White Paper

HD Scope

A new ultrasound imaging enhancement technology

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Introduction

Ultrasound imaging enables the visualization of internal body tissues and structures by interpreting and displaying ultrasonic echo signals in real-time through 2D images. With the merits of real-time non-invasive scanning and low cost, 2D ultrasound imaging has been widely applied to various clinical applications such as abdominal, cardiac, small parts, vascular, and obstetrics and gynecology etc.

Ultrasound is a critical imaging tool that provides valuable diagnostic information of lesions. However, for small lesions which are commonly seen in many clinical cases, the imaging features are often obscure and difficult to identify based on traditional 2D ultrasound images, making diagnosis a challenging task.

With the rapid development of ultrasound imaging technology in recent years, especially with the release of the revolutionary imaging technology – ZONE Sonography®, the image resolution of 2D ultrasound can be significantly enhanced, enabling the improved diagnosis of small lesions. Based on the breakthroughs in the system design and data processing algorithms, HD Scope, an innovative imaging solution dedicated to the diagnosis of small and complex lesions, is firstly released on Mindray's latest premium ultrasound imaging system.

Principle of HD Scope

2D ultrasound imaging is a process of managing and integrating various system resources (such as scan density, transmitting power etc.,) into equilibrium to achieve the global optimization of image quality. Limitations of such system resources often result in a major bottleneck to further improve the image quality. In clinical scanning, especially when examining small lesions, doctors usually tend to focus on some structural information in a specific area of interest. Accordingly, the core concept of HD Scope is to optimize the region of interest specified by user while maintaining the general imaging setup such as frame rate and probe heating. In order to achieve such local enhancement of image quality, the system is allowed to adaptively allocate more imaging resources to the region of interest. Therefore, doctors can gain more diagnostic confidence with better spatial resolution and contrast resolution in the local area.

As shown in Figure 1, the imaging resources of traditional 2D ultrasound systems are uniformly and equally distributed throughout the entire imaging field and the image quality is globally optimized. On the contrary, HD Scope is able to assign more system resources to the region of interest and make more effective use of idle resources. The local image quality is hence optimized based on the concentrated imaging resources.

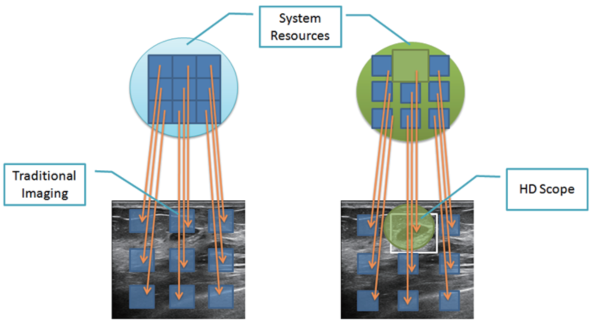
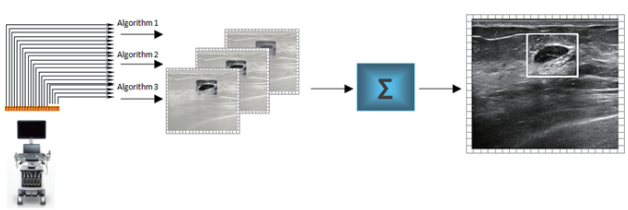


Figure 1: Traditional image (left): the imaging resources are uniformly and equally distributed through the whole field of view; HD Scope image (right): more imaging resources are assigned to the ROI

The local enhancement of HD Scope is implemented based on two strategies. One is to optimize the front-end transmitting and receiving modules based on the size and location of the region of interest. The other is to improve the image contrast resolution and suppress the speckle noises by automatically classifying the characteristics of the input image signals inside the specific region of interest during the back-end data post-processing stage. It is worth mentioning that the signal classification is mainly based on the channel data of the region of interest.

Specifically, for the optimization of front-end scanning, HD Scope distributes multiple system resources including the power of probe transmission, the number of transmitting and receiving zones and other system resources in the area of interest through algorithm optimization. Taking the power of probe transmission as an example, due to the safety concerns and the guidance of the ALARA principle (As Low As Reasonably Achievable), ultrasound systems need to limit the transmitting power within a certain range. HD Scope can raise the transmission power in the region of interest by reducing the power outside the specific area, and thus considerably increase the local SNR which often provides more anatomical information for more accurate diagnosis.

