CASE STUDY

Health & Life Sciences
Data Driven

Using AI in Medical Imaging to Improve Accuracy and Efficiency

Artificial intelligence, specifically deep learning training and inferencing, demonstrate a 10 percent greater accuracy in nodule identification in thyroid cancer screening in China

At a Glance

Zhejiang DE Image Solutions Company* and Zhejiang University* partnered with Intel to develop and deploy an artificial intelligence-based solution to identify thyroid nodules and classify them as benign or malignant. The solution has been used with over 5000 patients in China and shows the potential to:

- Enhance radiologists' accuracy in analyzing images
- Improve turnaround time for reports
- Increase case throughput of radiologists and diagnostic capacity of healthcare systems

"Not all radiologists are experienced, especially in primary hospitals. But with the help of AI, this study shows that they can make a diagnosis with better efficiency and accuracy. [The DL Inferencing Solution] achieved high accuracy and transformed from concept to reality in clinical practice in a short amount of time. It could not have happened without the support of Intel AI technology."

- Yan Zixu, Ph.D.

Director, Research & Development
Zhejiang DE Image Solution Company

Advances in deep learning (DL) and other artificial intelligence (AI) methodologies are demonstrating their potential to help health systems improve access to high-quality healthcare services. In China, Zhejiang University (ZJU) and Zhejiang DE Image Solutions Co., Ltd. have partnered with Intel to train DL models and deploy them on a DL Inferencing Solution to analyze ultrasound images of thyroids. Depending on the experience level of the radiologist, this solution has the potential to act as a preliminary screening tool to improve both speed and accuracy of diagnosis.

Challenge

The incidence of thyroid cancer has increased dramatically in recent years. Ultrasound imaging is the most common diagnostic method for thyroid nodules and biopsy, a painful and expensive procedure, is often required to determine whether they are cancerous. The number of radiologists, particularly in developing countries like China, available to read these images have not kept up with demand; and these available radiologists are overloaded and overworked which can lead to fatigue and decreased accuracy in analyses.

Solution

The School of Mathematics at ZJU and Zhejiang DE Image Solutions Co., Ltd. worked with Intel to train DL algorithms to identify thyroid nodules and classify them as malignant or benign in ultrasound images of patients. The algorithms were applied to a DL Inferencing Solution created by Zhejiang DE Image Solutions and deployed in Chinese hospitals. The trained algorithms and the solution were developed with Intel® optimized software and powered by the Intel® Xeon® processor.

Results

When ZJU tested the model to read ultrasound images of the thyroid, the AI-based medical imaging inferencing solution identified confirmed thyroid tumors with 10 percent or greater accuracy than radiologists at a Class A tertiary hospital in China. Radiologists were able to analyze images faster, and workflow efficiencies allowed experienced radiologists more time to focus on the complex cases. The solution has been used on over 5000 patients; and with broad deployment, the solution is expected to help increase the medical system's diagnostic capacity and improve patient outcomes.

Rising Cancer Screenings and Specialist Shortages Require Innovative Solutions

The incidence of thyroid cancer has increased dramatically in recent years and thyroid cancer is the highest occurring cancer in females under 30 in China.

Ultrasound imaging is the most common diagnostic method for thyroid nodule examinations. It is non-invasive, provides a real-time image, and reduces examination fees compared to more invasive or complex methods. Accurate diagnosis of thyroid cancer, however, presents several challenges. Nodules on the thyroid are common. Some research indicates that nearly 50 percent of the population has one or more such nodules, and 5-10 percent of thyroid nodules are malignant. Only 4-8 percent of thyroid nodules can be detected by a manual examination.[1]

Due to the increased occurrences of thyroid cancer in China, screenings have increased in response. The number of specialists, particularly in developing countries, trained to read these images cannot keep up with demand. Computer-aided diagnosis based on the reading of static ultrasound images can enhance radiology workflows and provide faster diagnoses. However, current algorithms for computer-aided diagnosis of thyroid nodules are only semi-automated and still require manual selection of the image by the clinician. Even with this technology, doctors often must rely on biopsy to determine whether a nodule is malignant, which significantly increases their workloads and costs while simultaneously increasing potential risk and discomfort for patients.

