SENSED SIMULATED RESPONDED

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Bachelor of Engineering 20' | School of Architecture, Southeast University

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Cover Image Credit: ACE Geosynthetics

YANG, YUXIN

Digit X Environments

Yuxin Yang is a climate-positive and technology-savvy designer. She interfaces the built environment as an engineered system with a particular interest in the mega-infrastructure, mix-used development, and energy and water system. She integrates the knowledge of sensing technology and data visualization in design thinking. At or after work, Yuxin values opportunities and tools to facilitate the public agenda.

Yuxin has worked as an urban designer and landscape architect for internationally renowned design companies. She has held a practice or research position at SOM, SWA Group, URBANGENE, Zhuyufan Studio of Tsinghua University, and Shanghai Study Center of Hongkong University.

Yuxin holds a Master of Landscape Architecture from Harvard Graduate School of Design and is cross-registered at MIT Media Lab and EECS. She has a Bachelor of Engineering in Landscape Architecture from the School of Architecture, Southeast University, China.

Technicals

Landscape and urban design (Rhino, Adobe Creative Suite (Photoshop, Illustrator, Indesign, Audition, Premier), Lumion, Vray, AutoCAD) - 5
Computation (Python, Grasshopper (Ladybug, Millipede), Arduino, Electronics) - 2
Geo tools (ArcGIS, ENVI, eCognition) - 3
Prototyping (3D Printing, Laser Cut, 3D Scan) - 3

IOT Shoreline; Wave, Weave

Fiber sensing for shoreline soil and wave monitoring

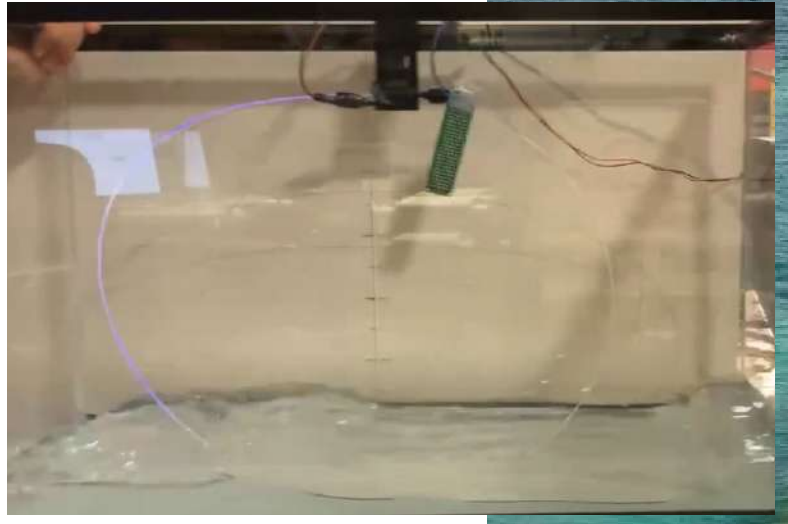
Key Words: Geotubes, Fiber-Optic Sensing, Coastal, Climate Action

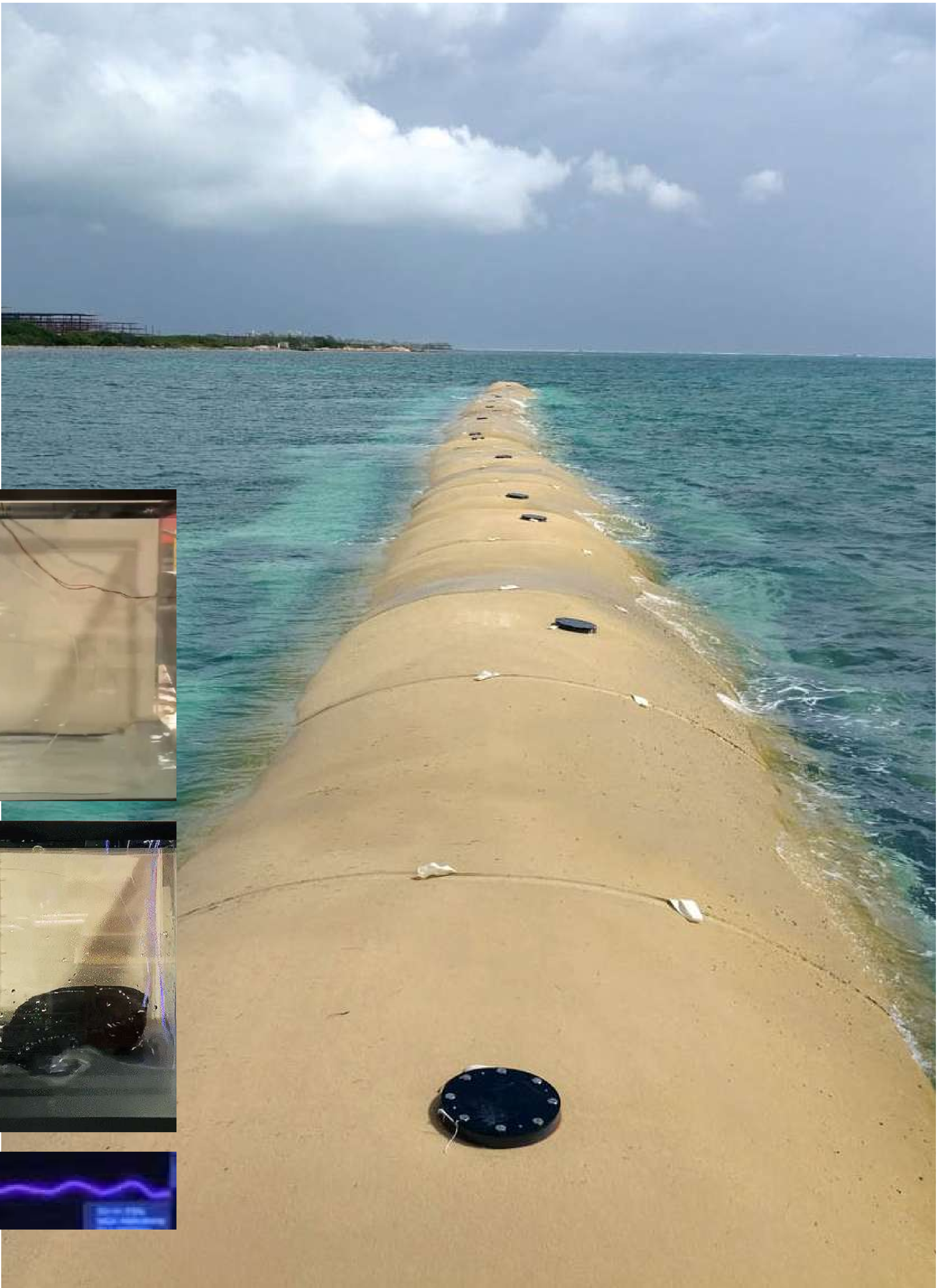
Individual Work, 02-05/2022, Academy

Instructor *Dr. Joseph A. Paradiso, joep@media.mit.edu*

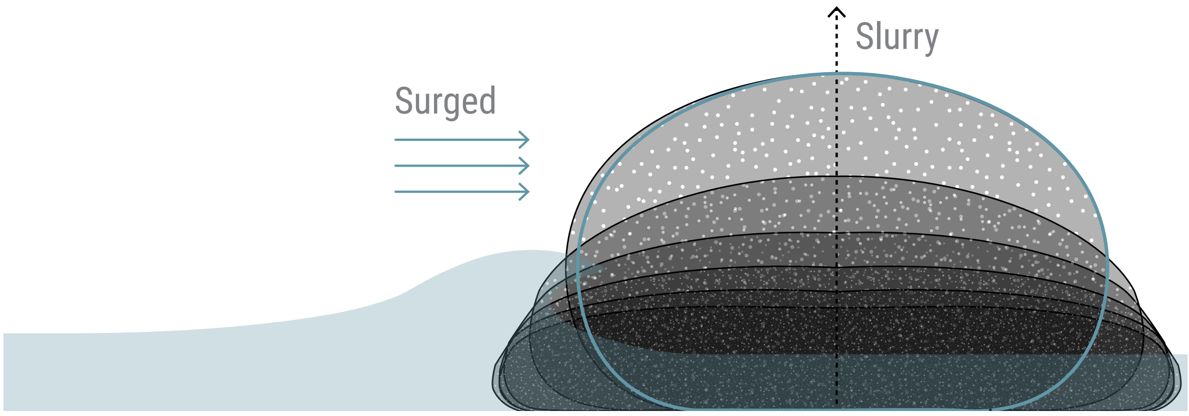
Institution *MIT Media Lab, Responsive Environments Group*

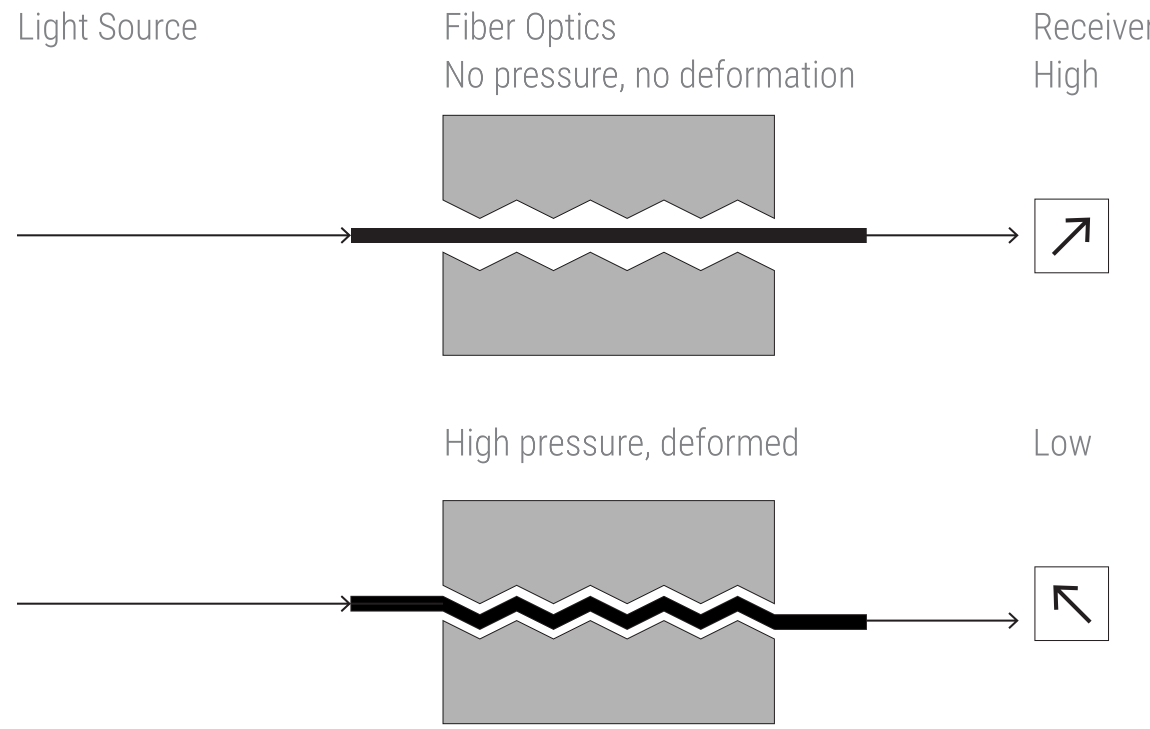
Geotextile tubes as submerged breakwaters are the shoreline climate-adaptive infrastructure. The project proposed fiber sensing, a weavable sensor for geotextile tubes, to capture environmental changes, soil, and waves, specifically in this project, enabling an IoT shoreline. The research includes fiber sensor prototype development and two set experiments - deformation experiments on fiber sensors of varying diameters and treatment and water tank waves experiments on breakwater mockups.





Fiber Sensing to Capture Environmental Changes





Above
Deformation principles of geotextile tubes

1.1 Geotextile tubes as submerged breakwaters

Geotextile tubes as submerged breakwaters are the widespread shoreline climate-adaptive infrastructure. Integrating sensors with geotextile tubes weave an Internet-of-the-Thing (IoT) on the shoreline. Shoreline sensing measures volatile phenomena -wave, soil, and temperature - which facilitates decoding the coastal morphophonemics in the age of climate change.

Driven by environmental factors, the geotextile tube is deformable when storm surges or the dredge material property changes. For one, experiments show that tube height reduction decreases as the dredge material goes from slurry to dense, indicating that the deformation of the geotextile tube is reflective of dredge material property inside the long-term monitoring. The geotextile tube rests on a rigid horizontal foundation and is analyzed in the filling and densified stages. Analytical and numerical solutions for determining the geometric dimensions and stresses of geotextile tubes are widely reviewed and modeled with field experiments and computational simulation (Kim et al. 2016). For another, waves generate direct pressure and produce micro deformation on the geotextile tubes, which can be recorded by the intensity and frequency of the wave data.

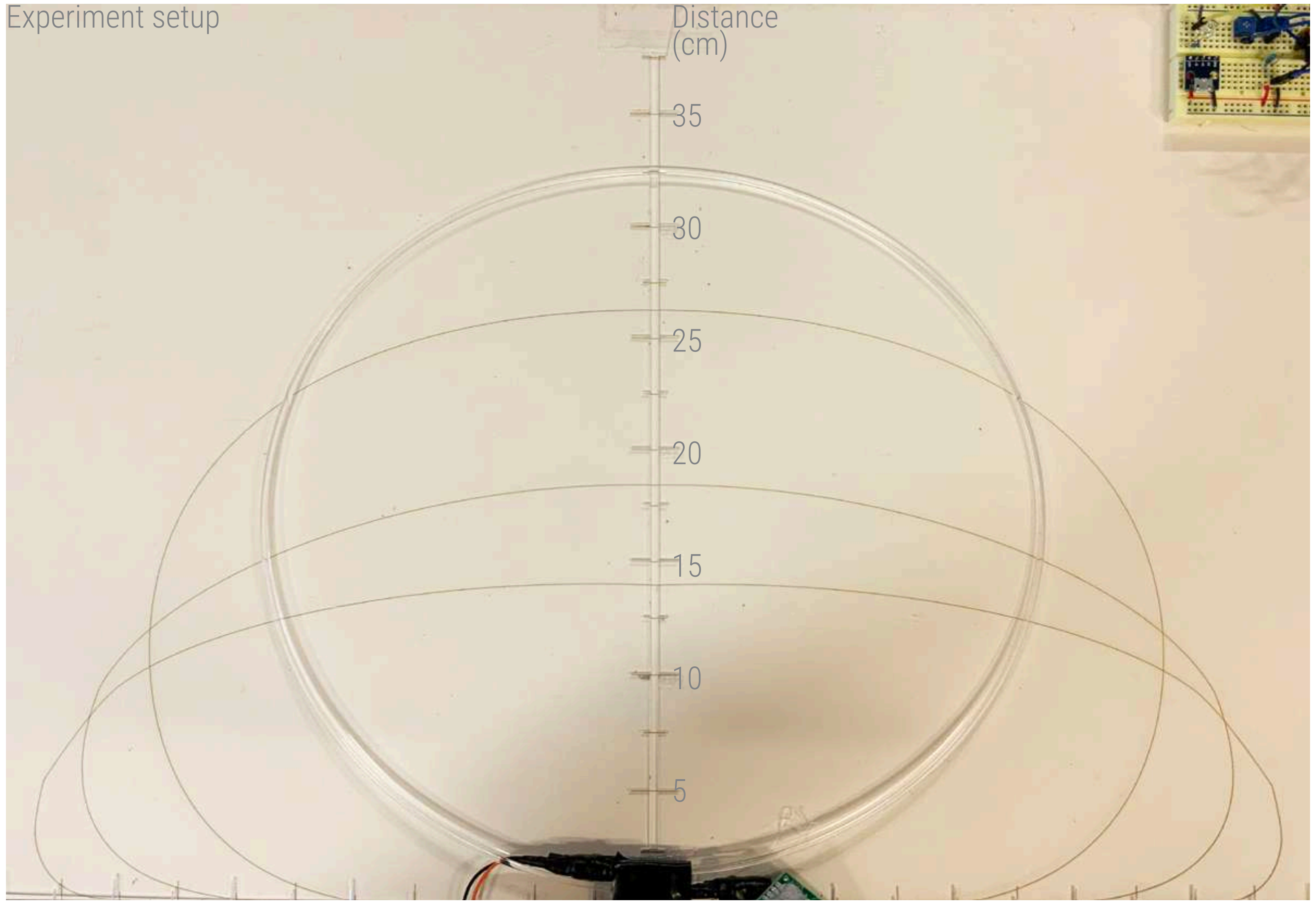
1.2 Fiber sensors capture environmental changes

With fiber optics as sensors, the external environment changes affect light transmission through fibers in a way that can be detected at the other end. The environment modulates light passing through fibers by directly altering its intensity, affecting its polarization, or shifting its phase. Specially designed fibers sensitively capture environmental changes such as temperature, pressure, and other parameters. (Fuhr 2000) A thin, flexible fiber is easy to weave on high-tenacity fabric and resistant to extreme and volatile coastal weather with the proper coating, which facilitates fiber optics as an ideal application for the geotextile tubes in the submerged breakwaters. On the other end, the photosensitive component, such as a photodiode, utilizes a photoelectric effect to transform the light signal into an electrical signal.

In this project, I developed a fiber-optic prototype that measures the light intensity changes with the fiber deformation. The setup is simply constructed. A light source, such as a LED or laser, emits light on one end of the fiber optics, and a photodiode receives light on the other. The further experiments first explore the relationship between the fiber deformation and signal intensity with different fiber properties and treatments and then simulate waves in the water tank environments.

Above
Fiber sensing working principles

Fiber Optics Sensor Deformation Experiment

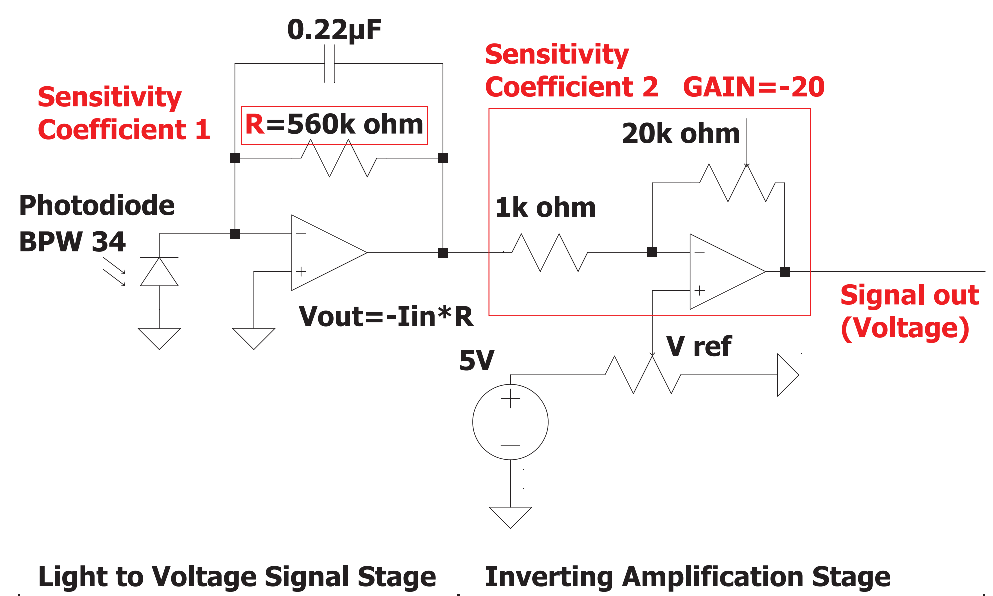


Above
Lab experiment setup

2.1 Fiber Optics Sensor Deformation Experiment

The first experiment sets up by varying the distances from the fiber top to the bottom. The setup assumes the round weaving of the fiber optics onto the geotextile tubes. By varying the distance, the experiment measures the deformation of geotextile tubes. In the lower range, the sides are curved, and the top is flat, while in the higher range, vice versa.

