Planning Urban Cities Smartly With Digital Twins

A new era in smart traffic enforcement.

Digital twins have revolutionized the way businesses operate, and now, startups like Hayden AI are exploring new aspects of the groundbreaking technology to transform the way cities are designed and maintained, and ultimately enhance the quality of life for communities.

Urban cities are struggling to keep up with the rapid growth in population, and this trend is bound to continue in the coming years. In fact, the United Nations predicts that by 2050, 70% of the world's population will live in urban cities, up from 50% today.[1]

However, it's clear that today's cities weren't designed to sustain such explosive levels of growth with the prevalence of urban issues such as air pollution, traffic congestion, and inequality. In order to build in the resilience that cities require to withstand the demands of tomorrow's urban population, governments will need to find smarter ways to design and manage urban cities while also addressing sustainability issues, and digital twins could be just what urban planners need.

Digital twin technology is not an entirely new concept.

For decades, businesses have relied on digital twin technology to create dynamic 3D replicas of products, services and processes, in order to test their performance and simulate real-world scenarios — sometimes, in real time — to mitigate operational risks and minimize the costs of maintenance.

These 3D models have been widely used to design, build, and operate physical and digital products. During the design phase, the model allows architects to optimize the concept of the product, even before a prototype has been built. Once built, the prototype is further optimized using digital twins by seamlessly running a series of tests that allow designers to understand how all the components interact with each other, as well as how internal changes and external factors impact overall performance.

1 https://news.un.org/en/story/2022/04/1116642

While the product is being built, digital twins enable in-depth testing and analysis to ensure that the optimal performance is achieved, while also predicting resource requirements to lower the risk of over-allocation. The digital twin continues to evolve in real time after the product is deployed to accurately reflect the state of all internal components at any given point in time, streamlining the process of monitoring performance and controlling internal variables.

All this is possible because of the sensors embedded in the product that facilitate real-time exchange of data and feedback with the virtual model. As sensors become more ubiquitous, broader applications of digital twin technology are now being explored — one of them being urban planning for smart cities.

Modernizing urban planning with digital twins.

While urban planners have historically relied on static 2D and 3D mappings, the growing complexity of cities and the rapidly evolving social and environmental requirements for sustainable communities prompted the need for more dynamic tools. By combining traditional urban planning tools with digital twin technology, dynamic virtual models of cities can be created in real time with greater levels of granularity. Digital twins democratize advanced urban planning, allowing people to easily try out new ideas without having to hire a design team. They also iterate quickly, at the scale of an entire city.

As with products, digital twins enable urban planners to virtually build out new cities and test out ideas before construction, and to monitor the performance and sustainability of city assets afterwards. This may include metrics such as traffic flows, energy consumption, and carbon emissions.

Digital twins also allow urban planners to better understand the issues that persist in existing cities and communities, and to run simulations of policy scenarios in real time to analyze the feasibility and determine what the possible outcomes would be. This minimizes the risk of project failures while maximizing impact and the return on investment. Urban planners can also leverage digital twin technology to optimize the utilization of city assets and enhance the efficiency of municipal services by experimenting with different variables and understanding the impact.

While digital twin technology offers endless possibilities for urban planning, the broader geographical area of cities means that geospatial data also needs to be captured in order to create a more accurate virtual picture of the city, as it incorporates additional information regarding particular locations and times.

Capturing geospatial data for urban digital twins.

Although capturing the required geospatial data presents a challenge, some startups are already finding innovative ways to achieve this.

Hayden AI, for example, is capturing geospatial data for its smart city digital twin solution GeminAI™ through its AI-powered cameras, which were primarily developed to detect and capture traffic violations. The company's traffic enforcement solution consists of perception-based devices that are mounted on public vehicles such as transit buses, school buses, street sweepers, and law enforcement vehicles. Hayden AI projects over 1,000 installations across major metropolitan areas by the end of the year, which will further expand the company's geographical coverage of visual sensing in urban areas.

The GeminAI platform capitalizes on the frequency and efficiency of public fleets, which have schedules that are designed to match the demand for mobility throughout the day. This means that during peak hours, public fleets may travel predetermined routes as often as once every few minutes; and during off-peak times of the day, the frequency is lower. As a result, Hayden AI captures geospatial data at a frequency that naturally evolves to provide finer temporal granularity when required.

Hayden AI's mobile perception devices scan entire road segments and thereafter, the platform's state-of-the-art AI constructs the scene virtually with rich information about vehicles, pedestrians, facilities, and infrastructure, while complying with global privacy regulations. This enables the company's digital twin to run simulations of new designs and to evaluate outcomes with high confidence. The platform's extensible device is combined with a cloud architecture, allowing for additional urban management use cases via software updates.

As a shared data platform, GeminAI provides third parties with access to its space-time database via APIs, which can be integrated into other applications like Esri GIS maps. The platform's modular AI software allows users to subscribe to the geospatial data feeds that are most relevant.

Digital twin technology in action with GeminAI.

GeminAI supports a wide range of applications, from analyzing the efficiency of public transit vehicles and examining the traffic patterns of pedestrians, to managing the time sharing of city assets such as curbs and predicting the maintenance of public infrastructure such as bus stops in need of repair.

For instance, the platform leverages digital twin technology to visualize the bus lane violations detected by the Hayden AI smart enforcement platform, allowing government officials to identify trends and patterns in particular areas. The platform also tracks bus speeds, travel times, the frequency of bus lane violations, and the amount of carbon dioxide emitted.

All this provides urban planners and transit agencies with real-time insights into the operation and performance of transit buses, as well as different ways in which the reliability of buses can be improved and the effectiveness of various measures that have been implemented. City officials, for example, can track the impact of the Hayden AI smart enforcement platform on the number of bus lane violations.

Ultimately, by leveraging GeminAI to enhance traffic flows, communities experience more sustainable cities with fewer transit bus delays, lower carbon emissions, improved air quality, and more fair and equitable mobility.

Digital twins are already impacting cities.

Digital twins will enable urban planners to build future cities with the resilience required to accommodate tomorrow's urban population. Innovative cities are already embracing digital twin technology to drive sustainability.[2]

Chattanooga, a city in Tennessee, is leveraging digital twins to improve traffic flow by up to 30% by modeling traffic congestion relief strategies. Singapore is leveraging digital twins to optimize its clean energy production by identifying the best location for solar panels based on light and temperature variations. A public university in Singapore is also utilizing digital twins to optimize its operations and reduce energy consumption by 31% and carbon emissions by 9.6 kilotons.

As more cities embrace digital twins, companies such as Hayden AI will continue to play a key role in streamlining the process of capturing the geospatial data required to bring the virtual 3D models to life.

2 https://www.capgemini.com/gb-en/research/digital-twins/

Author

Weilie Yi

Vice President of Data Science

HaydenAI

Stop by our office and say hello.

West Coast Headquarters

484 9th Street
Oakland, CA 94607

East Coast Office

375 Pearl Street Suite 1440
Manhattan, NY 10038

Center of Excellence

375 Pearl Street Suite 1440
Manhattan, NY 10038

Customer Support

support@hayden.ai

Sales

sales@hayden.ai