EvoIsland

Immersive Interactive Evolutionary 3D Modelling

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ABSTRACT

We present *EvoIsland*, an interactive evolutionary augmented reality interface for parametric 3D OpenSCAD models. Our mobile prototype enables content creators to explore the full range of design possibilities encoded in a model's source code through the combination and separation of hexagonal evolutionary tiles embedded with genetic data. As these tiles are grouped into islands, localized clusters of design populations emerge for creators to explore. Interactions that take place within our *EvoIsland* prototype provide content creators with a novel approach for shaping evolutionary populations in an immersive environment.

CCS CONCEPTS

• **Theory of computation** → *Evolutionary algorithms*;

KEYWORDS

Interactive evolutionary computing, augmented reality.

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1 IMPLEMENTATION

Current 3D CAD software equips designers with instruments to create unique models from the comfort of their computer. While applications for 3D design have been used for decades, performing even basic operations in current modelling software can be difficult as the projection of these models onto traditional 2D displays creates interaction challenges. Although the immersive quality of virtual reality and augmented reality (AR) design tools has transformed 3D modelling into a more natural experience [1], creators still must manually edit the geometry of models to iterate on their designs. Meanwhile, interactive evolutionary systems [5] have demonstrated the powerful ability to quickly generate a wide range of designs for creative purposes, while still prompting a human advisor to help guide the creative direction of the results. Similar to the technology behind *Project Dreamsketch* [3], with the introduction of smarter immersive tools in the future, artificially intelligent systems could suggest alternative designs to creators and assist in the completion of tedious tasks throughout the design process. *EvoVision 3D* [4] has recently demonstrated this potential of interactive evolutionary computing in an immersive space, displaying a 360 degree visualization of generated design paths to creators.

Inspired by isolated land masses seen on Earth, our novel interactive evolutionary interface, *EvoIsland* (Fig. 1), empowers designers with intelligent tools for the rapid creation of unique, parametric, 3D OpenSCAD models in augmented reality (AR). While an iOS device is currently used for display, our future vision for the project would make use of mixed reality headsets and fabricated tiles to power a collaborative design experience. Tapping on a surface in the scene snaps a new 3D model to a grid with a hexagon tile underneath, referred to as an *evolutionary tile*. Alternatively, tapping on a presented evolutionary tile removes it. Hexagons were an ideal shape as they have a high amount of clearly visible sides and have been shown to have better visual performance in graphics applications when compared to their rectangular counterparts [2]. If the newly created model has no neighboring tiles, the generated model will have a randomized set of valid parameters assigned to the genome. In the case that at least one neighboring evolutionary tile exists, the parameters of all connected genomes of the neighboring tiles are used as the population for generating the new child model's genome. Mutations performed on an underlying genome of each model consider both the type of each parameter (Numeric, String, Boolean) and its bounds specified in the original model file.

In the examples below (Fig. 2-3), we demonstrate some of the unique workflows of *EvoIsland* using a set of models found on Thingiverse. Both the number of tiles in each island at the time of capturing the models and the two most recently added designs are displayed in the figures. An evolutionary tile map is also displayed to show the steps taken during the breeding process of designs. We hope our *EvoIsland* concept inspires researchers to continue the development of immersive evolutionary experiences and leverage the exciting new potential of immersive computing for 3D design.

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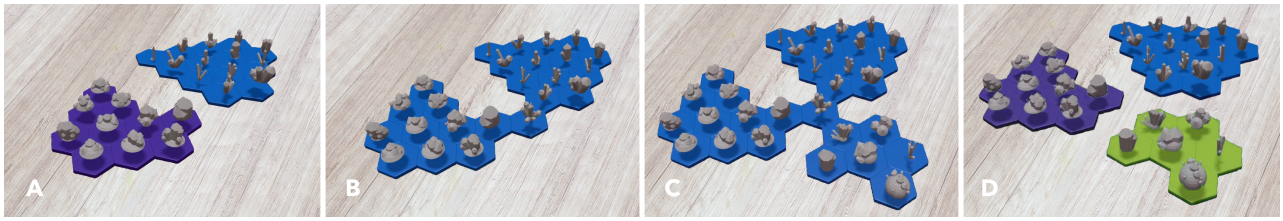

Figure 1: The *EvoIsland* prototype in action over time (from left to right). After the creator adds an initial two islands by tapping on a scanned surface in augmented reality (A), the two islands are combined using a jointly connected tile (B), combining the genetic makeup of both islands. The creator continues to expand the combined island (C) and then breaks the islands apart by tapping on the joining tile (D), isolating sub populations of the larger islands. Original *Customizable Tothite* model by *drxenocide* on Thingiverse [CC BY SA 3.0]

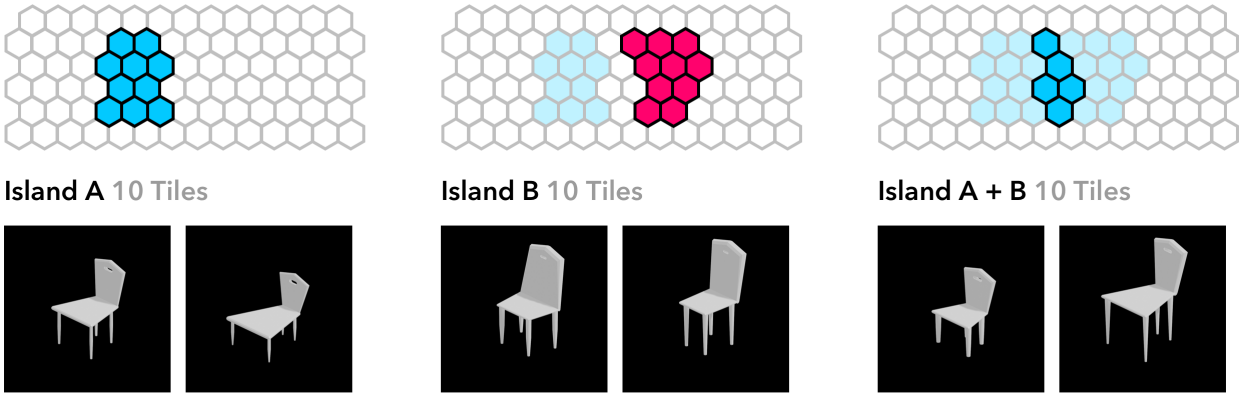

Figure 2: An example of an *Island Combination* workflow in the *EvoIsland* prototype for combining distinct populations of designs. Original *Miniature Chair (Customizable)* model by *deadlygeek* on Thingiverse [CC BY 3.0]

Figure 3: An example of an *Island Separation* workflow in the *EvoIsland* prototype for separating an island population of designs into two distinct parts. Original *Customisable House* model by *angelkoh* on Thingiverse [CC BY 3.0]