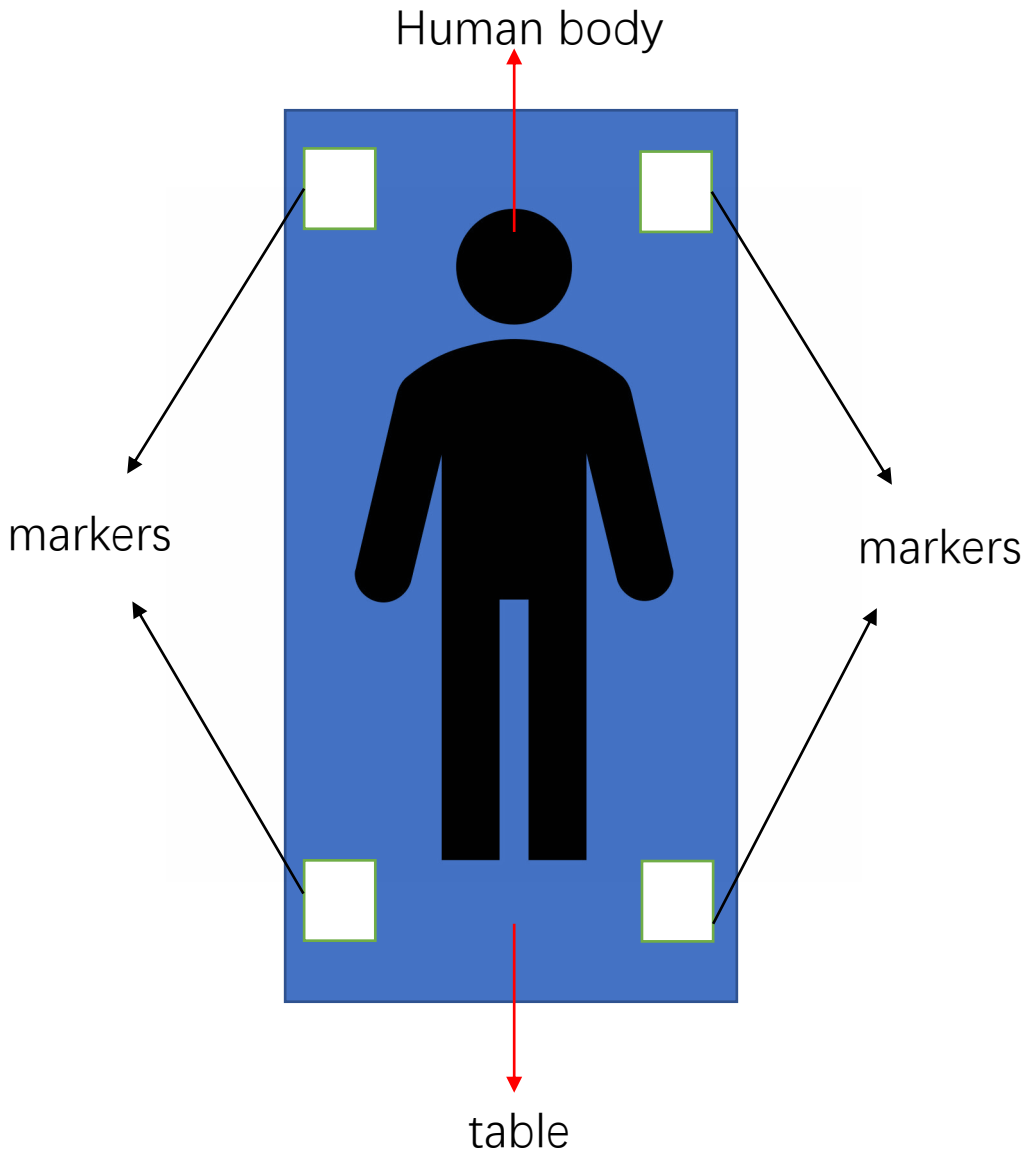
- Use optical markers attached on ultrasound probe to identify the orientation and location of it.



