Szilárd Vajda

THE NEXT STAGE

CWU Professsor Develops Vital TB Diagnoses via Computer

by Robert Lowery

In Western society, chest X-rays are routinely available. But that is not always the case in remote parts of Africa, where a health clinic—which may or may not include a physician—can be hundreds of miles away and patients have to make the journey on foot.

In specific countries, such as Kenya, that have high HIV/AIDS rates, detecting and treating tuberculosis is vital. The reason is, people with compromised immune systems are particularly vulnerable to TB, the fourth leading cause of death alone in Kenya.

TB is curable at a better than 90 percent rate. Chest radiography is a commonly used detection tool. But, in isolated areas of Africa, there are few medical facilities equipped to conduct those exams, and even fewer human experts available to interpret the results. It can take weeks to get diagnoses from specialized laboratory facilities.

Szilárd Vajda, CWU computer science professor, learned of that problem, and realized he may be able to help develop a solution. While completing post-doctoral work at the National Library of Medicine (NLM), Vajda was part of an eight-member team that developed software allowing less costly, portable X-ray units to use computerized screening and artificial intelligence (AI) to detect TB in a patient's chest image.

"The idea was to hire a special truck, equipped with a portable machine and a technician to operate it, to visit remote villages and do the X-rays there, and analyze the X-rays without medical personnel," Vajda explained. "We wanted to scan and digitize the image, and then process it by computer, using software to determine if a patient may have a problem in the lungs."

When a problem is found, patients are encouraged to visit medical facilities for further evaluation and treatment. In cases of no health issues, it alleviates patient and community concerns.

"In some of these societies, people thought to have HIV or TB are not accepted because of fear that others could catch the same disease just by being around that person," Vajda said. "TB can be transferred by coughing, but we definitely know that HIV is not like that. However, not everyone there is aware of that. Those thought to have the disease can end up being killed, even by their own families—that's what I was told. So, that's why this [research] is so important."

The challenge was find a way to analyze digital images in the field, without the need for a radiologist. While trained medical personnel can do visual readings, a digital image does not account for variations within tissues, determine the unique characteristics of each individual's lungs, or, even, differentiate one organ from another in the body.

"We had to find a solution that would work for everybody," Vajda explained. "We had to do some 'segmentation,' as we call it in image processing, to define the regions of interest that are the most important."

Once accomplished, Vajda, and his colleague, consulted with medical experts to develop a standardized set of common traits, like spots in the lungs, that typically indicate TB.

Using data collected from studies done in the United States and China, software was then developed for use with portable X-ray units for field diagnoses of TB. It refuted 40 years of studies, which suggested that no computer-aided diagnosis systems could correctly read chest X-rays. To the contrary, it has been found accurate in better than nine in 10 cases.

In cases where mistakes are made, Vajda notes the system is designed specifically to err on the side of caution with, "false positives, rather than missing a faulty lung."

The computerized screening research, conducted through NLM in collaboration with AMPATH (Academic Model Providing Access to Heathcare), now being deployed, has already been shown valuable in Kenya's noted drop in TB cases. It can return a diagnosis in about a minute following a test.

Vajda is now working to refine the software, specifically pertaining to "costophrenic angles," the sharply-pointed regions at the bottom, outside edges of the lungs. The less angular they look, the more likely it is that the lungs are diseased.

"Humans can see them [angles], but computers don't recognize the concept, they only 'see' a succession of pixels," Vajda noted as the issue. "We can do an estimation, but I want to improve on that, so we have even higher precision."

CWU graduate student Dmytro Dovhalets is assisting with the software refinement research.

"Recently, I shared with him this idea of the angle estimation," Vajda explained. "Now he is developing some algorithms to better estimate this angle, so that we can easily judge if there is liquid in the lungs or not."

Dovhalets said: "I was really interested because it's a real-world problem and we get to do something hands on and understand it's not just the theory behind it. This project is not just another assignment from a professor to get me a grade."

Dovahlets, a native of Ukraine, immigrated to the United States with his parents about 11 years ago. He came to CWU because of its location and affordability, to earn his undergraduate degree. But he acknowledges, he never expected to get the chance to be involved in research of such magnitude.

"I want to do something with machine learning, possibly research-and-development," he said of his career goals. "Lung segmentation and the angle, that is, essentially, machine learning. You have to come up with the algorithm that can adjust to different problems and solve them. This is something that I would come across in the industry."

Despite its low cost and improving accuracy, Vajda points out that the system is still best used to augment traditional diagnostic methods, when they are readily available.

"I would not replace a radiologist with this, yet," Vajda said. "But it's quite a good tool. And, the more we can refine the software the more accurate the results will become."

Vajda will also look to improve the system so it can assess lung ailments, and even sub-classes of them, apart from just TB.

"That's the next stage," he said.