MORPH

Taggenbrunn Edition

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ABSTRACT

MORPH TE (Taggenbrunn Edition) is an exploration of the relationship between humanity and robotics. In an age of endless automation and cold, technological prevalence, the piece sheds light on a new kind of artificial life. It is both a modern artwork and a deep-dive into technological anthropomorphism. The piece demonstrates the emergence of complex behavior through well-orchestrated simplicity, while its tessellated, geodesic surface provides a sense of organic intricacy. The work is timely in its reflection of humanity's symbiosis with machines, yet timeless in its pioneering embodiment of symmetry and naturally inspired movement.

CCS CONCEPTS

• ; • **Applied computing** → Arts and humanities; Media arts; • **Hardware** → Communication hardware, interfaces and storage; Electro-mechanical devices; • **Computer systems organization** → Real-time systems; Real-time system architecture;

KEYWORDS

Kinetic Art, Real-time Software, Installation Art, Industrial Design, Electronics

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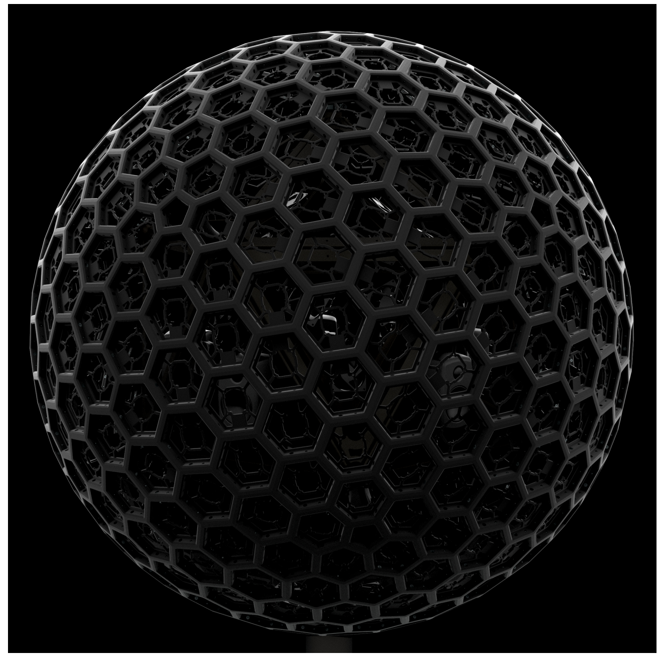

Figure 1: Outer frame 3d printed nylon mesh.

1 DESIGN

MORPH's spherical design consists of 486 nodes laid out across the surface of a dual geodesic icosahedron. The shape actually has 492 faces total, but one module has the 6 centre nodes removed in order for the support pole to pass into the sphere. Each face is what we refer to as a "node". Each node consists of a custom control PCB, ethernet and power PCB and linear actuator for driving the face. The linear actuator consists of a non-captive stepper motor with a 200mm lead screw guided by a rail. To accomplish the seamless geodesic sphere, there are 9 unique faces.

Each of the nodes are supported by and mounted to a 3D printed nylon mesh we refer to as the outer frame (Figure 1). The nodes and the underlying outer frame are divided into 12 symmetrical modules, each mounted on the vertex of the main folded aluminium icosahedron frame. Each module consists of 41 nodes, including a pentagon in the centre and 5 symmetrical branches of eight nodes extending from each edge of the pentagon.

Due to the dual-geodesic icosahedron tessellation, each node has one of 9 unique face shapes that exist across MORPH's surface [Cromwell, 1999]. Each module consists of one pentagon at the centre and 5 each of 8 unique hexagons, one for each branch extending from the pentagon. As a result, 9 unique LED PCBs were required, each with a unique LED count and layout aimed at providing an even LED distribution under the diffuser. LED counts vary from 51 (pentagon) to ~150 on the larger hexagons, resulting in over 80,000 LEDs in total.

