# ABSTRACT FACE PAGE

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   - Academia ✓
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   - K-12 student
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   - Graduate Student ✓
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10. **Is this the research presented in this abstract supported by IMAG MSM-related U01 funding? Yes**
11. **If the Presenting Author is a trainee, who is the trainee's primary research advisor? Dr. Thomas E. Yankeelov**

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**TRAINEE POSTER AND ORAL PRESENTATION COMPETITONS:**

New to the meeting this year, we are holding *both* a trainee poster competition and a trainee oral presentation competition! If the presenting author is a trainee (i.e., a student at any level or a post doctoral trainee), he/she may enter his/her abstract in the trainee poster competition, the trainee oral presentation competition, or both competitions. Trainees may also submit more than one abstract to the meeting and enter more than one abstract in these competitions. Prizes will be given to the presenters of the top-ranked trainee oral presentation and the top-ranked trainee poster (judged during the meeting by the Program Committee).

12. **If the Presenting author is a trainee, would the Presenting Author like to enter his/her abstract in the Trainee Poster Competition*? Yes**

*Note: Trainees who enter the poster competition are expected to stand by their poster during the scheduled poster sessions and present them to the judges.

13. **If the Presenting author is a trainee, would the Presenting Author like to enter his/her abstract in the Trainee Oral Presentation Competition**? Yes**

**Note: The Program Committee will select the top four abstracts from trainees who elect to enter their abstract into the trainee oral presentation competition, these four trainees will be notified by Feb. 17th, and they will deliver their oral presentations (which will be judged) on the second day of the meeting after lunch.

# SYSTEMATIC EVALUATION OF A METHOD EMPLOYING QUANTITATIVE MRI TO CHARACTERIZE VASCULAR MORPHOLOGICAL AND FUNCTIONAL FEATURES *VIA* A DYNAMIC DIGITAL PHANTOM

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**BACKGROUND:** Quantitative evaluation of the ability of an image processing method to perform as designed is central to the optimization of both data acquisition and analysis. Unfortunately, the task can be quite challenging due to the difficulty of experimentally obtaining the "ground truth" to which the output of a given processing method can be compared. One way to address this issue is to design and apply "digital phantoms", which are numerical models or software that provide known biophysical properties of a particular object of interest [1]. We have previously developed image processing and computational modeling methods to characterize tumor-associated vasculature [2] and hemodynamics [3] for assisting in the diagnosis of breast cancer. In this contribution, we introduce a novel framework based on a dynamic digital phantom to systematically evaluate these image processing methods and, furthermore, rigorously determine an optimal acquisition-reconstruction protocol that balances data quality demands with clinical reality.

**METHODS:** There are five major steps in the evaluation framework. First, the geometry of the digital phantom is constructed from ultra-high spatial resolution MR data of a rat kidney [4]. Then, the contrast agent delivery is computed by an advection-diffusion model [5], with realistic physiological properties (e.g., vascular permeability, tissue diffusivity) assigned to the domains. These first two steps generate the "ground truth". Third, a virtual MRI simulator [6] constructs dynamic contrast enhanced magnetic resonance images with specific acquisition and reconstruction parameters [7]. Fourth, the resulting imaging sets with varying temporal/spatial resolutions/SNR are analyzed *via* our vessel identification and fluid dynamics methods [2, 3] to recover estimates of the tumor-associated vascular network, pharmacokinetic parameters, and hemodynamic characteristics including blood flow rate and interstitial pressure. Finally, the outputs are compared to the "ground truth", so that the dependency of the analysis on image quality can be systematically determined.

**RESULTS:** We report the ability of our morphological analyses to return accurate estimates of the whole vascular centerlines and connective structure, as well as the location and source of tumor-associated vessels. The results demonstrate that all the analyses are more sensitive to the spatial resolution than to the SNR. The accuracy for segmenting major vessels in renal arterial vasculature is > 95% for spatial resolution (s.r.) up to 240 μm, while the small arterioles can only be preserved with 95% accuracy for s.r. up to 60 μm. When the small arterioles can be seen, gap filling improves the accuracy of the segmented vasculature's connective structure, by approximately 35%. Moreover, the accuracy of identifying tumor associated vessels is > 80% when s.r. ≤ 90 μm; when the s.r. climbs to 300 μm, the accuracy falls to approximately 60%.

**CONCLUSIONS:** A novel workflow was established to systematically evaluated the methods of tumor-associated vasculature identification we had developed previously. We are currently working on adapting this workflow to evaluate the estimation of tumor-associated hemodynamic characteristics. The next application is to use the framework to rigorously determine an acquisition-reconstruction protocol that can be implemented in the routine clinical setting, thereby enabling the quantitative image processing techniques to be widely available for the characterization of cancer.

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