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Healthcare

# Review of an automatic Ultra-sound & 3D pre-operative images fusion solution

## *A user experience in the context of Liver Ablation*

***Cleveland Clinic***

*Located in Cleveland, Ohio, USA, Cleveland Clinic is a non-profit multispecialty academic medical center that integrates clinical and hospital care with research and education. Ranked No. 2 in the nation by U.S. News & World Report "2017-18 Best Hospitals.", it has 1,400 hospital beds, 101 operating rooms and seven hybrid surgical suites. Its campus of 44 buildings includes the 377,700-square-foot Taussig Cancer Center.*

## *Meet the expert*

***Gordon McLennan, MD,*** *is Professor of Radiology & Biomedical Engineering at the Lerner College of Medicine at Case Western Reserve University, Ohio, USA. He is also a member of the Department of Interventional Radiology at the Cleveland Clinic Main Campus. His practice includes all liver cancer treatments, covering both hepatic arterial embolization and ablation.*

*Percutaneous tumor ablation are commonly guided using 3 techniques:*[1]

- *Computed tomography (CT),*
- *Ultrasound (U/S) only or in combination with CT guidance,*
- *Cone Beam CT (CBCT) and live fluoroscopy.*

*None of these options is optimal, each having its own benefits and challenges.*

*Today, we ask Dr. McLennan to share his point of view regarding an advanced solution allowing live Ultrasound automatic fusion with CBCT, as well as with pre-operative CT, MR and PET volumes for effective needle ablation procedures in the Interventional Suite*

**How many ablations do you perform each year?**
**Dr. McLennan:** "We perform 50 to 75 a year, about half in CT and half in the angio room."

**What are the imaging requirements to guide & perform successful percutaneous tumor ablations?**
**Dr. McLennan:** "We need to see the entire lesion, the needle path and confirm that our ablation zone entirely encapsulates the lesion and a normal zone of tissue around it."

**What modalities can you use to guide percutaneous tumor ablation?**
**Dr. McLennan:** "We could use CT, CBCT with fluoroscopic needle guidance software, ultrasound, ultrasound and CT, or ultrasound fusion to other imaging modalities. Certain types of ablation units can now even be used in an MRI scanner.
At our institution we perform about half of our ablations in the angiography room, where we can fuse live ultrasound with all the pre-operative imaging the patient has."

**What are the advantages and challenges of ablation with ultrasound guidance only?**
**Dr. McLennan:** "It is easy to place the needle under ultrasound. But ultrasound alone may or may not show the lesion. Now that we have contrast, it might be possible to do it. It wasn't possible before ultrasound contrast. That's something we are interested in, because if you can do a procedure entirely with ultrasound and have good contrast, you save a lot of time."

**Do you use ultrasound in combination with CT?**
**Dr. McLennan:** "Occasionally. It is easier to place the needle under ultrasound and then use CT to check the needle location and confirm the effect of the ablation."

**What are the benefits of using ultrasound in combination with angiography?**
**Dr. McLennan:** "In many IR departments it's very hard to get access to the CT room. The software that allows me to easily fuse the patients pre-operative CT or MR or PET with the live ultrasound is allowing me to work within my assigned environment, which is the angiography suite, independently from which modality optimally shows the lesion. So, it eases our workflow. The combination of ultrasound and angiography also eases some complex procedures that would be difficult without toggling between the two modalities. And post-ablation CBCT can be a substitute to a confirmatory CT that we would otherwise do on the CT scanner."

**Why do you use fusion of pre-operative images with ultrasound for ablations?**
**Dr. McLennan:** "The fusion allows you to identify where your target is on the real-time ultrasound, even when the target is not visible under ultrasound. Then you place your needle under live ultrasound. You can then visualize with the planning software that's built in the Ultrasound, where the ablation zone will be, even before you activate the ablation device. That gives confidence that you will cover the tumor and the normal tissue margin around it. The fusion also helps you assess the actual coverage of your lesion post-ablation, even if you can't see your lesion under ultrasound anymore."

