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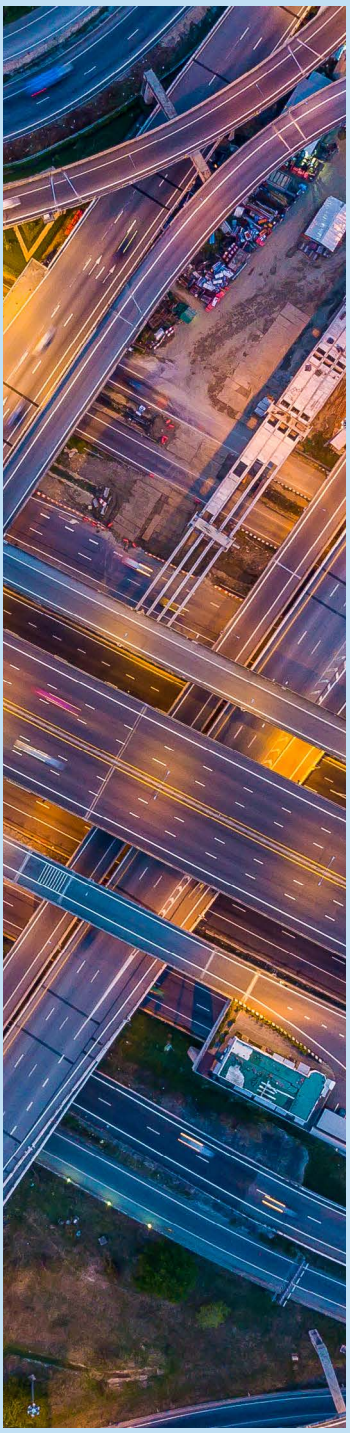

EXPLORING TECHNOLOGICAL DEVELOPMENTS IN GIS NAVIGATION

Abstract

Today, maps are so advanced that a large part of the world relies heavily on their features. Cartographers, researchers, scientists, and academicians use them extensively for story telling about real-world problems and to provide solutions. This paper discusses technological developments in the navigation domain within GIS (Geographical Information Systems), the extant challenges, and the impact on all stakeholders who are directly or indirectly using these services.

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Introduction

Maps have always been a part of human history, helping people explore and enabling effective decision making. However, we have come a long way from the early maps drawn on rocks and in caves to the indispensable mobile navigation units of today which provide visual and/or audible guidance to simplify moving around places known and unknown. This evolutionary journey has been a fascinating one, from yesteryears cartography and paper maps to the maps available now through computers, mobile devices, and virtual reality.

Advances in the navigation domain

Geographic information systems (GIS) include many domains such as telecommunications, transportation, electrical, utilities, military, earth observation, government services, and mapping services. Based on their requirements, there are different types of maps used in these domains such as thematic, atlas, navigational, cartographic, or hydrographic. Also, technological developments have enabled the development of new types such as animated, interactive, multimedia, and virtual providing effective modes of storytelling.

These new types have played a vital role in changing the way business is done today. Be it moving from point A to point B using transportation services, the ecommerce industry's usage of 3rd parties to ensure quick delivery of their products and services, usable point-of-interest search, or the food services industry shift towards seamless delivery models, in all of these areas, the use of maps has made a significant change in the daily lives of consumers.

The influencers driving change

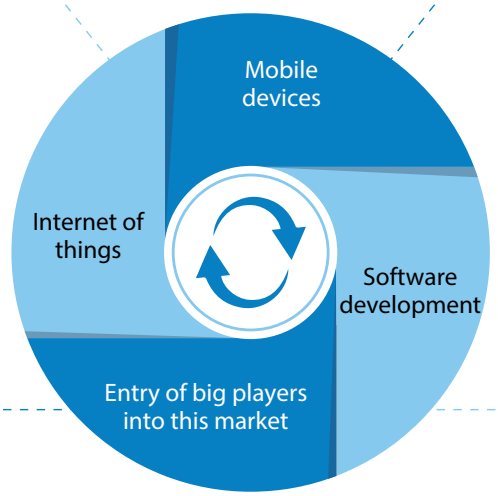
Several social and technological developments are driving the increasing relevance of maps across industries, domains, and consumers.

