***Maryland Blended Reality Center (MBRC): COVID Projects***

## ***1. AI tools for diagnosis and lung ultrasound interpretation in COVID-positive patients***

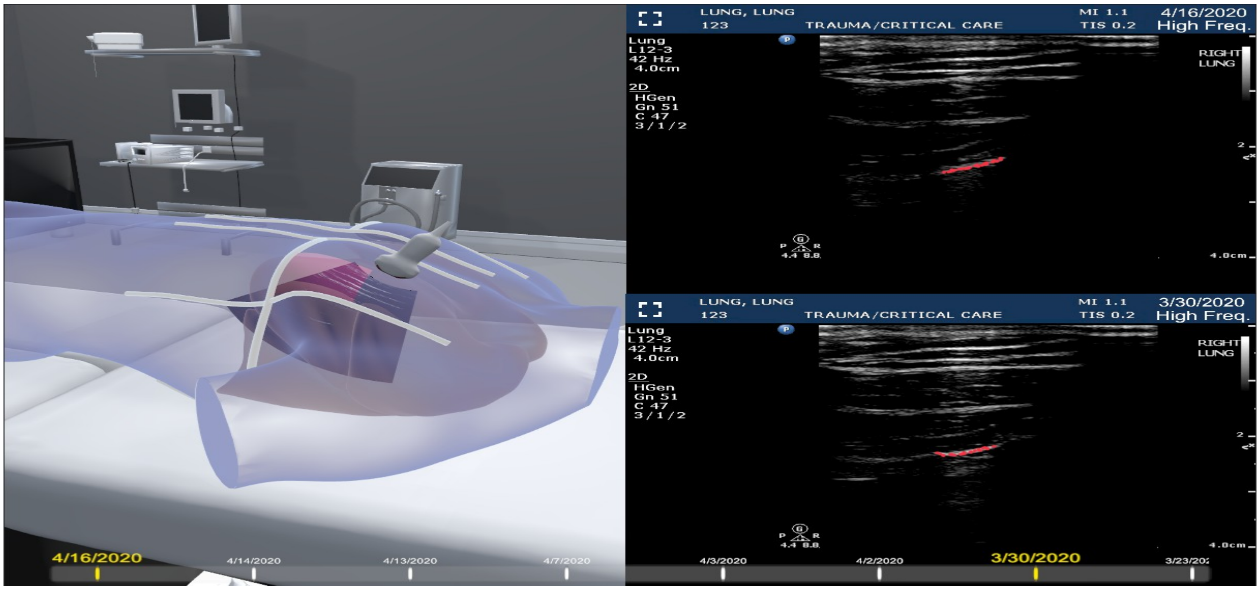


**Figure 1: Visualization of lung ultrasound volumes, with the pleural regions identified.**

Computed tomography (CT) and x-ray imaging of patients with COVID-19 is fraught. These patients are extremely sick and need frequent interventions; meanwhile exposure of healthcare providers and other patients to SARS-CoV-2 from contaminated equipment is an ongoing risk. Hospitals across the country must make difficult choices weighing the preservation of personal protective equipment, staff, and other patient safety against the best care for infected patients. Point-of-care ultrasound (POCUS) is emerging as the most important alternative, as it can be performed by the treating healthcare providers using equipment already in the rooms, and rapidly detect both pulmonic and cardiac dysfunction. Therefore, we are developing new artificial intelligence (AI) tools that will analyze and display POCUS images quickly, accurately, and in a way designed to facilitate clinical decision-making. The technology will allow quantification and standardization of lung and cardiac ultrasound findings in COVID-19, which is not currently possible. ***We are building on the already successful collaboration at the Maryland Blended Reality Center (MBRC) both to change how COVID-19 is managed worldwide, and improve the care of patients with COVID-19 in Maryland.*** While this effort is COVID-19- specific, the technology will impact and improve the care of *all* acutely ill patients. This could fundamentally change how patients are managed both in and out of the hospital setting.

## ***2. Point-of-Care Ultrasound (POCUS) App for COVID-19 patient care***

While POCUS is a logistically simple and straightforward imaging tool to deploy, analyzing the resulting scans is *cognitively* intensive and requires significant expertise, especially because there is very little software to assist with acquisition and interpretation. Full-lung diagnostic ultrasound (US) imaging entails 12 separate scans (or 24 if both low- and high-frequency imaging is being used) across the anterior, lateral and posterior regions of the lung. In order to facilitate rapid diagnosis, we are developing a visualization and database application that will assist healthcare providers with reading, annotating, drawing diagnoses from, and sharing US scans. Figure 2 illustrates our current application prototype. Such a reconstruction allows the US image in the scene to be blended together with other US images in the scene (potentially all 12-24). For the creation of a 3D volume, we render separate frames from each of the 12 scans into our 3D human model, which would depict a number of images that occupy the full range of each scan's "sweep." Thus, each rendered frame produces an image that represents a different moment in time, probe position, and angle for that scan. Once we do this for all 6-12 positions, using the method shown in the image and video above, we would have a model of a 3D lung captured by the US. Having such a model would greatly reduce diagnostic times, and would be an excellent resource for providers in the field without the usual levels of expertise required to "read" US data. ***We expect our app will be used for creation of a worldwide benchmark ultrasound database for diagnosis of COVID-19 and other respiratory pathologies.***