The right below displays the photodiode receiver circuit. The first stage is to turn the light signal into the current and then the voltage signal, and the next is the inverting amplifier. The two sensitivity coefficient determines the amplification of the sensor's sensitivity. The following variable experiments test influential factors on the sensitivity of fiber sensors.

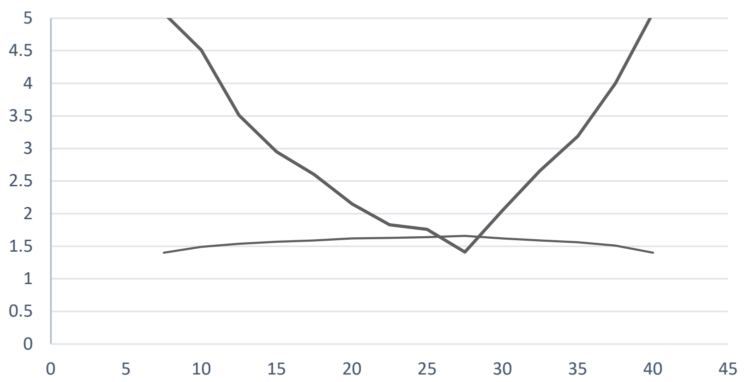


Above
Electronic and connective components, experiment process, fiber to test

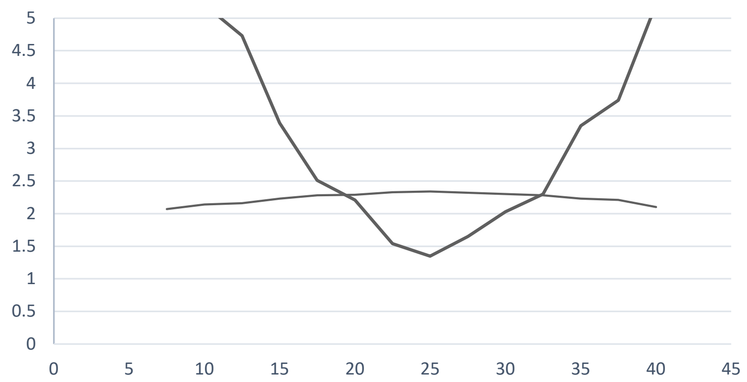
Below
Photodiode Receiver Circuit

Fiber Optics Sensor Deformation Experiment

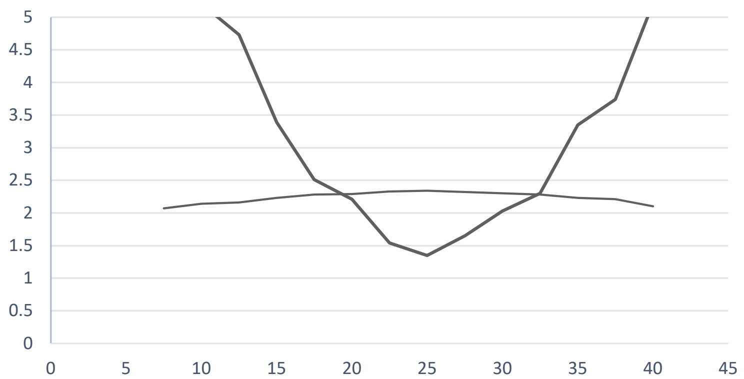
X-Deformation Distance (cm) to Y-Voltage Signal (V)



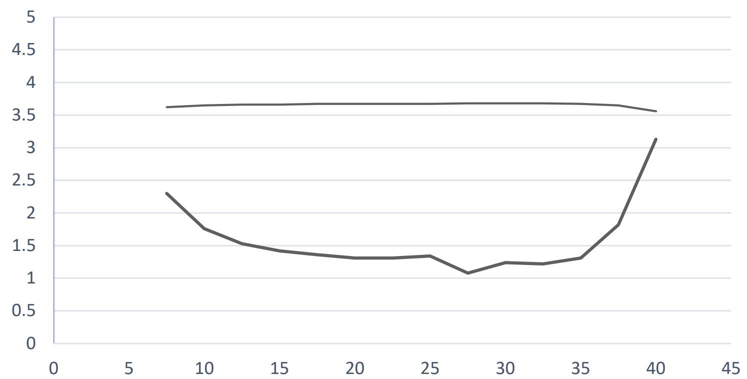
3mm Fiber, White LED
R= 560k ohm



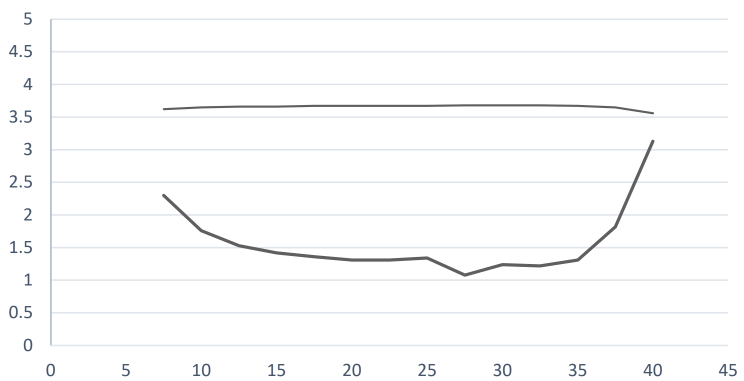
3mm Fiber, Blue LED
R= 560k ohm saturated, 267k ohm



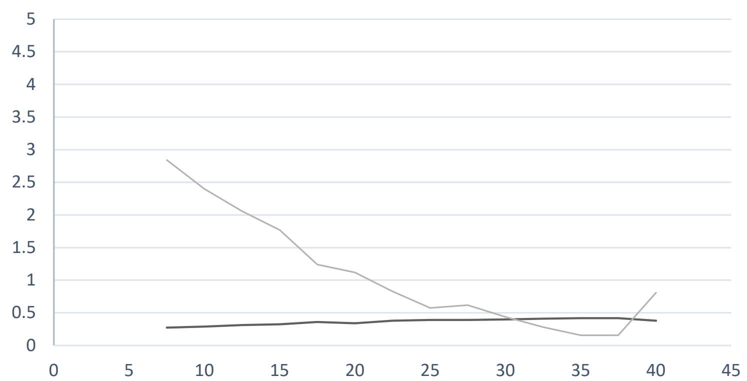
3mm Fiber, Blue LED
R= 560k ohm saturated, 267k ohm



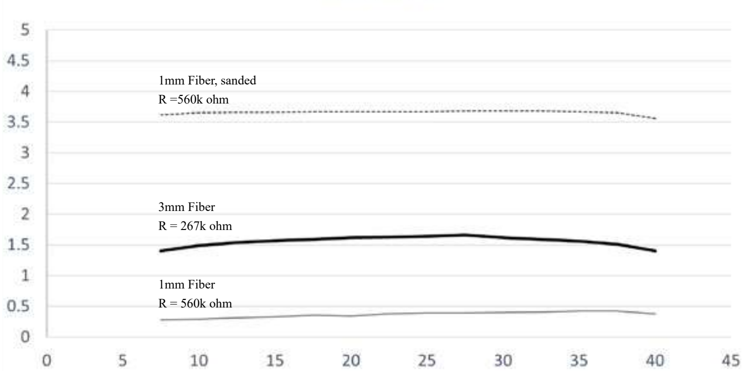
1mm Fiber, Blue LED
R=560k ohm



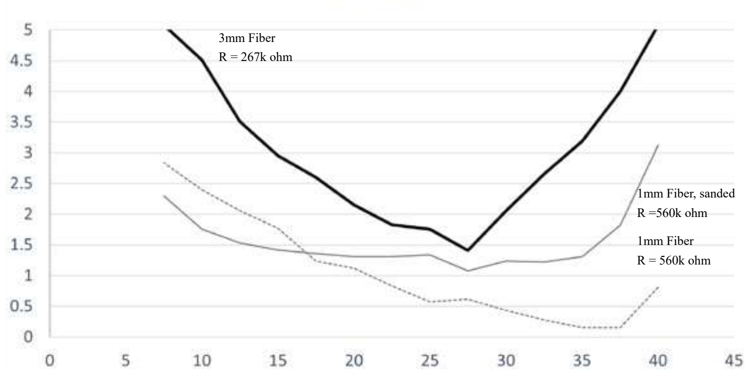
1mm Fiber,
Blue LED, R=560k ohm



1mm Fiber, Sanded
Blue LED, R= 560k ohm



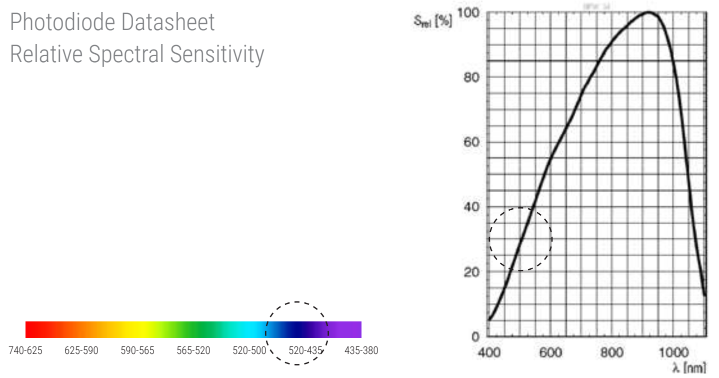
Light-to-Voltage Stage Sensitivity Comparison



Inverting Amplification Stage Sensitivity Comparison

Major Influential Factor

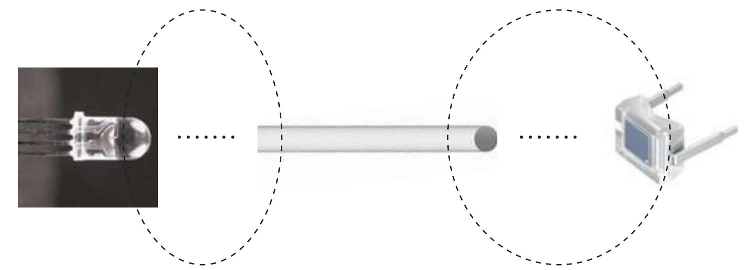
Photodiode Datasheet
Relative Spectral Sensitivity



Light Spectrum

2.2.1 Light source: Blue > White LED

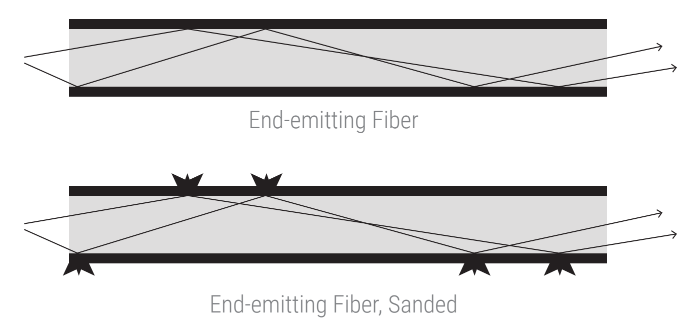
The critical factors of the light source are the photodiode receiver's spectral sensitivity area, the operating wavelength of the fiber, and the outside environment. White LED's sensitivity is not ideal as the blue LED as tested, which contradicts the fact that white LED has a larger spectrum.



Contact Area

2.2.2 Fiber Diameter: 3mm > 1mm Fiber

3mm core diameter fiber is more sensitive than 1 mm one. It is because, per the sensor setup, the contact area of the fiber-light source and fiber-photodiode determines the light signal captured and transmitted. 3mm fiber has a larger contact area than 1 mm.



Light Leakage through Fiber

2.2.3 Fiber Treatment: Sanded > Unsanded

After sanding 1mm fiber, the whole length, the fiber's sensitivity improved significantly. Because the sanded fiber allows much more light leakage, when it deforms, the fiber responds much more sensitively than the unsanded version.

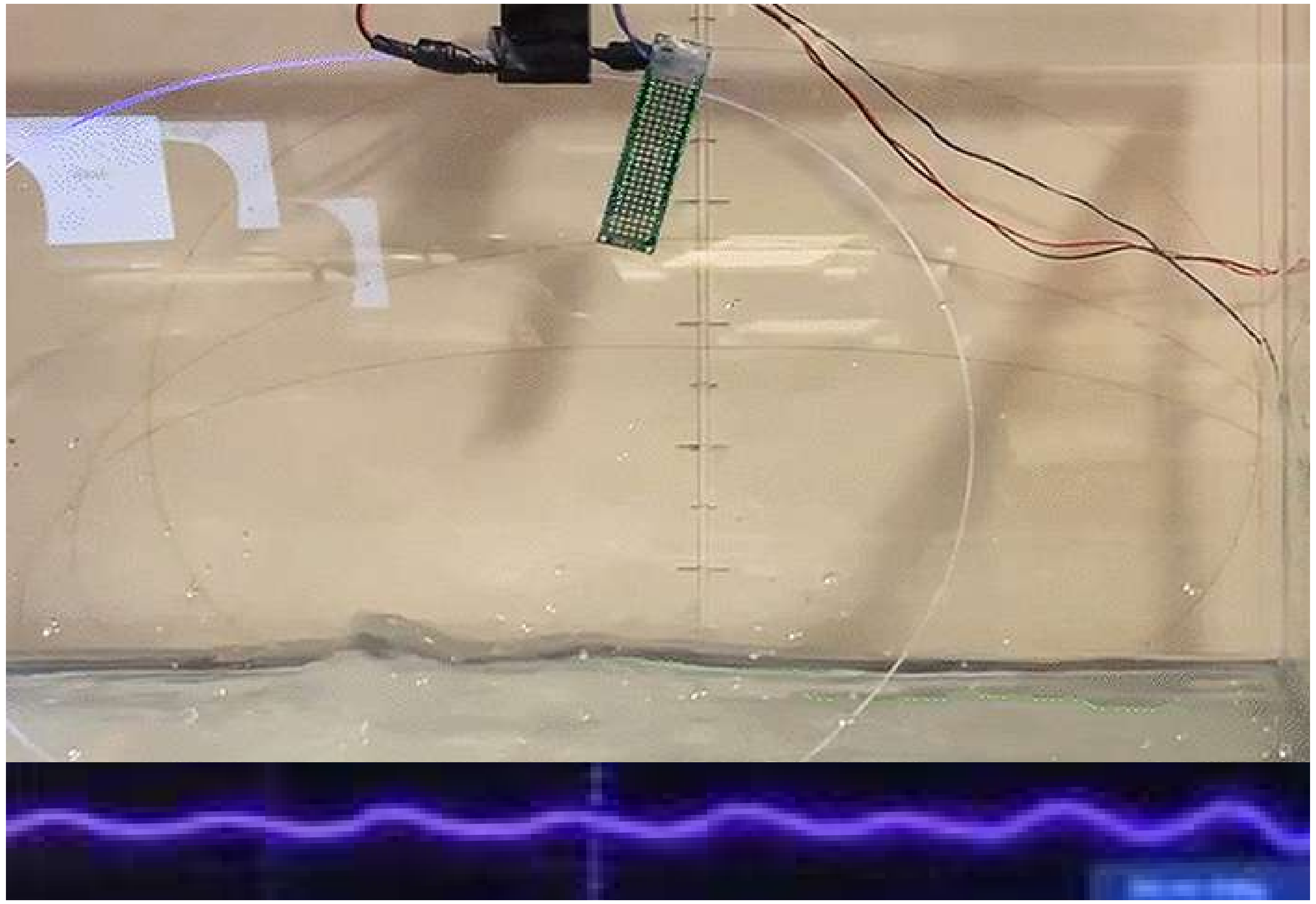
2.3 Conclusion

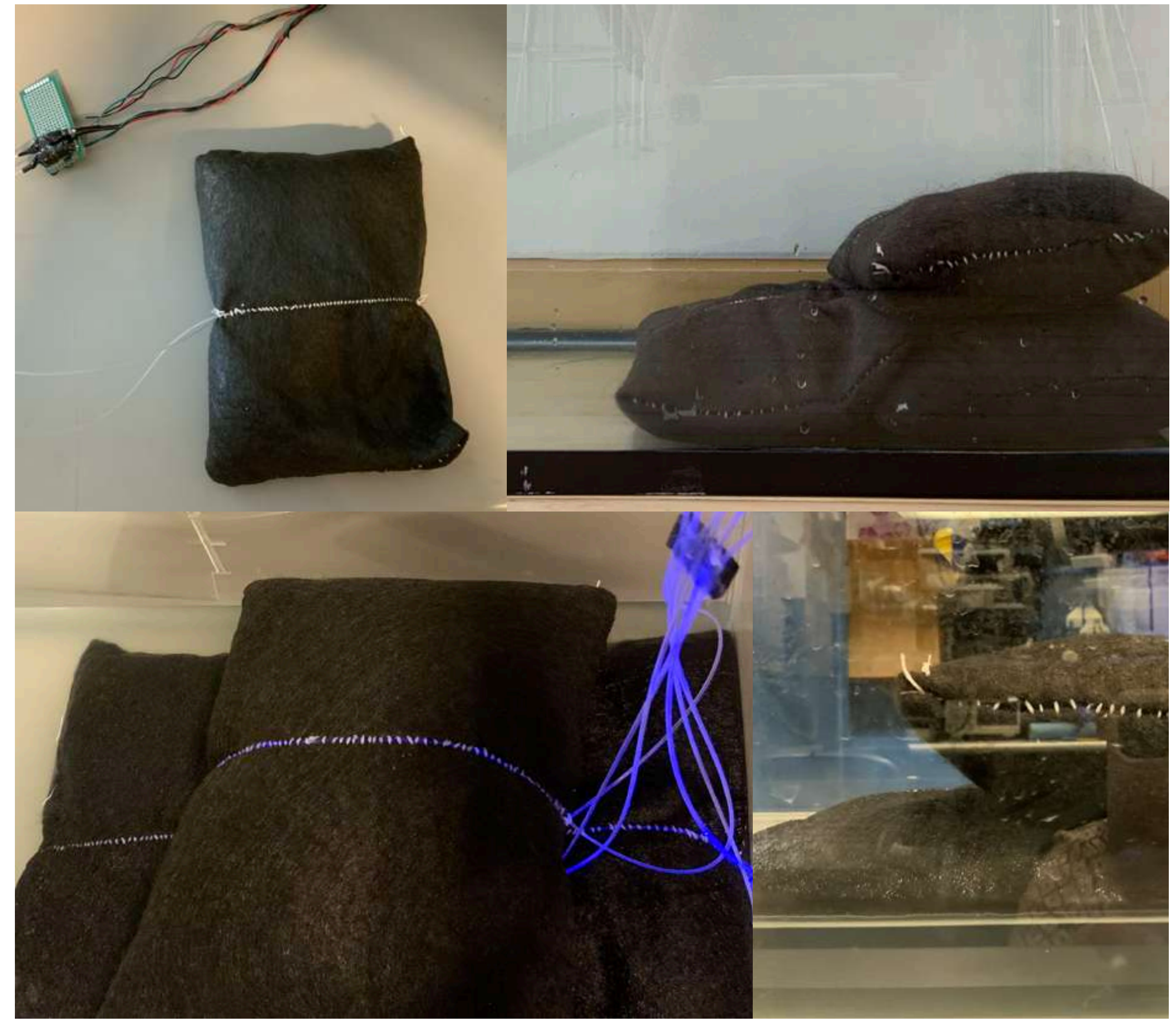
Chart comparison indicates the deformation pattern when round weaving of the fiber optic sensor and sensitivity.