Nguyen, T., Plishker, W., Matisoff, A. *et al.* HoloUS: Augmented reality visualization of live ultrasound images using HoloLens for ultrasound-guided procedures. *Int J CARS* **17,** 385–391 (2022). https://doi.org/10.1007/s11548-021-02526-7

Technical Approach: Estimation of Body Pose

- First we attach markers on the table to identify the relative position of the patient.



Technical Approach: Estimation of Body Pose

- Fix the position of the patient

https://smithersmedicalproducts.com/video/

Technical Approach: Imaging Saving and Display

- Display: Hololens
- Image-Saving: Hololens Clicker

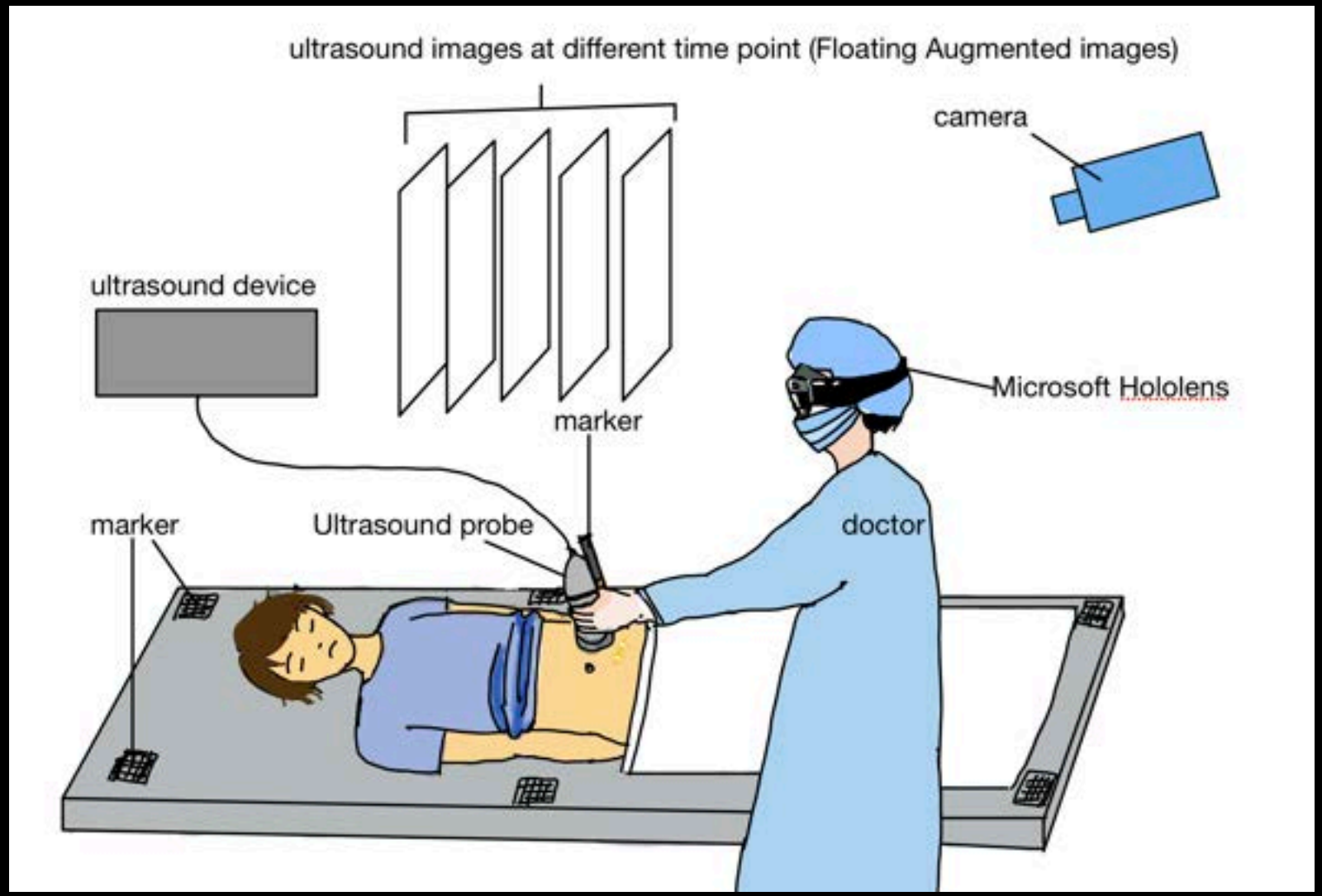
https://www.ithome.com.tw/news/104200

https://www.geekwire.com/2016/hololens-interface-leaked-in-app-walkthrough-video/

https://www.ithome.com.tw/news/104200

Technical Approach: User-interaction

- An extension of augmented reality and computer vision.



