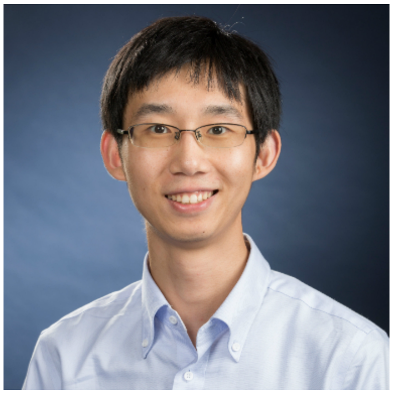
COVID Information Commons (CIC) Research Lightning Talk

Transcript of a Presentation by Haichong (Kai) Zhang (Worcester Polytechnic Institute), June 9, 2021



Title: Robotic Lung Ultrasound for Triage of COVID-19 Patients in a Resource-Limited Environment

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YouTube Recording with Slides

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Transcript

*Slide 1*

Thank you, Helen, for introduction and hello everyone. It was very great pleasure for me to have an opportunity to speak in this webinar series and my name is Haichong Zhang. I'm an Assistant Professor in Biomedical Engineering Robotics from Worcester Polytechnic Institute. Today I'm going to talk about a little bit different flavor from other talk. Probably it's more engineering focused, from an engineering and robotics perspective, how we can contribute toward the challenge we are facing with COVID-19.

*Slide 2*

And before I start, I would like to acknowledge all the team and collaborators where we have a multi-disciplinary institutional or even multi-continental cooperator from United States and Nigeria and Japan where we have the BIDMC [Beth Israel Deaconess Medical Center], MCPHS [Massachusetts College of Pharmacy and Health Sciences] as well as African University of Science and Technology, National Hospital Abuja from Nigeria. And I also appreciate the support from NIH [National Institute of Health] to allow us to do this research in a timely manner and like to give a special credit to Dr. Ryosuke Tsumura. He led this project and basically built this robot from scratch once we realized the need during this pandemic.

*Slide 3*

Okay, let me start from why we are doing this kind of project and why robots, you know, were necessary toward COVID-19. I need to start from describing why we need to have those imaging devices at the first place. As we already know that COVID-19 has already provided significant impact and at the same time the good news is we already know that there's a lot of like effective ways to detect COVID-19, including the previous presentation being presented. What PCR or antibodies provide us is the qualitative information- how much you know if we are infected with COVID-19 or not.

*Slide 4*

Then the next thing what patients want to know when they go to hospital is how much this virus is affecting the patient's lung and how urgent the treatment they should receive if the patient should go to ICU right away or the patient should be isolated or should be sent to quarantine, which requires more detailed analysis understanding the situation of the patient lung where diagnosed in diagnostic imaging will play a critical role such as x-ray imaging, computer tomography (CT) which is sound has been widely used in hospitals in the United States, or around the world. The limitation of those diagnostic imaging currently we identify is the fact that x-ray or CT are- affect the imaging device. We can see the, you know, picture of the lung, but accessibility for such device is limited, given the fact that we need to bring the patient to those machine rooms, which is cumbersome and has a risk of transmission and also need to sterilize the machine every single usage between different patients. And more importantly for resource-limited environments, including African countries that we're working with, the accessibility for those devices itself is not trivial. Therefore, we need to find a way to provide more cost-effective and effective diagnostic imaging to wider population around the world.

*Slide 5*

This is where we're focusing on lung ultrasound, which is currently used diagnostic imaging approach for COVID-19, which do have a high sensitivity to pneumonia. Actually, it is also it is actually more sensitive than x-ray and it's extremely low cost because of the presence of point of care, which is a system emerging these days and with no radiation and it's quite portable. This is why we thought about ultrasound can be, you know, a good alternative- an effective solution to diagnose patient status of the lung.

*Slide 6*

Then here's some examples of how an ultrasound is being performed on a patient is following the established clinical workflow where they have to scan in total 10 regions- like five regions for each side of the lung including anterior, lateral, and posterior side of the lung. And typical sign of COVID-19 in lung ultrasound, including those like a straight line up here towards that direction which is known as a patchy B-line as well as pleural thickening- the change of the plural line as well as some pleural consolidation or this other signature that we can observe from COVID-19 patients.

*Slide 7*

Then we know that lung ultrasound is going to be effective then why we still need to have robotics here? Fundamental challenge of current lung ultrasound to be used for COVID-19 is a limitation that there's a limited accessibility for the operator who can perform lung ultrasound effectively, and ultrasound is the procedure where, you can see from the picture, require operator to physically interact with the patient. They need to hold the ultrasound probe and you know touch the region to region to get a required information for them to diagnosis. Therefore, is highly user dependent or operator dependent. Therefore, to have accurate diagnosis you need to have someone who is well trained which is not that widely available, unfortunately, in this current situation. And more importantly, you may notice that the fact that the physician and sonographer and patient need to interact physically, which also pose huge risk of transmission which we want to solve.

*Slide 8*

So, what we want to propose in this project here is we are making a robotic solution to allow ultrasound procedure can be performed in at least resource limited environments [and] does not impose huge costs compared to x-ray or CT, at the same time minimize the risk of transmission because we don't- we're making a robotic system which eliminates the need that the doctor need to sitting right next to the patient anymore. And this system is structured like a gun tree, where is designed to be able to scan all the region where- which is required to perform diagnostic imaging of lung ultrasound procedure.

*Slide 9*

And this robot is consisted by several components, including the mechanical part which can allow to scan from the top and from the side, as well as some safety measures we call it as a passive end-effector, where this robot is only allowed to apply certain amount of force, which is not exceeding the limit. In other words, we mechanically make this system to be safe- not going to damage and providing any harm on the patient, which is related to one of the work that Dr. Tsumura, the postdoctoral fellow on this study perform a similar project for prenatal imaging undergo as a human study for validation.

*Slide 10*

And here is actual demonstration of the system. You can see the robocam scan and move around different regions of the body where it's currently showing the anterior region where we have three cameras which capture the patient body from the top and from the side, and where an ultrasound image can be provided in real time, can be recorded, can be transferred information to doctor for them for diagnosis and or evaluation. The robot arm can move from the side, can provide the lateral view, and when patient flips the body, they can also scan the back side of body, which will cover whole region where required to do COVID-19 diagnosis.

*Slide 11*

And we also asked the emergency physician to evaluate the score of the image collected by the robot compared to the image we acquired from manual scan. We can see that the score which is evaluated by doctor basically scoring the image quality where we can see that the comparable image quality can be acquired with a robot compared to manual scan without using the robot system.

*Slide 12*

So, where we- where our robot is right now? We started this project 2020 April and we started design from scratch and we made a robot and now the robot is transferred to Nigeria and hopefully this robot will be able to testing on actual patient subject there. We are very excited about this initiative.

*Slide 13*

Lastly, I would like to appreciate all the collaborators who's supporting project as well as the funding source from NIH to allow us to develop this new engineering technology. Thank you very much for attention and let me know if you have any question. Thank you.