

Introduction

Ultrasound is critical in fetal ultrasound measurement. It can show how the baby is growing and detect abnormalities, which is a significant step for testing the health of the mother and baby. Currently, such measurements could only be performed at hospitals, which requires mothers to visit hospitals frequently. However, several drawbacks should be considered:

- Obese mothers and moms whose babies are in the wrong position could cause more frequent visiting to the exam room, which would decrease the efficiency of the medical facilities.
- Moms would feel uncomfortable to revisiting hospital frequently.
- Patients could feel a revulsion against visiting hospital.

To avoid those inefficiency and unhappiness from patients, we suggested a new generation ultrasound that could get patients measured at home. Patients are required to visit the hospital only if something suspicious is detected during the measurement.

Problem

To realize the remote fetal measurement, we wanted to build a new generation of medical ultrasound called patch ultrasound, which enables the operator to use both hands to focus more on their operations, reducing hand-eye coordination requirements during the operation. The patch ultrasound should solve the following problems:

- Hands-free probe.
- Users should be able to acquire the ultrasound image from multiple angles.
- It could be controlled by the expert remotely.

Solution

- Develop manufacturable design for the patch ultrasound, using an acoustic mirror to reflect ultrasound waves coming from the transducer so that the operator could measure the patient from multiple angles.
- Perform a phantom study on acoustic mirror.
- The user interface interacts with a patch ultrasound get the images in real-time and transmit the images to the interface by the WebSocket protocol.
- As for remote control of the patch ultrasound, we can acquire the intended moving direction with buttons in the user interface, and then send the JSON request to the back end to move the patch ultrasound to the desired position.



Figure 1 (a): We placed a mirror in the water to test if the ultrasound image could be captured after the ultrasound waves were reflected.