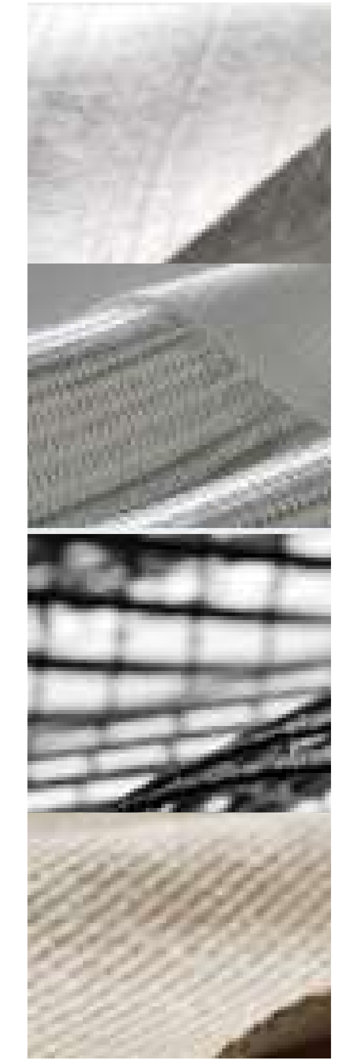
(1) The "V" Plot: >30cm: the setup's top is getting more curved, and the sides are flat. The larger the distance, the larger the signal. 25-30cm: fibers are overall round, most minor signal. <25cm: the top is flat, and the sides are getting more curved. The smaller the distance, the larger the signal.

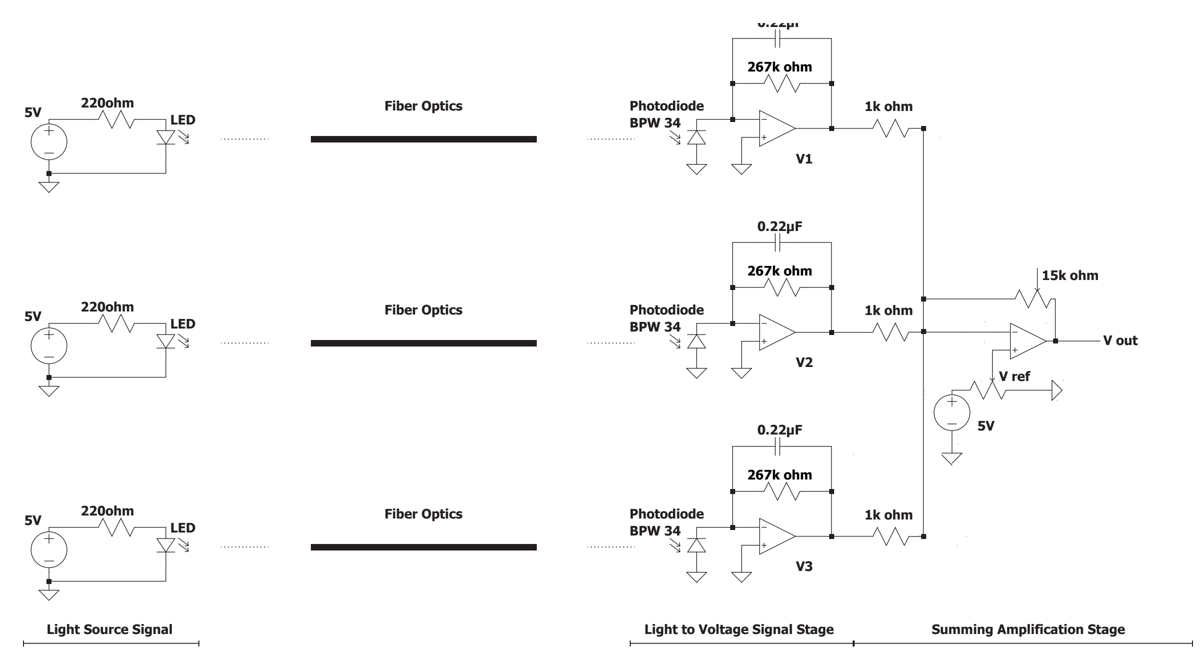
(2) Sensitivity tested (blue LED as the light source): 3mm Fiber > 1mm Fiber, sanded > 1mm Fiber.

Water Tank Wave Experiment









Above
Water tank wave experiment with one single fiber

3.1 Water Tank Wave Experiment - Single Fiber

Here, I chose the 1mm core diameter, sanded fiber for the underwater experiment. Firstly, I sink a decent amount of one single fiber into the tank. In the static mode, it is to examine the refraction indexes' influence on fiber optic sensing. As different mediums, water and air have a refraction index of 1.33 and 1, which might cause performance differences. It did not generate a noticeable signal change, and the reason behind it needs further research.

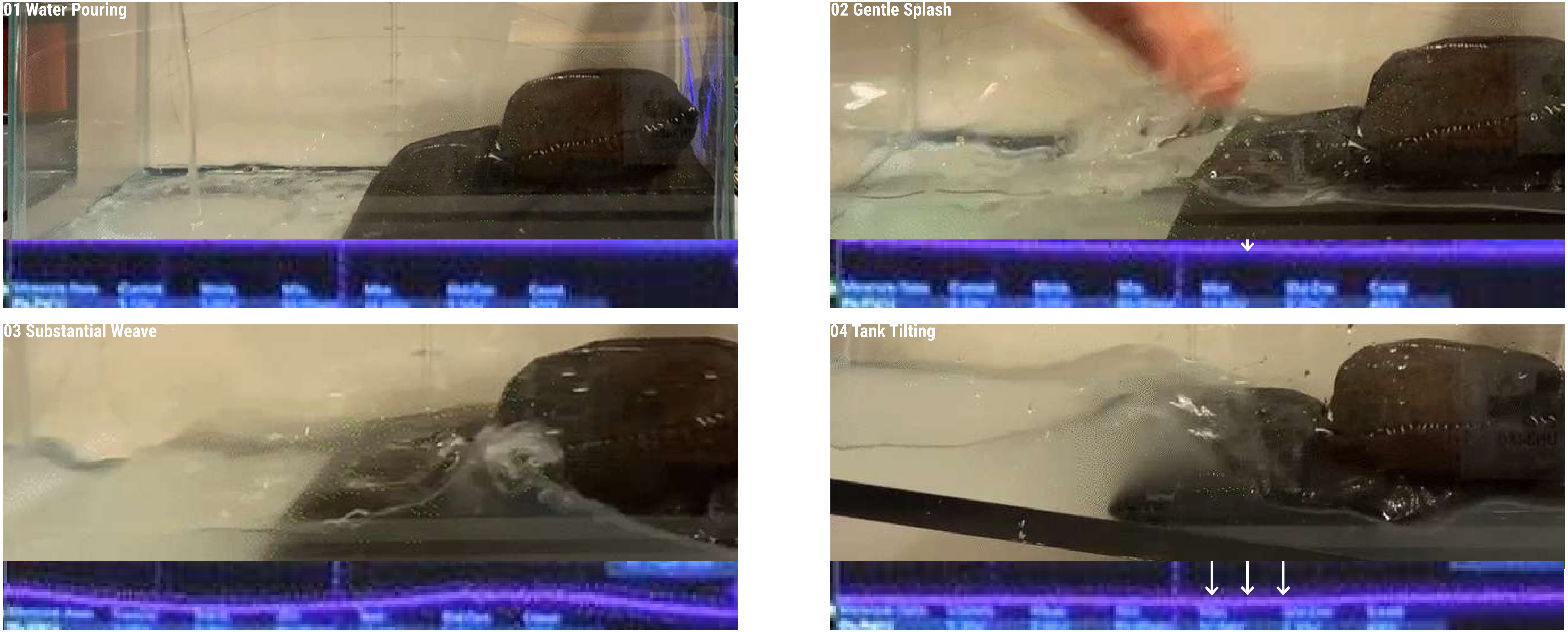
When I start pushing the tank and generating weaves, the fiber optic sensor sensitively reflects the wave amplitude and frequency.

Above left
Weaving fibers onto the mock-up geotextile tubes

Above right
Exemplar fabrics of the geotextile tube ("Geosynthetic Solutions in Civil Engineering - TenCate Geosynthetics" n.d.)

Below
Circuit in the mockup experiments

Water Tank Wave Experiment



Above
Different wave gestures and signal responses

3.2 Water Tank Wave Experiment - Weaving on geotextile tubes

One advantage of fiber optics sensing is that it is easy to weave on the fabric of the geotextile tubes. Various weaving pattern requires further explorations according to the fiber thickness and the fabric texture. Gestures of the water pouring, gentle splash, substantial wave, and tank tilting generate varied amplitude and frequency signals.

In future field experiments and weeks, months, long-term monitoring of accumulated soil and wave with this application and the coastal performance it can decode are very promising.

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Kendall Life-Work Crescendo, MA

The past year's remote working experience, whether hybrid or fully remote, poses many design problems for existing office space culture. According to the Microsoft Work Index, 66% of leaders answered that their company are considering redesigning their office spaces for hybrid work. Global office leasing volumes in the last two years have dropped by half, and the US office vacancy rate (27%) has doubled from the previous year. According to the JLL Boston office insight report, total vacancy and average asking rent in Boston are rising. The projected office vacancy rate is 16.8%, 5% higher than the current rate.

In response to these issues, our project explores the possibility of office building conversions in the scope of Kendall Square. Our interactive statistical tool assists decision-makers in rethinking existing office buildings in Kendall and transforming them into spaces in need. Our tool guides users to understand three perspectives based on the rate of office transition:

Environmental: How much can we reduce building and transportation **GHG EMISSIONS**?

Financial: Is annual residential rent showing more **FINANCIAL IMPROVEMENT** than annual office rent?

Wellness: Can we have more urban green space for **INCREASED WELL-BEING**?

Today, it is clear that the lack of housing stocks in Kendall Square has a severe adverse impact on housing affordability. By analyzing **OFFICE-TO-HOUSING**, **OFFICE-TO-GREENSPACE** conversions, our vision is to gradually evolve Kendall into a more livable place where people can have better work-life symmetry.

Collaborator
Patrick Chwalek, Yoonjae Oh, Mirah Xu
09/2021 - 12/2021

Contribution *30%*
Proposal, Analysis and Scenarios,
Data Collection and Cleaning

Instructor
Kent Larson, kll@media.mit.edu
Luis Alonso, alonsolp@media.mit.edu

Institution
Academic, MIT
MAS.552 City Science

Tools
Google Colab (Python)

Links
Colab: https://colab.research.google.com/drive/1mClz4WQfEIuzMbrph3_iVATuMkr6FKaZ?usp=sharing

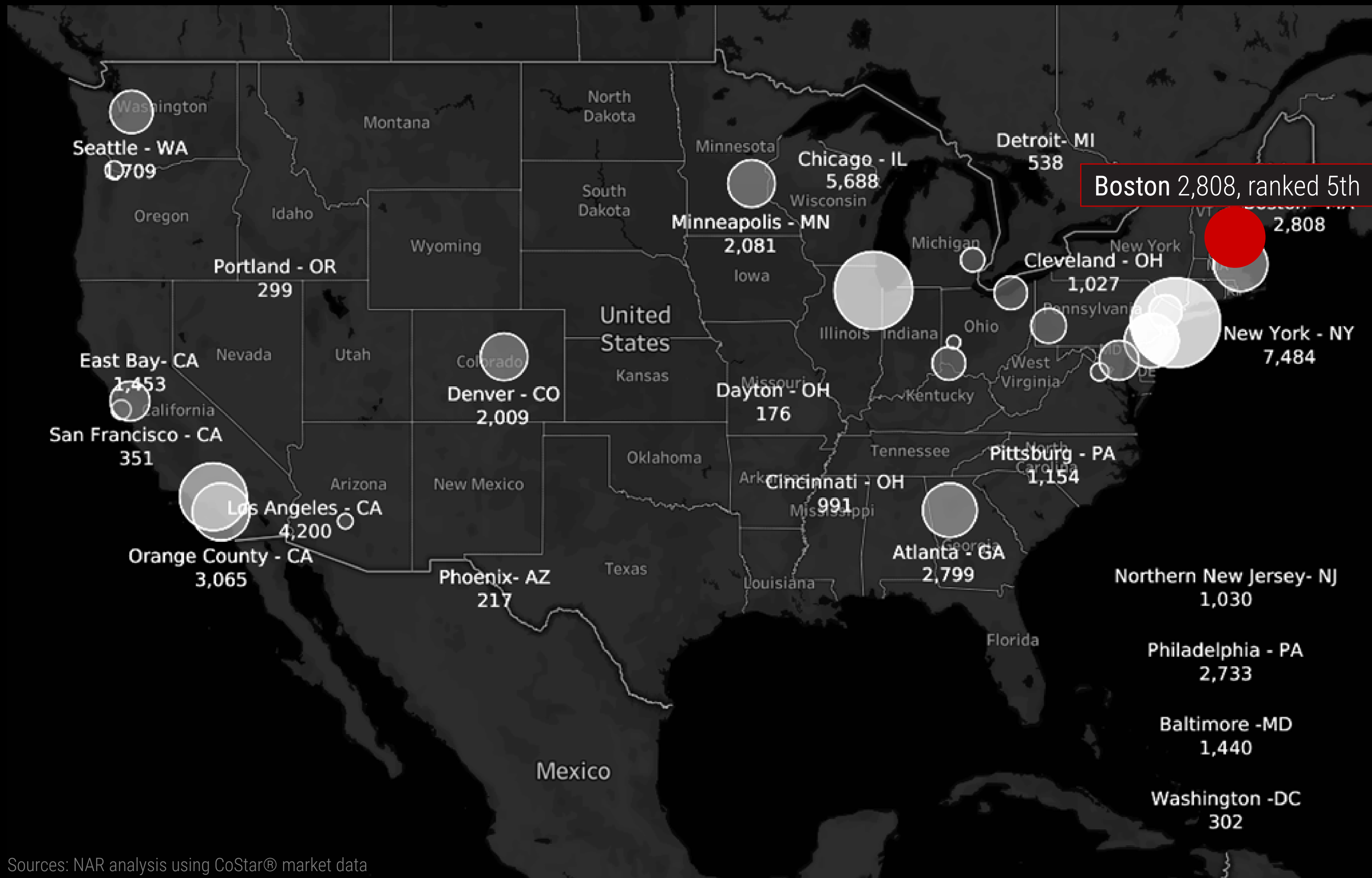
Target building types: Office / R&D

Current Residential Stocks

OFFICE-TO-HOUSING CONVERSION

Growing Trend of Office-to-Housing Conversion

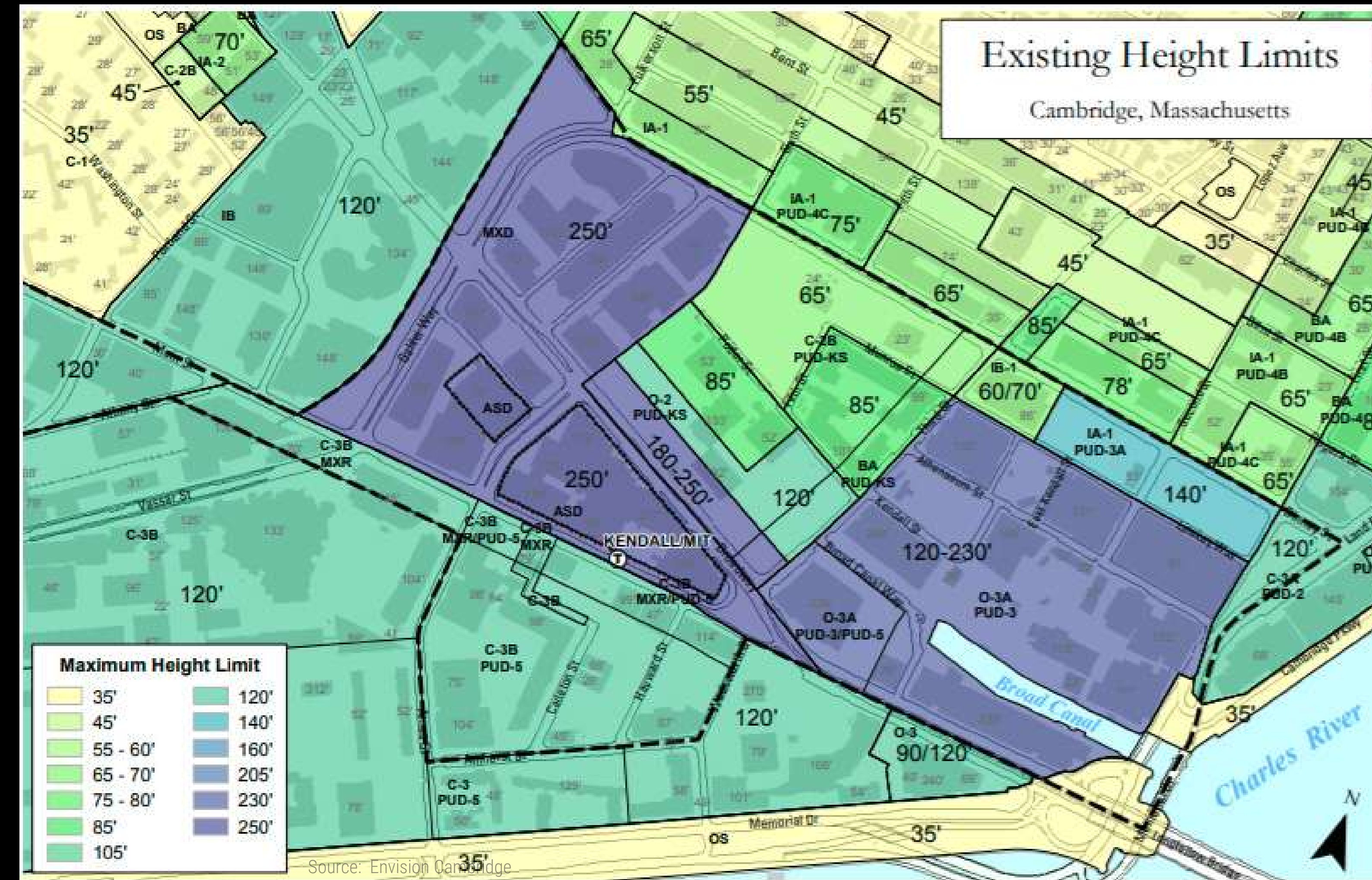
Estimated Housing Units from Office-to-Housing Conversions in Metro Areas or Submarkets with the Largest Declines in Office Occupancy Since 2020 Q2



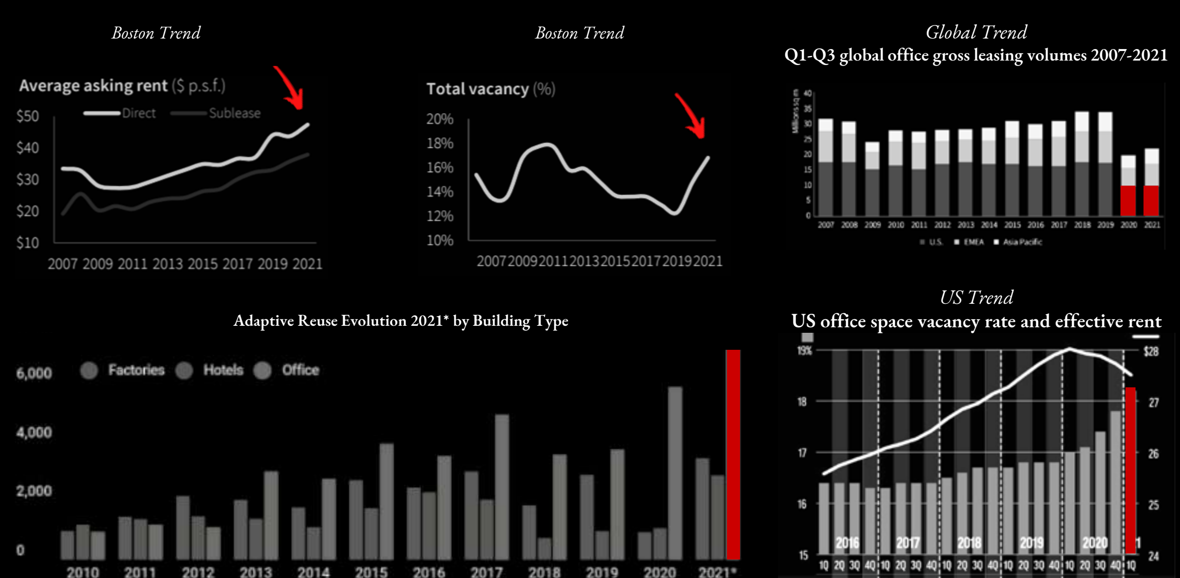
Sources: NAR analysis using CoStar® market data

Policy Challenge

Existing Height Limit of Kendall Square



The Future of Work is Hybrid.
Boston Office Vacancies are "High".
Market Momentum for Office-Apartment Conversion.



