Smart City Digital Twins
Toward More Sustainable, Resilient, and Livable Columbus

SMART Uptown Columbus
Georgia Smart Communities Challenge Webinar
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Smart Buildings
Examine, model and improve systemic changes occurring at the intersection between human and engineered networks.

Representative Publication:

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at/across scales to achieve smart, sustainable, resilient & livable cities
Isaac Asimov
FUTURE DAYS
A Nineteenth-Century
Vision of the Year 2000
Smart City
Digital Twin
Why Focus on Cities?

We need to meet the growing needs of our burgeoning urban populations

1.5 Million Urbanized per Week or
1.5 Million Urbanized per Week or
A new NYC Every Other Month!

Scale of Urbanization

How does population scaling in cities impact human and engineered networks?

Human interactions & Socioeconomic activity scale super-linearly with city population size ($\alpha=1.15$)

[Schläpfer et al., 2014; Bettencourt & West, 2010]

Income
Wealth
Innovation

Crime
Pollution
Disease

Physical infrastructure and energy use scale sub-linearly with city population size ($\alpha=0.85$)

[Bettencourt 2013; West, 2017]

The number of human interactions scales inversely to the degree that infrastructure scales with city population size... *Dynamics occurring at the Human and Engineered Network interface.*
Smart City Digital Twins

Can we expand building/community scale work to *Digital Twin* and integrate infrastructure / human / data dimensions?

1. What Happens?
2. Why it Happens?
3. What if ____ Happens?
4. Interventions

“A *Digital Twin* is a...pairing of the virtual and physical worlds [that] allows analysis of data and monitoring of systems to head off problems before they even occur, prevent downtime, develop new opportunities and even plan for the future by using simulations.” [Forbes, 2017]

“A *Smart City Digital Twin* is a smart, IoT-enabled, data-rich virtual platform of a city that can be used to replicate and simulate changes at the human-infrastructure interface that can improve resilience, sustainability, and livability in the real city.” [Mohammadi & Taylor, 2017]
Toward Smarter, More Sustainable, Resilient & Livable Cities
Representative Publication:


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Representative Publication:


Representative Publication:
Representative Publication:

Smart City Digital Twin: 
*Smart Corridor* at the Georgia Tech Campus

1. What Happens?
2. Why it Happens?
3. What if ___ Happens?
4. Interventions
Smart City Digital Twin → Citizen Feedback:
CitySnap Augmented Reality (AR) Crowd-sensing App (Citizens)
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CitySnap Augmented Reality (AR) Crowd-sensing App (Citizens)
Smart City Digital Twin → Multi-Sensor Integration:
Array of Things Multi-Sensor Node Enables *Smart Corridor*

- **Building-Level**
  - Electricity (Elevators, Lighting, Café etc.)
  - Gas

- **Water Consumption**
  - Water
  - Chilled Water
  - Steam
  - Rain Water

- **Ambient Air Quality**
  - Carbon Monoxide
  - Hydrogen Sulphide
  - Nitrogen Dioxide
  - Ozone
  - Sulfur Dioxide
  - Air Particles

- **Sound intensity**
  - RMS Sound Level

- **Street conditions, traffic flow, events**
  - Camera
  - Detect heavy vehicles, shock to street pole
  - Magnetic Field
  - Acceleration and Orientation
  - Physical Shock/Vibration

- **Weather Condition**
  - Barometric Pressure
  - Humidity
  - Temperature
  - Cloud cover, sunlight intensity
  - Infrared Light
  - Light
  - Ultraviolet Intensity
  - Visible Light

- **Citizen Feedback**
  - Comments
  - Tagged Images

- **Environment**
  - Equitable
  - Beauty

- **Mobility**
  - Safety
  - Energy
  - Environment
  - Beauty
  - Water
  - Equity
  - Health

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1. What Happens
2. Why it Happens
3. What if Happens
4. Interventions

Monitoring violations of World Health Organization (WHO) thresholds for health-harmful pollution levels.

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Smart City Digital Twins:
Smart Corridor → Energy/Water

1 What Happens?
2 Why it Happens?
3 What if ____ Happens?
4 Interventions

Monitoring variations in water/energy consumption levels correlated with human activities in buildings.
Smart City Digital Twins: Empowering City Governments

1. What Happens?  
   Monitor Sensor Data Against Thresholds

2. Why it Happens?  
   Correlations + Citizen Feedback

3. What if ___ Happens?  
   Scenario-based Predictions

4. Interventions  
   Automate, Optimize, & Improve
Smart City Digital Twins: Benefits of Smart Sensing in Columbus

1. **What Happens?**
   - *Monitor Sensor Data Against Thresholds*

2. **Why it Happens?**
   - *Correlations + Citizen Feedback*

3. **What if___ Happens?**
   - *Scenario-based Predictions*

4. **Interventions**
   - *Automate, Optimize, & Improve*
1 Equip Columbus to better understand how people move through Uptown.

2 Improve understanding of the impact of climate, air quality, noise and other factors.

3 Create a “digital twin” of Uptown with tools and resources for businesses, gov’t & the public.

4 Hyper-local data helps CCG anticipate and pro-actively address potential problems.

Smart City Digital Twins:
Benefits of Smart Sensing in Columbus
‘Transformative’ urban digital twin and city modelling deployments to exceed 500 by 2025, says ABI

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Thank you!

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