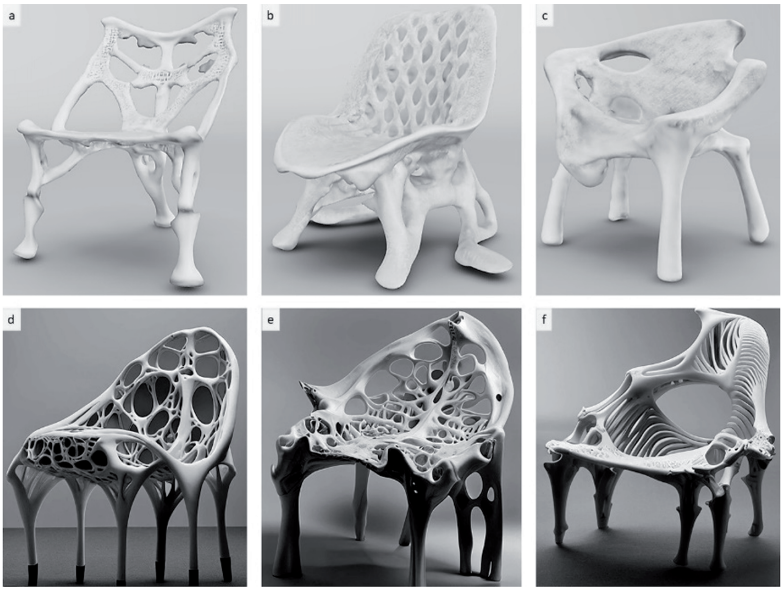

Figure 4. Comparison between the text-to-3D diffusion-based model generated biomimetic bone-tissue chairs in the first row, and the text-to-2D diffusion model generated 2D images of the same them (bone tissue chairs). The first (upper) row exhibits the high-resolution renders of the three bone chair designs that were 3D printed showing several added textural details that weren't present in the med-resolution 3D mesh file models: a) the Trabecular bone chair, b) the Cortical- Trabecular bone chair, and C) the cortical bone chair. The figures (a, b, and c) exhibits shortage in multi-scale lengths and fine resolution understanding of the bone tissue cortical and trabecular bone level details, where the three designs related more to the morphology and scale of entire long and wide bones. In comparison to the bottom row exhibiting the text-to-2D image results of the bone tissue chair designs, showing three different designs with deep understanding and more creativity in synthesizing the details corresponding to trabecular bone tissue in d), and to Cortical-Trabecular equilibrium in e), and more dense mineralized cortical rips in f).

3. Conclusion and further recommendations

The current study explored the potential integration of text-to-3D diffusion-based models in the biomimetic design-to-fabrication process. To design bone tissue inspired chairs that represent three different hierarchical levels of the bone tissue: cortical, trabecular; and cortical-trabecular. The Luma AI text-to-3D platform was used based on the Magic 3D model to develop bone-tissue chair designs corresponding to these levels. The results revealed possibility of integrating the employed text-to-3D model in direct rapid prototyping as well as a volumetric unlimited rapid and open access AI generative design to fabrication tool. However, by comparing the high resolution upscaled text-to-3D gener-

ated chair models with their high resolution meshes, a discrepancy was found in the level of detailing and texture. Furthermore, when comparing the AI diffusion-based text-to-3D and text-to-2D generated bone chair models, it is proved the need of further enhancement of the text-to-3D model in terms of increasing the training data set of 3D reconstructs representing the various scale lengths and fine resolution details of the bone tissue, as well as in increasing the capacity of the text-to-3D model in learning from 2D text-to-image diffusion models in understanding intricate scales and morphologies and expressing this knowledge correctly in the generated 3D topologies.

This signifies that although text-to 3D diffusion models are of particular value in the design to fabrication process enabling rapid prototyping and rendering as well as unlimited generative iterative volumetric design process, which cuts down the computation design effort managed by human designer in typical 3D digital and algorithmic design software. However, the level of detailing and innovative design solution requires extensive upscaling of the model capacity and the training data representation of various domains especially from anatomic and biomedical field in the case of biomimetic design methodology.

