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Intuitive Modeling of Voxel-based 3D Objects

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ABSTRACT

Voxels (volumetric pixels) are virtual cubes that can be used to construct, model, or analyze virtual three-dimensional objects. Voxels find extensive use in video game design, animation, three-dimensional printing, etc. Software modeling of voxel objects is difficult for a designer working on a two-dimensional computer screen because voxel placement in the third dimension (perpendicular to the computer screen) can be ambiguous or obscured.

This disclosure describes a simple, low-cost, and expandable hardware interface and accompanying software to intuitively model or define voxel-based 3D objects. The base has a matrix of connectors. A number of cubic pieces or physical voxels of different colors are provided that have connectors on each of their six sides. The cubic pieces can be connected to a connector on the matrix or to any other cubic pieces to form a three-dimensional object over the base. A scan command issued over the accompanying software translates the physical voxel object into a virtual voxel model.

KEYWORDS

- 3D model
- Object modeling
- Three-dimensional modeling
- Three-dimensional printing
- 3D input
- Hardware voxel
- Augmented reality
- Virtual reality
- Game design
- Game prototyping

BACKGROUND

Voxels (volumetric pixels) are virtual cubes that can be used to construct, model, or analyze virtual three-dimensional objects. Voxels find extensive use in video game design and prototyping, animation, three-dimensional printing, digital art, virtual reality, augmented reality, education, etc. Voxel-based 3D models enable the prototyping of games and applications at a low content design cost.

Voxel-based 3D objects are currently modeled using software tools. Software modeling of voxel objects is somewhat difficult for a designer working on a two-dimensional computer screen because voxel placement in the third dimension (perpendicular to the computer screen) can be ambiguous or obscured. For example, a voxel being placed deep in the third dimension might be obscured by previously placed voxels. In general, a given area on a two-dimensional screen corresponds to multiple three-dimensional voxel coordinates.

An example of the complexity of constructing voxel objects purely using software is the creation of a floating voxel (one that is disconnected from the rest of the model) by clicking in an area of the screen. The modeling tool typically interprets the new voxel to either be connected to the model or to be at the boundary of the model (e.g., touching the ground), rather than disconnected (floating) from the other voxels of the model. Here again, there are several equally valid and reasonable positions at which the voxel can be placed given the click (or other input) in the area of the screen.

Although there are three-dimensional displays that help disambiguate voxel positions, there is no easily accessible three-dimensional input device (e.g., a 3D mouse). Hand-tracking 3D input devices are generally decoupled from the 3D screen and typically require extensive training before usable to effectively define 3D models. Even with a 3D display, a 3D input

device, and the substantial training to compensate for the decoupled input and display devices, there are no software tools that enable a developer to define 3D models directly using such devices.

