New methods tackle a perplexing engineering concept

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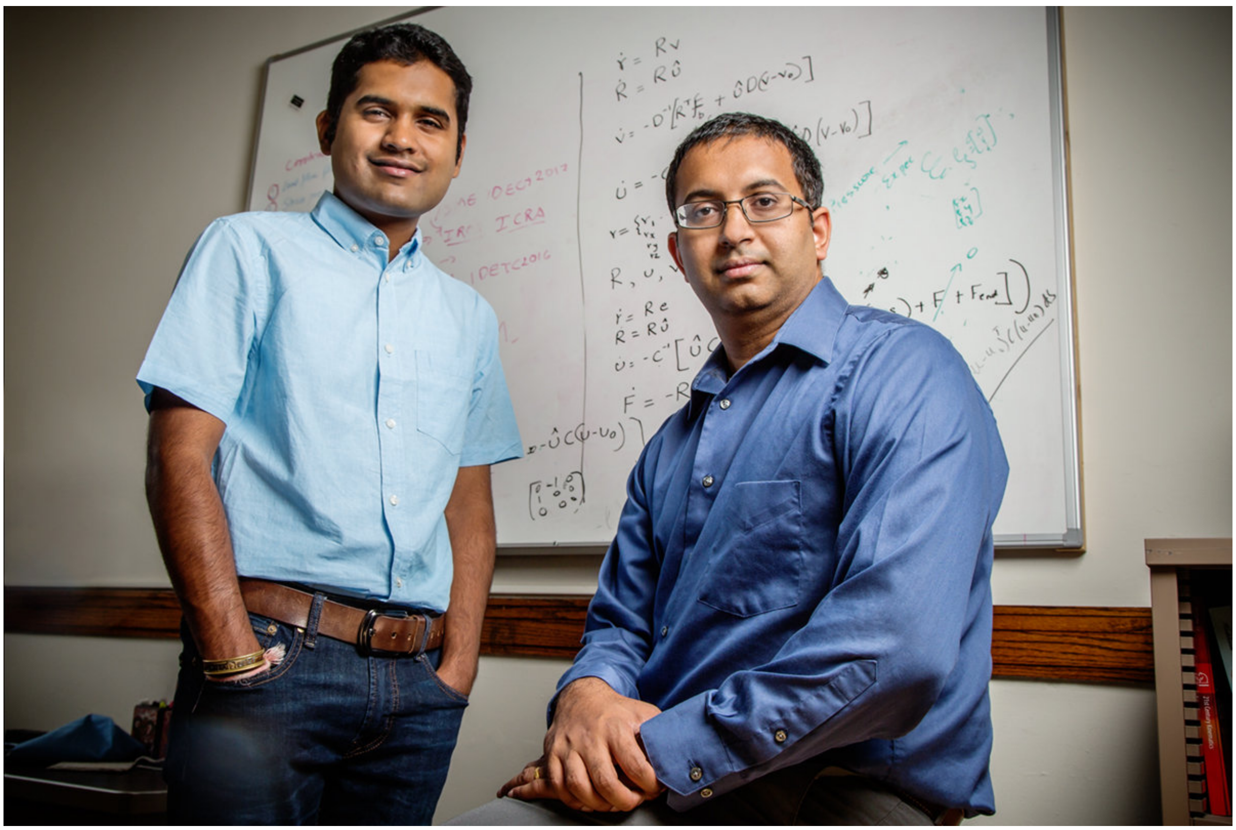

Sreekalyan Patiballa, left, and professor Girish Krishnan have developed a new, award-winning conceptual model to better define the complicated concept of auxetic materials. Credit: L. Brian Stauffer

Researchers at the University of Illinois are working to turn a complex materials design problem into an intuitive concept, understandable to engineers from novice to advanced experience levels. The group developed guidelines to help understand materials engineered to become thicker when stretched. This highly useful property, which is not commonly found in nature, has applications for protective sports equipment, body armor and biomedical devices.

The team presented their research at the American Society of Mechanical Engineers International Design Engineering Technical Conferences and Computers and Information in Engineering Conference in Cleveland, Ohio, where they received the Freudenstein Young Investigator Award for their paper.

Most materials, natural or engineered, become thinner in the middle when stretched along their length. The materials these engineers are working with, called auxetics, do the just the opposite – they become thicker in the middle when stretched – a difficult concept to grasp, and that is a problem, said Girish Krishnan, a professor of industrial and enterprise systems engineering and study co-author.

"The existing methods for explaining the behavior and properties of auxetic materials are computationally intensive," Krishnan said. "Currently, a materials engineer requires at least a graduate school level course behind them to conceptualize their design."

"Many engineers shy away from working with auxetic materials because of the perceived difficulty," said Sreekalyan Patiballa, an industrial and enterprise system engineering graduate student and study co-author. "Our goal is to have a part in reversing that trend."

In the paper, the researchers offer guidelines, in the form of mathematical equations and conceptual diagrams, which quantitatively analyze auxetic materials by emphasizing their macro- and microscale geometry.

"When we hear the word 'materials,' many think in terms chemical composition or properties, but we are interested in explaining these materials in terms of their geometric patterns and structure," Patiballa said.

"One of the reasons why we focused on purely geometric methods for our conceptual models is because they can be easily understood by many, from high school students to designers and the manufacturing professionals who produce the materials," Krishnan said.

This research marks the first time that this type of conceptual model has been used to describe auxetic materials. It may open a new area of extremely challenging research, but Krishnan and Patiballa believe that their tools will be able to tackle the difficult task.

"Right now auxetic design lies only in the minds of the experts," Krishnan said. "With the kind of conceptual thinking tools we are proposing, I believe we are heading towards the democratization of this type of design."

More information: "Qualitative analysis and design of mechanical metamaterials" Information in Engineering Conference (2017)

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