Deep Learning Solution Summary

Artificial intelligence has a number of subfields. Two of which are machine learning (ML) and DL. In traditional, rule-based ML, health professionals must define the characteristics and combinations of characteristics that can be used to describe and identify features in an image. Unlike ML, DL does not require explicit definitions of these characteristics and combinations of characteristics.

DL algorithms draw inferences and learn the distinctions in images, which developers then confirm. These algorithms imitate the human brain's functioning to extract the characteristics of medical images and form more abstract, high-level characteristics to classify or identify objects. This DL approach often provides results with greater accuracy than humans or feature-engineered ML approaches.

A development team from ZJU's School of Mathematics and Zhejiang DE Image Solutions Co., Ltd. used this DL technique to train algorithms that identify and classify lesions in ultrasound images. The algorithms were trained with the Intel® Xeon® processor and Intel® Math Kernel Library (Intel® MKL) which improved performance compared to an earlier implementation.

Spotlight on Zhejiang University

Founded in 1897, Zhejiang University (ZJU) is one of China's oldest and most prestigious universities. It is consistently ranked among China's top universities as well as among Asia as a whole. The national university has over 45 thousand students, over 110 specialties for undergraduate degrees, 264 master's degree programs, and 181 doctoral degree programs. It has 13 National Key Laboratories, 2 National Engineering Research Centers, and 3 National Engineering Technology Centers.

The algorithms were then applied to a DL Inferencing Solution developed by Zhejiang DE Image Solutions Company using the Intel Xeon processor and Intel® optimized software. The model was trained with image data from ultrasound machines of varied brands and models in different hospitals, in combination with segmentation, detection, and identification technologies. The algorithms developed by ZJU and Zhejiang DE Image Solutions quickly outlines the nodules on the original ultrasound image without the intervention of doctors. Then further analysis advises the clinician whether each nodule in the image is benign or malignant. This work is performed automatically and rapidly. Figure 1 shows the detection and selection of a thyroid nodule in an ultrasound image.

Improved Accuracy of Image Analysis by 10 Percent

To assess the diagnostic accuracy of Zhejiang DE Image Solutions' DL Inferencing Solution, the results from the trained algorithms were compared to scores provided by physicians in the radiology department of one of China's top 10, Class A tertiary hospitals. Ultrasound images previously scored and validated by pathology reports (the current gold standard) were analyzed by the DL Inferencing Solution and two groups of physicians: one group with an average of 10 years of experience and the other group with two years of experience. The identification accuracy of the DL Inferencing Solution was above 85 percent, while the identification accuracy of the doctors averaged 65 to 75