Internet of things:

Ubiquitous access to the internet through mobile devices with GPS connectivity, and the widespread usage of apps by consumers is enabling easy access of end user data by companies.

Mobile devices:

The availability of affordable mobile GPS systems and phones has enabled the large-scale collection of map data, and access to such maps at an affordable cost.



Entry of big players into market:

Competition has forced large businesses to venture into new areas using innovative models, many of which are built around GIS mapping advancements.

Application development:

Advances in software application development have enabled appropriate data consolidation and enhanced features. These have resulted in simpler, efficient, and user-friendly applications.

The role and development of maps of the future

The technological advances in mapping are building a foundation for an impeccable navigation experience. Tomorrow's maps will enable:

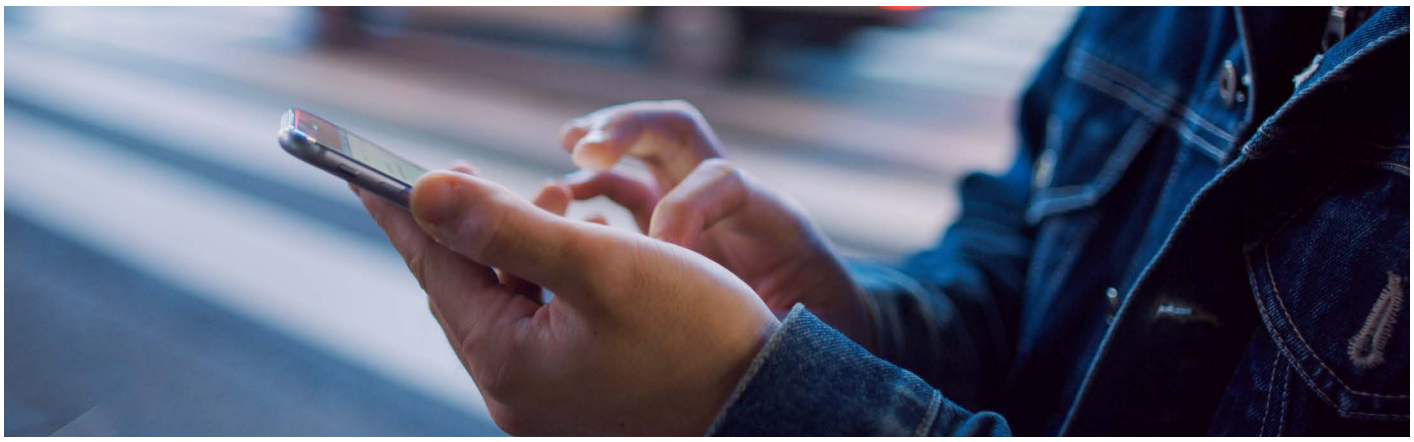
- 3D map navigation, AR/VR navigation
- Networking between autonomous cars, as well as between the cars, surrounding infrastructure, pedestrians, and other objects
- Enhanced in-car navigation information (braking, turning point, speeds for different seasons, and road types)
- Accurate driver guidance systems

Companies with diverse backgrounds and expertise are partnering to make these ambitious projects a reality. Today, such partnerships exist in various permutations between manufacturers of automobiles, hardware, and software, and map building companies and research institutes.

Three underlying differentiators

Maps have come a long way from being a static, information-focused map, to a graphical interactive map that focuses on storytelling. The current environment envisages the three factors making an impact on qualitative information: Light Detection and Ranging (LIDAR), High Definition Mapping (HD Maps), and Virtual Positioning System (VPS).

