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THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

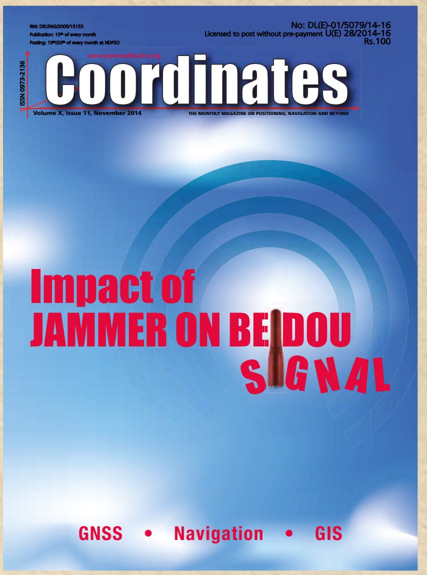
EMPOWERING THE POOR by slum and squatter resettlement in Delhi

INTELLIGENT AIRBORNE MONITORING of irregularly shaped man-made marine objects using statistical Machine Learning techniques

Mobile application based indoor positioning and navigational system using Dijkstra's algorithm

In Coordinates

10 years before...



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"Think of having 2030. Information is available anytime and anywhere. In its provision and delivery it is tailored to the user's context and needs. In this the location is a key selector for which and how information is provided. Cartographic Services are thus wide spread and of daily- use in a truly ubiquitous manner."

Says Prof Georg Gartner, President, International Cartographic Association (ICA) in an interview with Coordinates

Impact of cheap commercial jammer on BeiDou signal

Dr Laura Ruotsalainen, Dr Mohammad Zahidul H Bhuiyan, Sarang Thombre, Stefan Söderholm and Dr Heidi Kuusniemi
Department of Navigation and Positioning, Finnish Geodetic Institute, Finland

This paper assessed the impact of a cheap commercial jamming device on the BeiDou signal. The effects were monitored by examining the C/N0 values and the obtained position solution. The results were compared to the corresponding results obtained using GPS. The impact of the jammer was significant on GPS, as was known from previous research, but surprisingly it deteriorated the BeiDou performance slightly too. However, the impact was not as drastic as on GPS, the increase of the position errors was in the range of meters, as for GPS there was an increase of hundreds of meters.

Integration of Short Range Measurements into a standard Inland ECDIS navigation display

Driton Kuçi Dipl.-Ing.
Senior Systems Engineer, TeleConsult Austria GmbH, Graz, Austria

Dr Mykhailo Lytvyn
Senior System Engineer, R&D projects, TeleConsult Austria GmbH, Graz, Austria

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Project Manager, Development of River Information Services, Inland Waterways, via donau - Österreichische Wasserstraßen-Gesellschaft mbH, Vienna, Austria

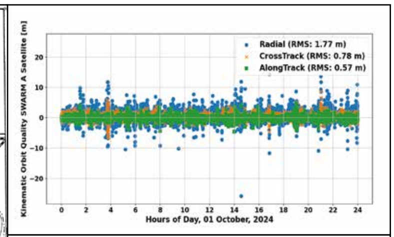
In this paper, the integration of an additional service (SRM) to the Inland ECDIS navigation display is presented in order to support the skippers with real-time information about passing and docking manoeuvres, and to help them in avoiding any collisions with the riverside infrastructure. The accuracy of the PVT solution in kinematic and static cases is reasonable. However, in case of approaching bridges, the GPS error increases due to satellite signal shading.

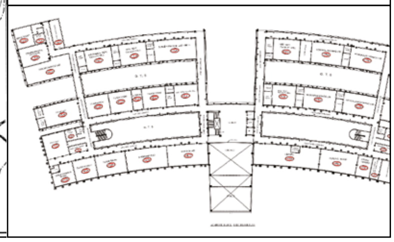
Integrated infrastructural design and management using BIM and GIS

Rahla Rabia M P
Civil Engineer, Pursuing PhD., Masters in Water Resources Engineering and Management, National Institute of Technology, Karnataka, India

Jasim Farooq
Electrical Engineer, Pursuing PhD, University of Petroleum and Energy Studies, Dehradun, India

At a time when the overall development market is tightening, these users are looking for BIM to help them gain a competitive advantage. The government should try to implement BIM supported by GIS in all big projects in an immediate basis to save billions of riyals and bringing the work force to cope with new technology.





In this issue

Coordinates Volume 20, Issue 11, November 2024

Articles

Columns

This issue has been made possible by the support and good wishes of the following individuals and companies
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Editor Bal Krishna
Owner Coordinates Media Pvt Ltd (CMPL)

This issue of Coordinates is of 36 pages, including cover.

COP29: More of the Same?

At COP29 in Baku, Azerbaijan,

The host country's president hails fossil fuels as "a gift from God,"

While pledges on energy storage and green energy are made,

Emphasizing the need to end fossil fuel dependence,

To avoid catastrophic climate impacts.

But alarming new predictions highlight rising CO_2 emissions,

Putting the 1.5°C target of the Paris Agreement at risk.

Although initiatives like the Global Energy Storage and Grids Pledge

Offer promising steps toward a sustainable energy future,

The absence of several key countries,

The ongoing power shift in the US,

And the overwhelming influence of fossil fuel lobbyists,

Paint a far less hopeful picture.

Bal Krishna, Editor
bal@mycoordinates.org

Empowering the poor by slum and squatter resettlement in Delhi

Urban policies, resettlement and low-cost housing are the powerful tools of the poverty reduction which transform the lives of the poor

A. K. Jain

Worked as Commissioner (Planning), Delhi Development Authority. He joined DDA in 1976 in the midst of massive resettlement of slums. This gave him first hand knowledge about the the programme and testing the dictum of John Turner at the UN Habitat Conference, Vancouver (1976) that the slums are not a problem but a solution.

During 1975-77, a massive program of slum resettlement, covering 7 lakh people living in the slums and Jhuggi-Jhompri (JJ) clusters was undertaken in Delhi. The Delhi Development Authority (DDA) developed 1,54,000 plots of 25 square yard (21 sqm) in 27 resettlement colonies for the slum dwellers (Figs. 1 to 5). Touted as one of the world's largest slum resettlement projects, it created controversies, such as forced evictions, whether the slums are a problem or a solution and disconnecting the poor from their livelihoods. It was a hot topic of discussion at the UN Conference on Human Settlements and Habitat Forum held in 1976 at Vancouver, Canada, which was attended by the heads of various governments (UN Member countries), delegates from professional and academic institutions, NGOs and the author (A.K. Jain).

The Union Minister of Works and Housing presented India's Country Report, highlighting various policies and schemes of urban development and housing, the establishment of the Delhi Development Authority (DDA) and formulation of Delhi Master Plan. He was followed by Jagmohan, the Vice Chairman of the DDA, and the architect of Delhi Master Plan and slum resettlement policy of Delhi. He forcefully defended the Resettlement Schemes, which not only aimed at making Delhi slum free, but also to serve the poorest of poor families to own a house. He mentioned that about 1000 Ha of DDA land was developed with site and services and allotted to the slum dwellers and squatters almost free of cost as an endeavour of equitable development.

However, the critics continued raising the questions of forced evictions, political aspirations, misplaced notions of beautifying the city, poor infrastructure services, disconnect with the livelihoods, entrenched poverty, fragmented environment and asymmetrical societies. It was alleged that the hutment dwellers immediately sell the land allotted by the DDA and squat again somewhere else. However, the surveys did not confirm this, except one-third of the resettlement plots were sold unauthorisedly (which also happens in posh colonies like Vasant Vihar). John Turner went to the

Slum eviction and resettlement are the painful processes, even more so by intimidating, police like attitude of the authorities. However, this is not the end, but with better communications, empathy and compassion the pain of eviction and relocation can be mitigated.

extent of saying that the perception of the governments and planners has to change as the slums are not a problem but a solution. Some speakers underlined the issues of corruption, non-participatory decision making and top-heavy planning. Keenly listening the criticism, it was my turn to speak.

I pointed out that sitting in Vancouver, it is difficult to visualise the reality of the hutment dwellers in India who are pushed out from their homelands and come to a big city like Delhi, just to survive and look for *roti, kapda and makaan* (bread, clothing and

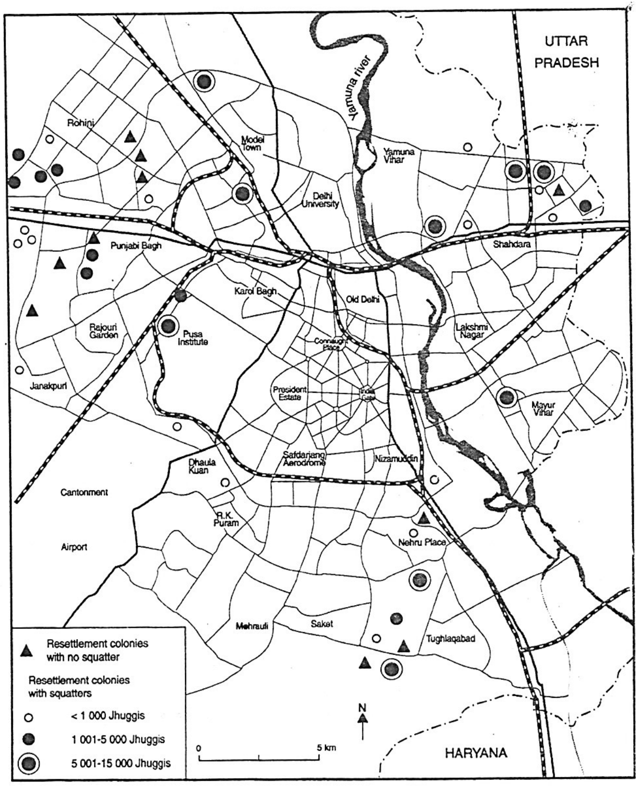


Fig. 1: Location of Resettlement Colonies in Delhi

Source: Dupont Veronique, Emma Tarlo and Davis Vidal (2000) Delhi Urban Space and Human Destinies, Manohar, New Delhi (Based on Slum and Jhuggi Jhompri Department, MCD)