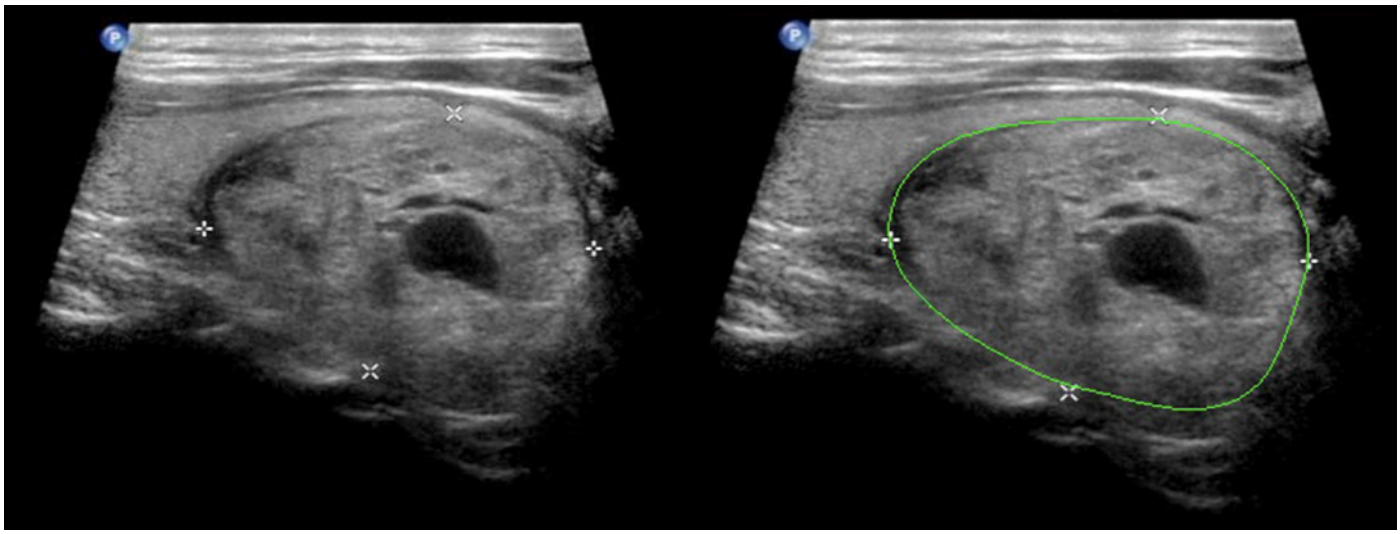

Figure 1. Original ultrasound image (left); Detection and qualitative diagnosis of a thyroid nodule using DL inferencing (right)

percent, depending on the radiologist's level of experience. In addition, radiologists could detect nodules and make diagnoses within a few seconds rather than in over 10 minutes[2].

"It never gets tired and it works really fast. Not all radiologists are experienced, especially in primary hospitals. But with the help of AI, this study shows that they can make a diagnosis with better efficiency and accuracy. [The DL Inferencing solution] achieved high accuracy and transformed from concept to reality in clinical practice in a short amount of time. It could not have happened without the support of Intel AI technology," says Yan Zixu, Ph.D., the Director of Research & Development at Zhejiang DE Image Solution Company.

Healthcare Providers Embrace New Solution

Zhejiang University is using this DL Inferencing Solution to support real-time imaging services in the Ultrasound Department of the First Affiliated Hospital School of Medicine at ZJU. It is being deployed in support of the National Thyroid Nodule Screening and Risk Assessment Program sponsored by the China Health Promotion Foundation with a target of screening 20 million citizens.

Response from physicians has been positive. Several directors at the First Affiliated Hospital School of Medicine have praised the solution. As a preliminary screening tool, the ultrasound solution allows doctors to concentrate on complex cases, efficiently reducing missed diagnoses and misdiagnoses. Doctors in the Radiology Department have heavy workloads and are likely to write hundreds of ultrasound reports every day. Although the majority of these reports are basic, they are time-consuming, possibly affecting the accuracy rate of the reports over a long, continuous work period. With ultrasound AI, doctors only need to review the regions labeled as suspicious. This DL Solution increases efficiency and accuracy and has become a popular method for training junior doctors.

Before the ultrasound solution, the limited experience of primary doctors often made it difficult to provide reports in a timely manner as ultrasound images had to be sent to specialists, often in more metropolitan areas and in other provinces, for review which could take days or weeks. Now, it only takes several minutes to generate a detailed reference report. This technology exposes community hospitals to high-quality diagnostic services and reduces wait times for treatments.

AI-based solutions for medical imaging have the potential to enhance image recognition in ways that allow for more efficient and accurate diagnoses and more effective use of highly skilled professionals. By enhancing diagnostic throughput and accuracy, health systems can improve radiologists' productivity and help enable radiology technicians to handle a wider range of image recognition tasks. With greater diagnostic efficiency and efficacy, patients may be able to avoid unnecessary biopsies and receive treatment more quickly when it is needed. These results can help improve patient outcomes, increase patient and clinician satisfaction, and contribute to lower healthcare costs.

Spotlight on Zhejiang DE Image Solutions Co., Ltd.

Zhejiang DE Image Solutions Company was founded in 2013 in China to develop image analysis and processing in the healthcare industry. The company specializes in 3D reconstruction and visualization, image segmentation and registration, and ultrasound and computed tomography (CT) algorithms. Its customers include software developers, equipment manufacturers, and system integrators in the medical industry. The company is a subsidiary of Oshi Image Technology Co., Ltd.

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[1] Teng Wei-ping, "A cooperative achievement of, and shared by, four academic societies – At the moment of the publication of "Guidelines on the Diagnosis and Treatment of Thyroid Nodules and Differentiated Thyroid Carcinomas," Chinese Journal of Endocrinology and Metabolism 28, no. 10 (2012): 777-778. [2] From an unpublished study conducted by Zhejiang University.