Sources: JLL Boston Office Insight - Q3 2021(Top, Bottom Right), RentCafe® Record Apartment Conversions Make 2021 Most Successful Year in Adaptive Reuse (Bottom Left)

Current

- Cambridge Ordinance permits building to go above 400' height if space above 250' are residential and mix-used zones within Kendall Square
- Cambridge requires developments to provide Green Space >=15% of land area, and excludes certain open space area from GFA calculation
- Congress proposed "Downtown Revitalization Act" in July 2021, crediting 20% of conversion cost from Office buildings* to Residential /Retail/other commercial use

* office building must exist at least 25 years before undergoing conversion

Potential

- Zoning allows higher density development for housing purpose
- Potential more aggressive tax incentive for residential transition
- Potential GFA Bonus strategy for economic loss in transition

User Interface and Widgets

Building information
- Building type
- Built year
- Building NSF (ft²)

01 Run Analysis Widget - Set Conversion Rate

BldgID: All Selected

ResPerc: 54

- [x] includeGreenSpace
- [x] applyToAllTargets
- [x] showCharts
- [x] showKendallStats
- [ ] showStatements
- [ ] applyNationally

02 Load Target Building Map (Types: Office / R&D)

03 Run Global Widget (Default Value Set to Cambridge Average)

Room information
- Room Size
- Room NSF (ft²)

Energy
- Site EUI

Rental price
- Apartment/Condo
- Office

Transition cost
- Residential $/sf
- Green space $/sf

Define size of each room type (ft2):

StudioSize	500
Bd1Size	600
Bd2Size	750
Bd3Size	1000
Greenspace...	256
Officespace...	110

Define room type as percent of NSF (ft2):

StudioNSF	20
Bd1NSF	42
Bd2NSF	38
Bd3NSF	0

Remaining alottment: 0

Define EUI per zone type (kBTU/ft2):

Residential	89
Office	180
Greenspace	-35

Define Rental Prices ($/SF):

Studio_Price	5.79
BD1_Price	5.04
BD2_Price	3.92
BD3_Price	4.06
Office_Price	6.53

Define Transition Cost ($/SF):

Residential	80
Greenspace	35

Analysis, Office to Residence

01 Office to Residence

02 Office to Residence + Greenspace

No conversion (Baseline)

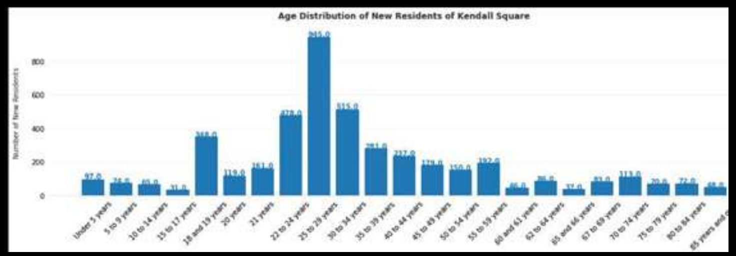
↓

Single office building conversion
All office buildings at Kendall conversion

↓

National scale conversion

Social +269 New Residents



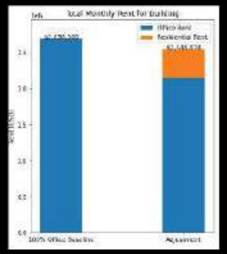
Education Stats

High School Age: 13

Primary School Age: 13

Pre-Primary School Age: 8

Financial -5.41% Rent



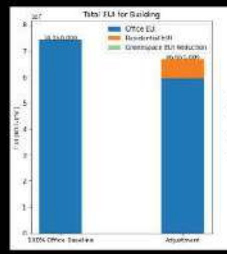
Transition Cost: $6,592,000

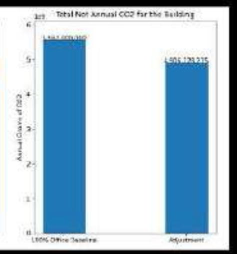
Office Monthly Rent: $2,152,288

Residential Monthly Rent: $ 392,587

Environmental +0.20% GHG Emission Reduction

- Building





Energy Use (kBTU): 1,565,722,260

GHG Emission(Grams): 117,429,169,500

- Transportation

Avg GHG emission per traveling work(round trips) (grams): 11761

Total GHG emission in Cambridge (round trips) (grams): 403,079,039,037

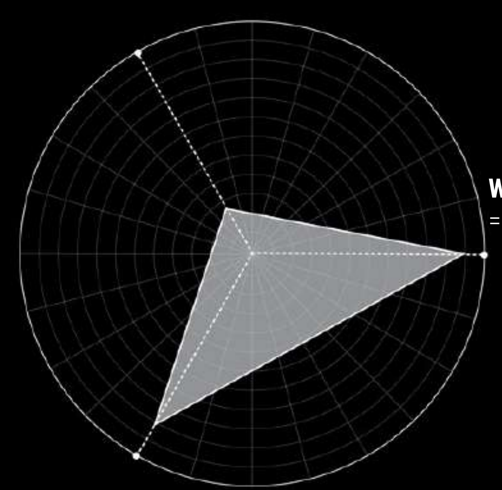
Percent reduced from current estimate: 0%

Residence Heatmap after Conversion Applied to All Office Buildings at Kendall

Analysis, Office to Residence + Greenspace

Performance analysis

Finance
= Σ Converted rent – Σ Existing rent



Wellness
=(Area of green space) / (number of new residents)

Environment
=(Σ Converted building GHG Emission + Σ Existing building GHG Emission) + Transportation GHG Emission reduction

Finance

Less economic value, less rent: **50%** Conversion — More economic value, more rent: **20%** Conversion

Environment

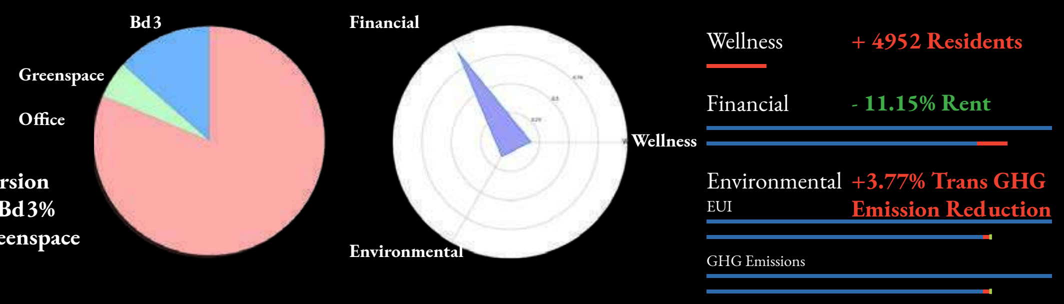
Less residents, less diverse, more privacy: **Studio** — More residents, more diverse, less privacy: **Bd3**

Wellness

Less GHG reduction, less energy savings, Less healthy: **96ft²** Greenspace — More GHG reduction, more energy savings, healthier: **539ft²** Greenspace

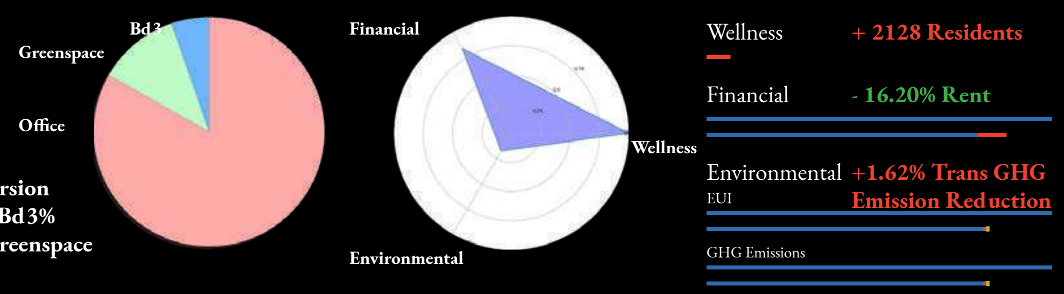
Applied to all office buildings at Kendall

1



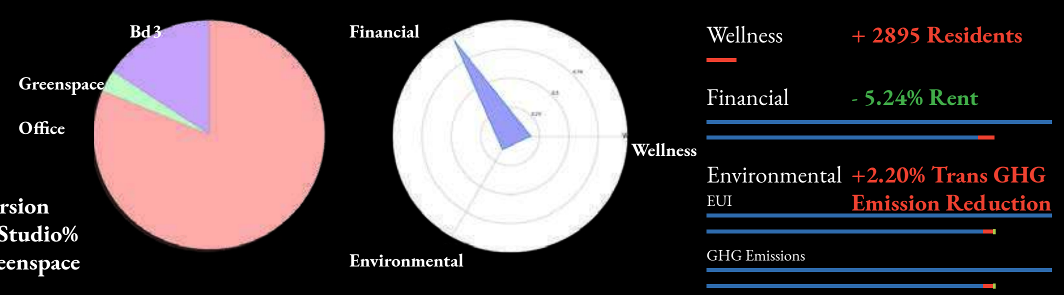
20% Conversion
Maximum Bd3%
96 sq ft Greenspace

2



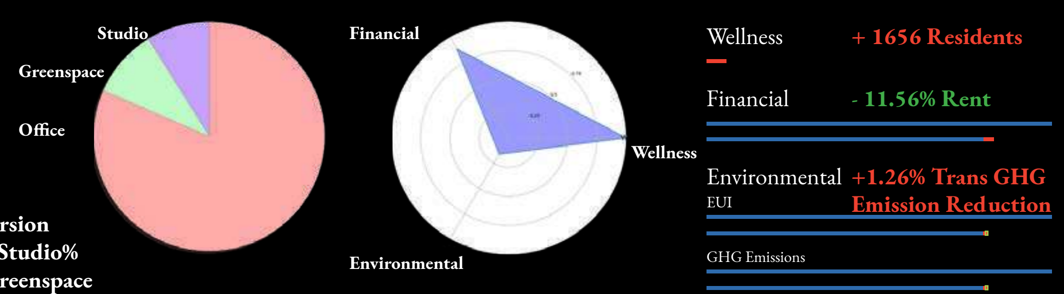
20% Conversion
Maximum Bd3%
539 sq ft Greenspace

3



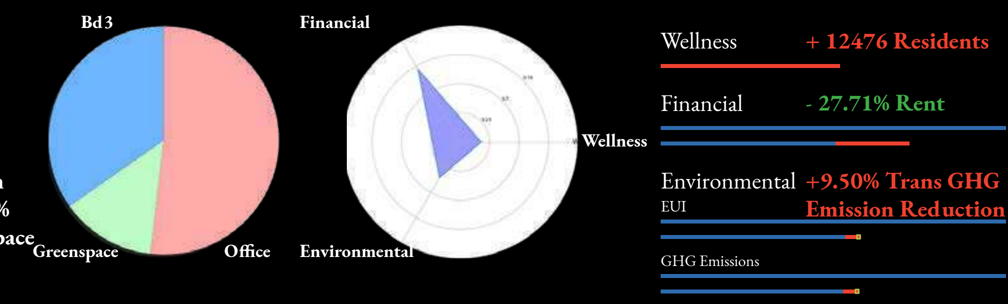
20% Conversion
Maximum Studio%
96 sq ft Greenspace

4



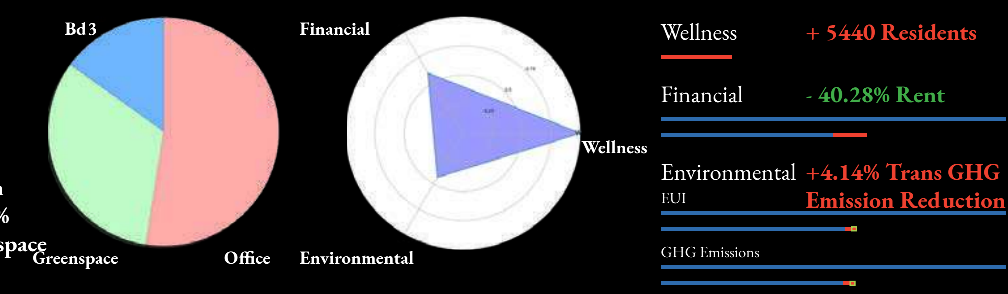
20% Conversion
Maximum Studio%
539 sq ft Greenspace

5



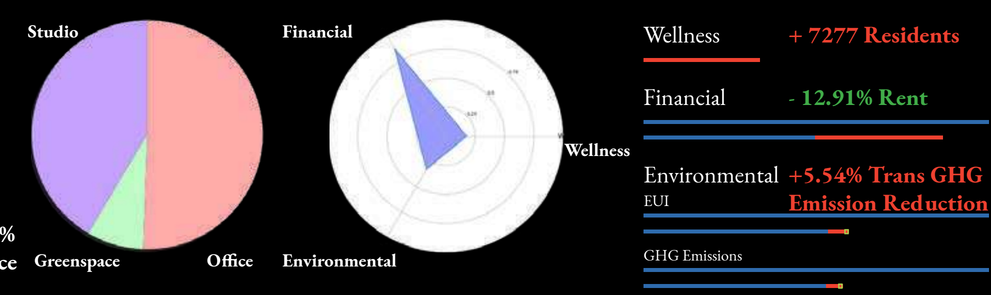
50% Conversion
Maximum Bd3%
96 sq ft Greenspace

6



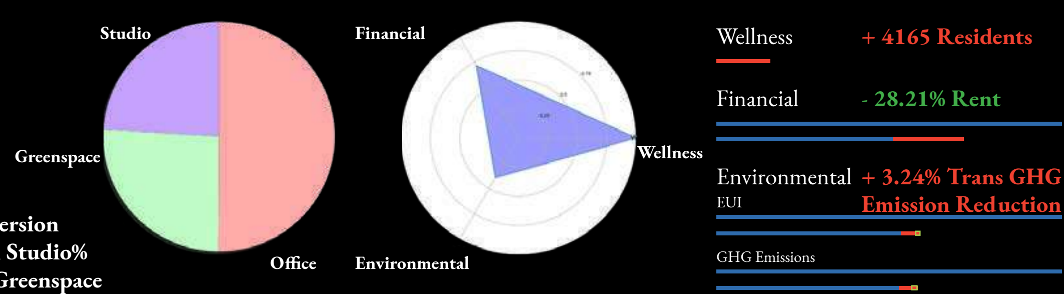
50% Conversion
Maximum Bd3%
539 sq ft Greenspace

7



50% Conversion
Maximum Studio%
96 sq ft Greenspace

8



50% Conversion
Maximum Studio%
539 sq ft Greenspace

Spatial Density of Landscape Environment Based on Remote Sensing Image Analysis, Sanyang Wetland, China

Spatial Density is a concept that measures the level that landscape elements (terrain, vegetation, architecture etc.) dominates the absolute space, which reflects the livability of the environment. The research is based on granular element patches extracted from Remote Sensing images. With the refined spatial density index and R analysis correlation with vegetation index, NDVI, we propose a workflow of rapid visualization of environmental spatial density. Datasets for various environments, as wetland, mountain, plain, would yield different models of this rapid visualization. This research takes Sanyang wetland environment as an example. The project explores:

What are the **REMOTE SENSING IMAGE POTENTIALS** in unfolding the invisibility of the environment?
How to define **PERFORMANCE INDEX** of a built environment?
What is a potential **TRAINING / CORRELATION METHOD** for a remote sensing image?

The landscape of Sanyang wetland features plain water network of rive and islands. The buildings are crowded and disorganized, with the height of 2-3 stories. The vegetation is dominated by cash crops. Orange 'ouguan' dominates, with a coverage of about 70%. Other cash crops include rape, cabbage, cabbage, etc., and some wasteland. There are often banyan, sequoia, camphor, weeping willow, cedar, sorrel, etc. around the building.