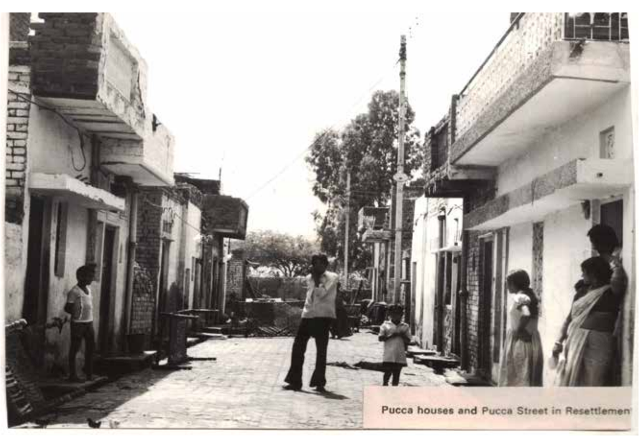
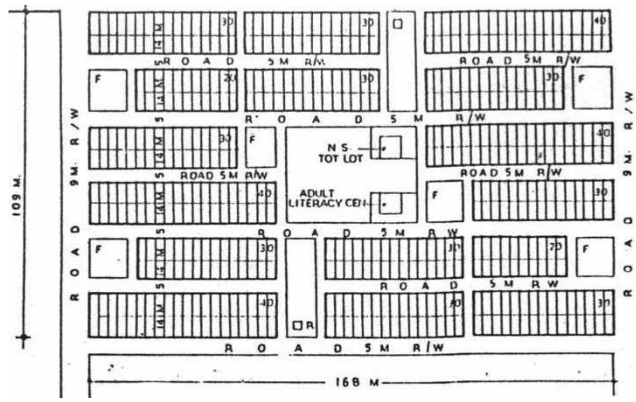


Fig 2: Ambedkar Nagar Resettlement Colony, New Delhi (Photo A.K. Jain)

Slums are inevitable products of urban development. No word suggests more terrible image of the poor man's life. No word is more capable of rousing people to protest and shock the politicians' conscience. The challenge and litmus test of urban planning lies in addressing the issues of slums and squatter settlements.



Density: 70-80 Plots/Acre

Plot Size: 10'x22'6" = 25 sq Yards

Fig. 3: Typical Layout Plan of a Resettlement (Site and Services) Scheme whereby 4 lakh slum/squatter household were resettled in Delhi between 1960 to 1996. Initially 21 sq.m plots were allotted which were subsequently reduced to 18 sq. m.

Source: DDA

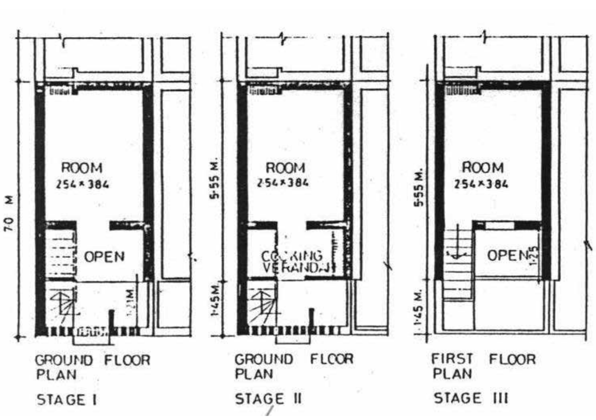


Fig. 4: Standard Design for 21 sqm Plot

Source: DDA

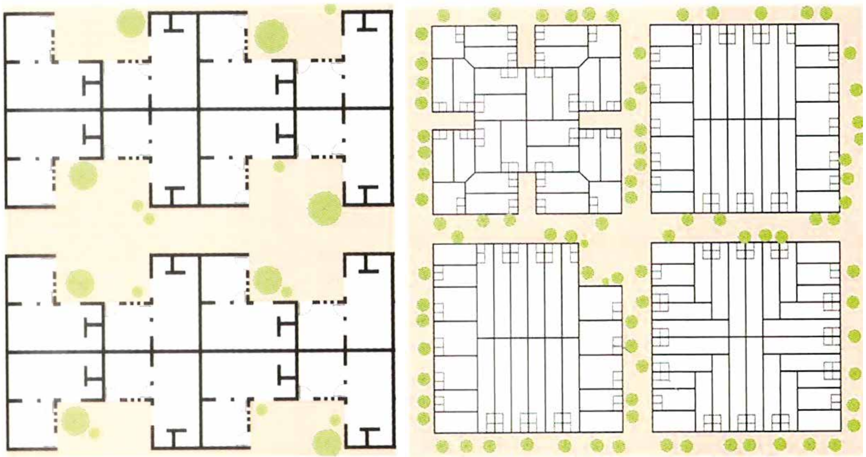


Fig. 5: Site and Services Layout Options (Architect Christopher Benninger)
Source: Christopher Benninger, Architecture for Modern India, India House, Pune, 2015

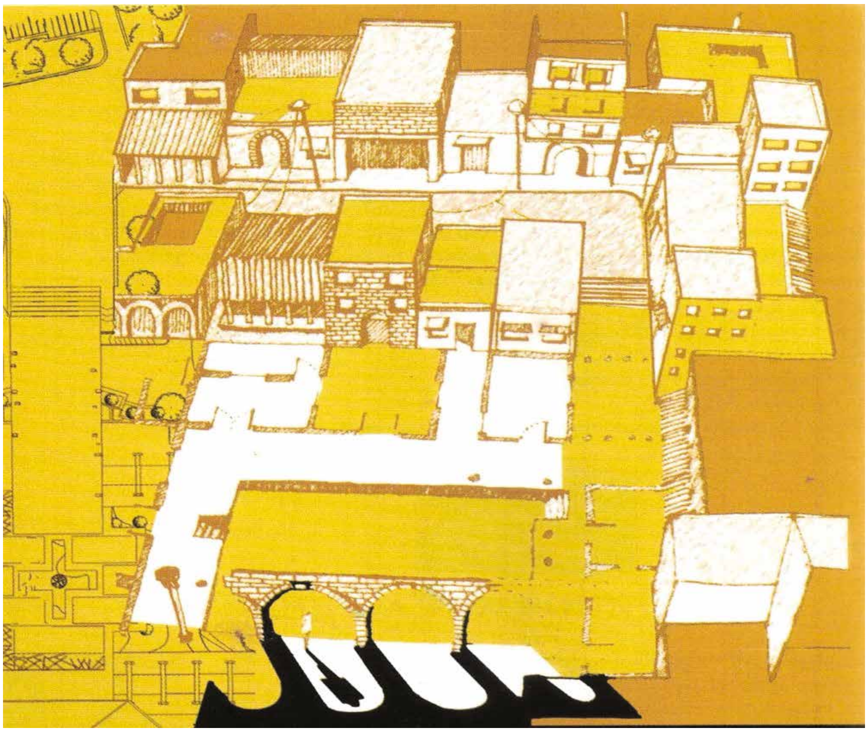


Fig. 6: Evolutionary Housing and Infrastructure Development
Source: Deependra Prasad, New Architecture and Urbanism, INTBAU, New Delhi, 2006

shelter). In order to survive, they work as the casual labours, rickshaw pullers, loaders, beggars, street vendors and domestic help. They seek shelter in the hutments, sharing the room with other 2 to 4 persons and pay for sleeping. It may be Rs 20 to 40 per night, per bed, but could be Rs 30 to 50 with electricity (a fan and tube light). These kind of the shacks are often put on government land by 'slum landlords' having political patronage as their names would suggest (Arjun Das, Sonia, Sanjay, Rajiv, Nehru, Gandhi camp, etc.). Under hand to mouth conditions, they could never imagine owning a house, or sending their children to a school, condemning even their next generation.

Slum eviction and resettlement are the painful processes, even more so by intimidating, police like attitude of the authorities. However, this is not the end, but with better communications, empathy and compassion the pain of eviction and relocation can be mitigated. Most of the slum dwellers are aware of the value of shelter which could catapult them and their children out of the cycle of poverty and perpetual suffering.

They need support from the planning and housing agencies, both governmental and non-governmental, to enable them to always *put the last person first,* looking at the hutment dweller, the informal sector hawker, the physically challenged, domestic servants, *rickshawalas*, and casual workers. This requires seeking the paths and channels to support, facilitate and empower the poor citizens into becoming its stakeholders, thus harnessing their energies and amplifying their contribution. We need to examine the shelter, in a milieu where planning has safeguarded disproportionately for the elite segments of the society.

Urban policies, resettlement and low-cost housing are the powerful tools of the poverty reduction which transform the lives of the poor and their children. As suggested by Jane Jacob, Hernando de Sato and Graham Tipple, the small shops and micro- businesses are the symptoms of inclusive growth and empowered informal sector, which should be encouraged in resettlement schemes rather than being controlled.

The greatest advantage of the site and services strategy is that it is rapid, low cost and provides freedom to the families to design their dwellings according to their needs, resources and tastes. The allottees finance the cost of constructing their houses and part of the land cost, whereas the development agency provides the land and services. This way every house is an expression of the lifestyle of its dwellers, but within an organised framework. In Delhi, Site and Services model provided plots with water tap, toilet and bathing space whereas the owners could add the kitchen and more rooms.