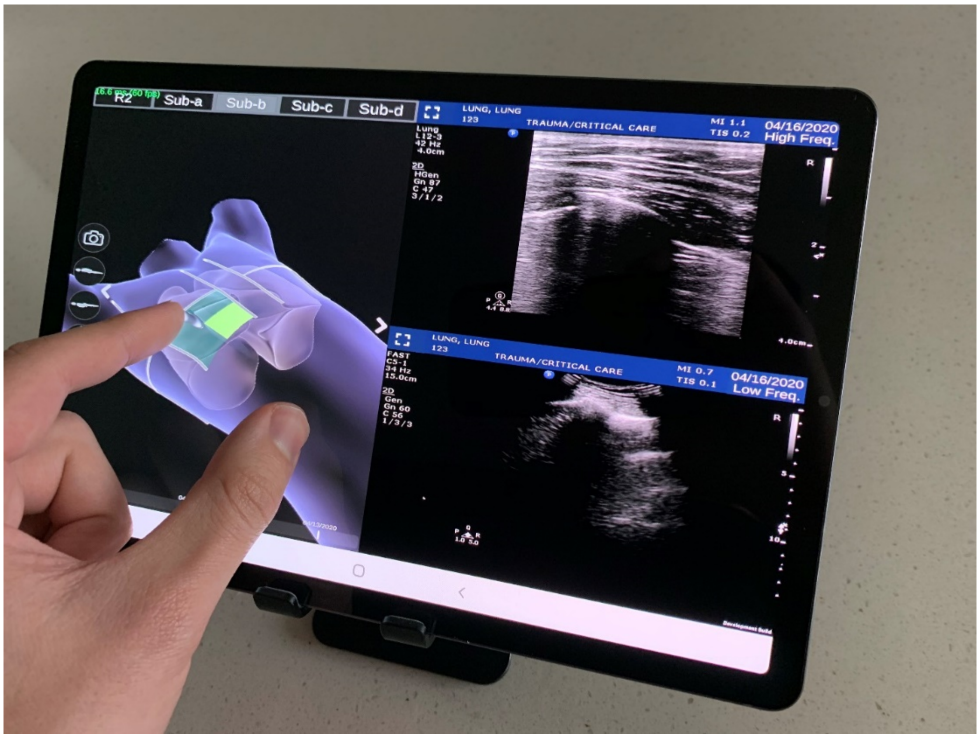


**Figure 2: MBRC's ultrasound database and visualization app under development.**

### *3. AI and biomedical data streams for COVID diagnosis*

We are working to develop innovative AI methods and software tools for visualization of biomedical big data streams. Streams can originate from biomedical sensors in an ICU (temperature, blood pressure, respiratory rate, etc.), real-time imaging (fMRI, fNIRS, EEG, MEG or US), and several other sources. We are building our visualization tools and

**Figure 3: Real-time predictive data streaming from the emergency department and several ICUs at the University of Maryland Medical Center.**

techniques for the driving application of study of vital signs and diagnostic imaging for cases of COVID-19. Early vital signs (VS) monitoring and imaging may provide valuable information to predict outcomes in COVID-19 patients. More importantly, this information will lead clinicians to early, targeted interventions to limit damage due to delayed diagnosis. Our work will allow: ICU clinicians to visualize and to use the massive amounts of data yielded by this intensive monitoring in their treatment plans; biomedical researchers to inject visualization capability at any point along the Big Data pipeline; immersive visualization techniques and software systems that increase data or relational awareness, visualization-guided discovery or processing methods; methods for visualizing embedded manifolds within higher dimensional data; and software that enables intuitive crafting of visualizations specific to biomedical Big Data.

***4. Interactive telepresence for COVID care and training***


**Figure 4: A conceptual view of an immersive surgical theater.**

We are addressing several technological challenges to enable telepresence over 5G networks currently under development. These include high-precision acquisition and rendering of dynamic digital humans and new streaming network protocols that will facilitate their transmission using low-latency, limited bandwidth, high-precision representations. Real-time, view-dependent fusion of multiple audio-video streams with depth cameras shall be an integral component of our effort. Key application areas for this effort are remote surgery and telepresence. While there are a number of virtual meeting options now available, current technology solutions that are primarily driven by 2D video lack critical human factors necessary for experiencing true telepresence. These factors include eye contact, facial micro-expressions, body language, person-to-person engagement, and effective participation. Our current prototype can fuse 8 video-streams and 4 Kinect depth streams for one human in 20 ms per frame and an additional 30 ms are currently needed for view-dependent fusion. In deploying this effort for remote medical training and patient care, we note that medical response time and quality is a matter of life and death. We envision applications to increase medical mobility, while ensuring access to essential medical expertise and support, and to deploy situational and immersive training to improve the skills of medical personnel and units.