SpaceCustomiser: InterActive

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Abstract

SpaceCustomiser is an ongoing research focusing on the development of digital methodologies and tools for designs based on non-Euclidean geometries. This paper describes SpaceCustomiser: InterActive, which deals with the development of digital design strategies based on non-Euclidean geometries, whereas the body in movement generates interactively architectural SPACE. The input – movement – is being electronically processed in such a way that the output represents a continuous, real-time modification of the space. For this purpose an on-site-built InterFace employing sensor/actuator technology enables translation of the recorded movement into spatial configurations. The InterAction between the body and the architectural space gives insight into how the human body shapes space.
Keywords: interactive prototype, interactive architecture, graphical programming, movement tracking, non-Euclidean geometries.

1 Content

The interactive processes in the SpaceCustomiser: InterActive project are controlled with software developed by K. de Bodt and J. Galle in Max/MSP, which is a graphical programming environment to create software using a visual toolkit of objects. The basic environment that includes MIDI, control, user interface, and timing objects is called Max. On top of Max are built object sets

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such as: MSP, which is a set of audio processing objects that enable interactive filter design, hard disk recording, and Jitter, a set of matrix data processing objects optimised for video and 3D graphics.

The interactive environment has been developed for transcribing the movement of the body into 3D-space based on SpaceCustomiser [1], which has been developed by H. Bier in 2005: SpaceCustomiser can be seen as the Modulor [2] of the Digital Age, since it establishes relationships between the human body and the architectural space. As a system of proportions Modulor uses measures of the human body in architecture by partitioning it in modules according to the golden section and two Fibonacci Series. It puts, basically, man as measure of architectural spaces, which SpaceCustomiser does as well in a more drastic manner, since it generates 3D space by following the movement of the body in space based on ergonomic principles.

While Modulor applies a 2D proportioning system, SpaceCustomiser employs a 3D, dynamic, space-generating system. If in this context can be talked about a paradigm shift based on the influence of digital technologies, than this shift can be described in the methodology: In opposition to modular, repetitive architecture developed by using grids and proportions based on functional and formal rules, curvilinear architecture is being developed by generating space through following the movement of the body in space.

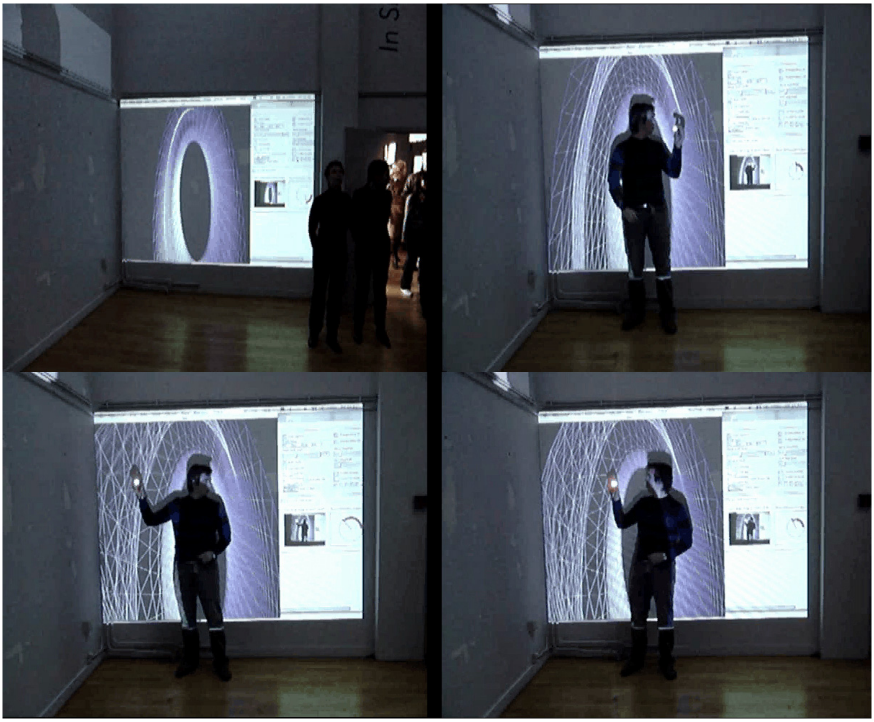

Figure 1: Deformation of the ellipsoidal cylinder.

2 Implementation

The initial space is an ellipsoidal cylinder, which represents the minimum space a standing person needs. This space has been divided in five segments, while the ellipse itself in divided in eight sectors. Each of the eight sectors is being activated, when movement in this area is detected. This means the movement of the arm to left/up triggers a deformation in the corresponding sector. The movement is being tracked by using a colour/movement tracking technique, which involves several steps: A camera captures the movements, while specific data is being extracted from the image sequence, for instance, an arm is tracked, while moving in space. This movement activates the spatial deformation in a direct way: A movement induces a proportional deformation of space. The space enlarges to accommodate the body in movement.