My presentation was heard with keen interest. Although, I was not part of the official delegation, the Vice Chairman, DDA said that he feels that I have

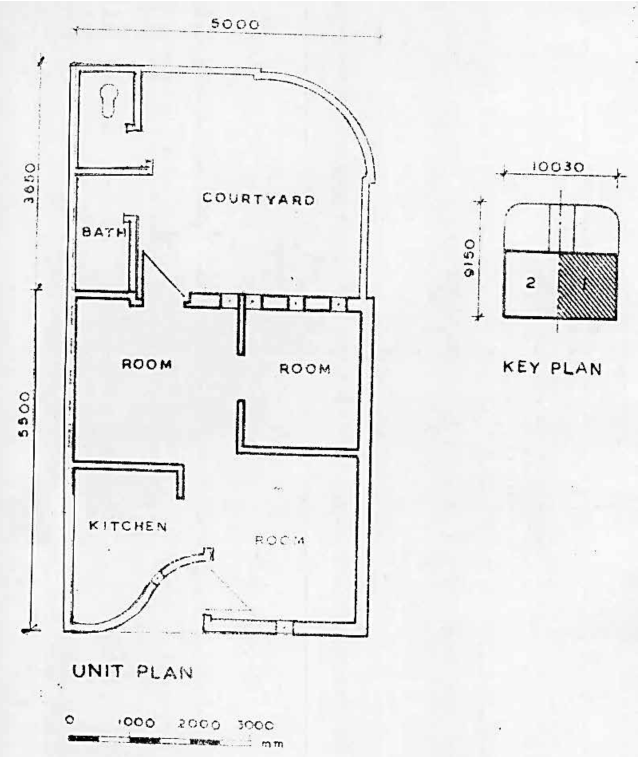


Fig. 7: 27.5 sqm House for Resettlement, Architect Laurie Baker, Rat trap bond, burnt brick paving, frameless doors and windows, no plastering, brick shell roof

Source: Jain A.K. Building Systems for Low Income Housing, J.M. Jaina, New Delhi, 2006

replied to most of the queries of the critics. After returning, I joined the DDA as Associate Planner. Besides other tasks, my duty was to brief and show the resettlement and other schemes to the important visitors, which included the officials from the UN, World Bank, ADB, media, professionals, NGOs, etc. Most of the visitors initially had a critical opinion about the resettlement schemes, but after the visit and briefing many of them gave constructive and encouraging suggestions.

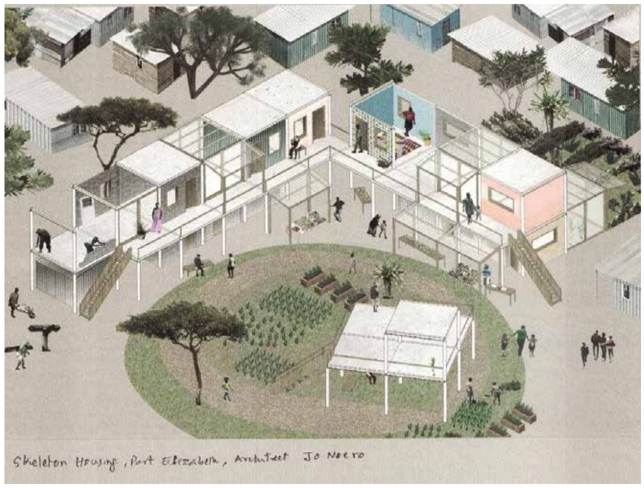


Fig. 9: Skeleton Housing, Port Elizabeth, Architect Jo Nooru

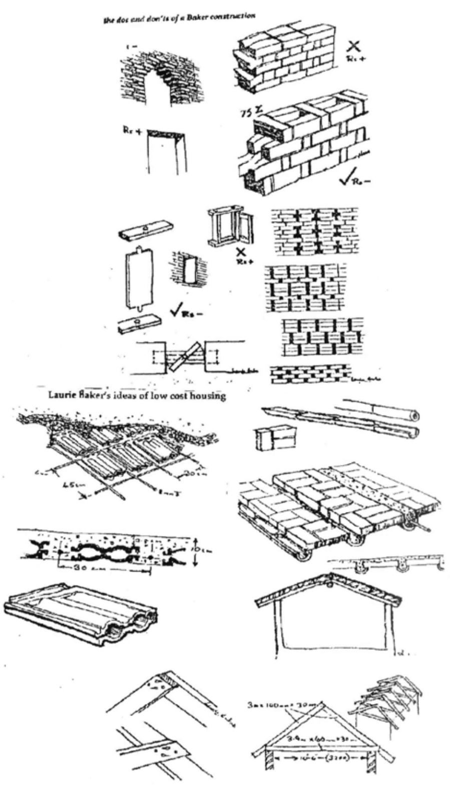


Fig. 8: Sketches by Laurie Baker in the publication 'How to Reduce Cost', COSTFORD, Government of Kerala, 1986

Source: Jain A.K. Building Systems for Low Income Housing, J.M. Jaina, New Delhi (2006)

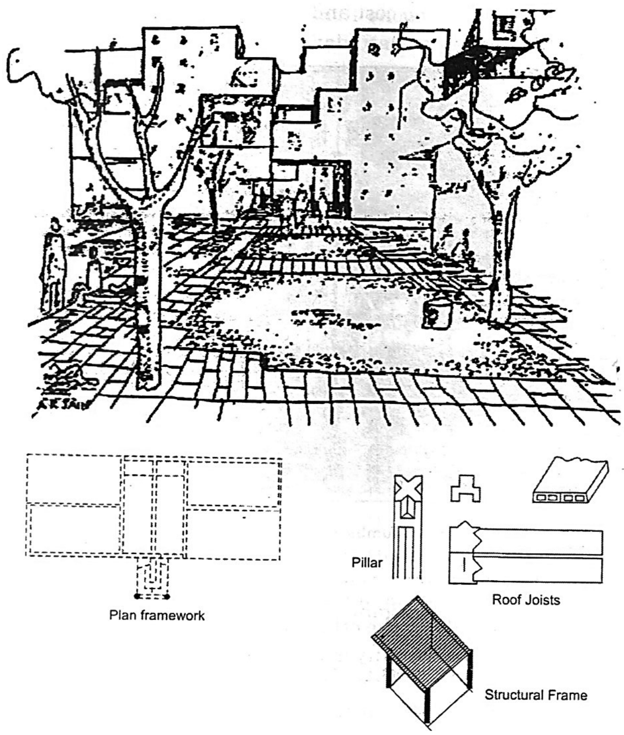


Fig. 10: Skeleton housing provides platform with a wet core for expandable houses (A.K. Jain)

Source: Jain A.K. Housing and Community Planning,, Discovery Publishing House, New Delhi, 2020

Keeping in view the feedback the policy of Slums and JJ Resettlement was amended towards in-situ and collective rehabilitation with a more active participation of the families and slum cooperatives (Fig. 5). Accordingly, the Master Plan of Delhi 2021 mandated that the existing resettlement colonies be upgraded and redeveloped, and reserve 15% of bonus Floor Area Ratio for LIG/EWS housing in all new housing schemes (Fig. 6). The community formation should be the basis of spatial organisation. The layout should allow evolutionary and participatory housing and infrastructure development.

Fig. 11: 14 storied In-situ Slum Rehabilitation in Kalkaji Extension, 3024 flats 25 sqm each, built by DDA, inaugurated by the Prime Minister in November 2022. The allottees felt happy becoming property owners, but also felt imprisoned in a small flat.

Source: DDA

Based on self-help, the simple, local concepts of construction can be promoted, as adopted by Laurie Baker. The principle of incremental housing can be developed with locally produced precast elements and components (Figs 7 to 10). The service cores and slots on alternate streets allow upgradation of the services, while the construction is done with simple and locally available materials. For quick and low-cost resettlement, skeleton housing clusters can be created which define a framework for construction of the dwellings by the residents themselves according to their needs and resources. Simple prefab elements- columns, beams, floor, roof tiles can be made available at the site for construction around a wet core.

The variety of slum and squatter settlements need differential approaches rather than a single approach. This involves redefining the space standards for shelter, greens, play area, social infrastructure, transport and utilities. Slum rehabilitation

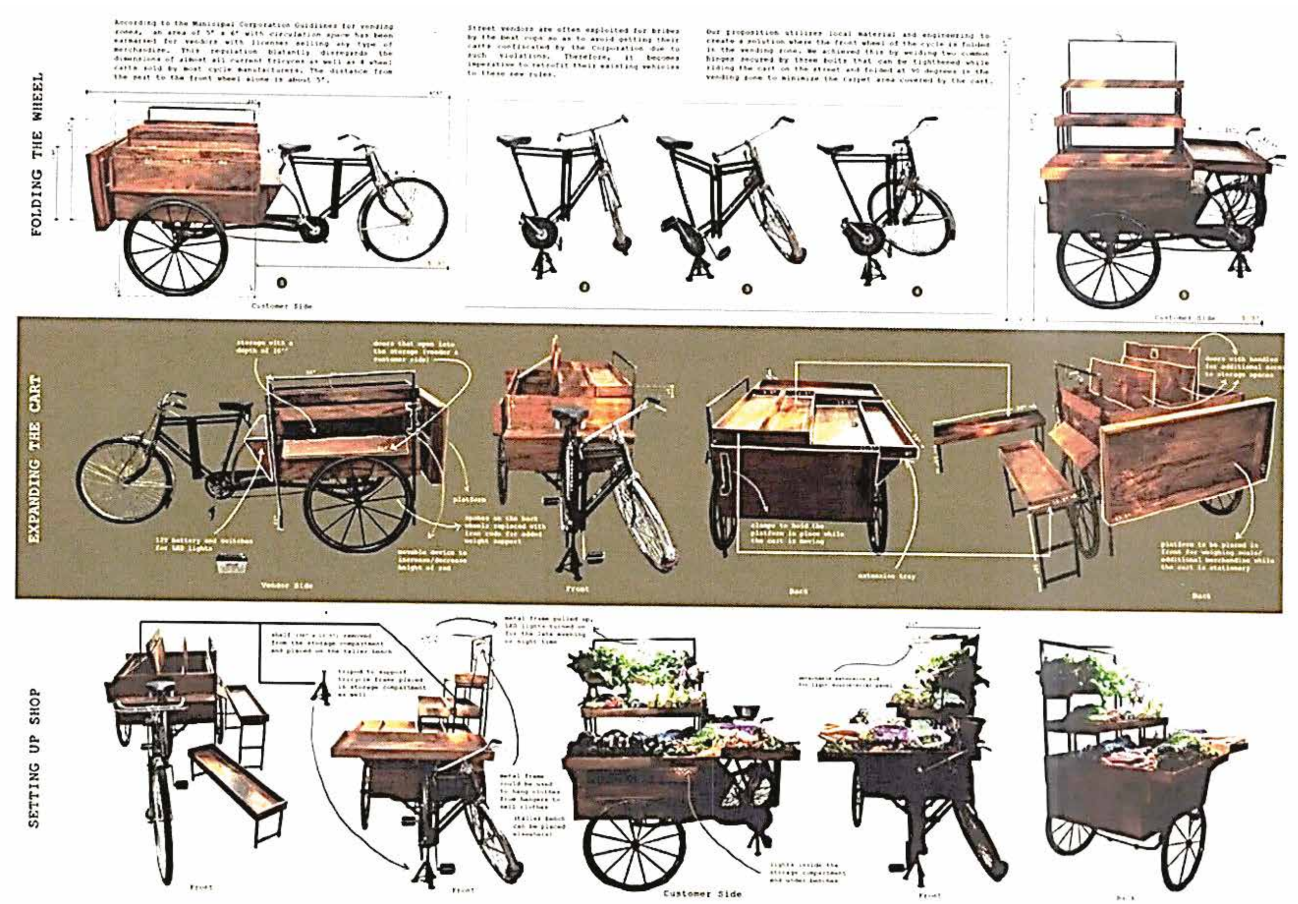


Fig. 12: Electric Cart for Street Vendors

Source: Gauri Nagpal, Seed for Change, Electric Carts for Street vendors, Graduate School of Design, Harvard University, Cambridge, MA, USA, 2023 in multi-storied apartments converts a house into a commodity and eschews participatory approaches (Fig. 11). On the contrary, Site and Services Resettlement helps in synchronising poverty reduction, livelihoods, community engagement and gender equity.