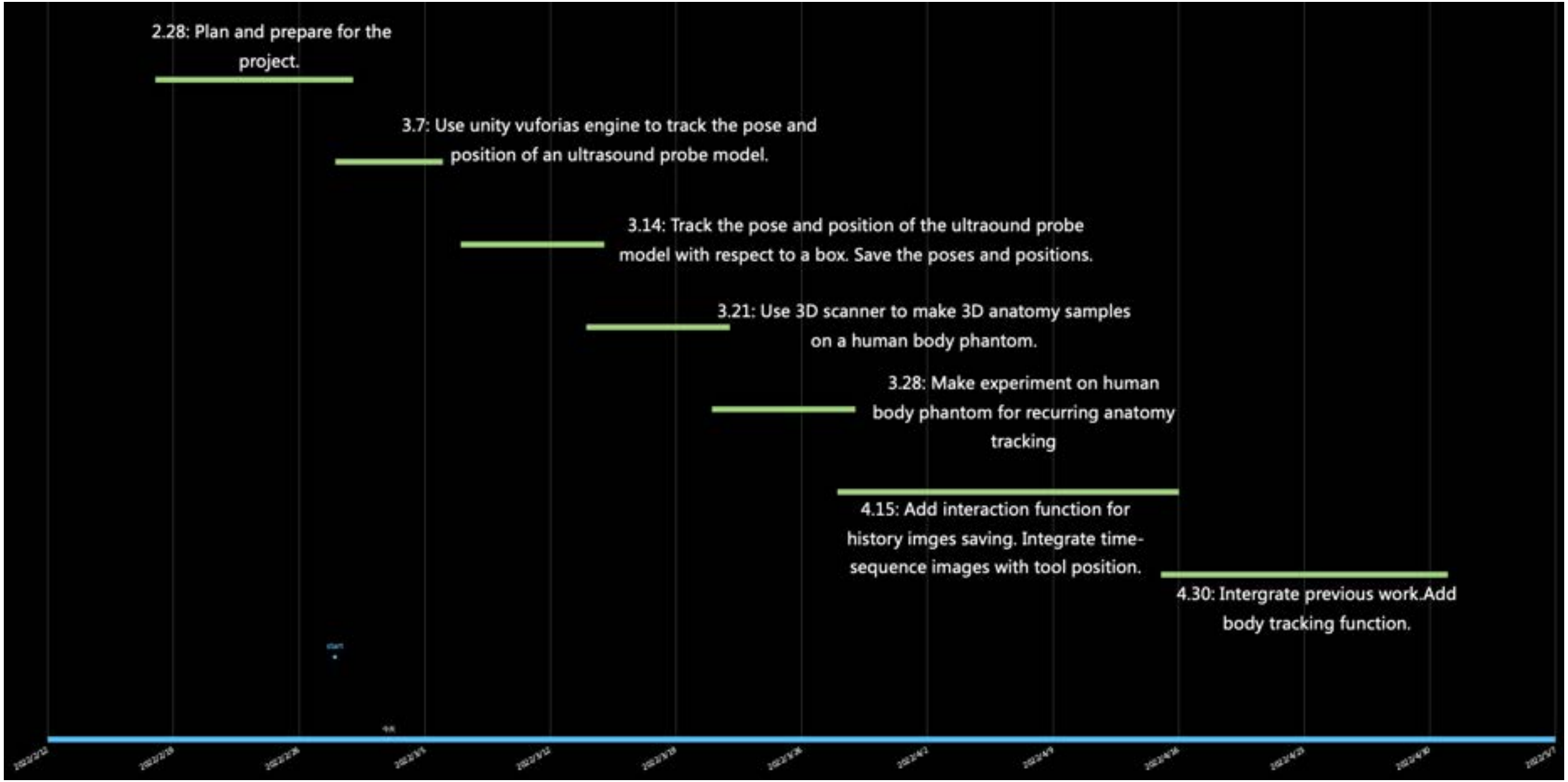
Summary of Technical Approach

- Platform:

  Unity&Vuforia Engine, C#, Microsoft Hololens

- Functions:
  - Tool Tracking
    - Track the ultrasound probe
    - Estimate the body pose
    - Identify the ultrasound probe's pose with respect to the human body
  - Image Saving and Display
    - Display: Microsoft Hololens
    - Image-saving: Hololens clicker
  - User-interaction
    - Hololens

Timeline


2.28: Plan and prepare for the project.
3.7: Use unity vuforias engine to track the pose and position of an ultrasound probe model.
3.14: Track the pose and position of the ultraound probe model with respect to a box. Save the poses and positions.
3.21: Use 3D scanner to make 3D anatomy samples on a human body phantom.
3.28: Make experiment on human body phantom for recurring anatomy tracking
4.15: Add interaction function for history imges saving. Integrate time-sequence images with tool position.
4.30: Intergrate previous work.Add body tracking function.

List of dependencies & plan for resolving

Items	Date	Status
Computer with Unity Vuforia Engine and C#	2 /28	Available
Human body phantom	2 /28	Available
Optical Markers	3/1	Downloaded online.
Cameras for tracking	3/1	Available.
Ultrasound probe model	3/14	Will be printed using lab's 3D printer.
Microsoft Hololens and Hololens Clicker	3/14	Lab purchased. Wait for mentor assignment
3D Scanner	3/21	Available

Milestones

Date	Object	Status
2/28	Learn Unity Essentials and Vuforia. Plan for the project.	Finished
3/21	Finish pose tracking. Use a box to simulate the human body. Use different markers to recognize the ultrasound probe model and the box. Use Unity and Vuforia for relative pose tracking and saving.	On progress
4/15	Use 3D scanner to create virtual replica of human body phantom for recurring anatomy tracking. Use the phantom to test previous work: save the position and pose of images with respect to ultrasound probe at different time point.	Pending
5/1	Integrate prior work. Add human body tracking function. Design better interaction experience.	Pending

Management Plan

- Meet with project mentor Alejandro every Thursday at 11:30 a.m.
- Daily communication with mentor through skype and email
- Code: Upload on Github
- Documentation: Google drive, CIS II Wiki and Github

Reference and Reading list

- Nguyen, T., Plishker, W., Matisoff, A. *et al.* HoloUS: Augmented reality visualization of live ultrasound images using HoloLens for ultrasound-guided procedures. *Int J CARS* **17,** 385–391 (2022). https://doi.org/10.1007/s11548-021-02526-7

- Magic pillow: https://smithersmedicalproducts.com/video/

- Matthew G. Hanna, Ishtiaque Ahmed, Jeffrey Nine, Shyam Prajapati, Liron Pantanowitz; Augmented Reality Technology Using Microsoft HoloLens in Anatomic Pathology. *Arch Pathol Lab Med* 1 May 2018; 142 (5): 638–644. doi: https://doi.org/10.5858/arpa.2017-0189-OA

- Farahani, N., Post, R., Duboy, J., Ahmed, I., Kolowitz, B. J., Krinchai, T., Monaco, S. E., Fine, J. L., Hartman, D. J., & Pantanowitz, L. (2016). Exploring virtual reality technology and the Oculus Rift for the examination of digital pathology slides. Journal of pathology informatics, 7, 22. https://doi.org/10.4103/2153-3539.181766

- M. Krichenbauer, G. Yamamoto, T. Taketom, C. Sandor and H. Kato, "Augmented Reality versus Virtual Reality for 3D Object Manipulation," in *IEEE Transactions on Visualization and Computer Graphics*, vol. 24, no. 2, pp. 1038-1048, 1 Feb. 2018, doi: 10.1109/TVCG.2017.2658570.

- Zhu E, Hadadgar A, Masiello I, Zary N. 2014. Augmented reality in healthcare education: an integrative review. PeerJ 2:e469 https://doi.org/10.7717/peerj.469

Thank you

Any Questions?