Technology	Light Detection and Ranging	High Definition Mapping	Virtual Positioning System
What is it	Uses airborne vehicles to capture terrain data through measuring reflected light pulses	Uses sophisticated cameras to capture high definition images for high quality maps	Uses the camera in mobiles along with geo location details for visually dynamic maps.
Uses in Navigation	Helps in viewing datasets in 3D perspective for better visualization. It can be used for dynamic mapping; updating digital map applications with the latest developments such as new constructions or road blockages.	Differentiates between pedestrian routes and driving routes with minimal/zero human intervention, helps automated vehicles with dynamic driving assistance and in identifying traffic flow.	Guides users to their destinations with a visual representation of the route searched for.
How does it work	• Airborne vehicles using LIDAR equipment emit laser light waves (ultraviolet, visible, or near infrared) and capture data from the reflected pulses • The emitted light waves that travel outwards in all directions until reflected back to the source from objects in their path. • The pulse data is rectified to identify the features of the reflecting object • LIDAR gives a 360-degree view of the objects that helps viewing datasets with a 3D perspective	• An autonomous vehicle (AV) captures street data using LIDAR equipment and cameras. • The street data includes road contours, traffic signs, road obstructions, blind spots, parking assist features, and lane departures. • The captured data is incorporated into HD maps and sorted using certain algorithms for the AV to react in the same way that humans would in real-world scenarios.	• Cars fitted with 360-degree GPS cameras and LIDAR equipment on the roof are driven across the streets. • The captured images are stitched together into a video including vector 2D, 3D images of objects such as signboards and general obstacles. • Algorithms are added into the system, with obstacles identified to aid driver-less cars.
How will it help	• Informed analytical decisions • Accurate 3D modelling of objects	• Enhanced quality data • Symmetric traffic flows, and robotic vehicular movements • AVs interacting with each other while executing their active programs	• Precise walking images / driving directions



Understanding the challenges

All data acquired using these technological enhancements will need rectification, category definitions, and structuring prior to usage. However, there are several factors that challenge such map making:

Skill: Data rectification involves large scale operations with skilled resources. However, there is limited availability of manpower skilled on the unique tools and processes used by individual product owners. This leads to a high cost associated with training a large workforce.

Cost: Obtaining data and creating such maps is very expensive. Rectification is also time consuming due to the very specific details needed to obtain 5mm accuracy levels

Technology: Advanced technologies and tools are needed to understand the captured datasets, and integrate them into aesthetic displays of features, and to convert them into standard navigational formats

Environment: Weather conditions such as rain or storms effect the collection of required datasets. Also, noise and image errors caused by faulty equipment result in data that is not useful, necessitating multiple scanning/drive data collection efforts for single points

The stages of map building

The process of building maps can be categorized into five stages to address issues in a systematic manner.

Throughout the cycle the map data goes through various changes due to development, natural disasters, environmental and climate changes, 3rd party data aggregation, or technological developments.

Post-production activities

Maintenance activities to ensure continuous enhancements to maps data to provide a better end user experience.

Data collection

Collation of data from multiple parties based on the need of the product outcome expected by the client/product owner.

Production activities

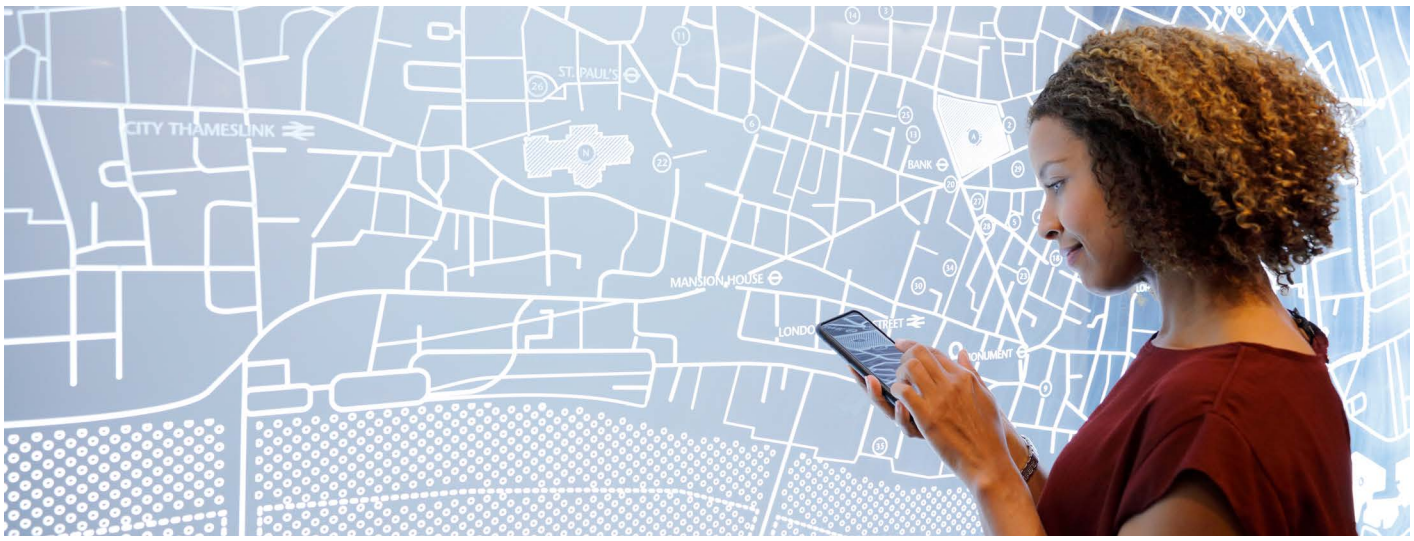
Creation of spatial and attribute data. Processes are structured in an effective manner to ensure flawless flow of information.

