

From cars to cancer: Researcher employs auto industry tools for tumor therapy

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Dr. Ali Kamrani is the founding director of the Design and Free Form Fabrication Laboratory at the University of Houston. Credit: Adam Blount/Texas Learning and Computation Center at UH

An effort is under way at the University of Houston to use technologies with origins in the automobile industry to develop new tools that will help doctors and technicians better plan radiation therapy for patients with head and neck cancer.

Dr. Ali Kamrani, founding director of the Design and Free Form Fabrication Laboratory at UH and a former auto industry researcher, is teaming up with Dr. Lei Dong, associate professor and deputy research director of radiation physics at the University of Texas M.D. Anderson Cancer Center, to develop predictive models of tumors that hopefully will increase the accuracy of radiation therapy.

"We aim to better understand [tumor](#) deformations using geometric and statistical models - rather than repetitive CT scans," said Kamrani, an associate professor of industrial engineering at the Cullen College of Engineering. "In this case, patients will undergo a minimum number of CT scans, and the radiation plans will be developed using the predictive models."

Traditional computed tomography sessions, also known as CT scans, require a large series of two-dimensional X-ray images that, when combined, provide detailed three-dimensional images of many types of tissue.

"A CT scan is used to collect information with respect to tumor size, location and volume," he said. "But the CT scan itself is a source of harmful radiation to body tissues and other organs. During the treatment, patients undergo a series of CT scans, which are costly and tedious."

Reducing the number of CT scans is a primary objective for Kamrani, because it will reduce patient's risk to unwanted radiation.

Dong said patients receiving radiation usually have up to 40 treatment sessions, which are administered about five days a week for six to eight weeks. Thanks to computers, the treatment plans are now designed "almost perfectly," he said, and they may be "too good to be true."

"A tumor shrinks as it responds to the treatment," Dong said. "Unfortunately, as they do, the beautiful plan at the beginning may not be optimal for later treatment. Essentially, the patient has changed."

Since 2000, Dong and his colleagues at M.D. Anderson have been using computerized treatment planning systems, called "intensity-modulated radiation therapy," to design highly precise dose distributions tailored to the specific shape of the tumor. For the past year, they have been

designing new radiation plans that account for changes in the tumor volume and organ position in a selection of patients who are being rescanned daily.

"You can imagine there is lots of new information as you rescan a patient," Dong said. "Replanning a patient can take between three and five days. It's a big effort. Then the question becomes: Can we predict how the tumor changes based on a limited number of CT scans? Then, we can decide when to replan during the treatment course."

Treatment for a head and neck tumor depends upon the type, size and stage of the cancer, where it is located and the patient's general health.

"[Radiation therapy](#) is a compromise between treating the cancer cells and, at the same time, sparing normal cells," Dong said. "It's very easy to kill cancer by radiation, but not harming normal organs at the same time can be tricky. So, it's a delicate, fine balance."

Kamrani hopes that, based upon initial [CT scan](#) readings, the team will be able to classify tumors and predict through radiation models the various stages of their demise.

"The purpose is to create a model to show this trend, with some level of acceptable error, by looking at the initial tumor and classifying it based on these attributes," Kamrani said. "If there is a correlation, we have to figure out why there is a correlation and then create classification of tumors. So if a patient comes in, and he falls into that attribute, we can say, with some degree of accuracy, the tumor will be of this size at this point."

As a tumor changes, Dong said, radiation oncologists can reduce the radiation treatment volume.

"Say the tumor shrinks by half. Then you can reduce the target volume and spare the normal tissue," he said. "Your side effects will be reduced because you're adapting. The benefit is you're not compromising the treatment and still reducing the toxicity."

Dong emphasized the importance of high-quality visualization tools in his field.

"You need that object - that 3-D representation - to make your plan," he said. "This is a real human patient. It's not a theory. It's both."

Kamrani has a long history with visualization and rapid prototyping, a fabrication technique common in the auto and manufacturing industries.

"Rapid prototyping is a technology that allows the automatic construction of physical models and prototyping of parts directly from a three-dimensional computer-aided design model," Kamrani said. "Thin, horizontal cross-sections are used to transform materials into physical prototypes layer by layer."

Rapid prototyping, also known as solid free-form fabrication, has changed the face of manufacturing, he said.

"In traditional manufacturing, you design something, send it to a foundry, and they make it for you. Now, with rapid prototyping, you design something and send it directly to the printer," he said.

Back in Michigan, Kamrani prototyped valves and cylinders. Today, he's prototyping bones and organs.

"The concept is the same," he said. "When I came here, with the Texas Medical Center, it kind of came together. The industry is different here, so I started focusing on a particular problem: trying to create a three-

dimensional geometry, going from valves to skulls and things like that."

Dong called Kamrani's idea of applying the auto prototyping tools to [tumor](#) modeling "novel."

"It can help us solve the problem. There's a big workflow issue. If we do replanning every day and re-CT every day, that's lot of effort," he said.
"We're thinking there is a better, smarter way."

Source: University of Houston ([news](#) : [web](#))

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