For most of the slum dwellers, livelihood is a major issue. 10% of the space in all shopping centres should be reserved for street vendors and informal traders. Electric handcarts for fruits and vegetable vendors can be designed with better storage and services (Fig. 12).

Slums are inevitable products of urban development. No word suggests more terrible image of the poor man's life. No word is more capable of rousing people to protest and shock the politicians' conscience. The challenge and litmus test of urban planning lies in addressing the issues of slums and squatter settlements.

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NEWS - GIS

Sceye partners with NASA to address climate change

Sceye have announced a cooperating research and development agreement with United States Geological Survey (USGS) and a Space Act agreement with NASA. The purpose of these agreements is to enhance climate and environmental imaging, monitoring, and data collection from the stratosphere. This collaboration positions Sceye's HAPS technology as a critical partner in providing precise earth observation and lifting multi-mission payloads. *https://sceye.com*

NV5 awarded $14 Million to advance global AI-driven data center

NV5 Global has been awarded $14 million in recent contracts to support the global development of data center infrastructure. It will support the scalability and efficiency of new construction and the retrofitting of existing data centers in response to the heightened electrical and cooling pressures of AI-driven workloads. *www.NV5.com*

Building the Geospatial Future Together – the NSDI Strategic Plan 2025 - 2035

The Federal Geographic Data Committee (FGDC), USA has developed a new Building the Geospatial Future Together – the NSDI Strategic Plan 2025 - 2035. The plan was approved by the FGDC Steering Committee in October 2024 and was endorsed by the National Geospatial Advisory Committee. The plan was developed with inputs from a variety of sources, including FGDC agencies, the National Geospatial Advisory Committee, and geospatial partner organizations. The plan expanded the previously more Federally-focused strategic plan and developed a broader nationally scoped plan, designed to encourage active engagement and leadership from multiple sectors The new plan presents a bold vision for the future of the NSDI in the U.S., emphasizing collaboration, partnerships, innovation, and technological advancement to create a seamlessly interconnected national geospatial ecosystem that delivers actionable insights to address the complex challenges of our time. *www.fgdc.gov/nsdi-plan*

GNSS Constellation Specific Monthly Analysis Summary: October 2024

The analysis performed in this report is solely his work and own opinion. State Program: U.S.A (G); EU (E); China (C) "Only MEO- SECM satellites"; Russia (R); Japan (J); India (I)

Narayan Dhital
Actively involved to support international collaboration in GNSS-related activities. He has regularly supported and contributed to different workshops of the International Committee on GNSS (ICG), and the United Nations Office for Outer Space Affairs (UNOOSA). As a professional employee, the author is working as GNSS expert at the Galileo Control Center, DLR GfR mbH, Germany.

Introduction

The article is a continuation of monthly performance analysis of the GNSS constellation. Please refer to previous issues for past analysis. The time transfer method using GNSS pseudorange measurements is further analyzed in this month's analysis. An example of the application of GNSS for on-board orbit determination and time synchronization in LEO missions is provided.

Analyzed Parameters for October, 2024

(Dhital et. al, 2024) provides a brief overview of the necessity and applicability of monitoring the satellite clock and orbit parameters.

a. Satellite Broadcast Accuracy, measured in terms of **Signal-In-Space Range Error (SISRE) (Montenbruck et. al, 2010)**.

b. **SISRE-Orbit** (only orbit impact on the range error), SISRE (both orbit and clock impact), and SISRE-PPP (as seen by the users of carrier phase signals, where the ambiguities absorb the unmodelled biases related to satellite clock and orbit estimations. Satellite specific clock bias is removed) (Hauschlid et.al, 2020)

c. **Clock Discontinuity**: The jump in the satellite clock offset between two consecutive batches of data uploads from the ground mission segment. It is indicative of the quality of the satellite atomic clock and associated clock model.

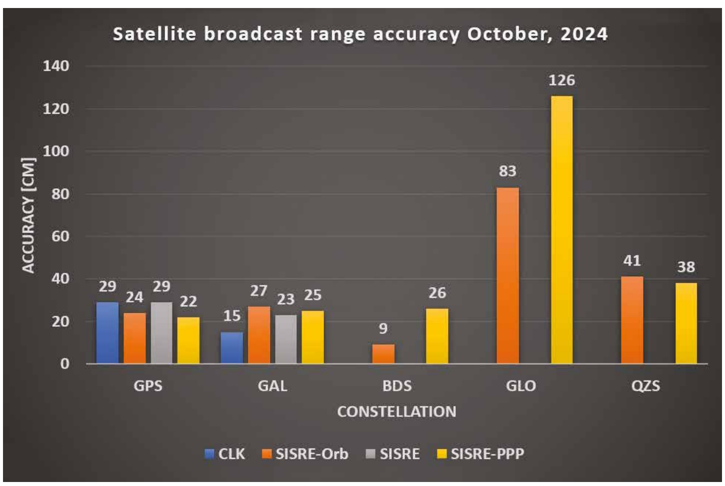
d. **URA**: User Range Accuracy as an indicator of the confidence on the accuracy of satellite ephemeris. It is mostly used in the integrity computation of RAIM.

e. **GNSS-UTC offset**: It shows stability of the timekeeping of each constellation w.r.t the UTC

f. **Time Transfer and LEO Mission Application**: The analysis shows the performance of kinematic orbit and satellite receiver clock determination for LEO missions.

Note:- for India's IRNSS there are no precise satellite clocks and orbits as they broadcast only 1 frequency which does not allow the dual frequency combination required in precise clock and orbit estimation; as such, only URA and Clock Discontinuity is analyzed.

(a), (b) Satellite Clock and Orbit Accuracy (monthly RMS values)



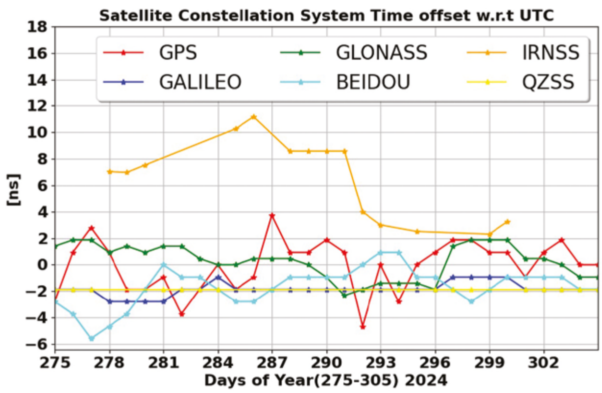
(c) Satellite Clock Jump per Mission Segment Upload

Const	Mean [ns]	Max [ns]	95_Percentile [ns]	99_Percentile [ns]	Remark (Best and Worst 95 %)
IRNSS	7.72	7741.08	7.86	36.17	Best I02 (4.49 ns) Worst I06 (19.89 ns) Big jumps for each satellite, in particular for I06
GPS	0.81	2836.23	0.87	2.09	Best G14 (0.43 ns) Worst G03 (2.49 ns) Relatively large jump for G10 (DOY 295); G17 (DOY 289); G05 (DOY 282); G30 (DOY 284)
GAL	0.09	3.62	0.18	0.44	Best E04 (0.14 ns) Worst E19 (0.37 ns). E30 had a relatively large jump on day 282. Note: E14 and E18 are excluded

(d) User Range Accuracy (Number of Occurrences in Broadcast Data 01-31 October)

IRNSS-SAT	2 [m]	2.8 [m]	4.0 [m]	5.7 [m]	8 [m]	8192 [m]	9999.9	Remark Other URA values (frequency)
I02	2990	11	2	2	2	-	-	-
I03	-	-	-	-	-	-	-	-
I06	1196	25	4	2	11	1	19	16 (2),11.3 (1)
I09	544	1	-	-	1	-	-	-
I10	847	3	-	-	1	1	-	-

(e) GNSS-UTC Offset



(f) Time Transfer and LEO Mission Application

Time synchronization and precise orbit determination is crucial in Earth observation satellites, telecommunication satellites and broad band services and GNSS has significantly advanced their mission capabilities. The use of legacy GPS receivers like Blackjack, PODRIX, IGOR and TriG and oscillators has been well documented, especially in missions like SWARM, Sentinel, CHAMP and GRACE. The time synchronization is driven by the short-term and long-term stability of the oscillators and two of those are the Ultra-Stable Oscillator (USO) for a better short-term stability and the Oven Controlled Crystal Oscillator (OCXO) for a better long-term stability. The performance of such oscillators in above mentioned satellite missions are provided in the references (check at the end of this section). In this article, only a brief analysis is carried out with a real Satellite data to demonstrate the use case of GNSS based inter-satellite time transfer. Figure f(1) shows the time synchronization accuracy for the SWARM mission (time link between SWARM A and SWARM B satellites) on October 1, 2024. This is based on the purely kinematic GNSS orbit & clock estimations that are referenced to the GPS timescale. There are various approaches and new innovative techniques regarding the high precision time link between satellites (check at the end of the section). In the SWARM mission, the oscillator is the OCXO and is integrated in the PODRIX GPS receiver. The comparison and mission specific usages between the OCXO and USO, particularly in terms of their stability and behavior, provides valuable insights into their performance in different conditions. Therefore, as an example, the satellite mission (Sentinel 6A and GRACE) using USO is analyzed as well (Figure f(2)). The stability of the oscillators tied to the GPS timescale are primarily driven by factors like the GPS estimation errors, the stability of the frequency oscillator itself, the systematic effects caused by relativistic effects or other factors, and stability of the real-time time reference. While the GPS estimation errors and the stability of the real-time time reference are key factors for the short-term stability, for the mid- and long-term stabilities, the behavior of the oscillator itself and the systematic effects play a more important role. In Figure f(2) the systematic effects are mainly coming from the effects of geophysical phenomena: the Southern Atlantic Anomaly (SAA) and relativistic effects. These systematic effects can significantly impact the performance of oscillators, especially in higher altitude missions and in inclinations that align the orbit with the SAA like Sentinel 6A, and in lower altitude missions closer to the Earth (like GRACE) where powerful relativistic effects are in action. In the plot, GRACE satellite clock offset is shown as free running clock which is not tied to a GPS timescale and as such has a linear trend. The behavior of the Sentinel 6A clock is also linear but the plot is based on the detrended data to focus on the period variations triggered by potential SAA and relativistic effects. A deeper analysis in this topic is found in references at the end of this section.