Design & development of tools

Design, development of tools and technology to customize the work as per the need of the product outcome expected by the client/product owner. Workflow tools, editing tools, data integration, and testing are all performed at this stage.

Pre-production activities

Design processes and procedures to address process related issues. Prototyping activities are performed to design process related documents.



Readiness to be part of these ambitious projects

Technological development and the competitive need to deliver unique customer experiences have pushed most businesses to innovate. As time is of the essence, integration between tools, and between technology and data service providers is a commonly seen trend given the need to provide quality services to end users of the product. The other trends below are also expected to transform the map building space and are important for map-building companies to adapt to, to avoid being left behind.

Machine Learning

Machines have been trained to identify, extract, and display accurate data

Rules, algorithms need to be designed, tried, and tested to enable smart learning

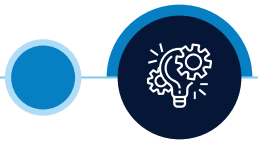
Process break down and simplification of work will be instrumental in enabling efficient learning

Development of Skilled resources

Processes are becoming simpler to enable higher usage of machine learning. As machines become smarter the workforce to handle these machines also need to become smarter.

Technical skill development will play a key role and companies will have to upskill the workforce accordingly.

Manpower will still be required to handle data correction errors, however the skillsets will need a boost.



Innovation

Collaborations are seen between companies and the vision / outcomes will be detrimental if not they are not able to sync well

Development and innovation will have to be at par between companies to comprehend each others strategy and align themselves accordingly

Time and cost factors will also play very critical roles in this space

While considering these trends map building companies need to shore up on:

Domain understanding: to provide value and keep innovating and improving through artificial intelligence and process automation

Technical skills: to handle various data formats that require integration with multiple tools

Data availability: abundant data needs to be sourced through end-user contributions and crowdsourcing

The way forward

The Geographic information system industry has seen a paradigm shift over the last couple of years. Data suggests that the industry had grown to $8985M in 2016 and is expected to reach $17510M in the next 7 years.

The best years are ahead of us where GIS services are going to be increasingly and commonly used by consumers, governments, software developers, hardware manufacturers, and firms in real estate management, supply chain management, transportation, e-commerce, and several other such industries/services.

Artificial intelligence, process automation, and the increasing involvement of machines are inevitable for businesses of the future. Map-building companies that understand and adapt themselves through innovation to cater to the growing demand will be the ones that will be the intermediaries in tomorrow's map-enabled world of human-machine co-ordination.

Author

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Mothiraj has over 17 years of experience spanning customer service, operations management, training, centre of excellence, and solution design. He has experience in working on multiple service lines such as sales & fulfilment, search engine marketing, search engine optimization, and geographic information systems – navigation domain. In his current role as a senior practice lead, he is responsible for GIS engagement delivery support, best practice implementation, performing POC's and working closely with the solutions team for all GIS related engagements. He holds a Bachelor's degree in business management and a post graduate diploma in business administration.

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