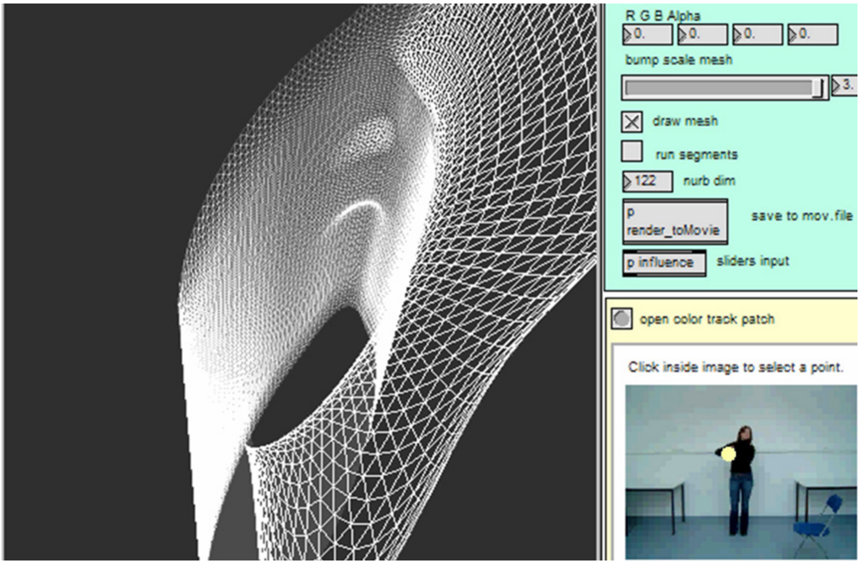

Figure 2: SpaceCustomiser: InterFace.

Geometrically speaking, the movement tracking is based on the conversion of the Cartesian coordinates of the tracked point into polar coordinates, while the deformation principle is based on NURBS, which is a mathematical model for generating and representing curves and surfaces. Editing NURBS-based curves and surfaces is easy: Control points are connected to the curves and/or surfaces in a way that their pulling or pushing induces a proportional deformation. While it is easy to manipulate NURBS surfaces by puling control points, the question is how to control this manipulation, which rules and design methodologies can be developed to control designs based on NURBS geometries? SpaceCustomiser proposes a NURBS-manipulation based on the movement of the body through space.

3 Programming

Max/MSP is a graphical programming environment for music, audio and multimedia, used to design cross-platform programs and user interfaces. Programming takes place in the Patcher window, where Max/MSP Objects, represented as boxes, are connected with patch cords. The program library includes several Objects to perform a wide range of tasks, from adding two numbers together to waveform editing, etc.

SpaceCustomiser: InterActive consists of three patches: 3.1 3D Shape, 3.2 Deformation, and 3.3 Movement Tracking.

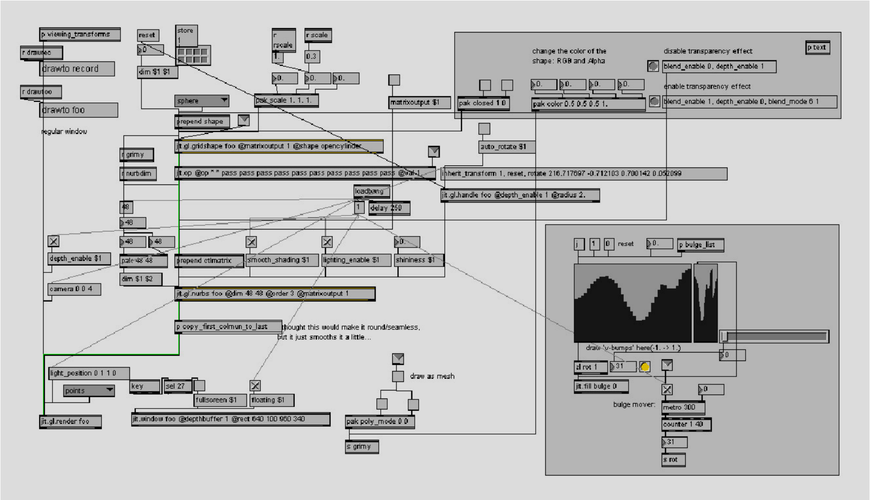

Figure 3: Programming: 3D shape and deformation.