Most of the LEO missions are for Earth observations for which the precise location of the satellite instrument is critical. Furthermore, the on-board

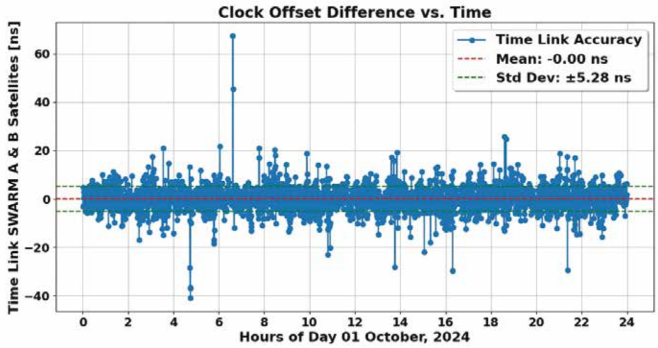


Figure f(1): The time transfer stability between SWARM A and SWARM B satellites using GPS IF combination with broadcast ephemerides.

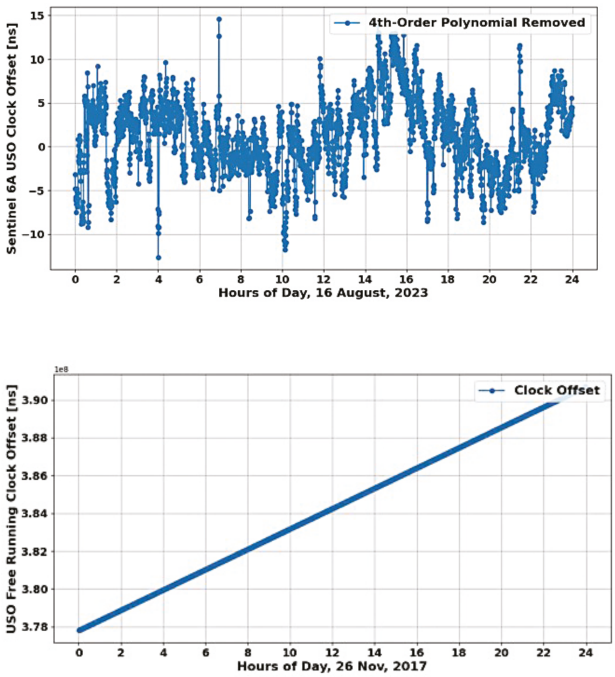


Figure f(2): The stability of the satellite clock driven by Ultra Stable Oscillator from Sentinel-6A (top) and GRACE (bottom). For Sentinel-6A, the fourth order polynomial is removed to detect the periodic variations. For GRACE, the clock offset is intact to show the free running nature of the USO driven clock.

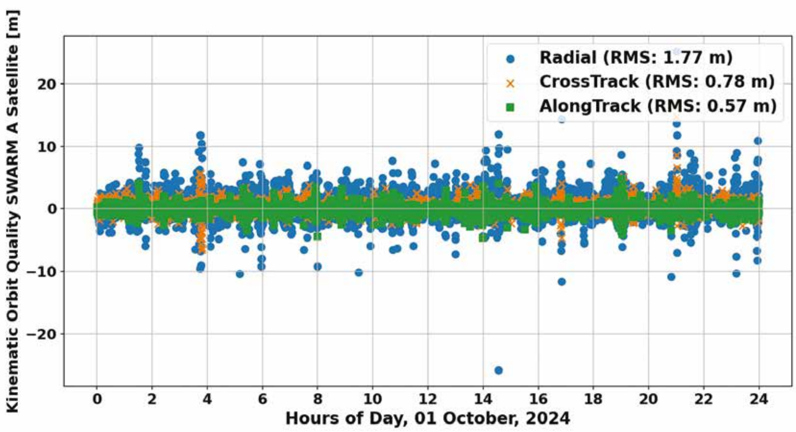


Figure f(3): The accuracy of kinematic orbit of SWARM A satellite based on GPS IF combination with broadcast ephemerides.

real-time clock estimation requires the precise knowledge of the orbits. The LEO based PNT services, for example, can benefit from the on-board precise orbit that can be used to tie the oscillator to GNSS timescale and use for LEO PNT signals as well. Therefore, a very short analysis is provided here focusing on capability of kinematic orbit determination using the dual-frequency code-only measurements with broadcast ephemerides. The Figure f(3) shows the orbit accuracy of the SWARM A satellite for October 1, 2024, in comparison to the precise science orbit. The advanced methods like PPP-AR and reduced-dynamics provide even precise orbits.

The data for above analysis is retrieved from European Space Agency's SWARM data portal (for SWARM satellite data), COSMIC data center (for GRACE data) and Copernicus Hub (for Sentinel data, accessed in 2023).

All important papers and product information used above analysis are listed here, providing the direct access sources:

1. Examples on the effects of SAA: https://www.tandfonline.com/doi/full/10.1080/10095020.2021.1917310#d1e6103 https://www.sciencedirect.com/science/article/abs/pii/S0273117716305282
2. Different methods of Time Transfer with LEO satellite (for inter-satellite link) using GNSS: https://navi.ion.org/content/navi/71/3/navi.659.full.pdf
3. Overview of various GNSS receivers used in LEO missions: Overview of Space-Capable Global Navigation Satellite Systems Receivers: Heritage, Status and the Trend towards Miniaturization
4. Performance of USOs and OCXOs: https://www.tandfonline.com/doi/full/10.1080/10095020.2021.1917310 https://www.tandfonline.com/doi/full/10.1080/10095020.2021.1917310

Monthly Performance Remarks:

1. Satellite Clock and Orbit Accuracy:
   - For Galileo, the performance looked similar to the past months.

- There is, however, a slight degradation in the orbit quality, hence, impacting the overall SISRE. GPS constellation provided several intermittent clock jumps, without drastic impact on the SISRE, that require further analysis and will be a part of next month's issue.
- For GLONASS, the overall performance looked similar to last month
- For BDS and QZSS, the performance looks very much the same as in the past.
- For IRNSS, I06 has the poorest performance in terms of URA and satellite clock jumps.

2. UTC Prediction (GNSS-UTC):
   - All constellations show better stability in comparison to previous months.

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Note: References in this list might also include references provided to previous issues.

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(The monitoring is based on following signals- GPS: LNAV, GAL: FNAV, BDS: CNAV-1, QZSS:LNAV IRNSS:LNAV GLO:LNAV (FDMA))

Time Transfer Through GNSS Pseudorange Measurements: https://e-learning.bipm.org/login/index.php Allan Tools, https://pypi.org/project/AllanTools/gLAB GNSS, https://gage.upc.edu/en/learning-materials/software-tools/glab-tool-suite

Mobile application based indoor positioning and navigational system using Dijkstra's algorithm

The proposed method is implemented in our college academic block and the experimental results show that our navigation method is feasible and effective

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Abstract

This paper offers a method for developing an efficient indoor navigation system with the consideration of the shortest path between source and destination. The challenge for the indoor navigation system is to provide personal navigation information and the optimal route. Applications of indoor navigation systems need consideration of the Shortest Path problem. The shortest pathways can be used to find solutions to the current problems using Dijkstra's algorithm. Based on the issue with the indoor navigation system, the shortest way and the best path are calculated. This is crucial to navigation systems since it can aid in making wise decisions and time-saving choices. The primary goal is to obtain the implementation at an affordable price. These applications and services are made available indoors, where the GPS does not function. The goal of indoor navigation is to direct users inside buildings. Dijkstra's algorithm for locating objects and for moving along the shortest path in an indoor setting are examined in this work. Experimental results of indoor navigation systems were carried out on my organization's indoor environment and verified the applicability of the presented Indoor Navigation System. The techniques provided include map digitization, locating a user, and choosing the shortest route. This is accomplished through a mobile application created for the Android operating system, and indoor navigation is carried out by using Dijkstra's algorithm. The proposed method is implemented in our college academic block, and the experimental results show that our navigation method is feasible and effective. To verify the reliability of the algorithm, the proposed application fulfils the criteria of an indoor navigation system to produce the optimal route between two points when applied to a map of our college's indoor terrain.

Introduction

Now-a-days, As the advancement in digital technology and its devices, Location Based Services (LBS) are considerably growing. LBS has long used global navigation satellite systems (GNSS) to navigate, get accurate and reliable information about the outdoor environment. The signals from GNSS are weak, when it penetrates through walls, making it impossible to get accurate indoor LBS [1]. Because GNSS are ineffective indoors, it takes a lot of research and development to create an indoor positioning system (IPS). For the development of IPS, numerous technologies and methods have been investigated.

