



Development of Intra-Fraction Soft Tissue Monitoring with Ultrasound Imaging

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July 13, 2015

AAPM 2015, Anaheim, CA – July 12-16, 2015

Disclosure



- This research is supported in part by Elekta and NCI CA161613

Acknowledgement



HUG (Hopkins Ultrasound Group)

- Radiation Oncology
 - John Wong, Lin Su, Yin Zhang, Sook Kien Ng, Junghoon Lee, Ted Hooker, Joseph Herman, Harry Quon, Phuoc Tran, Danny Song
- Engineering
 - Iulian Iordachita, H. Tutkun Sen, Peter Kazanzides, Muyinatu A. Lediju Bell
- Radiology
 - Jinyuan Zhou, Chen Yang

Background



Seed based
snapshots



Non ionizing
Seed based
Real time



Non ionizing
Non invasive
Real time

Background



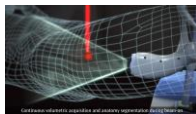
- US is portable, non-invasive, and non-ionizing modality for daily setup and real time monitoring



US challenge 101



Who is going to hold the probe during radiation?



Prostate



Liver

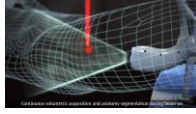


Pancreas

US challenge 102



Can the probe be placed in a repeatable way?



Prostate



Liver

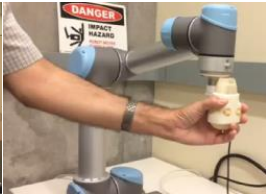


Pancreas

Two solutions

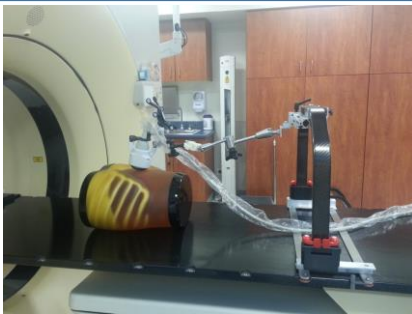


Passive arm (arm bridge system)
+Small size
+Easy docking
-User dependent



Active robotic arm (UR5)
+Less user dependent
+Feedback loop
-Complex docking

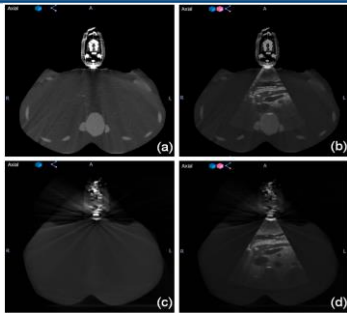
Arm bridge system (ABS)



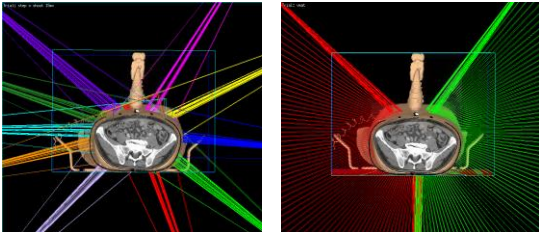
Arm bridge system (ABS)



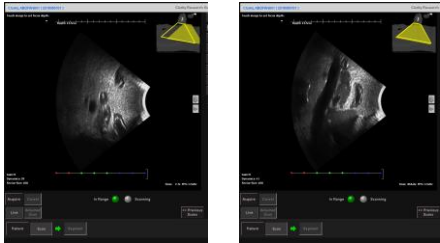
Arm bridge system (ABS)



Probe impact on planning



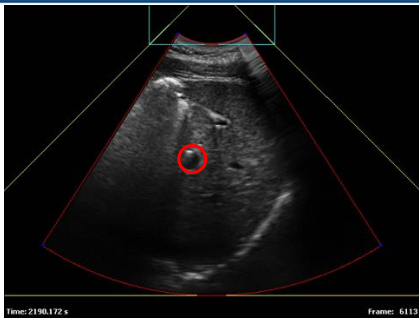
Repeat probe position



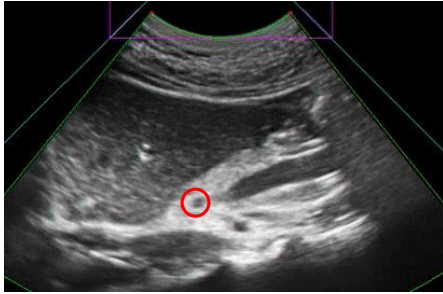
Arm bridge system (ABS)



Free breathing monitoring Liver



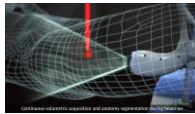
Active breath hold monitoring Pancreas



US Challenge 102



Can the probe be placed in a repeatable way?



Prostate



Liver

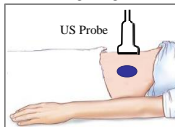


Pancreas

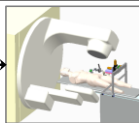
US challenge 102



✓ When the US probe is placed on the patient, the target organ deforms



Simulation Room CT



Treatment Room LINAC

✓ For accurate radiation treatment, same soft tissue deformations should be created between Simulation and Treatment

Active robotic arm



- Less user dependent: can record the position and force of the probe and repeat probe placement
- Feedback: can fine adjust the position and force based on the acquired US image
- Complex docking: docking system needs to be designed for quick clinical setup

Experiment

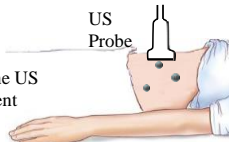


Goal :

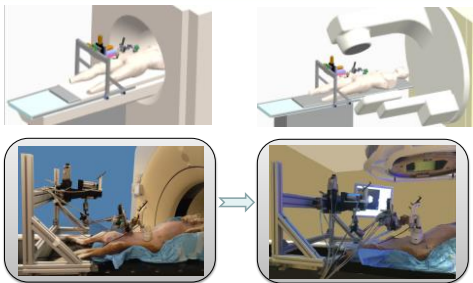
1. To place the target organ to the simulation day position
2. To create the same soft tissue deformation between sessions

Experiments :

- ✓ 3 metal markers are implanted into a canine kidney to represent a tumor
- ✓ Implanted markers are localized in the US and CT images taken in the experiment
- ✓ Marker positions in the CT images are used as the ground truth



Experiment



Summary



Passive arm (arm bridge system)
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Questions