Quality Aware Generative Adversarial Networks

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Generative Adversarial Networks (GANs) have become a very popular tool for implicitly learning high-dimensional probability distributions. Several improvements have been made to the original GAN formulation to address some of its shortcomings like mode collapse, convergence issues, entanglement, poor visual quality etc. While a significant effort has been directed towards improving the visual quality of images generated by GANs, it is rather surprising that objective image quality metrics have neither been employed as cost functions nor as regularizers in GAN objective functions. In our work, we show how a distance metric that is a variant of the Structural SIMilarity (SSIM) index (a popular full-reference image quality assessment algorithm), and a novel quality-aware discriminator gradient penalty function that is inspired by the Natural Image Quality Evaluator (NIQE, a popular no-reference image quality assessment algorithm) can each be used as excellent regularizers for GAN objective functions. Specifically, we were able to demonstrate state-of-the-art performance using the Wasserstein GAN gradient penalty (WGAN-GP) framework over CIFAR-10, STL10 and CelebA datasets. We call our proposed framework Quality Aware Generative Adversarial Networks (QAGANs). This work was carried out by PhD Scholar Ms. Kancharla Parimala. For more information (including the related publication and code), please visit our lab LFOVIA website at https://www.iith.ac.in/~lfovia/publications.html

3D Printing: Connecting the Virtual to Real

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Artificial intelligence is often linked to the ability of a machine to solve a given problem by itself, without human intervention, based on data and past experiences. In this regard, 3D Printing serves as a critical link in the physical translation of a virtual perception. 3D Printing is a process for making a physical object from a three-dimensional digital model, typically by laying down many successive thin layers of material. It brings a digital object (its CAD representation) into its physical form by adding layer by layer of materials. When AI is combined with 3D printing, it can lead to not just automated production but automated manufacturing process planning adaptable for a different set of shapes and geometries; imagine just having to give the CAD model and the machine figuring out the process steps, tool paths, online motoring and final part fabrication. Today with the help of 3D Printing, one can make parts, appliances and tools in a wide variety of materials right from your home or workplace. Using a computer, simply create, modify or download a digital 3D model of an object. Click "print," just as you would for a document, and watch your physical 3D object take shape.

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The pedagogical uniqueness of IIT Hyderabad in this area is looking at 3D printing as a basic skill, capable of radicalizing design and fabrication, instead of relegating it to be a tame elective. Every undergraduate student who joins IITH is introduced to 3D printing/digital fabrication technologies right in the first year. The course is divided into two parts viz., (1) CAD modelling and (2) Project on 3D printing. It is expected that this will become the backbone of all future design and fabrication initiatives of the students. Also, exposing the students to cutting edge technologies right in the beginning catches their fascination and involves them in the creation of products of high technological value right from the beginning.

On the research front, the focus has been on integrating the manufacturing constraints into the computational and optimization stages of the design. In the 3D Printing, it is crucial to ensure that not just the process, but the process planning too is optimized. The Design for Additive Manufacturing paradigm integrates the 3D printing constraints into the design process. This is achieved by incorporating additive manufacturing-specific constraints like the material continuity, anisotropic modelling and support material optimization into the topology optimization process. This not just 'improves' the process, but makes it possible to create components with tailored properties. The illustration shows an example of a gradient density shoe sole based on pressure distribution. The component is fabricated in such a manner that it has a different pressure response at different locations, compensating for the pressure variations seen on a foot.

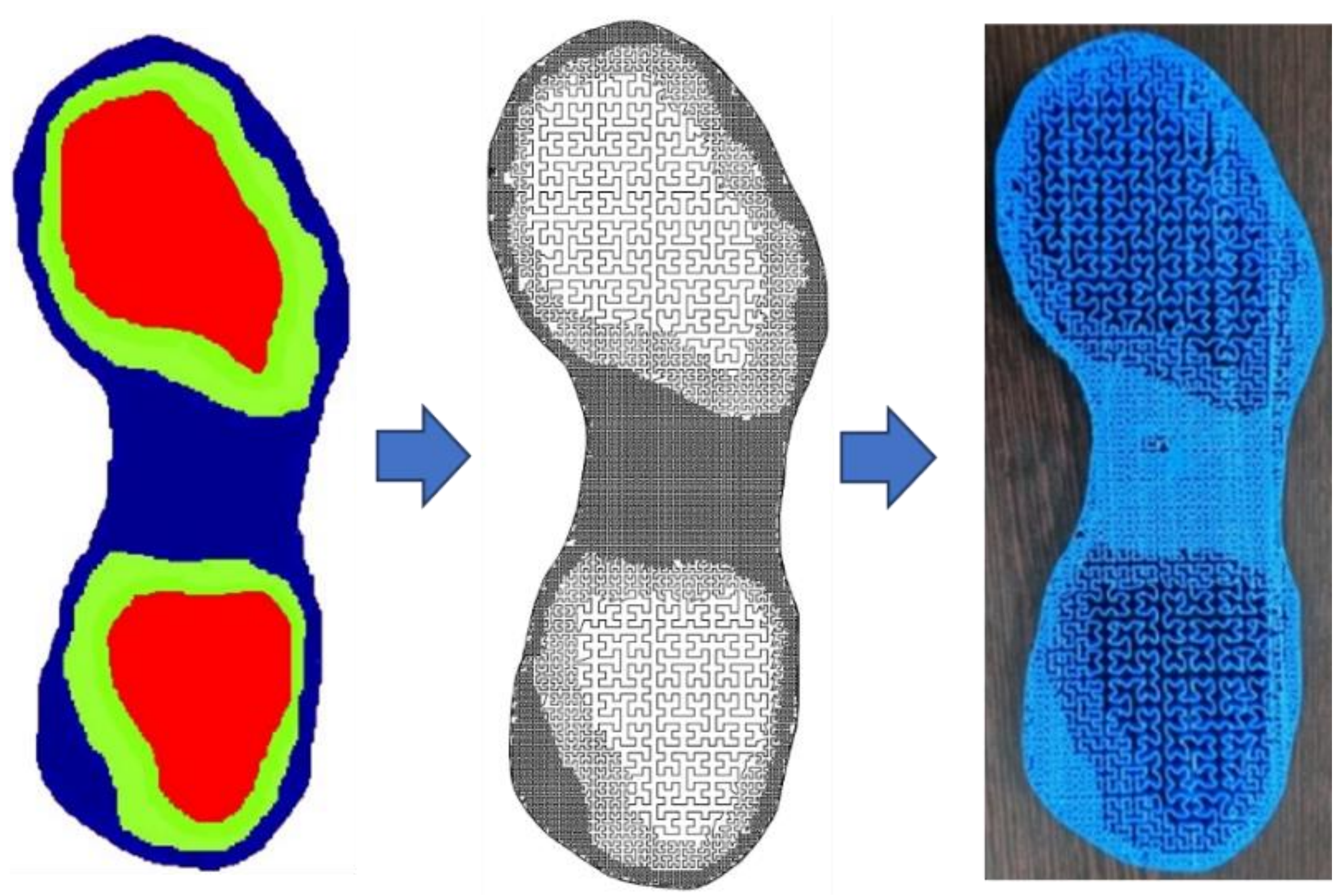

Figure 10: 3D printing shoe sole with gradient density tailored to for variable pressure distribution