THE UNIVERSITY OF TEXAS AT AUSTIN
TEXAS ADVANCED COMPUTING CENTER TACC

Virtual Breath

Multidisciplinary researchers use TACC systems to develop breakthrough models of the human lung

Ching-Long Lin, Eric Hoffman (University of Iowa), and Merryn Tawhai (University of Auckland) have developed a new tool to image, understand and diagnose how air flows through the thousands of branching passageways of the lung, and how abnormalities can lead to illness.

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Ching-Long Lin, University of Iowa

"Our approach to understanding the airflow and particle transport in the human lungs is quite novel," Lin said. "We use computed tomography (CT) images to construct realistic human lung models, and then we use computational fluid dynamics models to simulate the airflow through the lung."

With a patent pending, and tools created by the group recently approved by the U.S. Food and Drug Administration for clinical use, this research on TACC's supercomputers will impact how doctors explore pulmonary problems in the near future.

The project required the creative application of supercomputers to model complicated physiological structures with enough resolution to be useful and meaningful. Since airways at different scales have important, interrelated features, all of them need to be integrated into a multi-scale whole—a feat that had never before been accomplished because of the algorithmic challenges and extreme computational demands.

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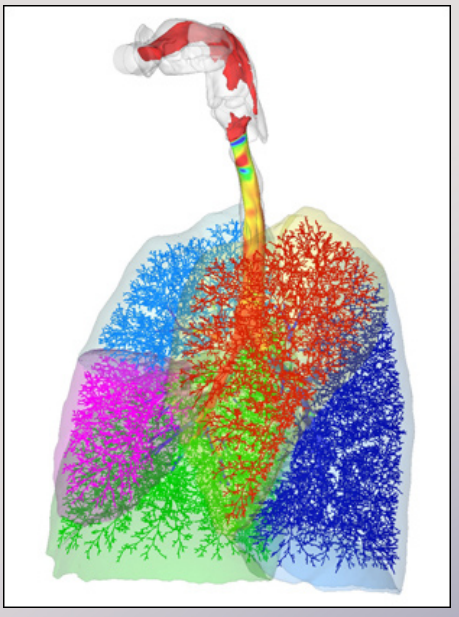
Using the combination of CT and high-performance computing, the team was able to determine the boundary conditions at the outlets of the smallest branches with far greater accuracy. This allows researchers to model how air flows through 23 generations of branches, to learn where air becomes turbulent, and where particles are deposited. This is an amazing feat considering that just 10 years ago, it was only possible to simulate the trachea and a single bifurcation of the lung.

With a multidisciplinary team approaching airflow modeling from many perspectives, the system that Lin and his colleagues have created may soon be a standard diagnostic tool in all hospitals.



This image shows a computerized representation of a subject-specific breathing human lung. The airflow in the CT-based airway tree is simulated on TACC supercomputers, Lonestar and Ranger.

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