**In what percent of your cases do you see value in fusing CT/MR/PET-CT to live ultrasound?**
**Dr. McLennan:** "I see value in almost all cases, assuming that the fusion process is easy to do and accurate."

**What about fusing live ultrasound with an injected CBCT acquired during the case?**
**Dr. McLennan:** "That's very doable, and I commonly do it when it's appropriate. Occasionally the target tumors are best seen on a very early arterial enhancement. The contrast resolution between the enhancing mass and the background liver is much more distinct on an injected CBCT than it is on the pre-procedure CT. Or sometimes I want to check that there are no new tumors. In this case, I place the electromagnetic tracker on the patient during the injected CBCT so the fusion between ultrasound and CBCT is fully automatic. When I don't need a new injected CBCT because the patient has recent images showing me what I need to see, then I usually save the contrast dose upfront."

**There are several techniques to fuse 3D volumes (CT/MR/PET/CBCT) to live ultrasound: manual registration, image based registration, and automatic electromagnetic registration. What are the challenges and benefits of each technique?**
**Dr. McLennan:** "Automatic fusion is time-efficient. Manual registration and image-based fusion are essentially equivalent manual techniques. They provide a fair amount of accuracy to where your images correlate, but you have to know what you're looking at, so it takes a lot of time. Typically, I start with automatic registration, and if I'm not happy with it, I would go for manual registration."

**Automatic electromagnetic registration can be used to fuse the live ultrasound to any DICOM volume showing the target, if the volume is acquired with tracker on the patient. In what percent of your cases was the diagnostic pre-operative CT, MR or PET image acquired with the tracker on?**
**Dr. McLennan:** "If I don't request it specifically, the tracker is never placed on the patient for pre-operative images. For about half of my patients this last year, I requested a new CT/MR/PET to be acquired with the tracker on. It allowed me to have a more recent image and to get automatic fusion.
When I do this, I plan the procedure on the day after the imaging study, to be able to mark the tracker location on the skin during the imaging study and put the tracker back on the exact same location for the procedure on the following day. But it's not always possible, reimbursement is not always approved, and sometimes you prefer to save radiation & contrast. "

**GE Healthcare recently developed an automatic mul-**

**ti-modality fusion solution that allows to automatically fuse live ultrasound to any CT/MR/PET images previously acquired with no tracker on the patient, by using a non-injected CBCT acquired at the beginning of the case, acting as a bridge between live ultrasound and the other modalities. What are the benefits of this solution?**

**Dr. McLennan:** "It's fast. It makes the process of getting the fusion very efficient. It allows me to easily use any modality or image I already have, to guide my ablations in the angio suite."

**This new automatic multi-modality fusion solution allows the CBCT/live ultrasound automatic fusion, even if the tracker is not in the CBCT reconstruction. Before this solution, both the lesion and the tracker had to be included in the CBCT for the fusion to be automatic. Was this often a challenge?**

**Dr. McLennan:** "Yes. That is a big deal, especially when centering CBCTs with large patients, meaning time delays or simply not being able to use automatic fusion."

**How long does a standard CBCT centering usually take, when no tracker is involved?**

**Dr. McLennan:** "Under three minutes."

**How long does a CBCT centering take on average when both the lesions and the tracker have to be included?**

**Dr. McLennan:** "That can take a little longer. It depends upon the size of the patient. For some patients we were just not able to do it, even with a 40*40 cm detector and the wide bore C-arm. But with he new solution this should not be an issue anymore, it will help us save time and facilitate the automatic fusion workflow."