As a result of various access points (APs) and multiple signal sources, the IPS is realised. [2] There are many ways for establishing the source signal such as Bluetooth low energy (BLE), ultra-wideband (UWB), radio frequency identification (RFID) tags, or use already installed APs, such as Wi-Fi, geomagnetic fields. A dead-reckoning technique called "signal-free solutions" in IPS uses commercially available mobile sensors to detect changes in location. Received signal strength (RSS), time of arrival (TOA), time difference of arrival (TDOA), and angle of arrival (AOA) are few of the IPS concepts for sensing radio signals [3]. Due to its simplicity of implementation and lack of additional hardware requirements, RSS has been commonly employed for IPS design.

Compared to the outdoor environment, it is difficult to predict the indoor radio signal transmission. Minor changes to the indoor environment can invalidate the indoor signal propagation model, which is typically based on a propagation channel and known barriers. Localization methods include trilateration and weighted centroid (WC) localization [4] compute the separation from the RSS using the wireless channel model. Additionally, these techniques need the route loss exponent to be precisely calibrated for each indoor environment.

Even when users are in strange environments, IPS aims to help them get to their final destination. A smartphone is required for the system, along with the installation of an application. The proposed method obtains blueprint data of an organization and updates them at the top of the map; the smartphone application is based on the building's floor plan. The integrated SDK in the mobile application will assist the third-party user in locating inside a building and determining the quickest route between the source and destination after updating the floor plan details in the map.

Related works

In the literature, a number of strategies have been put up that make use of various technologies, including infrared, ultrasound, WIFI, RFID, Bluetooth, Visible Light Communication (VLC), UWB, magnetic fields and Wireless ad hoc networks. According to the methods employed to estimate the position, the majority of existing technologies can be generally divided into four categories: trilateration/triangulation, fingerprinting, proximity, and dead reckoning.

RFID tags [5] come in two varieties: active and passive. Passive tags are used in the majority of modern RFID-based navigation systems, because they don't need an external power source. In order to estimate a position, RFID systems use received signal strength (RSS), angle of arrival (AOA), time of arrival (TOA), and time difference of arrival (TDOA). The widespread usage of RFID technology in navigation systems is due to its ease of use, low cost, and extensive operational horizons. Wi-Fi-based approaches are used in indoor settings [6], where there are enough Wi-Fi access points to avoid the need for a separate infrastructure; instead, these approaches can make use of the infrastructure already present in buildings since the majority of modern structures come with Wi-Fi access points. For positioning, Wi-Fi based indoor localization systems employ trilateration, triangulation, and RSS fingerprinting methods. However, non-line sight conditions indoors, other than RSS, other techniques might fail to precisely predict the user's location. Trilateration and fingerprinting are the popular RSS-based positioning techniques [7].

The precision of Bluetooth-based systems is almost on par with that of Wi-Fi-based systems, and they track users' movements using Bluetooth low energy (BLE) beacons as a source of RF signals, whereabouts using RSSI fingerprinting or proximity sensing techniques. Similar to Wi-Fi, BLE enables the implementation of localisation techniques like proximity, trilateration and fingerprinting. By intercepting the advertisement packets that the BLE beacons emit, the device might use a beacon to calculate the nearby RSS Signal [8]. The BLE beacon is often interoperable with Android and iOS devices, unlike Wi-Fi. Modern technology typically uses smartphones as a Bluetooth and Wi-Fi signal receiver. VLC-based systems are inexpensive since they make use of the existing LED lighting in buildings. In indoor spaces, these LEDs or fluorescent bulbs are increasingly common [9]. Using the camera on a smartphone or a separate photo detector, light coming from lamps is recognised. The most often utilised measurement techniques in VLC-based positioning systems are TOA and AOA. In [10], Positioning systems based on UWB can deliver accuracy in centimetre(cm) range, which is highly effective than Wi-Fi and Bluetooth. For position estimation, UWB uses TOA, AOA, TDOA, and RSS-based techniques.

The indoor navigation system will choose the user's path inside the built-in map based on their present location. A map that depicts the areas of an indoor environment and a tool for planning navigation routes make up the majority of the navigation module. Various algorithms [11-14] are most widely used for route planning. Additionally, there are certain systems that offer navigating without a map. The sections that follow discuss each of these systems. The benefit of using ML, according to a recent survey, is effective information collecting. Following an overview of the rationale for applying machine learning to indoor localization, the authors [15], examined ML-based methodologies using their own criteria and classified them into various categories of research topics. However, this survey didn't take into account how various ML-based solutions' respective performance metrics. The indoor navigation system in [16] used Google Glass and an Android phone. The techniques suggested for object detection using Hough Transform and Canny detection methods. By measuring the height of the floor region, the wall presence was detected by the floor recognition algorithm, because walls may be one of the key impediments in interior environments. However, the proposed method for object identification did not work for indoor low contrast wall pixels or bulletin boards. An indoor navigation system for malls was suggested by the author [17]. The GIST feature descriptor was employed in the proposed system, which improved image processing and required less memory. The primary tasks of the systems are keyframe extraction, geometric map creation, positioning and routing. The significant frames taken from walkthrough videos and utilised to build a topological map are called keyframes. The author [18] presented a wearable virtual usher that includes a camera which takes photographs of frontal images, headphones that allow users to hear voice routing instructions to get to a specified location, and a computer to assist users in discovering routes in indoor spaces for an indoor environment. A navigation system based on RFID technology, PERCEPT [19] which includes kiosks placed at the entryways and exits points of landmarks, "gloves" made of RFID readers, and passive RFID tags placed in indoor places. Information on significant locations and landmarks is available at the kiosks. Moreover, an Android smartphone with a text-to-speech engine that instructs the user. Wi-Fi and Bluetooth will be used by an Android phone to connect to the PERCEPT server and the glove. The PERCEPT system's directions are not precise enough. Furthermore, neither steps nor feet were used to describe the direction.

In [20], Underground mines cannot use the Global Navigation Satellite System (GNSS); additional technologies are required for localisation. Currently available sensors and radios in smartphones and tablets can give useful data for indoor localization using RFID tags, Bluetooth Beacons and other devices. Smartphones may be a very useful tool for mineworkers to carry around because they make localization and navigation much easier. But installation costs are needed and everyday locations of mines are changed frequently. By determining a user's location, obtaining information about the desired destination, and computing a path for navigation, Bluetooth Low Energy (BLE) beacon-based positioning systems are utilised for indoor mapping and creating a 2D indoor navigation system [21]. Dijkstra's algorithm and a specially created Indoor Positioning System (IPS) are used to accomplish this. This increases the cost of installation of BLE beacons. In [22], the author discussed different indoor localization methods and technologies. The author provides an overview of existing localization techniques and contrasts them in terms of precision, cost, benefits, and drawbacks. The author also compares various detection methods' accuracy and costs while presenting various detection strategies. In [23], the author discussed the various routing methods that adjust to dynamically changing environments. In order to improve road navigation, bio-inspired algorithms for finding the shortest path have been discussed. Dijkstra's Algorithm performs well on finding the optimal path between source and destination with fewer costs.

Numerous frequency bands, including the 0.9 GHz, 1.8 GHz, and 2.8 GHz bands, are used by cellular networks. Compared to Wi-Fi networks, these networks have better coverage and don't need any extra equipment. In the beginning, localization relied on proximity, where the mobile location was found inside the cell service area; however, this method yields incredibly poor results [24]. Utilizing the signals obtained from the Global System for Mobile Communications (GSM), localisation was carried out in [25] utilising RSS fingerprinting. In their research, fingerprints were taken from 6 cells and 29 GSM channels. According to a study on localisation using LTE-only and LTE-WLAN fingerprinting described in [26], LTE-only fingerprinting produces poor results while LTE-WLAN fingerprinting significantly improves performance. Other RF localisation methods that are currently in use, such as RFID and Wi-Fi, can be supported by cellular systems. In [27], the author created a location-based task reminder for indoor (and outdoor) mobile users and alerts them as they approach a desired and practical destination. The authors leveraged the widespread inside use of the IEEE 802.11 WLAN infrastructure to compensate for the absence of GPS position sensing, which was previously the only method of indoor localization. Their architecture, which is deployed on Android-based devices, principally relies on RSSI measurements at various ranges from the Wi-Fi AP and Database tables approach. In comparison to earlier architectures, it offers consumers better performance and a better user interface.

We aim to develop a smartphone app that can locate each visitor inside our college's academic building and point them in the direction of a specific location. The suggested strategy focuses on coming up with a simple and safe solution for the benefit of new guests to our college. There is a need to improve pathfinding and navigation for new students and guests due to the large area with numerous distinct buildings and rooms in our college academic block, so that they could discover any of the necessary services nearby. In this method, visitors can utilise a smartphone app to access digital guiding signs to go where they're going. The route to the different destinations and the classes can be projected on a digital map with sequential check points and paths to the benefit of new students, particularly during the registration period at the beginning of each semester. For these reasons, we made the decision to create a smartphone application that guides users to their goal by locating them on our college academic block. An academic block of our institution is considered as a testbed for the system and the obtained experimental results are discussed in later sections.

Proposed methodology

Analysis of indoor navigation apps

Today, almost everyone owns a smartphone, making it much simpler to navigate since these devices have built-in GPS systems that assist everyone in finding their way. These interior navigation apps are a gift for people in today's world where people are continuously moving from one area to another. When it comes to navigating inside spaces like crowded malls, cafes, shops, restaurants, public markets, or stores inside vast complexes, typical GPS-based mapping apps somehow fall short of expectations. Consequently, you require specialised indoor positioning and navigation apps that are distinct from outdoor navigation apps for use indoors. The issue is that because outdoor navigation mobile applications (Apps) rely on GPS signals, they frequently lose service in congested areas and within substantial complexes or buildings. These indoor positioning apps were created particularly for smaller places and use augmented reality to show your location using built-in GPS maps. The shortest paths to your location are provided when the user uses the built-in GPS maps present in the apps.

The indoor GPS navigation applications work similarly to outdoor GPS navigation apps in that they enable users to locate a certain spot inside of huge business facilities. This was the recent method in the position identification and navigational field. These Indoor Positioning System (IPS) enabled services make it easier to find places inside of airports, hospitals, and other buildings rapidly. It displays the users' current locations on the maps and points them in the direction of the quickest route to get them where they need to go. These apps primarily concentrate on navigation, positioning, and voice over notification to the users via their mobile devices so they can quickly get where they're going. They provide assistance to people and businesses in a variety of ways and enable users to move rapidly through densely populated, expansive retail malls and airports. Visitors may reach their destinations quickly and without any problems using indoor navigation apps, which eliminate the need for them to ask others for directions or search the internet. Simply download the app using your smartphone, then use it to quickly go to your desired location.