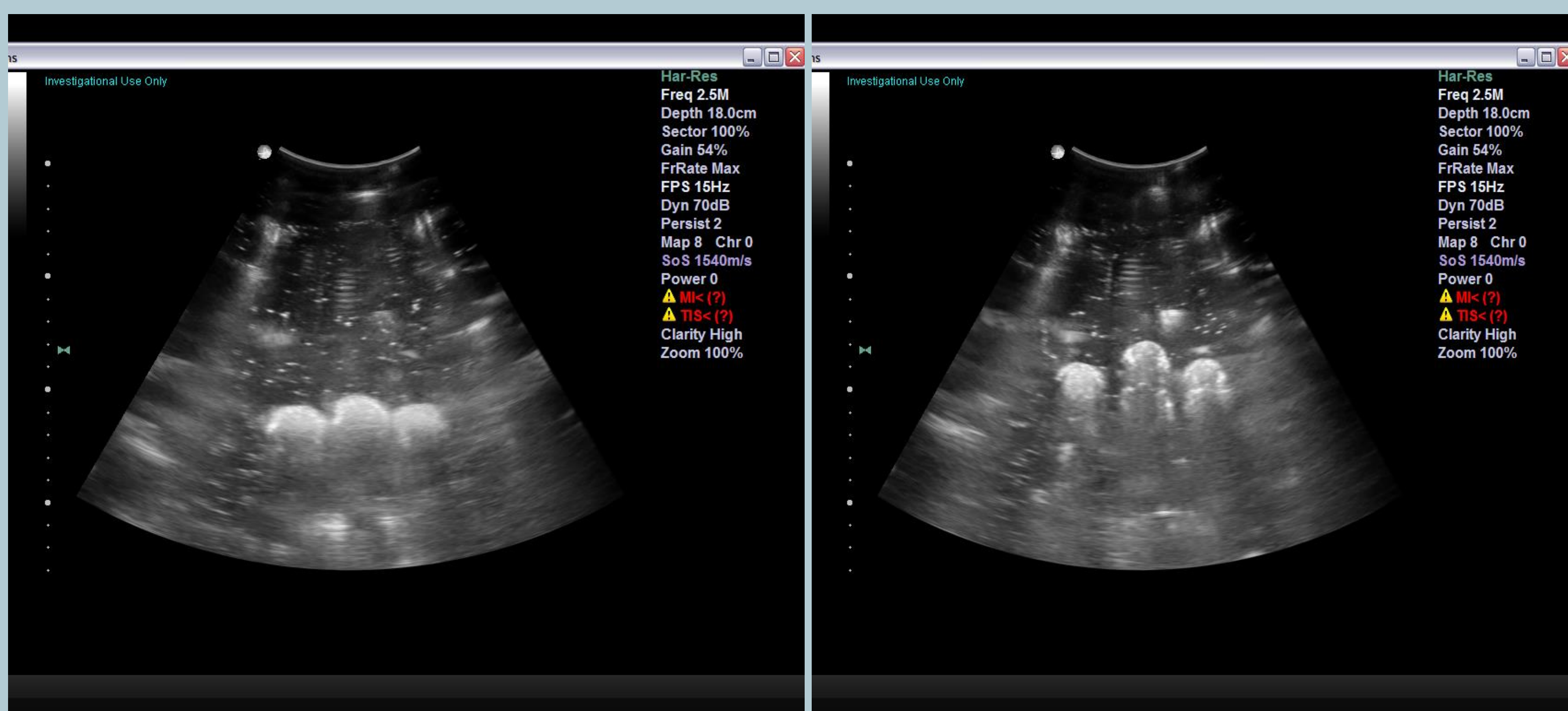


Figure 1 (b): Ultrasound image captured without using acoustic mirror

Figure 1 (c): Ultrasound image captured using acoustic mirror

Outcomes & Results

- We have developed our manufacturable design for the patch ultrasound.
- We have realized the real-time ultrasound image display and remote control.
- To test the user interface, we put the patch ultrasound on a bone model. We can see the real-time ultrasound images obtained by this ultrasound probe and move the probe by clicking the button on our user interface.

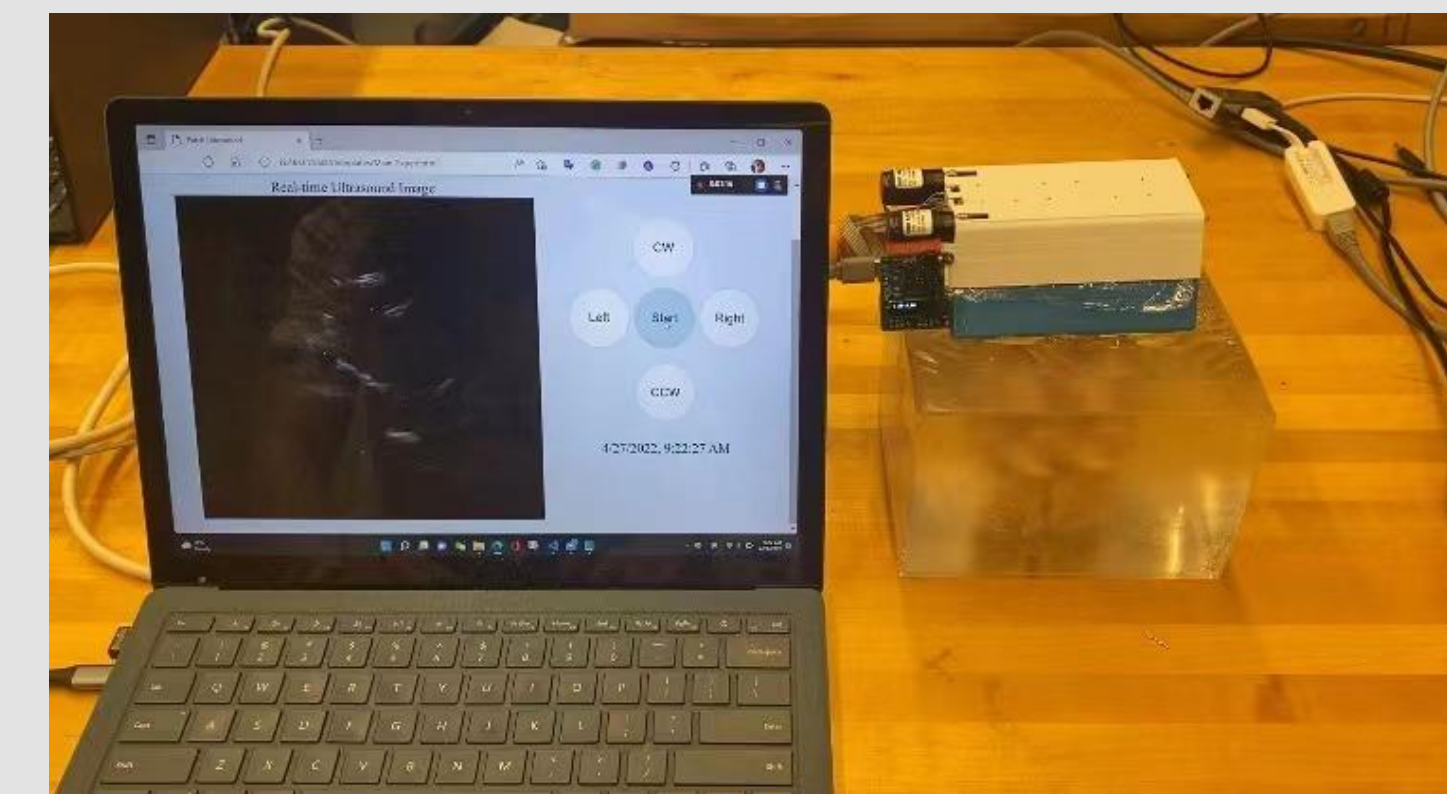


Figure 2: Demo scenario of the user interface.