**What would you say are the main benefits of such an automatic multi-modality fusion enabler?**

**Dr. McLennan:** "The main benefits are:

1. The fusion is accurate so I can confidently use preoperative CT, MR, PET or CBCT fused to live ultrasound to guide ablation probe placement, which may significantly reduce radiation dose to the patient & to the operators. I don't have to see the lesion with ultrasound, I can easily get the pre-operative imaging automatically fused to live ultrasound and use the fusion to guide me the way simultaneous CT, MR or PET imaging would.
2. With the ablation profiles stored in the ultrasound, I can confidently confirm whether my ablation zone will encompass the target.
3. Using ultrasound with an automatic multi-modality fusion solution allows me to perform ablations in the angio suite where I can approach the lesions with more complex angulations than I can in a CT or MR room."

**In which cases would you recommend using such an automatic ultrasound multi-modality fusion solution?**

**Dr. McLennan:** "I have used it for kidneys and livers. I would use it in any case that you would consider doing in CT, especially if your access to the CT scanner is limited "

**Is it possible to combine ultrasound multi-modality fusion with advanced fluoroscopic needle guidance solution?**

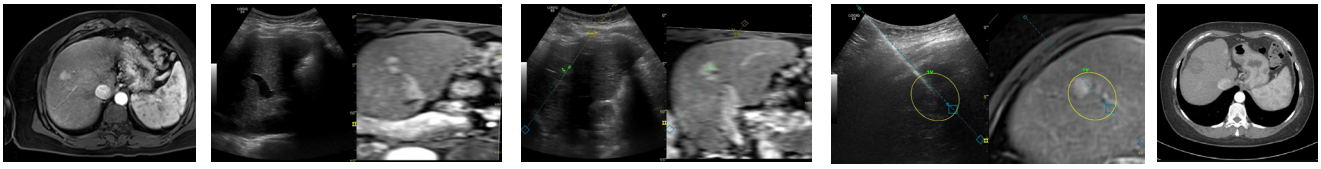
**Dr. McLennan:** "I do it commonly. Being able to efficiently toggle between these two guidances without losing any fusion allows me to adapt & optimize my guidance to any clinical situation, it's very reproducible."

**What practices or physicians do you believe would find value in such an automatic ultrasound multi-modality fusion solution?**

**Dr. McLennan:** "It could have impact in a variety of situations. One is small hospitals with limited resources, where tying up a CT scanner for an intervention is a problem financially. Doing ablations in an ultrasound-angiography integrated room, can be much more financially feasible while achieving the expected clinical results. During a recent American College of Radiology in 2017, we have presented the conclusion of an analysis[2] we did to evaluate the financial impact of transitioning the interventional procedures we have been doing in our CT rooms to our Interventional suite. Our analysis showed that the procedures we performed in CT, that could have been performed in IR with no suspected clinical impact, represented ~1600 hours of room occupation per year, and that transferring them from CT to IR would increase any hospital net annual income by 1.5 million dollars on average, maintaining clinical workflow while increasing accessibility to diagnostic CT.

Some of these procedures could even be facilitated by the advanced guidance tools available in our Discovery IGS 740 angiography suite, and that includes automatic ultrasound multi-modality fusion for liver and renal ablations.

Having this complete set of advanced solutions available in a practice is also very helpful because it keeps the radiation dose down, especially for complex procedure."



(a) (b) (c) (d) (e)

Preoperative MR (a) automatically fused to live Ultrasound (b) using non-injected 5sec CBCT as a bridge between modalities (Automatic multi-modality fusion solution, GE Healthcare).

Needle trajectory planning & guidance (c) and microwave ablation parameters planning (d) to optimize lesion coverage, post-operatively confirmed (e).

**Imagination at work.**



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1. Abdel-Rehim M., Ronot M., Sibert A., Vilgrain V. Assessment of liver ablation using cone beam computed tomography. World J Gastroenterol. 2015 January 14; 21(2): 517–524. doi: 10.3748/wjg. v21.i2.517
2 . https://www.acr.org/-/media/ACR/NOINDEX/Abstracts/2017/17012_Martin.pdf?la=en

The Statements described here are his professional opinions.
Dr. Gordon McLennan is a paid consultant of GE Healthcare.

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