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IMPROVING 3D PRINTED PART QUALITY USING ARTIFICAL NEURAL NETWORKS OF THE GENERATIVE ADVERSARIAL TYPE

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Improving 3D printed part quality using Artificial Neural Networks of the Generative Adversarial Type

The challenges for digital manufacturing today are vast. Challenges like reproducibility and mechanical properties preservation are crucial. Currently, 3D printed parts are affected by each build setup. The thermal diffusion occurring in the process affects the final product once it has cooled down.

This invention proposes to use Generative Adversarial Networks (GANs) in order to automatically learn the 3D printing parameters that satisfy quality and reproducibility of 3D printing products. The description of the method is as follows:

The invention consists of three main elements:

- A print quality system that measures quantitatively how accurate a 3D printed part is from its digital input representation (called discriminator). It can be a traditional fiducial system or any software that quantifies the part quality.
- A 3D printer that takes a 3D model or 3D print build as input, and returns a physical 3D printed object. Optionally, this process can also be simulated and synthesized by a neural network that learns how to mimic the physical 3D printer behavior (digital twin).
- An artificial neural network that takes a 3D model or 3D print build as input, and generates a digitally corrected version that is fed into the 3D printer or Digital Twin. We call this network the Generator system.

The system is set up in the following steps:

1. 3D print data is collected by printing parts and measuring them with the Discriminator system.
    a. If using the Digital Twin, we train it to learn the mapping between the digital 3D inputs and the actual 3D physical printed parts.
    b. The quality discriminator may provide results based on multiple part features including but not limited to the features listed below.
        i. Dimensional Accuracy
        ii. Color Reproduction
        iii. Mechanical part qualities such as torsion and stiffness

2. The generator is trained to apply alterations to the digital inputs based on the type of a printer. These alterations can include:
    a. Part repositioning distributions in the printing volume.
    b. Part orientation within its assigned position in the printing volume.
    c. Part volumetric shape
    d. When possible, choice of type of material to be used for printing.
    e. When possible, choice of material density to be injected.
    f. Other allowed variable parameters such as heat, support structures and ancillary supplies.

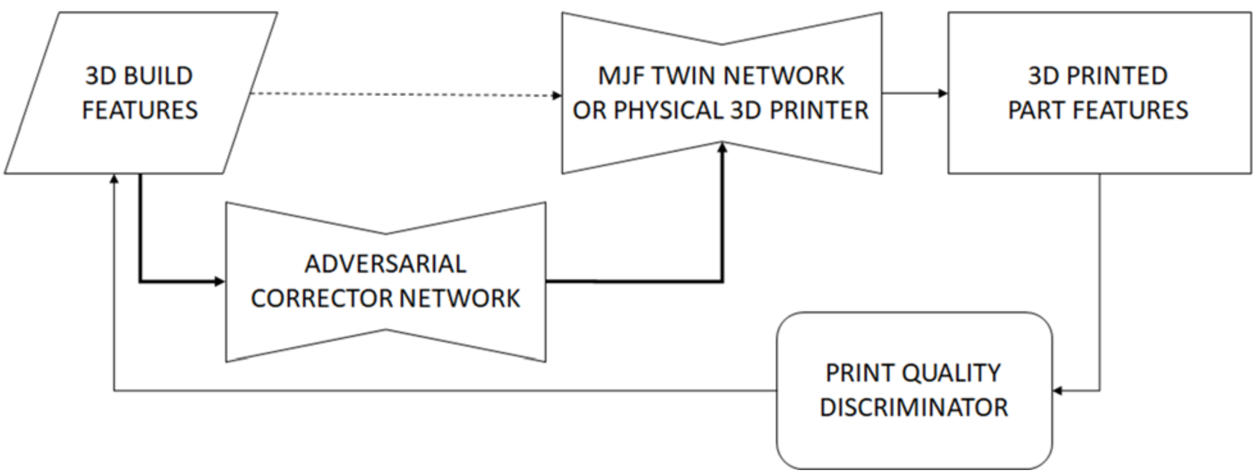
3. The outputs obtained from the generator are fed into the 3D printer or the Digital Twin, and measured against the discriminator system again

4. Repeat 2 and 3 until the discriminator cannot discern whether the printed part is generated using the 3D printer/Digital Twin or using the Generator network. In other words, the Discriminator obtains better measurements from the 3D printed parts once they cool down.

An advantage of using GANs adapted to 3D data is that they can mimic the exact same behavior of the current 3D printer. Thus, this digital twin of a physical printer can be used as a proxy to simulate and synthesize potential new printing scenarios virtually. These virtual scenarios will help a generator network to automatically learn the printer parameters and necessary alterations to the printer's input to yield the correct and desired output from the customer from a holistic point of view.

Once trained, this discriminator is also able to act as an independent Quality Control agent in addition to helping aid produce higher quality parts via the Adversarial Network.

System Flow



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