Collaborator
Qizheng Xie, Xi Cao, Shifeng Zheng
09/2017 - 11/2019

Contribution *40%, Group Leader*
Roadmap, RS image pre-processing, feature classification algorithms, and spatial density definition refinement

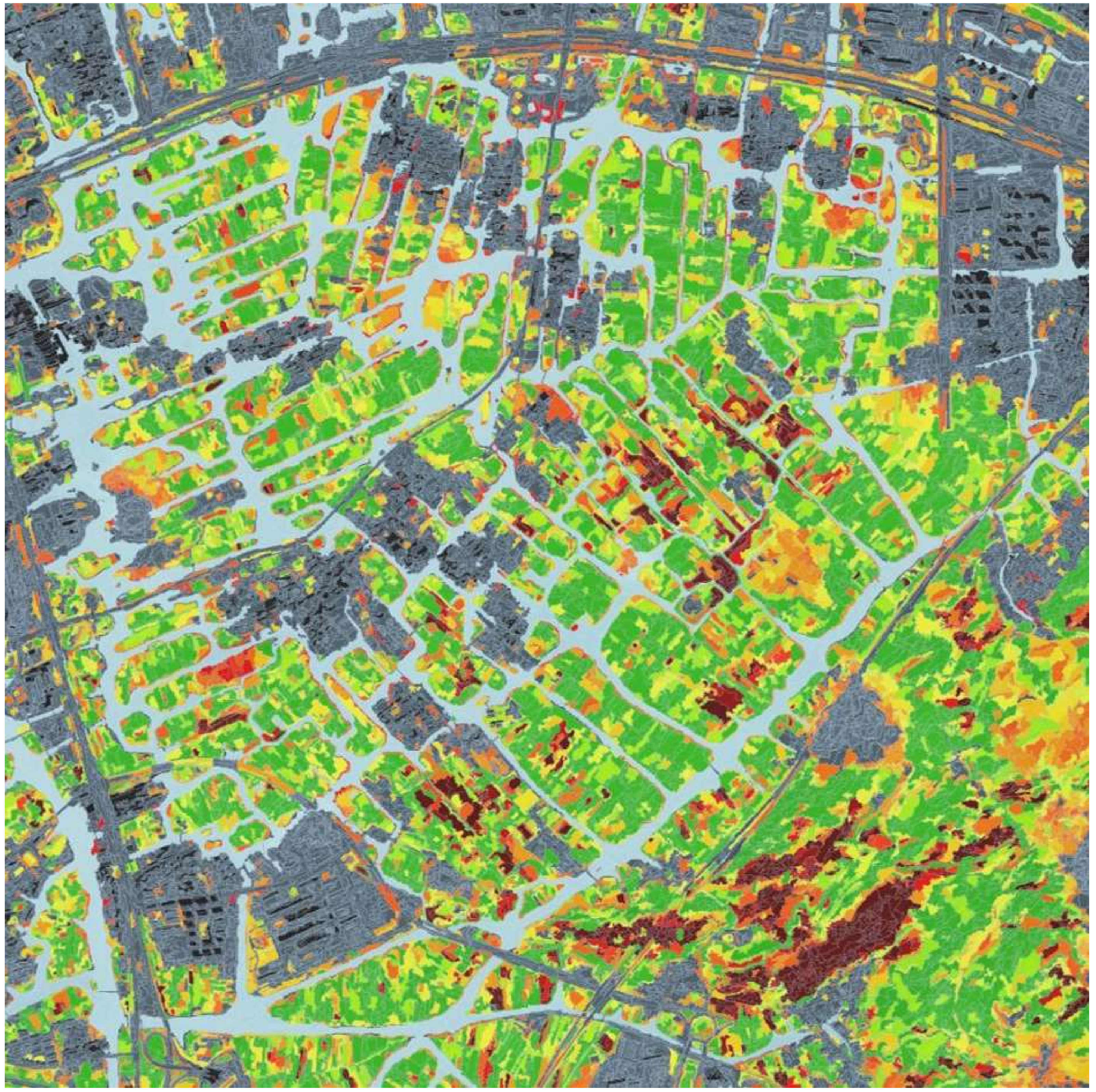
Instructor
Zhe Li, lizheseu@seu.edu.cn

Institution
Academic, Southeast University, China's Student Research Training Program (SRTP), National Funded

Tools
ENVI, eCoginition, Rhino, Grasshopper, SPSS

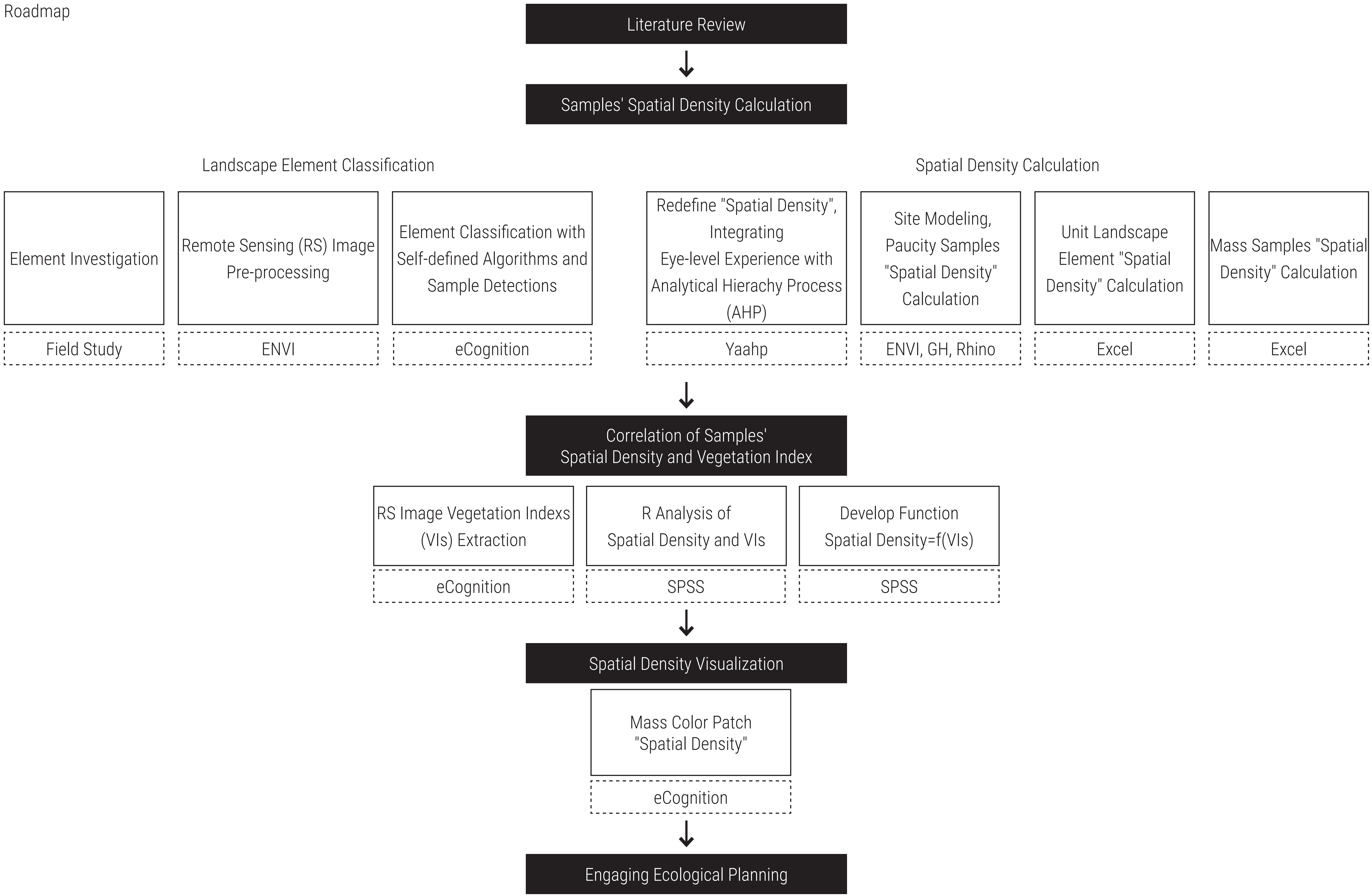
Publications
Patent: No.201910553177.7, 2021.4.25, China
- Zhe Li, Yukun He, Yuning Cheng, Kaiyu Zhao, Xiao Han, Feifei Chen, Shuang Song, Yuxin Yang, *Qizheng Xie, Xi Cao, Shifeng Zheng | "An Extraction Method of Architecture in the Mountain Environment from High Resolution RS image"*
14th Innovation and Entrepreneurship Achievement Exhibition, Southeast University

Spatial Density Visualization



0-0.1
0.1-0.2
0.2-0.3
0.3-0.4
0.4-0.5
0.5-0.6
0.6-0.7
0.7-0.8
0.8-0.9
0.9-1

Roadmap

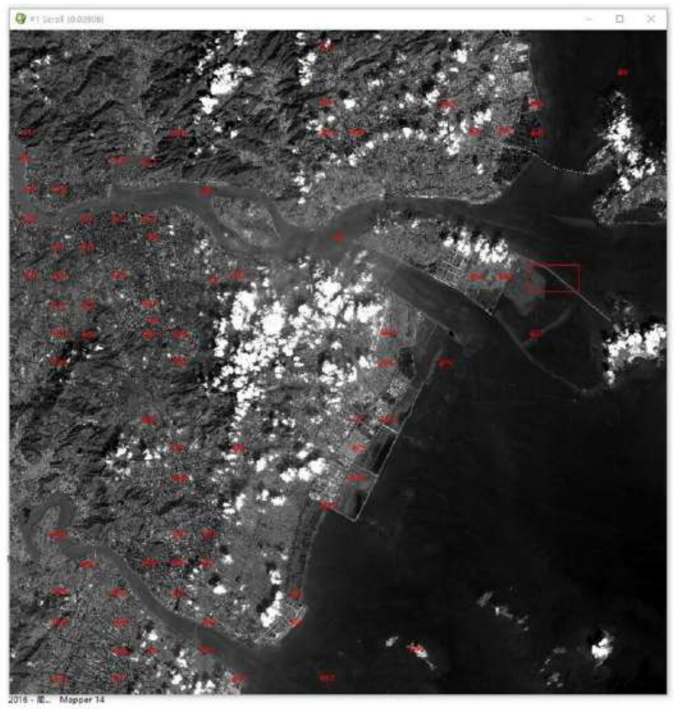


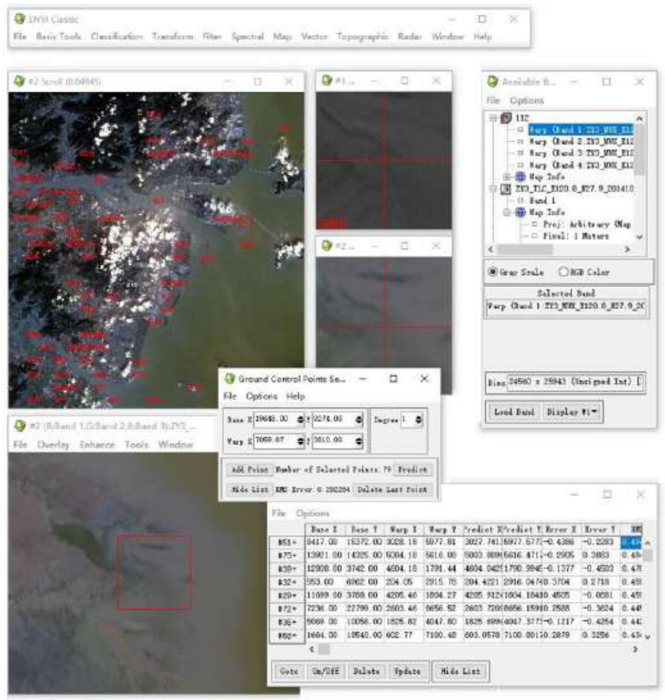
Literature Review
Samples' Spatial Density Calculation
Landscape Element Classification
Spatial Density Calculation
Element Investigation
Field Study
Remote Sensing (RS) Image Pre-processing
ENVI
Element Classification with Self-defined Algorithms and Sample Detections
eCognition
Redefine "Spatial Density", Integrating Eye-level Experience with Analytical Hierachy Process (AHP)
Yaahp
Site Modeling, Paucity Samples "Spatial Density" Calculation
ENVI, GH, Rhino
Unit Landscape Element "Spatial Density" Calculation
Excel
Mass Samples "Spatial Density" Calculation
Excel
Correlation of Samples' Spatial Density and Vegetation Index
RS Image Vegetation Indexs (VIs) Extraction
eCognition
R Analysis of Spatial Density and VIs
SPSS
Develop Function Spatial Density=f(VIs)
SPSS
Spatial Density Visualization
Mass Color Patch "Spatial Density"
eCognition
Engaging Ecological Planning

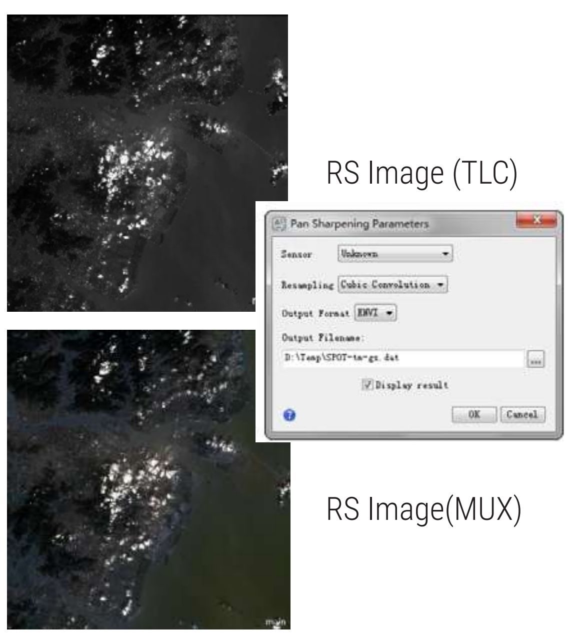
RS Image Pre-processing

RS Image Augmentation

Orthorectification
Registration
Sharpening
Band Remix

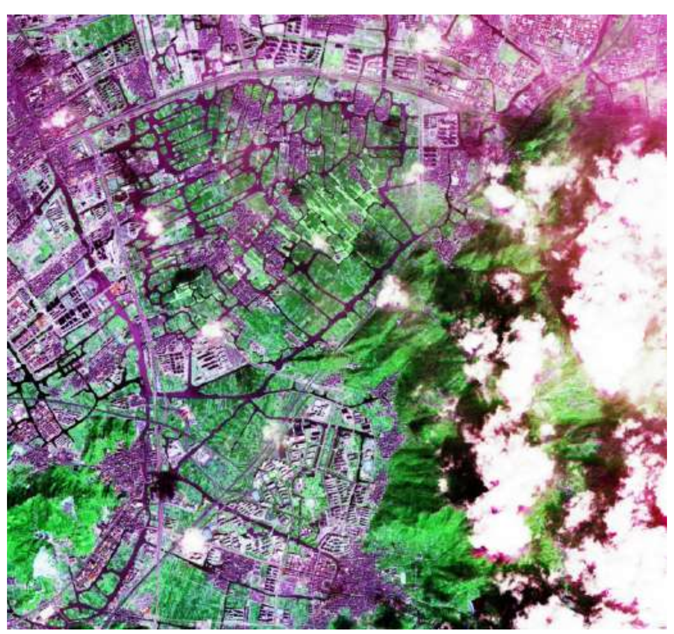






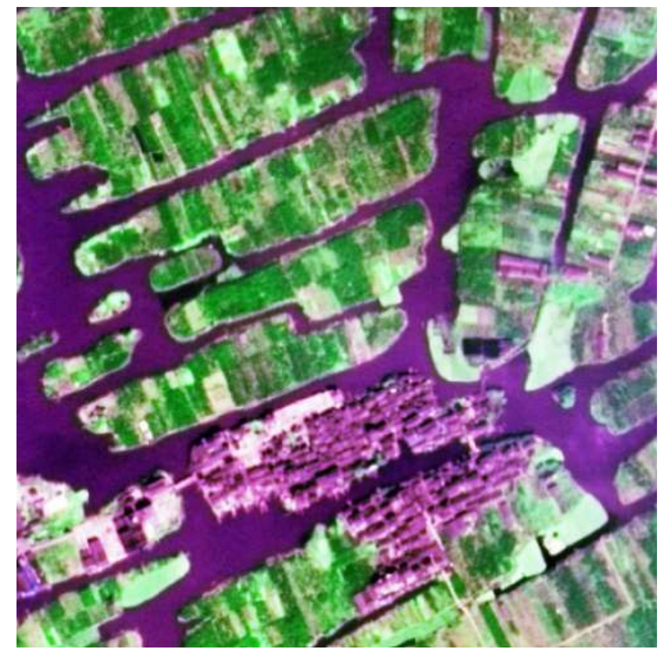
RS Image (TLC)

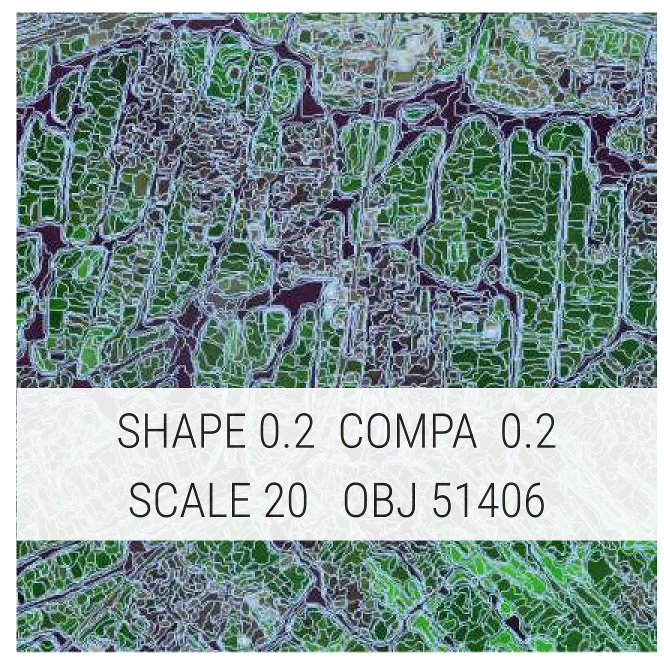
RS Image(MUX)