For the optimization of back-end data post-processing, HD Scope is designed to assign more computational resources in the region of interest for better filtering and processing. As shown in Figure 2, thanks to Mindray's new ZST+ platform, HD Scope can recursively analyze and process the channel data in the region of interest by taking advantage of its powerful computing capability. HD Scope is able to obtain the characteristics of the input signals by intelligently analyzing the raw image information from the channel data. By applying different filtering and processing algorithms to different input signals based on their characteristics, the optimization of both contrast and resolution for each type of tissue inside the region of interest can be achieved. By synthesizing all the optimization results, the final HD Scope image is generated.



a) Signal classification and optimization based on channel data

b) Synthesizing these optimization results and generating an enhanced image

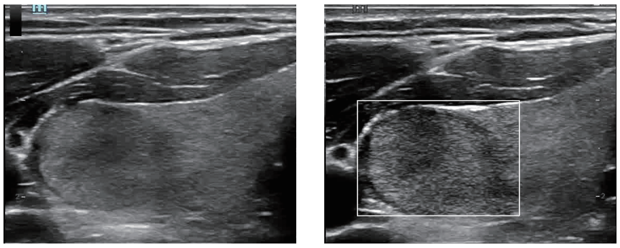
Figure 2: The processing flow of HD Scope using channel data. a) The ROI image is decomposed to its original signals for signal classification and adaptive optimization; b) All these optimization results from different algorithms are synthesized to generate an enhanced image.

Case Study

The following images show the actual clinical cases using HD Scope which demonstrate the clinical value of HD Scope in improving the spatial and contrast resolution of the region of interest, especially for enhancing the display of small lesions and organs. It should be noted that since HD Scope enables real-time imaging, the comparison images shown in each case were scanned at similar spatial location and acquisition time but they are not the exact same images.

Case 1:

as shown in Figure 3, the Left image is an original display of a thyroid mass, in which the boundary between the mass and the surrounding normal tissue is not clear, and the internal structure of the mass is not clearly displayed. The right image is the same case in the same plane with HD Scope, in which the boundary between the mass and the surrounding normal tissue becomes much more clearer, and it can be clearly observed that internal structure of mass is not uniform. Overall, the image with HD Scope has much better contrast resolution with more details, and blood vessels around the mass are nicely defined.

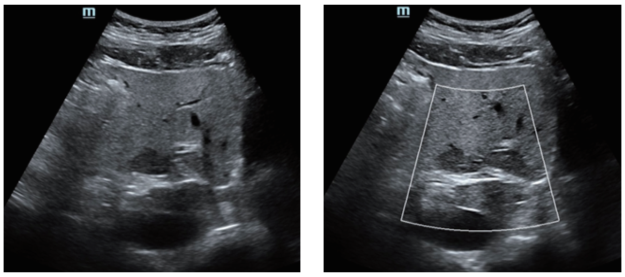


HD Scope off HD Scope on

Figure 3: The comparison images of a thyroid mass using HD Scope. The boundary of thyroid mass is much clearer and the inside of the lesion shows more details when HD Scope is switched on.

Case 2:

As shown in Figure 4, the left image is an original display of a liver mass, in which the contrast resolution between liver mass and the surrounding tissue is poor. The right image is the same case with HD Scope, which shows much better contrast resolution, and better definition of the boundary between lesion and surrounding tissue.

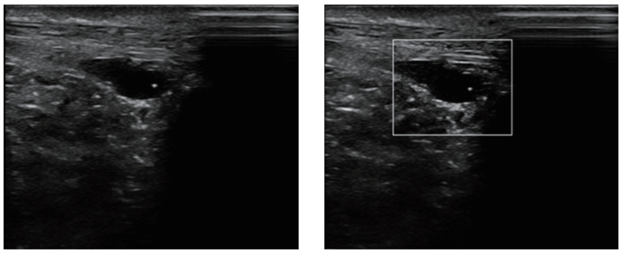


HD Scope off HD Scope on

Figure 4 The comparison images of a liver mass using HD Scope. After switching on HD Scope, the boundary of the live mass is sharper, and the contrast inside the mass is improved.

Case 3:

As shown in Figure 5， the left image is an original display of a Bursa cyst, in which the cyst boundary is not sharp, and the internal structure of the cyst is not clear. The right image is the same case with HD Scope, in which the contrast resolution inside ROI is clearly improved, the boundary between the lesion and the surrounding tissue is sharper, and the structures inside the cyst is more clearly displayed.



HD Scope off HD Scope on

Figure 5: The comparison images of a Bursa cyst using HD Scope., With HD Scope on, the boundary of the Bursa cyst is clearer, and the structures inside the cyst is more clearly displayed.

Conclusions

HD Scope is an innovative tool for image optimization. By assigning more system resources to the region of interest specified by user, HD Scope is able to significantly boost the SNR of the regional front-end signal and optimize the corresponding back-end data post-processing, leading to a local improvement of both spatial resolution and contrast resolution which can provide more valuable diagnostic information for clinical diagnosis.

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