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Resumen: Las herramientas de diseño generativo de Inteligencia Artificial se están desarrollando rápidamente y revolucionando su aplicación en los procesos de diseño a fabricación. En particular, los modelos de generación de imágenes de aprendizaje profundo basados en transformadores, difusión y convolución facilitan la generación de una cantidad ilimitada de visualizaciones rápidas de alta resolución, muy detalladas e innovadoras a partir de texto, ya sea en estático (texto a imagen) o en animación (texto a vídeo). Estos modelos desempeñaron un papel crucial en la aceleración del proceso de diseño, especialmente en las fases de conceptualización y renderización. Sin embargo, sus posibilidades de fabricación directa eran limitadas, ya que requerían la intervención humana en el modelado digital y algorítmico para convertir los detalles y parámetros de las imágenes 2D en objetos 3D. A pesar de algunos modelos DL de mapeado de profundidad y predicción 2,5D desarrollados recientemente, que también requerían la intervención humana para manipularlos. En la actualidad, los modelos AI-DL de texto a 3D están impulsando la capacidad ilimitada de cálculo del reconocimiento de imágenes, la difusión, la convolución

y la generación de nuevos patrones para la fabricación directa. Donde el modelo AI texto-a-3D genera mallas editables que pueden imprimirse directamente en 3D o personalizarse para estrategias de fabricación digital. La presente comunicación reporta la manifestación de la integración de AI-DL texto-a-3D modelo libre de acceso abierto (Luma AI) en la generación de estructuras biomiméticas similares al hueso de diseños de sillas, expresando las características morfológicas del nivel jerárquico cortical-trabecular en el tejido óseo. Los resultados del presente trabajo pondrán de manifiesto la posibilidad de integrar estos textos de IA a herramientas 3D en el diseño biomimético e impresión 3D de injertos óseos, así como en el diseño estructural optimizado similar al hueso en arquitectura.

Palabras clave: Herramientas de diseño generativo AI - Texto a 3D - Motivos estructurales jerárquicos óseos - Nivel cortical-trabecular - Diseño biomimético.

Resumo: As ferramentas de design generativo de Inteligência Artificial estão se desenvolvendo rapidamente e revolucionando sua aplicação nos processos de design para fabricação. Em especial, os modelos de geração de imagens de aprendizado profundo de IA baseados em transformadores, modelos de difusão e convolução que facilitam a geração de uma quantidade ilimitada de visualizações rápidas de alta resolução, altamente detalhadas e inovadoras a partir de texto, seja em estática (texto para imagem) ou em animação (texto para vídeo). Esses modelos desempenharam um papel fundamental na aceleração do processo de design, especialmente nas fases de conceitualização e renderização. No entanto, eram limitados em termos de possibilidade de fabricação direta, pois exigiam a intervenção humana na modelagem digital e algorítmica para transformar os detalhes e parâmetros da imagem 2D em um objeto 3D. Apesar de alguns modelos DL recentemente desenvolvidos de mapeamento de profundidade e previsão 2,5D que também exigiam intervenção humana para manipulá-los. Atualmente, os modelos de AI-DL de texto para 3D estão impulsionando a capacidade ilimitada de computação de reconhecimento de imagem, difusão, convolução e geração de novos padrões para a fabricação direta. Onde o modelo de texto para 3D da IA gera malhas editáveis que podem ser impressas diretamente em 3D ou personalizadas para estratégias de fabricação digital. A presente comunicação relata a manifestação da integração do texto AI-DL ao modelo 3D de acesso livre (Luma AI) na geração de estruturas biomiméticas semelhantes a ossos de projetos de cadeiras, expressando as características morfológicas do nível hierárquico cortical-trabecular no tecido ósseo. Os resultados do presente trabalho destacarão a possibilidade de integrar esse texto de IA a ferramentas 3D no projeto biomimético e na impressão 3D de enxertos ósseos, bem como no projeto estrutural otimizado semelhante ao osso na arquitetura.

Palavras-chave: Ferramentas de design generativo de IA - Texto para 3D - Motivos estruturais hierárquicos ósseos - Nível cortical-trabecular - Design biomimético