RS Image Segmentation

Multi-scale segmentation





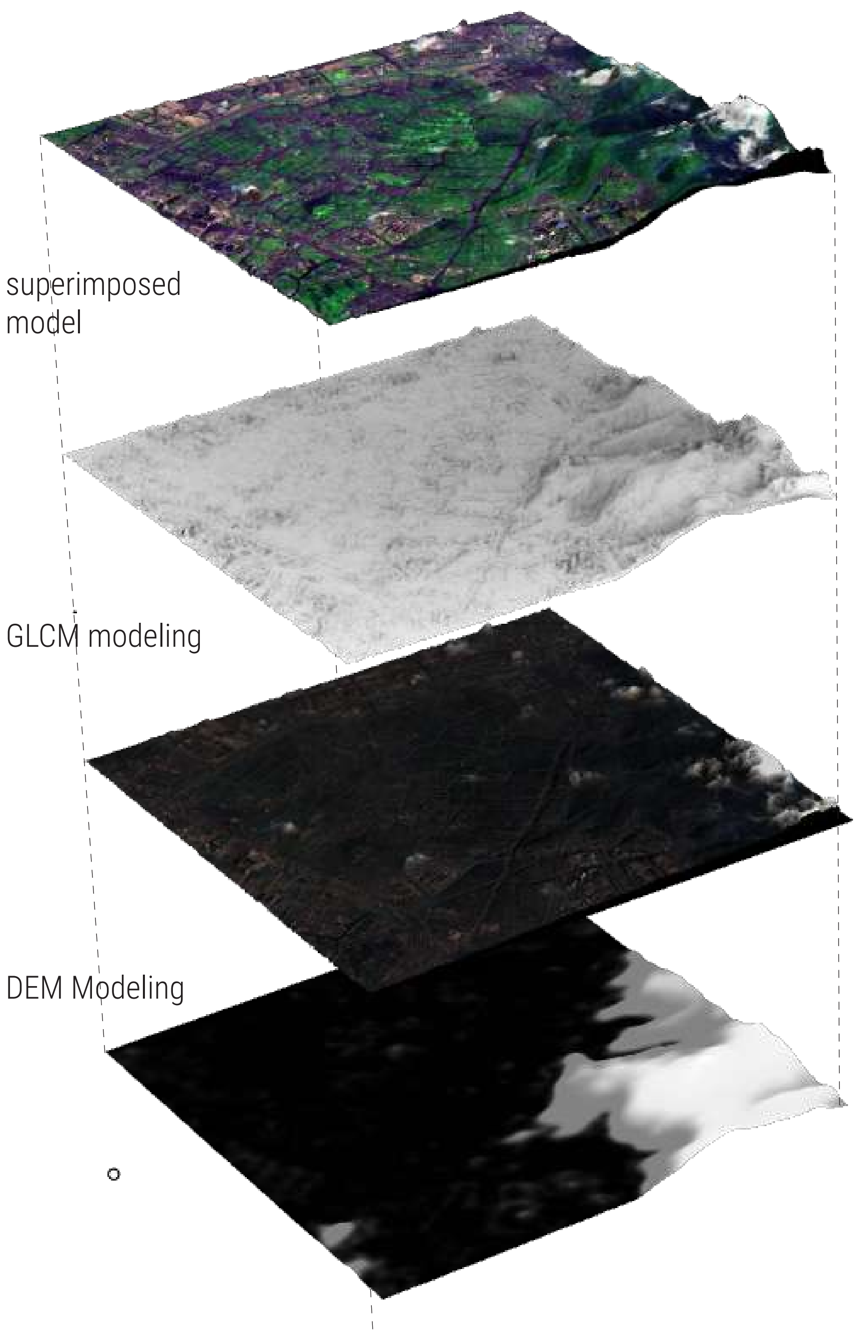
Territorial Modeling

textured

superimposed model

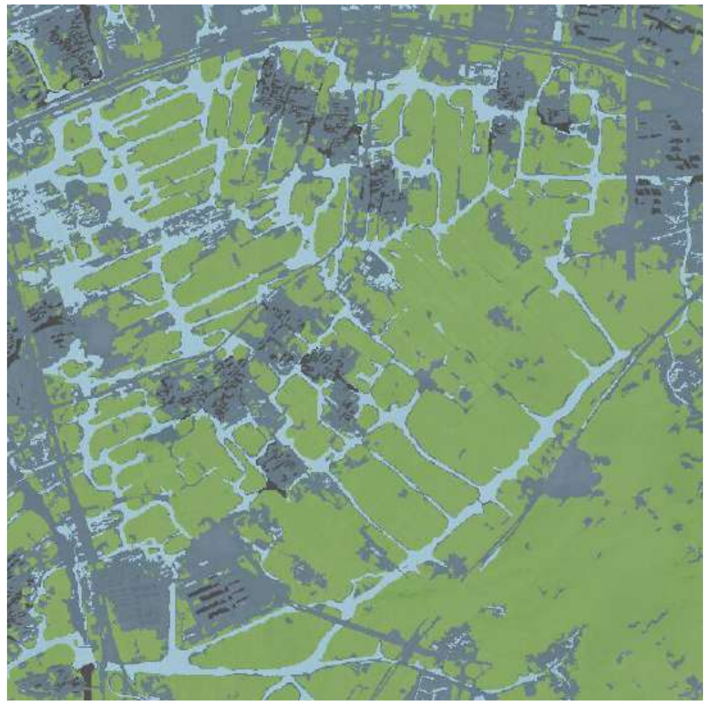
GLCM modeling

DEM Modeling

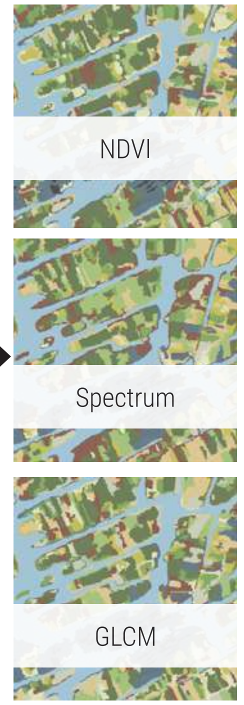


Landscape Element Classification

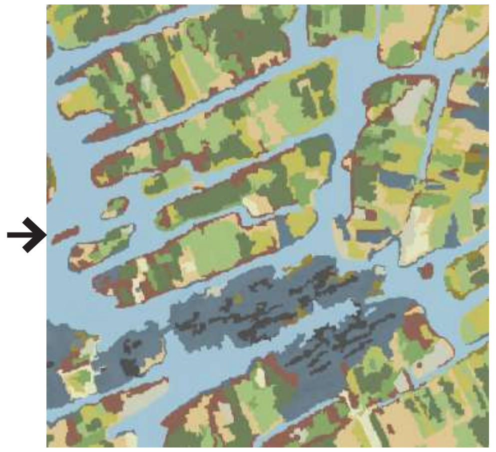
Process



Preliminary
Classification

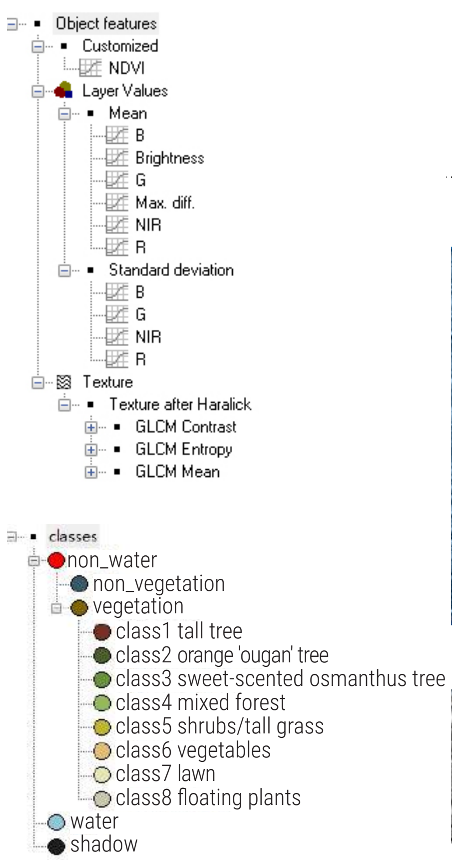


Refined Classification
with by varied principles



Overlapped Result

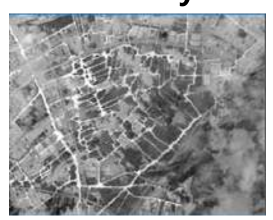
Classification Principle



$$K_{NDVI} = \frac{(K_{Green} - K_{Nir})}{(K_{Green} + K_{Nir})}$$

$$K_{NDWI} = \frac{(K_{Nir} - K_{Red})}{(K_{Nir} + K_{Red})}$$

Water Body



NDWI

Architecture

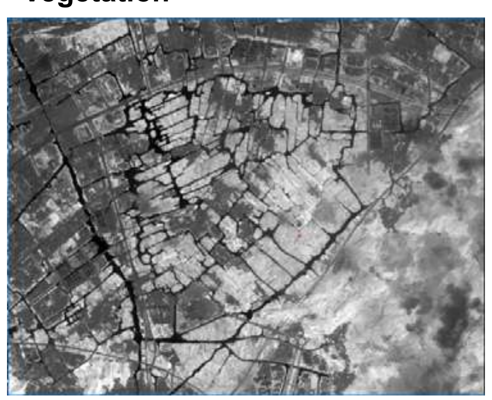
Rectangular fit

Length/width

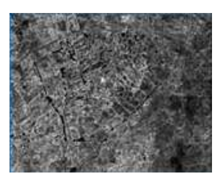
Shadow

Manual Adjust

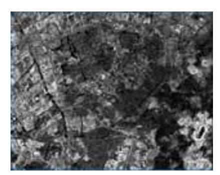
Vegetation



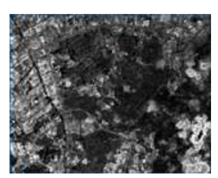
NDVI



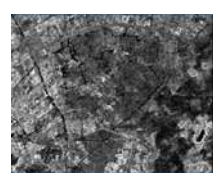
Standard deviation B



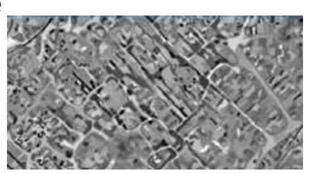
Standard deviation G



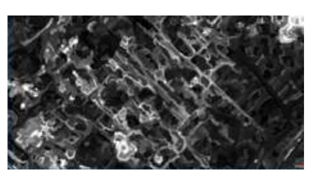
Standard deviation NIR



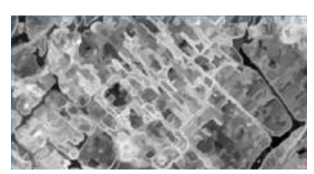
Standard deviation R



GLCM Mean



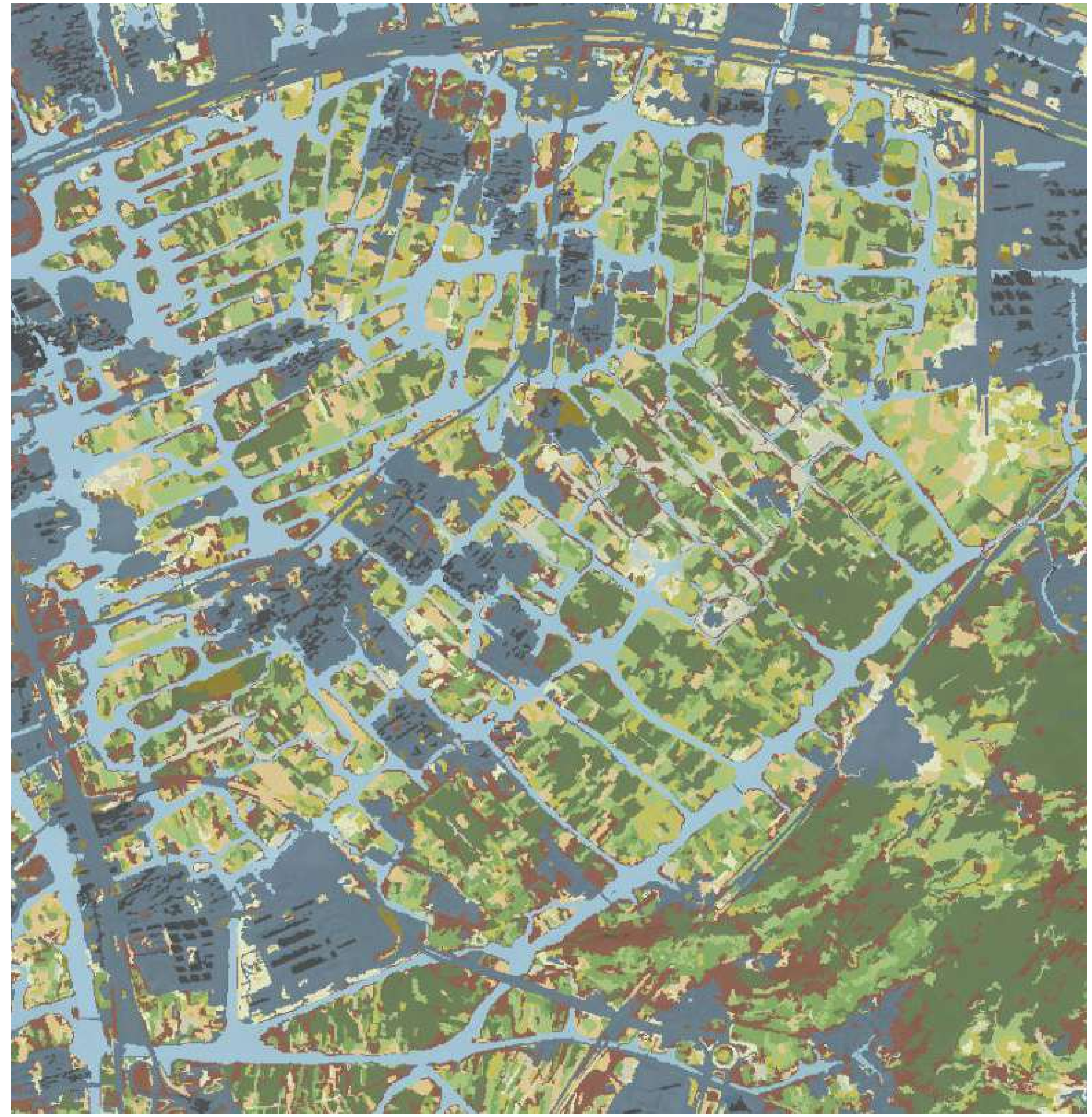
GLCM Contrast



GLCM Entro

*eCognition provides an "assign class" classification, it allows user's knowledge-based algorithms definition and object sample training.

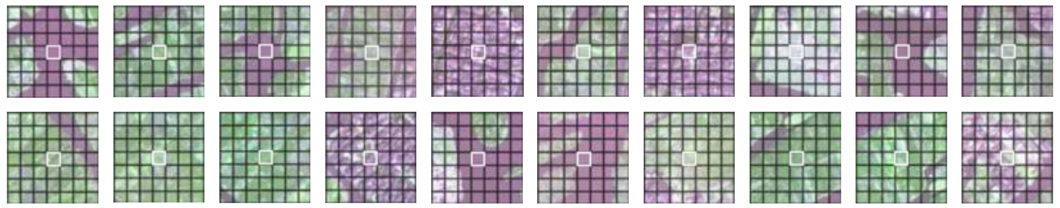
Element Classification



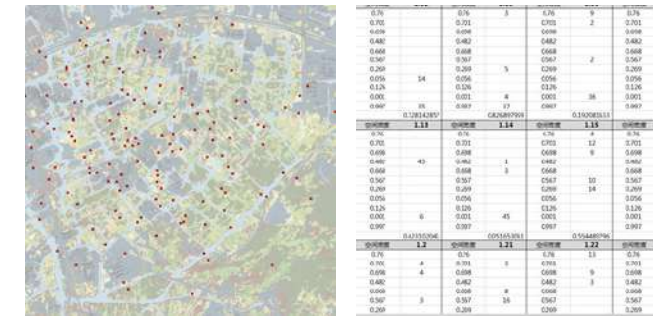
tall tree
others
mandarin orange tree
lawn
sweet-scented osmanthus tree
floating plants
mixed forest
water
shrubs/tall grass
constructed field
vegetables
shadows

"Spatial Density" Calculation

x15
Segmentation Resolution: 15X15 px



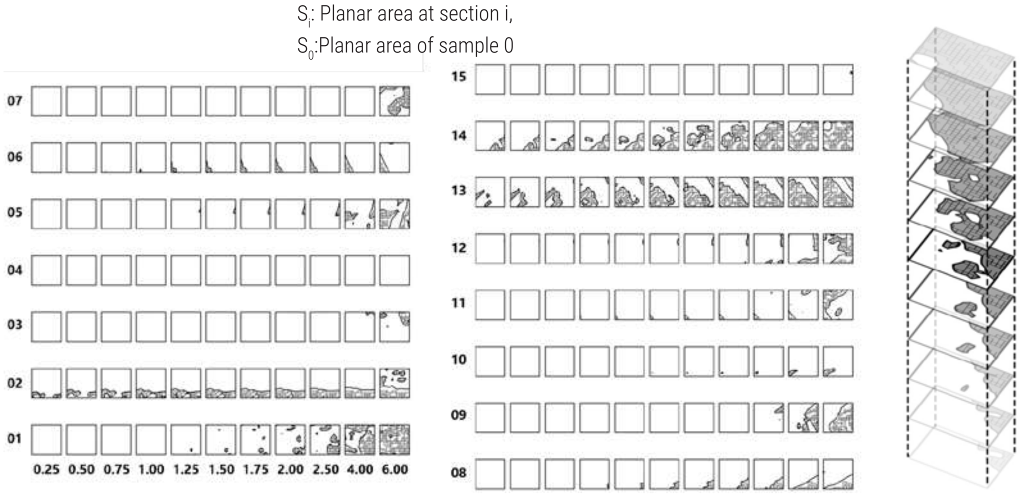
x150



"Spatial Density" as weighed section density overlay integrating eye-level experience

$$\rho_0 = \frac{\Sigma(k_i * S_i)}{\Sigma k_i * S_0}$$

ρ_0: Spatial density of the sample 0,
k_i: Vertical influence factor at section i,
*calculation integrating eye-level experience with Analytical Hierachy Process(AHP)
S_i: Planar area at section i,
S_0:Planar area of sample 0

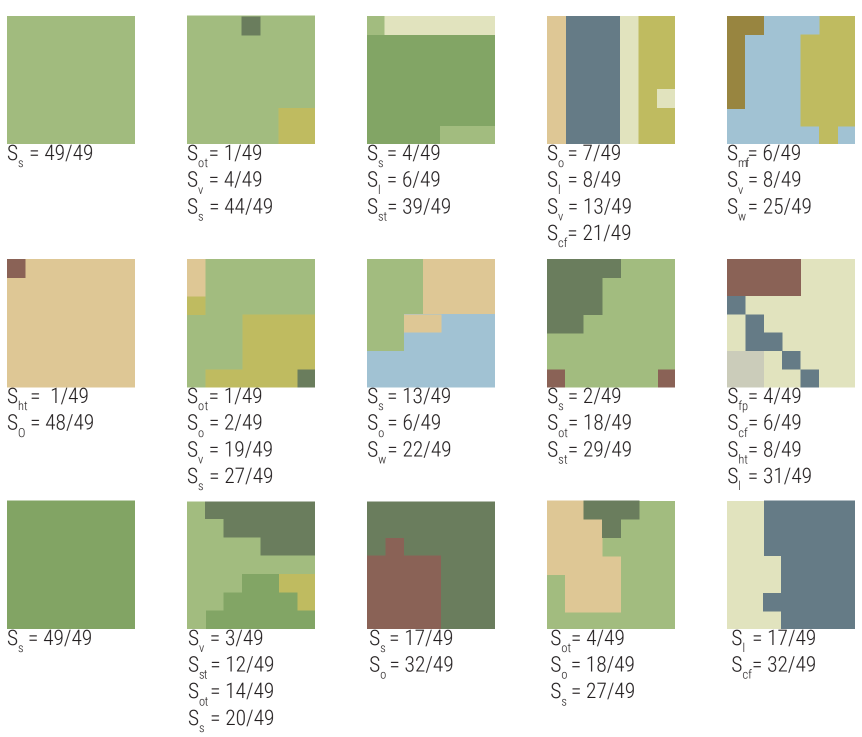


Planar area ratio of section i and sample		Vertical Influence Factor
0.085	x	0.2
0.156	x	0.3
0.265	x	0.5
0.394	x	0.7
0.508	x	0.8
0.642	x	1.0
0.728	x	0.7
0.779	x	0.5
0.821	x	0.3
0.864	x	0.2
0.891	x	0.1

"Spatial Density" as sum of unit landscape elements' spatial density

$$\rho_0 = \frac{\Sigma(\rho_i \cdot S_i)}{S_0}$$

ρ_0: Spatial density of the sample 0,
ρ_i: Spatial density of landscape element i
S_i: Planar area of landscape element i
S_0:Planar area of sample



$49/49\ \rho_s = 0.478$
$1/49\ \rho_{ot} + 4/49\ \rho_v + 44/49\ \rho_s = 0.458$
$4/49\ \rho_s + 6/49\ \rho_l + 39/49\ \rho_{st} = 0.608$
$7/49\ \rho_o + 8/49\ \rho_l + 13/49\ \rho_v + 21/49\ \rho_{cf} = 0.579$
$6/49\ \rho_{mf} + 18/49\ \rho_v + 25/49\ \rho_w = 0.176$
$1/49\ \rho_{ht} + 48/49\ \rho_o = 0.576$
$1/49\ \rho_{ot} + 2/49\ \rho_o + 19/49\ \rho_v + 27/49\ \rho_s = 0.412$
$13/49\ \rho_s + 14/49\ \rho_o + 22/49\ \rho_w = 0.283$
$2/49\ \rho_{ht} + 18/49\ \rho_{ot} + 29/49\ \rho_{st} = 0.765$
$4/49\ \rho_{fp} + 6/49\ \rho_{cf} + 8/49\ \rho_{ht} + 31/49\ \rho_l = 0.295$
$49/49\ \rho_s = 0.486$
$3/49\ \rho_v + 12/49\ \rho_{st} + 14/49\ \rho_{ot} + 20/49\ \rho_s = 0.587$
$17/49\ \rho_{ht} + 32/49\ \rho_{ot} = 0.715$
$4/49\ \rho_{ot} + 18/49\ \rho_o + 27/49\ \rho_s = 0.527$
$17/49\ \rho_l + 32/49\ \rho_{cf} = 0.647$

Correlation for Mass Calculation

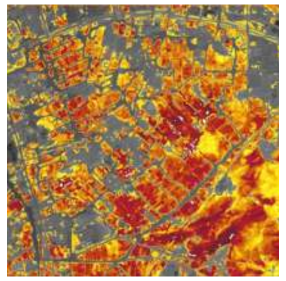
$\rho_{ht} = 0.760$
$\rho_{ot} = 0.701$
$\rho_{st} = 0.698$
$\rho_s = 0.482$
$\rho_{mf} = 0.668$
$\rho_o = 0.567$
$\rho_v = 0.269$
$\rho_{fp} = 0.126$
$\rho_{cf} = 0.997$

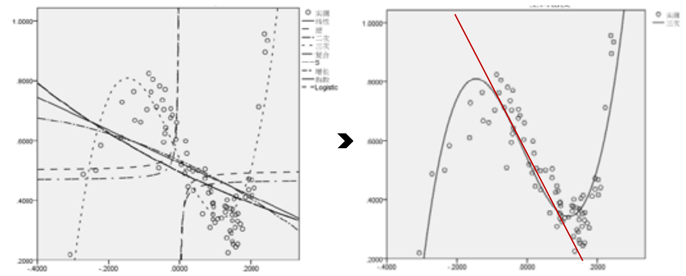
ht=huge tree
ot=mandarin orange tree
st=sweet-scented osmanthus tree
s =shrubs/tall grass
mf=mixed forest
v =vegetables
o =others
l =lawn
fp=floating plants
w =water
cf =constructed field
ss=shadows

Correlation of Vegetation Index and Spatial Density

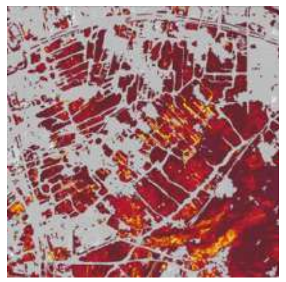
A Vegetation Index (VI) is a spectral transformation of two or more bands designed to enhance the contribution of vegetation properties and allow reliable spatial and temporal inter-comparisons of terrestrial photosynthetic activity and canopy structural variations. (Wikipedia) It is an easy-to-obtain index for RS images. The correlation aims to decode the relation between spatial density and spectral information from RS image. Therefore, the spatial density visualization could be rapidly obtained from RS images.

