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Advancing Ultrasound: The Future of Real-Time Fetal Anomaly Detection with AI

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Abstract

Artificial intelligence is starting to play a significant role in contemporary ultrasound imaging, particularly in systems built on artificial neural networks. Al in ultrasound was still evolving slowly just a few years ago, but it has advanced quickly since then. The majority of Al systems were still in their infancy, according to a 2020 review on artificial intelligence in obstetric and gynecological ultrasound. The situation has quickly changed, and real-time Al applications are starting to show up in clinical settings. Lin and colleagues' work, for instance, created a real-time Al system that can recognize common fetal brain ultrasound planes during routine pregnancy scans. The Trans ventricular, Trans cerebellar, and Trans thalamic planes are among them (1).

Introduction

Artificial intelligence is starting to play a significant role in contemporary ultrasound imaging, particularly in systems built on artificial neural networks. Al in ultrasound was still evolving slowly just a few years ago, but it has advanced quickly since then. The majority of Al systems were still in their infancy, according to a 2020 review on artificial intelligence in obstetric and gynecological ultrasound. The situation has quickly changed, and real-time Al applications are starting to show up in clinical settings. Lin and colleagues' work, for instance, created a real-time Al system that can recognize common fetal brain ultrasound planes during routine pregnancy scans. The Trans ventricular, Trans cerebellar, and Trans thalamic planes are among them (1).

The researchers performed a great deal of manual labor in order to train this system. More than 21,500 photos from more than 2800 fetuses-including those from pregnancies in the second and third trimesters-were segmented and labeled. The algorithm was able to identify various pathologies thanks to the abundance of abnormal cases in this large dataset. Depending on the condition, the Al system's area under the curve ranged from 0.81 to 0.95 during testing. Ventriculomegaly diagnosis had the highest accuracy, whereas non-visible cavum septi pellucidi and some cystic lesions had the lowest accuracy. The system's speed is among its most remarkable features. It is significantly quicker than even skilled sonographers,

analyzing an ultrasound plane in roughly 25 milliseconds (2).

Despite the ease with which clinicians can diagnose ventriculomegaly, the usefulness of this system rests in knowing how ultrasound exams are carried out. The sonographer, who must control the transducer while monitoring the screen and modifying the probe to obtain the necessary standard planes, plays a major role in a routine scan. This procedure creates an ongoing feedback loop: move the probe, observe the screen, make another adjustment, and so forth. Especially useful for trainees, beginners, or people who do not frequently perform obstetric ultrasound. It gives them confidence that they are capturing the correct image. Second, the system can detect abnormalities instantly. For non-experts, this can be reassuring because identifying fetal brain anomalies requires experience. Even experts' benefit from AI assistance, as human performance can be affected by fatigue, time pressure, or difficult scan conditions. However, the system still depends on the sonographer to acquire a proper standard plane. If the image quality is poor or the view is not a standard plane, the AI may fail to detect the abnormality (3). Second, anomalies can be quickly identified by the system. This can be comforting to non-experts because it takes experience to recognize fetal brain abnormalities. Because human performance can be impacted by fatigue, time constraints, or challenging scan conditions, even experts benefit from AI assistance. To obtain a suitable standard plane, the system still relies on the sonographer. The AI may miss the anomaly if the view is not a standard plane or if the image quality is low (4).

The model put forth by Bitter man and associates is useful when examining the degree of autonomy of such systems. The real-time Al system described by Lin and colleagues is classified as Level 2, or clinical decision support, on their five-level scale. This implies that while AI can help and guide, it cannot take the place of a clinician. The human operator is still ultimately responsible for the diagnosis. The system has not been sufficiently tested, which is one of the main reasons it cannot be positioned at a higher level. It's unclear how it would function on various ultrasound machines with varying resolutions or with new kinds of abnormalities (5).

When analyzing the level of autonomy of such systems, the model proposed by Bitter man and colleagues is helpful. On Lin and colleagues' five-level scale, the real-time AI system they describe is categorized as Level 2, or clinical decision support. This suggests that although Al can offer guidance and assistance, it cannot replace a clinician. The diagnosis is still ultimately the responsibility of the human operator. One of the primary reasons the system cannot be placed at a higher level is that it has not been thoroughly tested. How it would work on different ultrasound machines with different resolutions or with new types of abnormalities is unknown (6).

The potential of AI in ultrasound has also been shown by other recent studies. For instance, Arnaout and associates created a system that can read standard fetal cardiac views and differentiate between congenital heart disease that needs to be treated and normal hearts. More than 100,000 manually labeled photos were used in their work. AI has been applied to other aspects of obstetrics and gynecology, such as classifying ovarian tumors as benign or malignant and determining fetal occiput position during labor. Al-based features are also being added to commercial ultrasound machines by numerous manufacturers (7).

However, businesses also stay at Level 2 in the autonomy model since they frequently fail to disclose information regarding the development or validation of these systems. The need for sizable labeled datasets is a significant obstacle in the development of medical imaging AI. It takes a lot of time and expert knowledge to label images. Researchers are investigating self-supervised

Learning, a technique that enables AI algorithms to learn from unlabeled data, as a solution to this issue. According to preliminary findings, this can drastically lower

the quantity of labeled photos needed to train a model. The use of synthetic or simulated data is another new method that can help expand datasets without relying solely on actual clinical images (7).

Concerns about automation and job loss are growing in tandem with these technological advancements. Even Aristotle wrote about tools that could function independently, so the idea that machines could eventually replace human workers is not new. These days, similar concerns are present in a wide range of industries, including accounting, healthcare, and transportation. Ultrasound specialists, radiologists, and sonographers are also concerned about AI replacing them. But according to available data, AI won't be able to take the place of these experts-at least not anytime soon. Rather, AI will serve as a helpful tool that collaborates with medical professionals to help them conduct examinations more precisely and effectively. Clinical responsibility, human judgment and scanning abilities are still crucial (8).

Ultrasound imaging is being revolutionized by artificial intelligence, particularly in obstetrics and gynecology. AI can help clinicians identify standard planes, detect abnormalities, and improve diagnostic accuracy, as evidenced by the quick development of systems like the one developed by Lin and colleagues. AI is still a supportive tool rather than an autonomous system, despite remarkable advancements. AI will continue to develop as a useful partner in ultrasound imaging rather than as a substitute for human specialists with additional study, clinical trials, and technological advancements (9).

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