DESCRIPTION

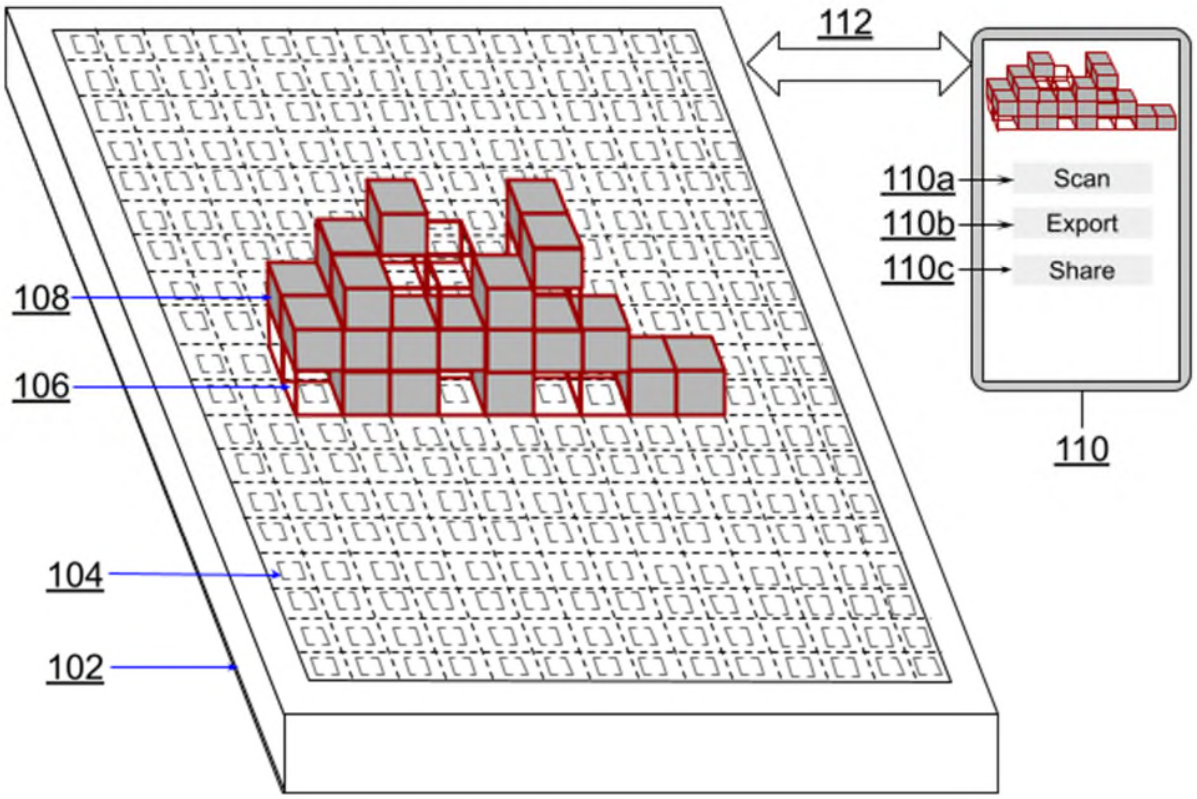

Fig. 1: A hardware interface and accompanying software to intuitively model voxel-based 3D objects

Fig. 1 illustrates a simple, low-cost, and expandable hardware interface and accompanying software that enables users to intuitively model or define voxel-based 3D objects. A rectangular base (102) has, on its upper side, a matrix of connectors (104). One or more connectors, e.g., the central connector, can be colored differently to act as a reference point. A number of cubic pieces or physical voxels (108), possibly of different colors, have connectors on each of their six sides. Some cubic pieces can be transparent (106). Transparent or translucent

pieces enable users to model floating structures. The cubic pieces can be connected to a connector on the matrix or to other cubic pieces. Connectors on the base and on the pieces can attach physically, magnetically, electromagnetically, etc., and can propagate signals and power.

The user can model a voxel-based 3D object by stacking pieces on the base or on other pieces. The base and the pieces can communicate with each other; for example, a given piece can identify its neighboring pieces and communicate the same to the base.

The hardware interface connects (112), e.g., via Bluetooth, USB, etc., to a software module or app that runs on a computer, smartphone, or other computing device (110). The user can perform a scan of the voxel-based structure assembled on the hardware interface using the software module. Upon a scan command (110a), the physical structure (including piece colors) is translated to a virtual voxel-based 3D model in a standard format and uploaded (or live-updated) to the computer or smartphone.

The described hardware, e.g., the base and the pieces, are relatively simple, low-cost, and modular, e.g., easily expandable by using additional pieces of different colors. The accompanying software can interpret, display, and export live snapshots or pictures of the model (110b). It enables exporting to common 3D model formats used by game engines, graphic libraries, 3D printers, etc. The models or pictures can also be shared directly or exported (110c), e.g., to social media, to 3D model sites, to game-engine marketplaces, to replace characters in generic video games or game engines, etc.

CONCLUSION

This disclosure describes a simple, low-cost, and expandable hardware interface and accompanying software to intuitively model or define voxel-based 3D objects. The base has a matrix of connectors. A number of cubic pieces or physical voxels of different colors are

provided that have connectors on each of their six sides. The cubic pieces can be connected to a connector on the matrix or to any other cubic pieces to form a three-dimensional object over the base. A scan command issued over the accompanying software translates the physical voxel object into a virtual voxel model.

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