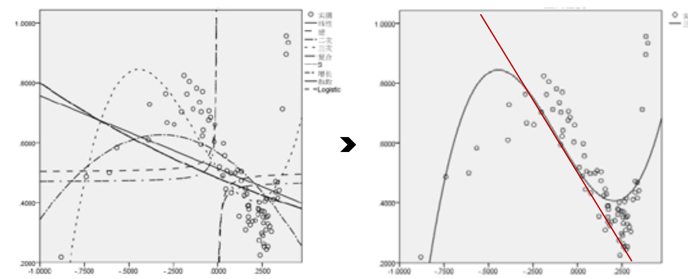
$NDVI = \frac{NIR-R}{NIR+R}$



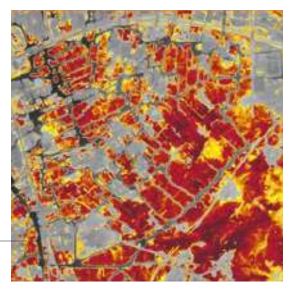


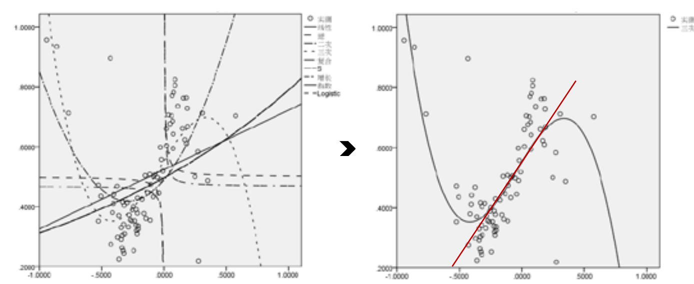
$MSAVI = \frac{2NIR+1-\sqrt{(2NIR+1)^2 - 8(NIR-R)}}{2}$



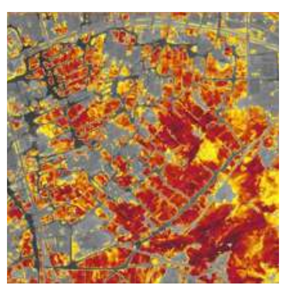


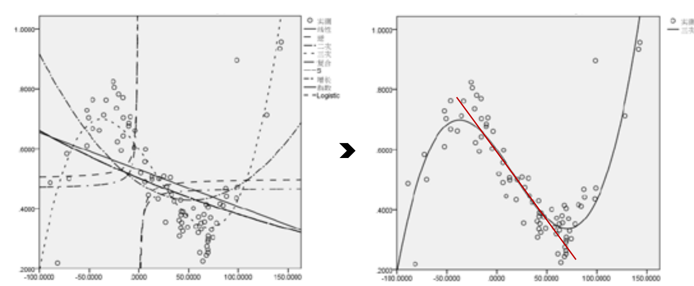
$EVI = 2.5 \frac{NIR-R}{NIR+6R-7.5B+1}$



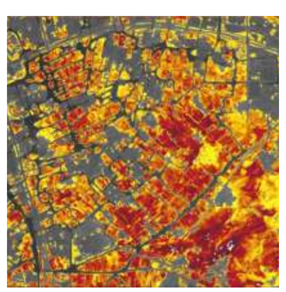


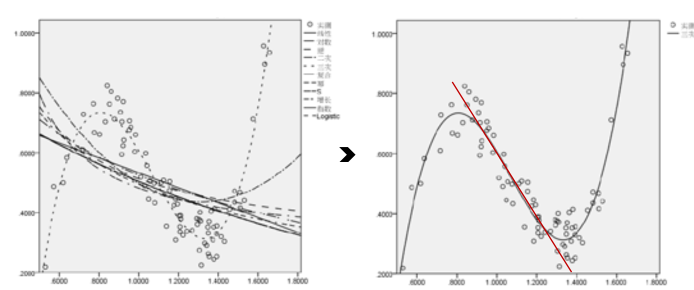
$DVI = NIR-R$





$RVI = \frac{NIR}{R}$

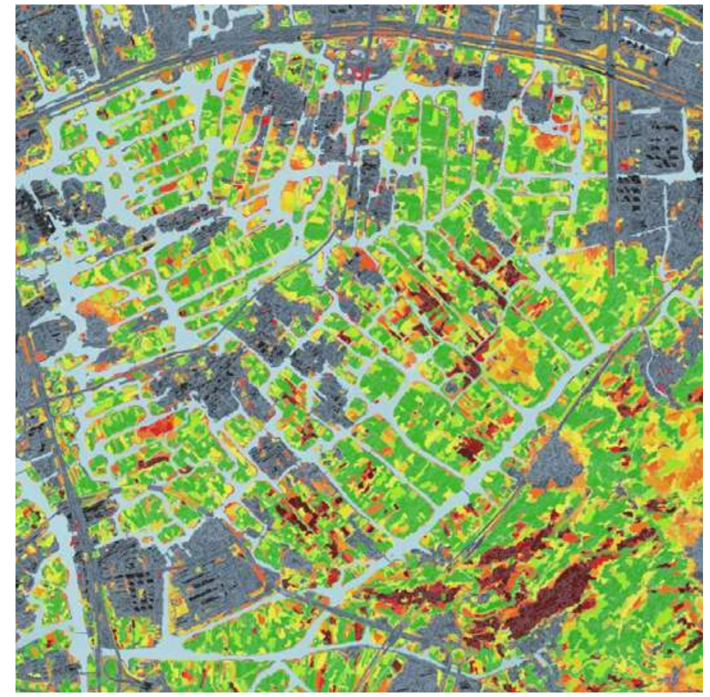




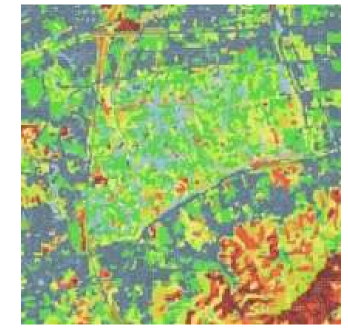
Vegetation Index

Correlation

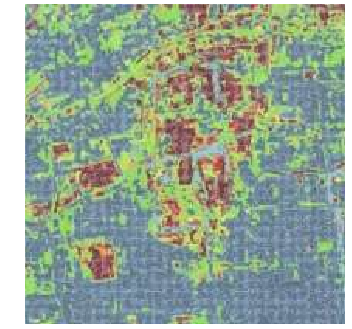
Spatial Density Visualization and Research Extension in Mountain Environment



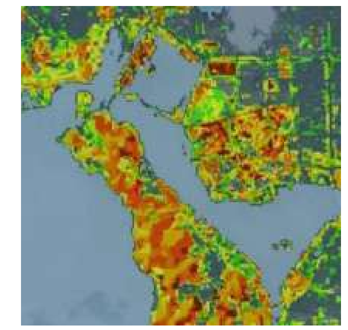
Sanyang Wetland, Zhejiang, China



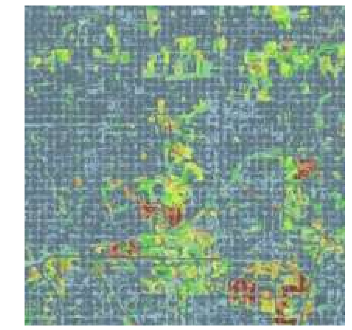
Xixi Wetland, Zhejiang, China



Slender West Lake, Jiangsu, China

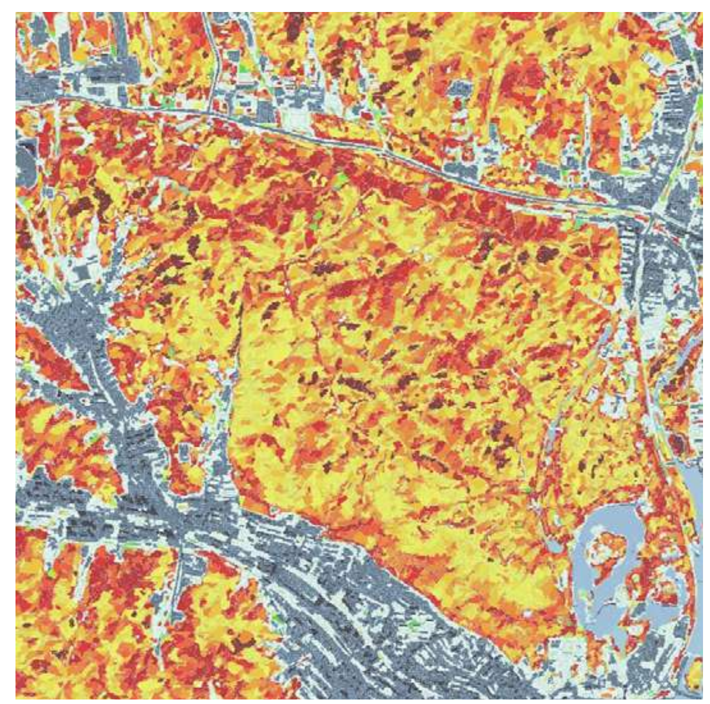


Yuantou Island, Jiangsu, China

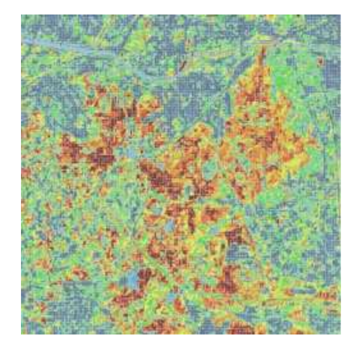


Olympic Park, Beijing, China

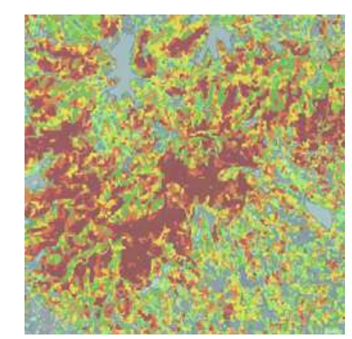
Spatial Density in PlainTerrain



Chengde Summer Resort, Hebei, China



Mt Niushou&Jiangjun, Jiangsu, China



Mt Heng, Jiangsu, China

Spatial Density in MountainTerrain

Adaptive Rocking Lattice Stool

What makes a structure ADAPTIVE?
Supports for Dynamic Postures
Stiff, Ergonomics

What makes a dynamic base QUALIFIED?
Rocking Foundation Morphology
Deformed, Playful

What makes a seating INTERFACE-FRIENDLY?
Lattice Seating Surface
Lightweight, Porous, Fuzzy

Collaborator
Lianliu GUO, Qing FENG,
09/2021 - 12/2021

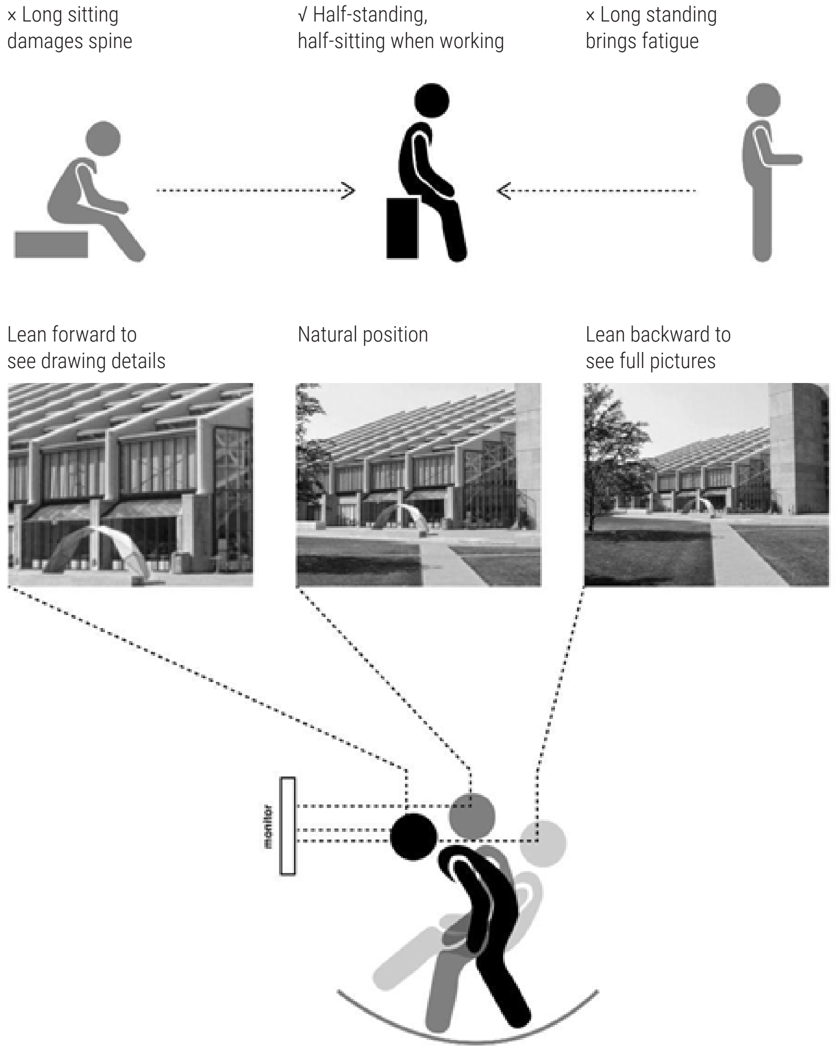
Instructor
Sawako Kaijima,
skaijima@gsd.harvard.edu

Contribution
Computation and Design
15% Lattice seating surface
40% Support and foundation
Fabrication:
50% 3D Print Lattice Detail
50% 1:4, 1:10 Mockup

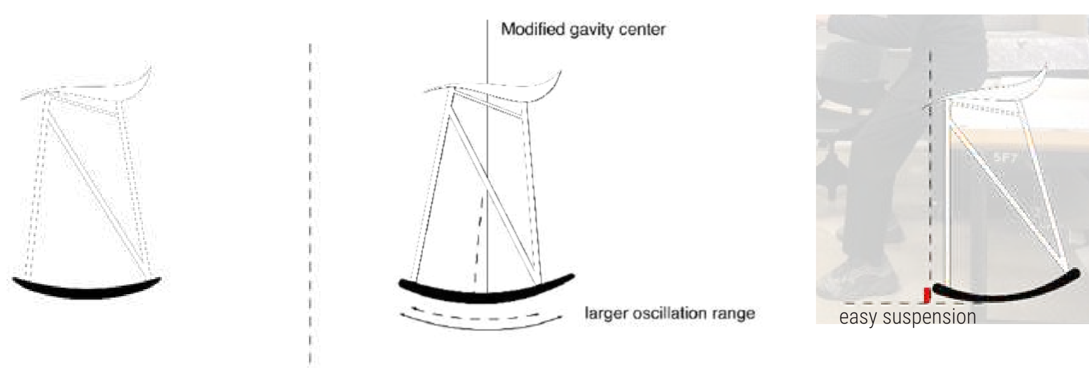
Institution
Academic, Harvard GSD,
SCI 6359 Interface Design:
Integrating Material Perceptions

