MATHEMATICAL APPROACH ON 3D PRINT MODELS FOR SUPPORT AND PRINTING TIME OPTIMIZATION

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Resumo: The 3D printing process is gaining space in many areas around the world. Its versatility can be used to print artistic objects, architectural mock ups, civil constructions, aerospace models, parts of physics experiments, educational instruments, as well as delicate objects as prostheses and real representations of human organs.

When we need to print some 3D solid in a 3D printer, some parts of this solid may be suspended in the air and need support for a better print. However, these supports are detached from the final surface and will not be reused, leading to a waste of material, time and money.

Currently, the most affordable 3D printers use a printing technology known as *fused deposition modeling* (FDM). This printing process, as shown in figure 1, melts a type of polymer, that solidifies on the moving platform, or on the surface itself, printing the desired solid with cross-sectional layers, from bottom to top.

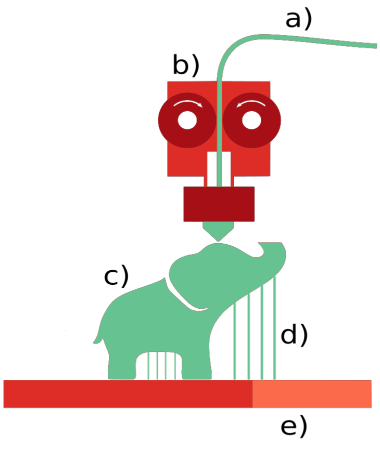

Figura 1: A plastic filament (a) is horizontally heated by a controlled nozzle (b), allowing the template (c) to be printed over the horizontal platform (e), that moves on the vertical direction. Some sloping parts of the template need supports (d) to be printed.

Some parts of the solid need support because they are suspended in the air, which can damage the object or generate wrong prints. These parts are called *overhangs*.

To avoid overhangs, the 3D printers print columns to support the parts of this solid that have no material underneath them, otherwise the material would be melted and fall on

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the platform. This extra material must be removed from the solid, leading to a waste of material, time and money. As we can see represented in figure 2,

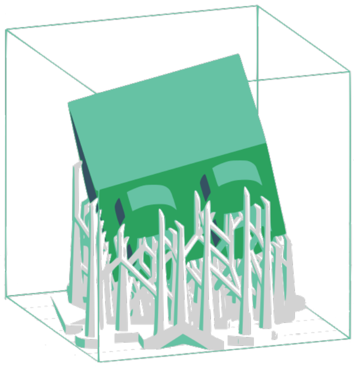

Figura 2: This solid has parts that need support to print correctly. So the printer will build some structures to hold this parts while it is printed.

the solid has overhanging parts that need support to print correctly.

However, some overhangs are tolerable. Each printer has a limiting angle to tolerate these overhangs. Given an angle θ, the printer only prints an overhang support if the part of the solid that will be printed forms an angle with the horizontal plane less than θ.

We propose a formulation for the overhang problem based on the normal field of a surface and an optimization method to find a global rotation of a surface that minimizes overhanging parts that cannot be printed without supports. This global rotation does not change the surface since the printed object can be derotated in the real world after printing.

Referências

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