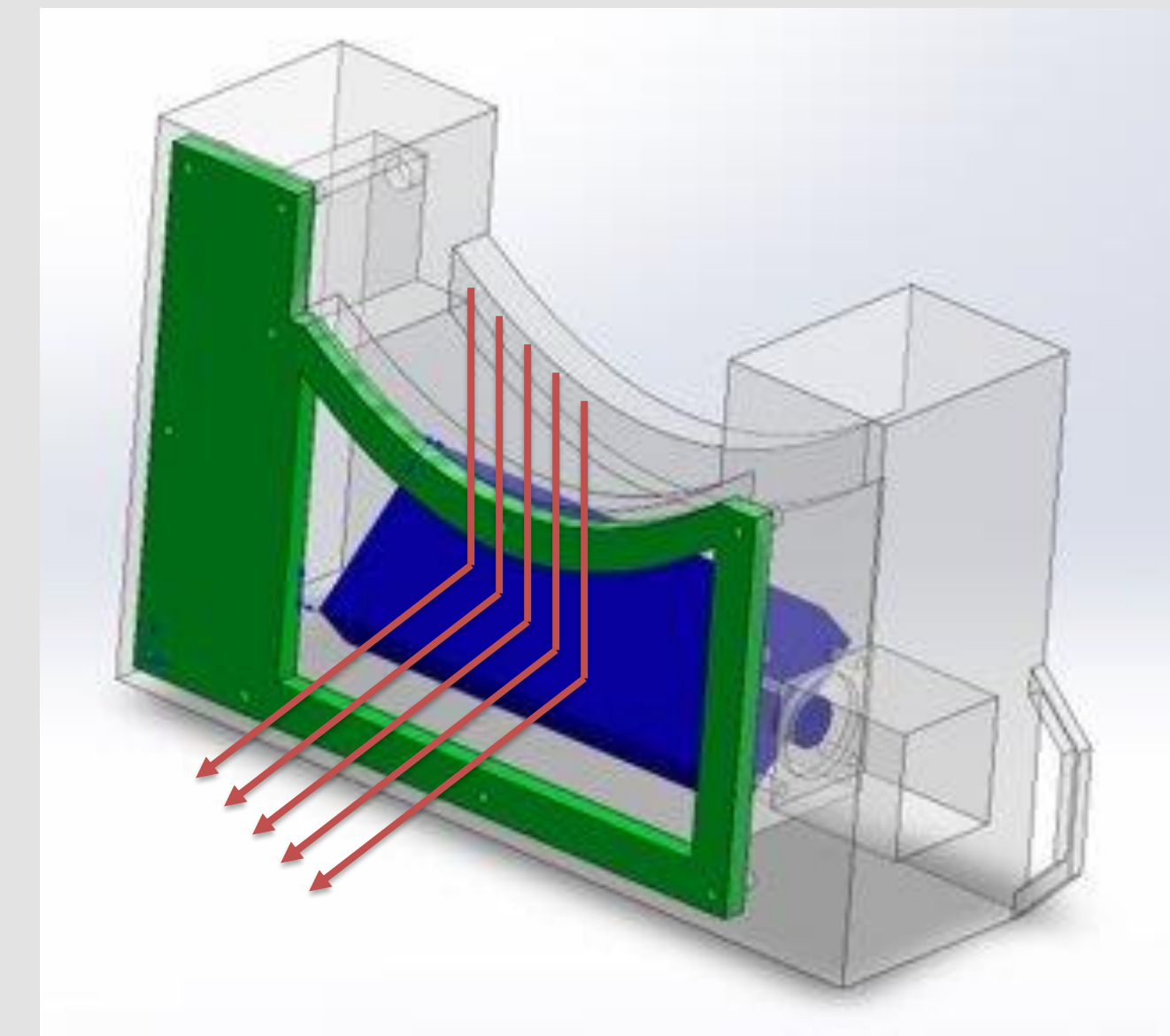


Figure 3: Manufacturable design of the patch ultrasound (the green part is the lid of the patch ultrasound, the transparent part is the outer frame of the patch ultrasound, the blue part is the acoustic mirror) Red arrows represent the emitted and reflected ultrasound waves.

Future Work

- Print out the manufacturable design and build up the prototype.
- Set up the communication between the UI and the prototype.
- Build a patient-side user interface and connect the user interface to the patient database.
- Add identity authentication to the user interface.

Lessons Learned

- Learned how an ultrasound machine works and how we can detect the target by using the ultrasound probe.
- Learned how to accommodate the difference between the design and real product.
- Learned the new concept – acoustic impedance.
- Learned to build a user interface.

Credits

- Yuanwu He designed the patch ultrasound.
- Shuran Zhang built the user interface.

Acknowledgements

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