Tools
Millipede, Grasshopper, C#

Ergonomics



Qualified Rocking

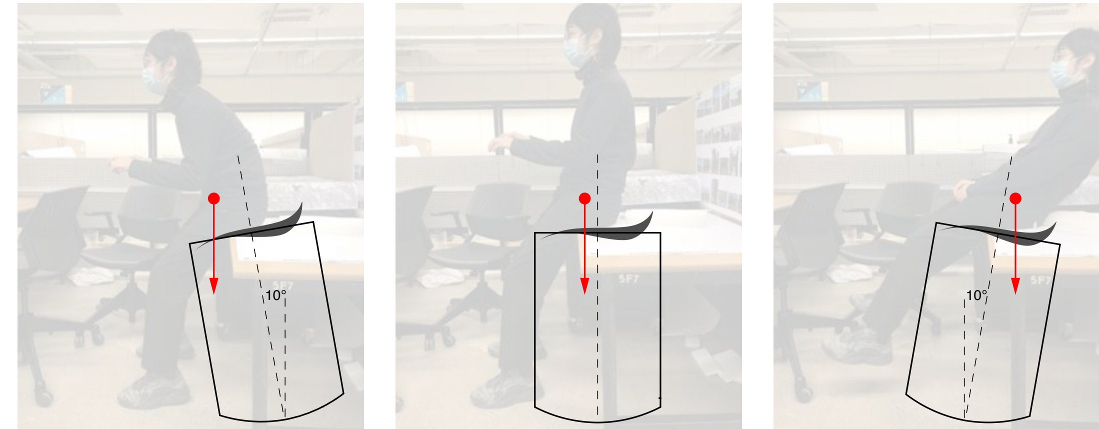


Baseline: Thin ends, Thick Body
Symmetrical Foundation

Variance 1 : Thin ends, Thick Body
Asymmetrical Extended Foundation

Variance 2 : **Thick Ends, Thin Body**
Symmetrical Foundation

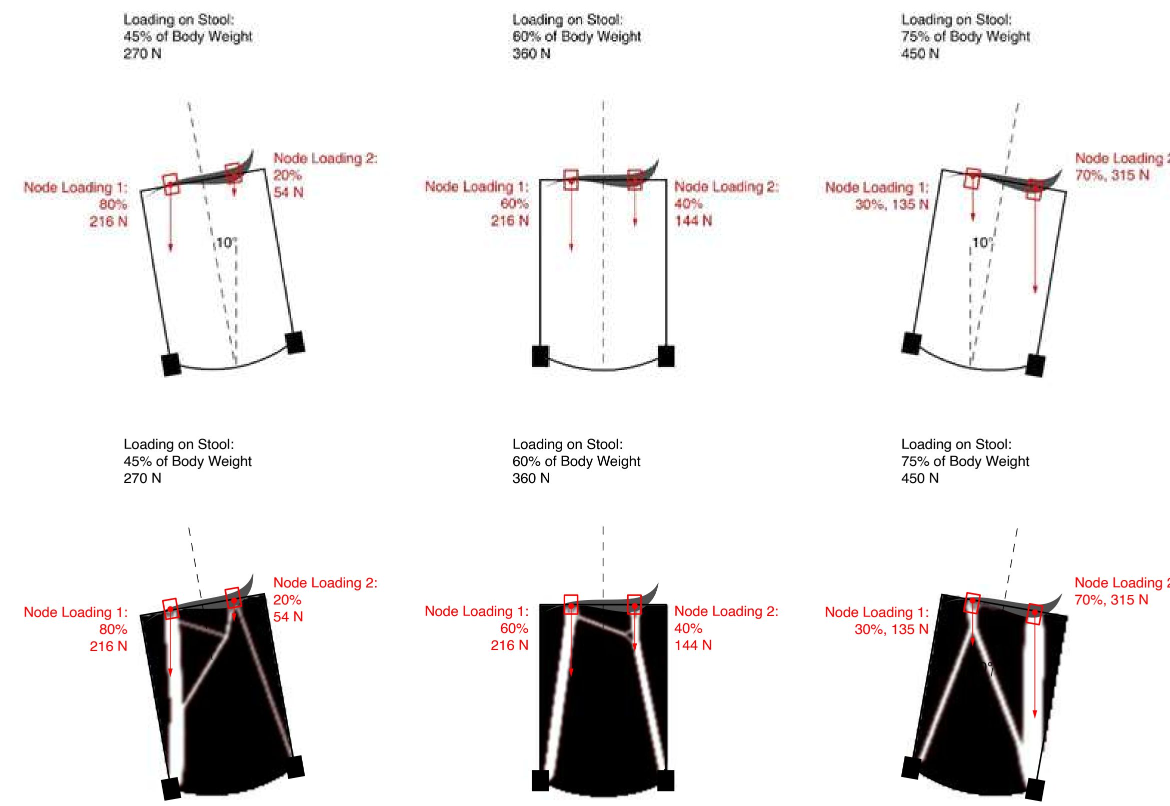
Dynamic Loading Support

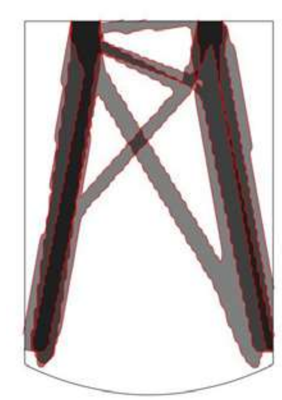


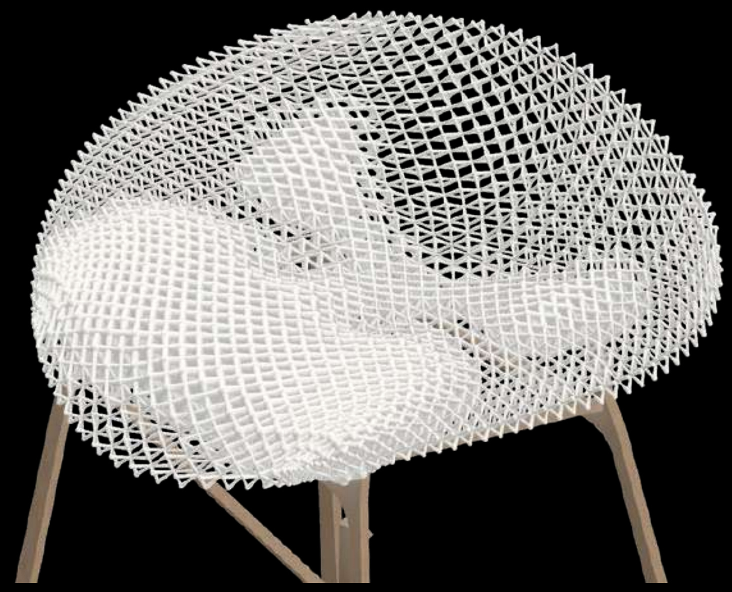
Loading on Stool:
45% of Body Weight
270 N

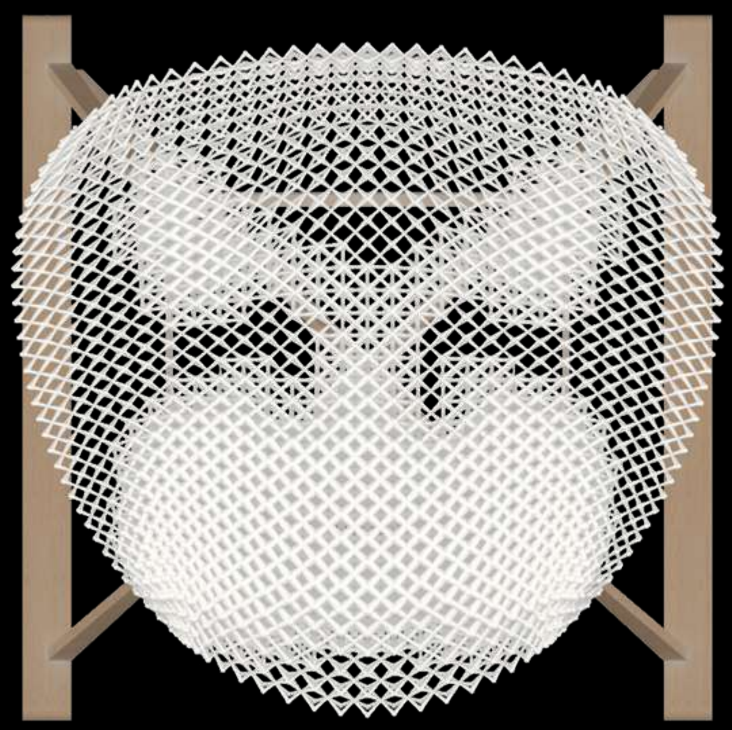
Loading on Stool:
60% of Body Weight
360 N

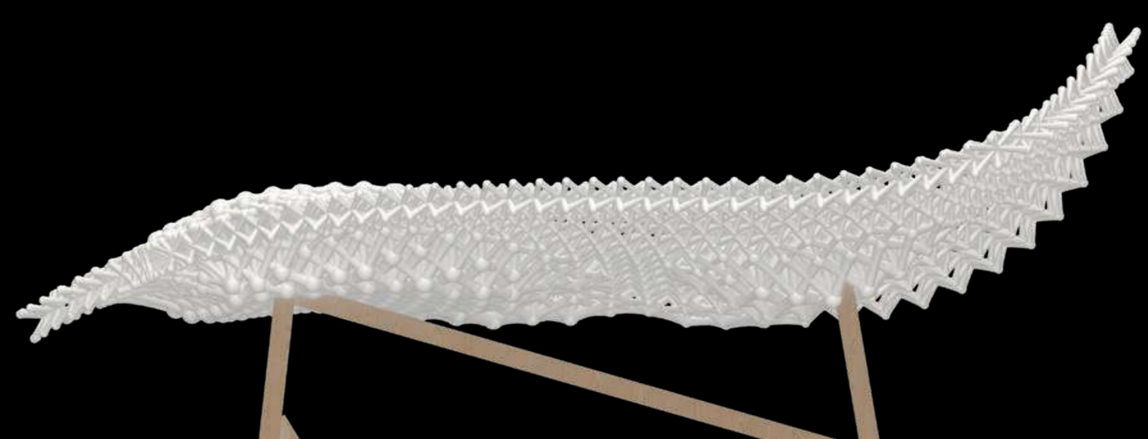
Loading on Stool:
75% of Body Weight
450 N



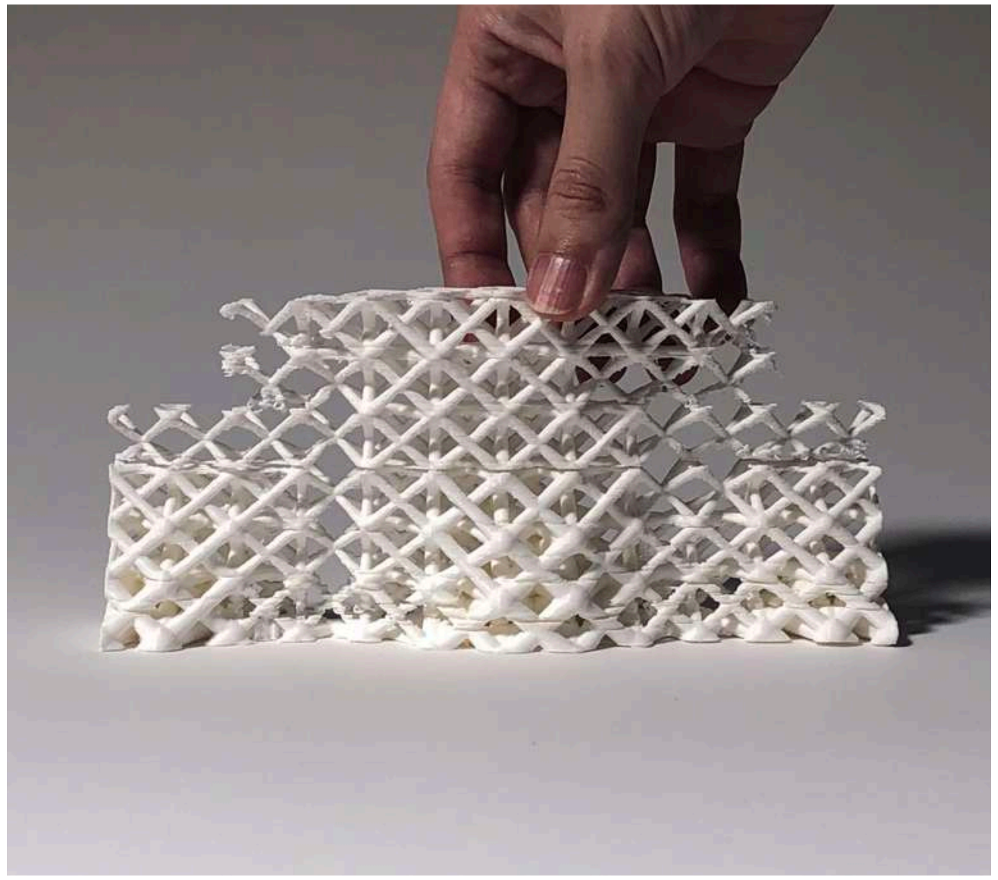




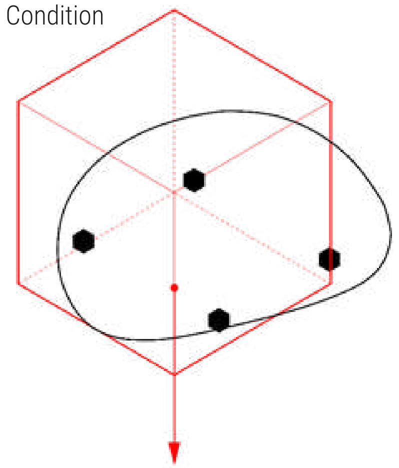




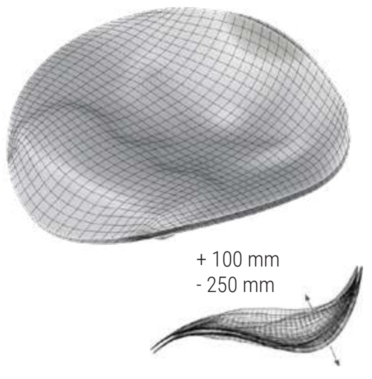
Lattice Seating Surface



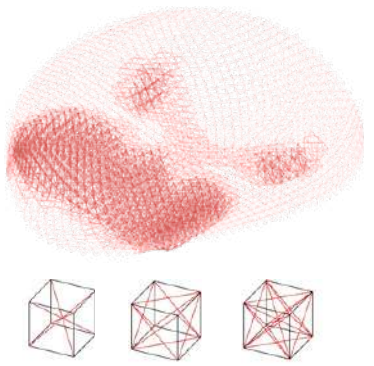
Load Condition



Thickness Offset

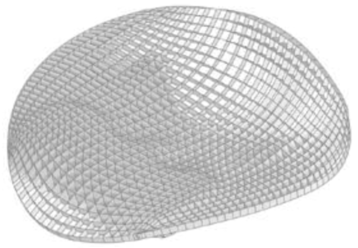


Lattice Curve

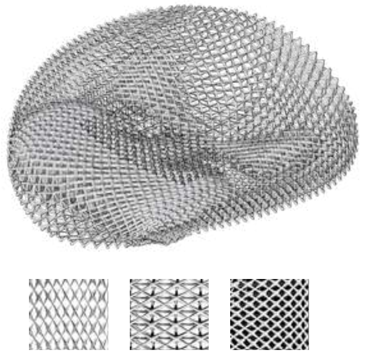


Shell Thickness Optimization

Grid to Cell



Lattice



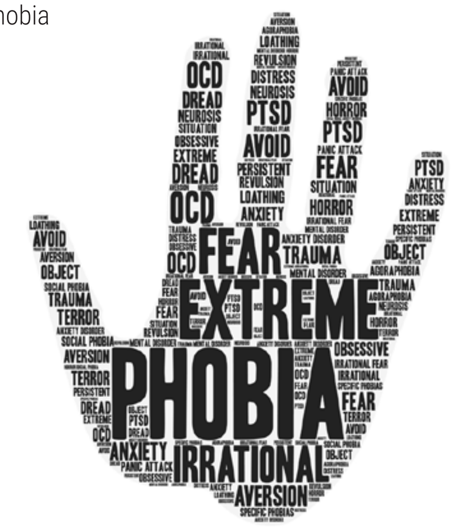
Air-Pillow Attire for Haphephobia

Collaborator *Harshika Bisht,* 03/2022-06/2022
Instructor *Allen Sayegh, asayegh@gsd.harvard.edu; Humbi Song, hsong1@gsd.harvard.edu*
Contribution *50%, Electronics, Prototyping*
Institution *Academic, Harvard GSD, VIS 2314 Responsive Environments: Poetics of Space*

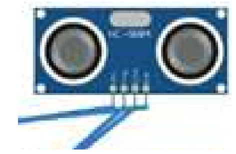
Haphephobia is an intense, irrational fear of being touched. People with haphephobia feel extreme distress over the thought of being touched. This anxiety can lead to physical symptoms like nausea, vomiting, or panic attacks.

So we propose a physical attire with a collapsible mechanism made of inflatable packing filler material, aka air pillows. Using self-assembled parts and air pumps, we control the collapsing and inflating properties based on a person's biological and physiological changes in reaction to a more crowded space.

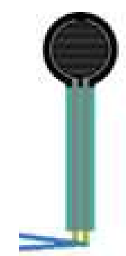
Haphephobia



Passive Control
- Ultrasonic sensor (distance)

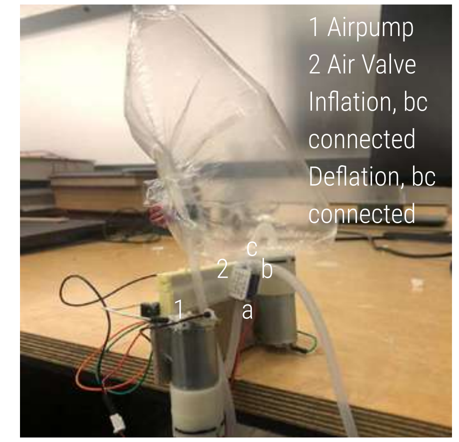


Active Control
- pressure sensor

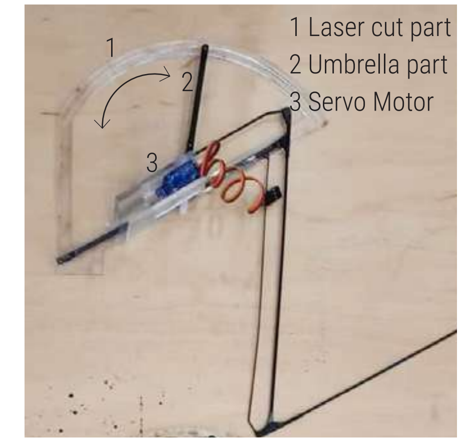


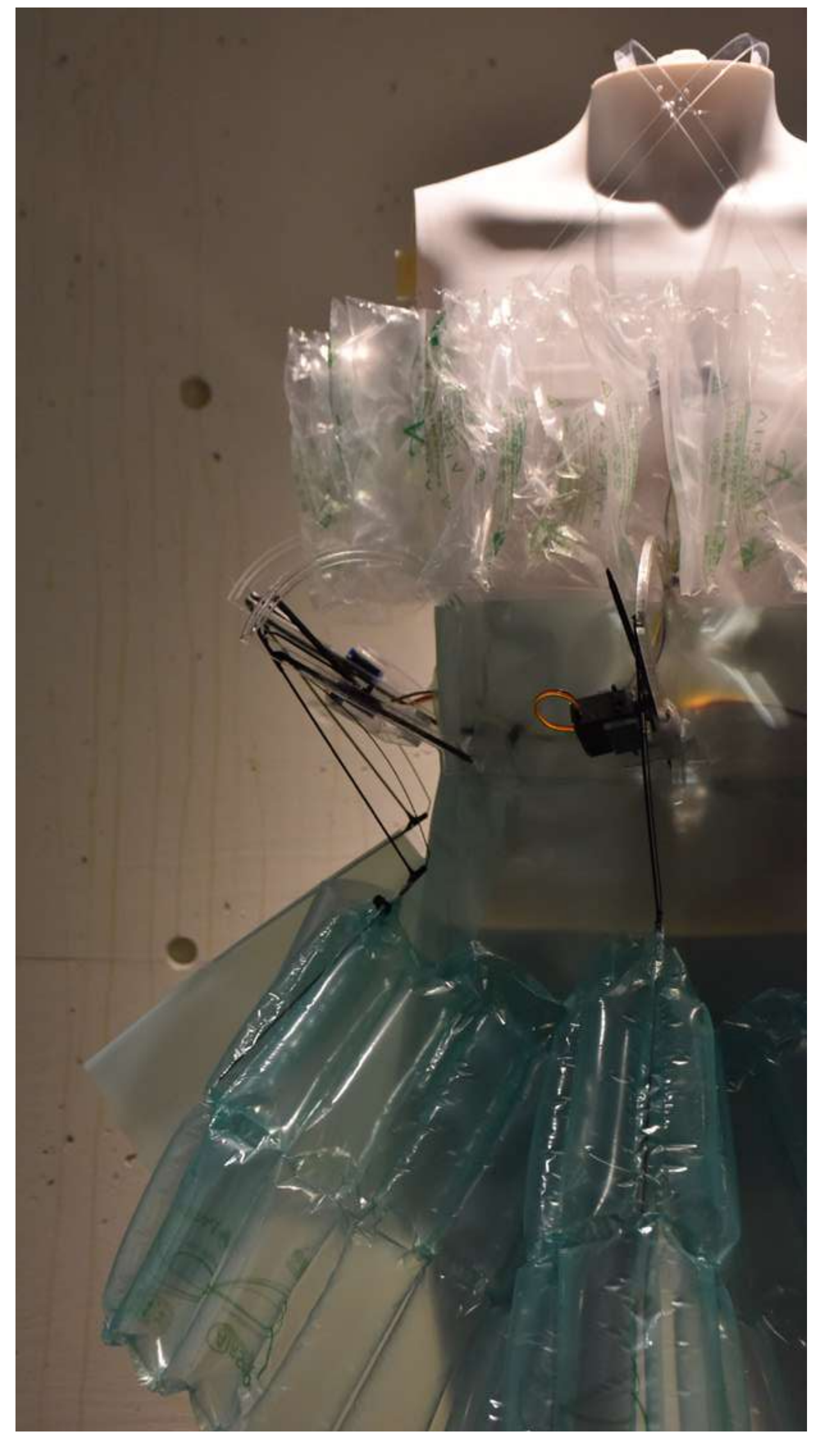
→

Response Upper Attire
- Inflation and deflation



Response Upper Attire
- Collapsing and expansion





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