Drawing plans

Understanding the structure of a building is necessary for indoor navigation. This makes it possible to identify the points of interest and estimate the quickest path between the starting and ending location. The construction designs are also essential because they will serve as the primary user interface for the system. The real building dimensions must be included in these blueprints. There are tools that give us a variety of features that make it easier to create plans; one of these features is the ability to include photos that can stand in for locations like offices, classrooms, laboratories, etc. As soon as the building designs are created, they must be fully scaled in the navigation system. The recommended system will be updated with an organization's route map design and building structure plan design. To determine the user's location or position from the source to the destination point via the quickest route, the integrated software application is adapted for mobile applications. The tests were conducted in our organization, which was a 3 floor building. The building layout of our institution's academic block was shown in the following figure 1.

Development of algorithm

The algorithms for the indoor navigation system are being developed and put into use at this point. Algorithms are crucial because they allow for the location of a user to be determined, the creation of a route from one point to another, the suggestion of the best path, and the usage of GPS in open areas. The algorithms for position identification and navigation path generation algorithms are crucial to our concept since they allow for the completion of the most crucial tasks: Determine the location of a user and Create a path between a starting point and an ending point.

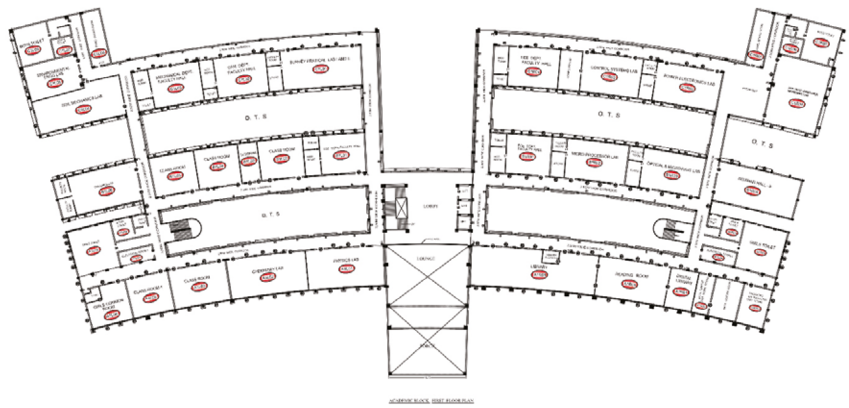

Figure 1. Building layout of our institution's academic block

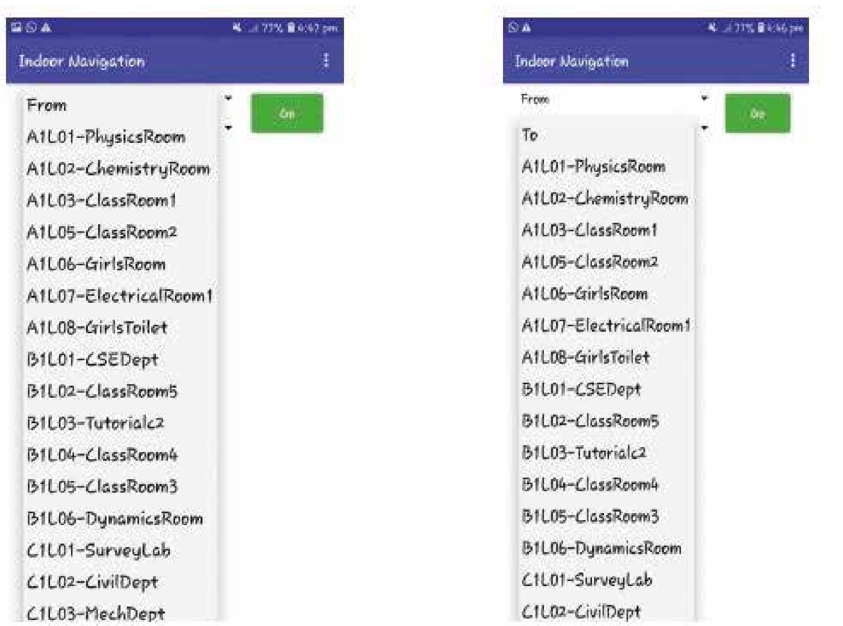

Figure 2. Selection of source and destination path in the indoor navigation mobile Android application

The straightforward technology behind this is that a smartphone application helps the user locate specific locations in an unfamiliar environment when GPS isn't available. The usage of an indoor navigation and positioning system aids users in finding specific locations within vast university campuses, corporate buildings, airports, malls, hospitals, etc.

Algorithm to identify the user's position and shortest navigation routes

The process of developing an indoor computer application is complex. The best navigational technology must be chosen based on the structure. Then, in relation to this technology, it is necessary to consider the techniques for measuring the distance and the algorithms for figuring out the way. However, research has demonstrated that the steps taken can be combined and presented as ways that are based on well-known methods and algorithms for developing a software solution for guiding individuals inside buildings without access to a GPS signal. The proposed system used the Dijkstra algorithm, which was discussed in the following section. Additionally, this algorithm utilises the ideal path. To employ it, the Dijkstra algorithm was modified to find the destination in an optimal way. This algorithm seeks to identify a user's location. This algorithm is used to determine the user's location, allowing us to determine the user's starting point, places visited, and when they arrived at their destination.

Dijkstra's algorithm

A label-set system called the Dijkstra algorithm categorises network nodes into three groups: marked nodes, temporarily labelled nodes, and nodes without labels. In order to begin searching, we initialise all of the nodes to be unlabeled, nodes that are connected to the shortest path nodes should be converted into temporary labelled nodes, and mark the nodes that are closest to the source point. Each cycle, we convert a selection of temporary labelled nodes into marked nodes, searching for the target nodes or labelling every node. A well-known algorithm for solving the narrow shortest path issue is the Dijkstra algorithm. After removing one side from the original path, it has been discovered that the problem of finding the particular shortest pathways in the subgraphs can be translated into the problem of finding the first N shortest paths.

Implementation

The proposed intelligent Indoor Navigation System was implemented in our educational organization, which is described in this section. The client-server architecture of the Indoor system allows mobile applications (clients) to communicate with the Server by sending requests. Then, based on the requests, the server sends a json response to the mobile application. Web Services are used for sending requests and responses. The appropriate implementation technology must be selected based on the suggested approach for creating the indoor navigation application. This section will identify the user-estimated location using a mathematical algorithm technique. Based on the mobile application, Android technology was used to pinpoint a user's exact location within an organization's indoor space. Then, using implementing technology, the system locates a user's destination location using the Dijkstra's shortest path on the building's planned layout. The information will be shown as an output feedback display in the mobile device via the integrated indoor navigation application system.

When the user has not correctly followed the directions, the Indoor App may tell. "You have departed from the route," the application notifies the user through voice command. In this scenario, the mobile app recomputed the path based on the user's position. The application also has the ability to recognise whether a user has switched buildings after beginning a route in another building. The purpose of the mobile app is to attain the user's destination point from the source point in an optimal route using the shortest path algorithm. The algorithm used in the mobile app is Dijkstraw's algorithm to identify the location where the user is located as well as to determine their exact position, indicating which building, floor, office, and other details they are in. You can specify the starting point and ending point with this level of geographic accuracy to create the best route.

Results

The tests performed to assess the proper operation of our Indoor Mobile Application and the Dijkstra algorithm to determine the best route are displayed in this part. The tests were conducted in our organization, which was a 3 floor building. The suggested system makes it easier for users to navigate within a constrained campus, which helps to minimise confusion and improves the system's physical environment. Users can choose the source and destination points for an interior navigation from the android system as shown in the following figure 2. Our specifically created solutions enable online and mobile applications to transform into personalised navigational aids that can handle any problem. The navigation outcome of the planned project, completed for our college. Dijkstra's method can be used to identify answers to the current issues utilising the shortest routes. The shortest route and the optimum path are determined based on the problem with the interior navigation system. This is important for navigation systems since it can help with making time- and decision-saving decisions. The implementation of the proposed system using Dijkstra's algorithm and its efficient indoor navigation system output was shown in the figure 3. The following table 1 indicates the comparative results of existing indoor localization technology with the proposed technology.

Conclusion

Most businesses and organisations use Android applications to give quick and simple access to their locations and goods in order to promote their operations and client services. It is preferable to use a mobile device with GPS services to identify unknown cities or locations when you have a smartphone in your hand. In reality, the Global Positioning System (GPS) services can track the user's location or locations via a mobile device. However, in enclosed spaces or foreign locations, the GPS service is unable to offer the hassle-free services. Applications for indoor positioning and navigation can address the issue in an indoor environment. The straightforward technology behind this is that a smartphone application helps the user locate specific locations in an unfamiliar environment when GPS isn't available. The usage of an indoor navigation and positioning system aids users in finding specific locations within vast university campuses, corporate buildings, airports, malls, hospitals, etc. Reduced hardware infrastructure, power usage, and system complexity have all enhanced the system. While preserving the system's accuracy, the cost of the system is also significantly lower.

