شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم

جامعة عين شمس
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MONA MAGHRABY

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قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
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Architectural materialization of digital discrete assemblies using smart materials

By:

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Bsc. Architecture
Faculty of Engineering, Ain Shams University, Egypt

A Thesis
Submitted for Partial fulfillment of the requirements for the degree of
Master of Science in Architecture

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Cairo, 2021

AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Architecture

Architecture materialization of digital discrete assemblies using smart materials

by

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Bachelor of Science in Architectural Engineering

(Architecture Engineering)

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Date:8 September 2021

Statement

This thesis is submitted as a partial fulfillment of Master of Science in Architectural Engineering Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Dalia Tarek Niazy Ahmed Niazy

Signature

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Date

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Acknowledgement

I am grateful for my supervisors Prof. Mostafa R. Ismail and Prof. Ahmed El Sabbagh for their endless efforts and support. They are the pillars and reason why this research continued with all hindering challenges. I am blessed to have them as my mentors in this journey of exploration.

The author greatly appreciates the support of Polylab at faculty of Engineering, Ain Shams University, Cairo, Egypt for providing the machinery for the DSC test and any machinery needed for material programming. The Mini interactive wall was fabricated in FabLab Egypt as part of Maker diploma and funded by American Center in the U.S. embassy in Egypt. I am thankful for the FabLab team for guiding me through making the Mini Interactive Wall.

May 2021

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Abstract

Digital materiality exploits the material dimension of architecture structures. The enhanced material performance help increase sustainability of the system complying with the sustainable development goals SDGs. This research investigates the material dimension of interactive architecture systems. The research aims to explore the materialization of climatic passively responsive digital building units using smart materials for a light weight physical prototype, encompassing construction reversibility of the assembled architectural system. CES architectural EduPack is used for initial material screening. DSC thermal analysis test is conducted to deduce the thermal properties of material and TA instrumental software is used for graph analysis. Tensile stress test is done using LR 300K machine. Samples are digitally fabricated using commercially available FDM 3D printers. Materials 3D printing parameters are modified using Cura software. An experimental thermo-mechanical programming is conducted using thermal chamber. Experiments are video recorded and the motion analysis is done using Kinovea software. Modelling the bending active textile with 4D components is done using Grasshopper plugin in Rhinoceros software. The Mini Interactive Wall is computationally programmed using Arduino Coding. The research identifies a digital production framework. Also, programming methods are classified into Pre and post-fabrication programming. A case study of Mini Interactive Wall is modelled using Fusion 360 software and constructed with high biodegradability of the discrete units using digital fabrication. A simulation of replacement of the mechanical parts in the wall with 4D discrete assemblies/components is present, a model of bending active textile with 4D components is done using Grasshopper plugin in Rhinoceros software. PA 12 samples show thermal sensitivity within the built environment temperature range, while it does not show shape recovery after programming. 4D printed mono-material component is fabricated. 4D printed PA6 component show total shape recovery to initial position. A computational simulation of the 4D component as an interactive architecture feature is presented. 4D printing in architecture will help decrease energy consumption while optimizing the interactive system.

Keywords: Shape memory polymers, 4D printing, interactive architecture, smart materials, Arduino programming, digital fabrication.

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