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2 SOFTWARE

An entirely custom software architecture was created using the Rust programming language and the nannou creative coding framework [nannou for Linux, 2021]. This allowed for Rust types to be shared between the firmware and control software, enabling functionality such as serialization and deserialization. The control software featured an extensive modulation routing framework, hot-reloading

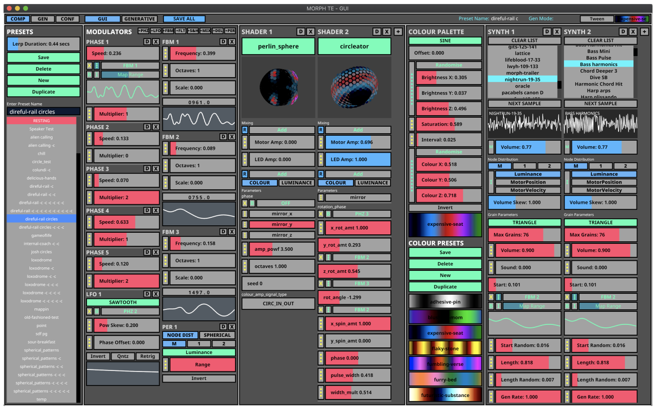

Figure 2: Various patterns created from the control software and output to MORPH.

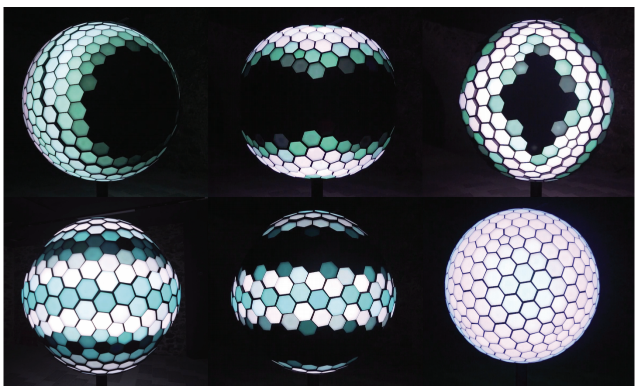

Figure 3: Various patterns created from the control software and output to MORPH.

shader engine and a 5-channel surround sound granular synthesis engine (Figure 2).

A near limitless amount of unique patterns can be created with this design (Figure 3). Modulators, shaders, color palettes, and granular synthesizers can be added and routed into each other in a very similar fashion to traditional modular synthesis.

3 COMMUNICATION

Each node's micro-controller communicates with a single master computer via Ethernet using TCP/IPV4. Ethernet was chosen due to its support for high data rates, well-established protocol options and wide availability in terms of available components. TCP was chosen due to the wide-range of existing software and firmware support for the protocol, along with in-built error checking. Nagle's algorithm was disabled due to our low bandwidth and low-latency requirements [Mogul and Minshall, 2001].

Each node is expected to receive at least 60 updates per second consisting of new LED data and motor targets and responds with time-of-flight measurements just as quickly. This high rate allows for serving real-time generated unique patterns with persistence of vision and very low-latency interaction.

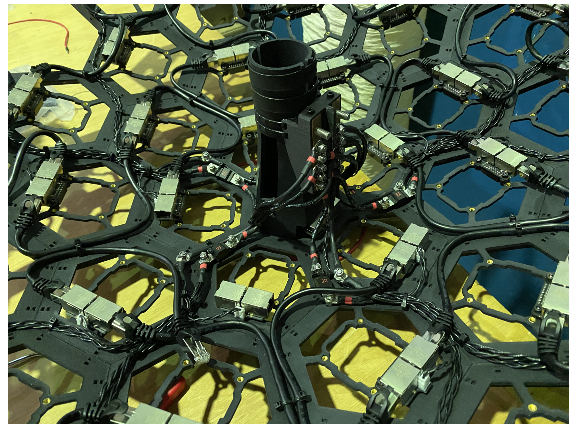

Figure 4: Ethernet and power routing of a single module.

A tree of 100 Mbps Ethernet switches enables this communication (Figure 4). A single 16-port switch connects the master computer to the modules, each with their own 8-port switch used to communicate with the pentagon and each of the aforementioned 5 branches. Each node within these branches of 8 are then connected in series using the 3-port switch integrated circuit on each node.

ACKNOWLEDGMENTS

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