3.1 3D shape

This patch implements 3D modelling in openGL. It is, basically, a rendering patch, enabling NURBS representation in real-time. The 3D shape itself has been developed by following a more steps procedure: The *jit.gl.nurbs* object has been used to generate the cylindrical shape, from which the ellipsoidal cylinder has been derived by scaling it down to 1/3 in the y-direction. An 8 x 5 *jit.matrix* has been mapped onto the control points of the NURBS surface, in a way that the cylinder is divided in five sections and each section is subdivided into eight sectors. This enables an accurate implementation of shape deformation according to the movement, since every subdivision can be addressed separately. How?

3.2 Deformation

An initial displacement matrix establishes the way the movement is translated into shape deformation: The sections 1-8 of the ellipse are mapped into the displacement matrix in a way that a row represents the eight sections of the ellipse, while the degree of displacement of each section is shown in the corresponding min-max columns. For instance, the initial ellipse – I – is represented in the displacement matrix as corresponding to a middle value [Figure 4], while the deformed ellipse – II – is shown as an alternation between middle and maximum values of displacement.

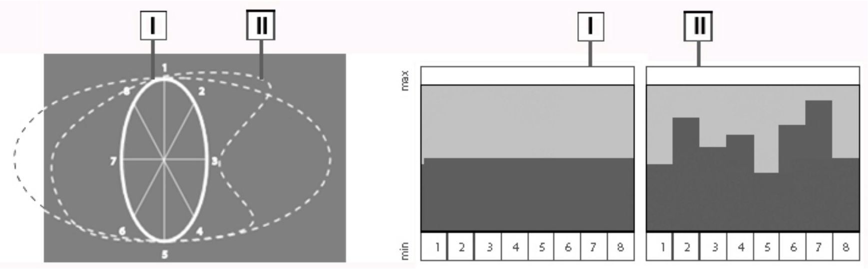

Figure 4: Diagram of the displacement matrix.

The displacement matrix establishes, therefore, how the movement of the body is being translated into spatial deformation, while the deformation of the ellipsoidal cylinder is implemented by movement/colour tracking.

3.3 Colour tracking

The movement tracking in real-time has been implemented by means of computer vision, which employs colour tracking performed with *cv.jit.track*, which is an external object for Max. It extracts xy coordinates from the movement and sends them to the Deformation patch, which in turn executes the shape deformation itself.

The colour to be tracked is being selected by clicking with the mouse in the video frame window, which shows the real-time movements captured with the camera connected to it. The Cartesian coordinates of the tracked colour/point are then converted into polar coordinates, which find their correspondence in the eight ellipsoidal sections.

4 Conclusions

This exercise in interactivity shows that the concept of responsive environments applied to architecture can be implemented in spaces, which dynamically react to the movement of the human body in space.

In this context, emergence and self-organization can be seen as principles on which interactive architectures can be based on, since building components dynamically adjust to their users needs. One of the modes of emergence and self-organisation in interactive buildings is based in space-customisation, as described in this paper.

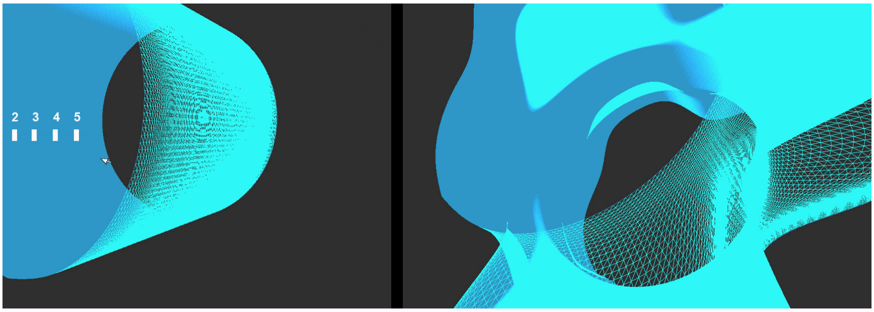

Figure 5: Five part segmentation of cylindrical space.

5 Perspectives

The next step in the development of this interactive prototype is the implementation of movement transcription not only on one segment of the ellipsoidal cylinder but on all five segments. For that, each segment of the ellipsoidal cylinder needs to be connected to push sensors on the floor, so that a forward movement of the body can be applied to the corresponding segment allowing transformation and deformation of space in three dimensions.

Furthermore, the pro-active potential of the space has been not yet explored: Following the example of interactive floors, which configure themselves as surfaces to lie and sit on, the interactive building components might follow principles such as ‘store agenda and move accordingly’ and/or might use sensor/actuator technology interacting with the environment according to the principle ‘sense your proximity and react on it’.

In this context, architectural space based on NURBS can be understood as a space, which reconfigures itself according to the principle of swarms: Control points of NURBS can be seen as birds/boids [3] in a swarm, which configure themselves spatially according to preset rules, which accommodate the users’ needs.

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