Table 1: Comparison of proposed indoor localization technology with existing technology

Technology	Maintenance	Installation Costs	Sensitivity
Bluetooth Beacons Based	Average	High	Sensitive
Ultrasound or Wi-Fi Based	Average	High	Sensitive
Indoor Atlas Solution Based	Easy	Low	Based on electronic noise/ moving metal objects
Visible Light Communication Based	Easy	Average	Sensitive
Mobile Application Based (Proposed)	**No need**	**Zero**	**Works in all environment irrespective of sensitivity**

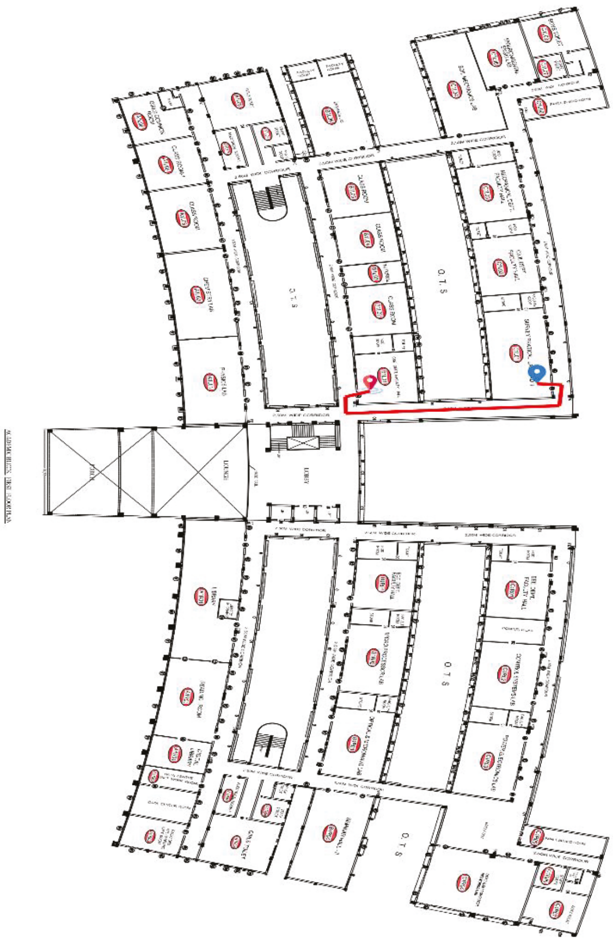

Figure 3. Implementation of shortest path between source and destination using Dijkstra's algorithm

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Intelligent airborne monitoring of irregularly shaped man-made marine objects using statistical Machine Learning techniques

The objective of this study is to create a new platform for the automated detection of irregularly shaped man-made marine objects (ISMMMOs) in large datasets derived from marine aerial survey imagery. Readers may recall that we published the first part of the paper in October issue. We present here the concluding part

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3. Experimental design

Offshore digital wildlife surveys for the offshore renewables sector are performed by APEM, capturing high quality images year round in all light conditions and up to four different sea states. The data is recorded using a wide range of advanced, high-resolution photogrammetry sensor technologies, including 35 mm and medium format sensors from a variety of manufacturers, in either multiple camera or a single camera configurations, subject to the scope of the project. These high-tech cameras, enabling a very high resolution ranging from 35MP to 50MP, are mounted in a tiny twin engine aircraft (e.g., *Fig. 17*) on a route where all areas of interest are monitored with geospatial data (i.e., latitude, longitude, and altitude). It is noteworthy to emphasise that we have followed the standardised way of constructing applications for real-world uses with the development phases of i) build the model using a dataset and move to the second phase if the test results are satisfactory ii) test/evaluate the model using another dataset completely different from the first dataset to observe if the test results are satisfactory without overfitting, and finally iii) let field experts evaluate the model with a completely new dataset independent from the first and second datasets. The model can be deployed if it passes these three phases successfully. These phases are outlined in Fig. 3. The obtained results as well as their evaluation are provided in the following section. The experimental design of data utilisation and data processing phases with their targeted objectives are outlined in Table 3 regarding the APEM‘s database. The viability of the methodology was ensured in 4 phases.

Phase I. Model construction (Fig. 3 I)**:** The proposed methodology was established using 145 images with ISMMMOs and 5000 images with no ISMMMOs acquired from the 22 surveys between 2014 and 2017, with around 250 samples from each survey. The sub samples of these surveys have around 3 million large-scale images that have been obtained from the various areas of the world in all seasons and numerous time zones. This large number of surveys enabled us to identify the broad features and parameters of aerial surveys and apply these parameters to make our methodology robust. All the steps of the model construction phase are explored in the sections above in detail. Phase II was conducted after the successful execution of Phase I by realising the targeted objectives, which is elaborated as follows.

Phase II. Test of the model (Fig. 3 II)**:** In addition to the dataset used for the establishment of the methodology, a test dataset was prepared. This set was composed of 55 images with ISMMMOs and 5000 images with no ISMMMOs, The test results are displayed in Table 10 A. We moved to the next phase to evaluate the system using independent datasets after the satisfactory results (*Se, Sp, PPV, NPV*, and *ACC* > 0.95) obtained in this phase.

Phase III. Evaluation using recent surveys (Fig. 3 III)**:** A dataset was prepared to evaluate the eligibility of the methodology. This set consists of 57 images with ISMMMOs and 5000 images with no ISMMMOs. This set is not included in the dataset used for the establishment of the methodology to observe if the methodology works as desired for other independent datasets. The test results are displayed in Table 10 B. We moved to the next phase to verify the system with field experts using other independent datasets after the satisfactory results (*Se, Sp, PPV, NPV,* and *ACC* > 0.95) obtained in this phase.

Phase IV. Validation by field experts using the most recent surveys (Fig. 3 IV)**:** Furthermore, in an independent verification dataset, 9 more images with ISMMMOs and 50 images with no ISMMMOs in different surveys from the surveys on which the methodology was established were provided by APEM for affirming the viability of the system to observe if the methodology can work as desired for any aerial datasets. Two field experts from APEM Ltd. confirmed that the established system can meet their needs to detect ISMMMOs while performing surveys. The test results are displayed in Table 10 C. The results (*Se, Sp, PPV, NPV*, and *ACC* > 0.95) obtained in this phase were found to be highly satisfactory by the field experts.

4. Results

The effectiveness of the proposed methodology in detecting images with ISMMMOs is demonstrated by several experiments performed on many aerial survey images as elaborated in Section 3. The results of these experiments are outlined in Table 10 and they are summarised in Table 11. The numerous tangible outcomes of these successful results are demonstrated in the supplementary technical reports of the paper and in Figs. 11f, 12f, 13f, 14f, 15f. With this approach, ISMMMOs can be captured with *Se, Sp, PPV, NPV*, and *ACC* values over 0.95. More specifically, 140 images out of 145, 55 images out of 57 and 9 images out of 9 in the test, evaluation and validation phases (Fig. 3) are tagged as the images with ISMMMOs successfully with a high Se over the targeted value (> 0.95) in the research, which indicates that the methodology is strong in separating positive images from negative ones in situations where it is preferable to not miss positive images. The particular results of these phases are averaged at the bottom column in Table 11. All the averages are higher than 0.95, which indicates that the required phases were completed successfully and the application is ready for real world deployment (Fig. 3). It is noteworthy to emphasise that Precision (Pr), i. e., Positive Predictive Value – *PPV* = *Pr* = TP / (TP + FP) – is 0.9813 for the average. This high value demonstrates that the model is highly successful in assigning "Positive" images to the "Positive" class while the 'Negative" images are assigned to the "Negative" class effectively with a NPV of 0.9995. Most importantly, we calculated Matthews Correlation Coefficient (MCC) due to an unbalanced number in the classes where the number of negative values were high, which may yield misleading ACC values. The MCC, ranging from – 1 to 1, was found to be 0.971, which indicates that the model is very close to a perfect prediction (i.e., 1).

During the implementation of the methodology, testing, and evaluation, it was observed that the ISMMMOs with completely white features (i.e., R = 255, G = 255, B = 255) had difficulties being detected by our methodology since they have the same characteristics as waves with respect to HSV conversion, where zero is assigned to the S component during the conversion from RGB to HSV mode (Table 1, Table 2). In this respect, it is worth noting that the images with ISMMMOs that could not be detected during the design and development phases (Fig. 3) are these types of images. Examples of these images are presented in Appendix B (Fig. 18). We refer the readers to Fig. 13 to observe how the white parts of the wind turbine cannot be detected adequately.

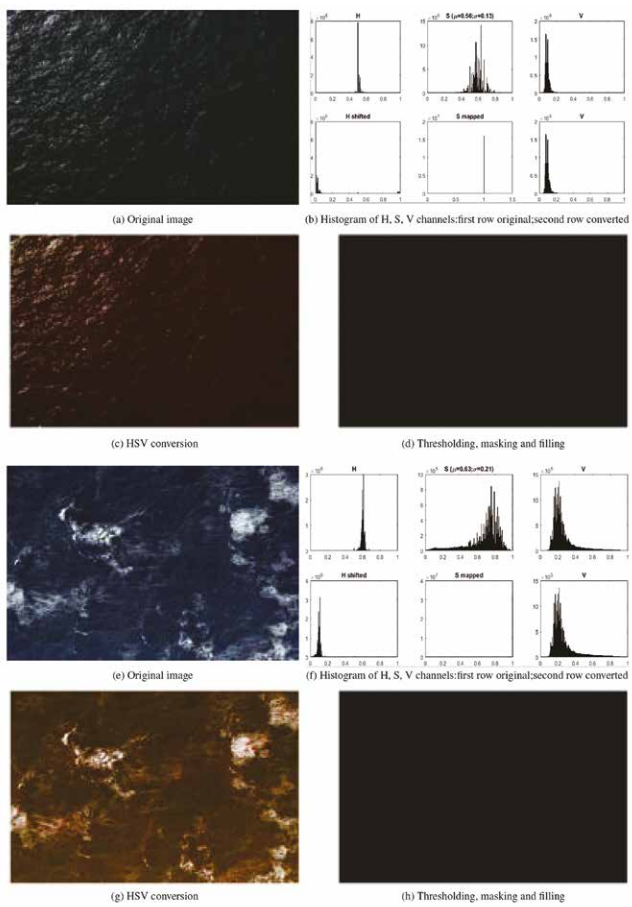

Fig. 16. Examples for blank images with no man-made objects.

5. Discussion

Gibert et al. (Gibert et al., 2018) defined Data Science as a multi disciplinary field that is a combination of data analysis, data processing techniques, and domain knowledge that transforms data into comprehensible and actionable insights relevant to making informed decisions. Within this context, the objective of this study is to create a new environmental platform for the monitoring of the maritime environment by combining domain knowledge and data scientists in a productive collaboration and perform the detection of mobile and stationary ISMMMOs in an automated manner with their geospatial coordinate system. Changes in the marine ecosystem, such as habitat loss or population decreases in marine organisms, may not be readily foreseeable and it requires long term studies to reveal the environmental changes and impacts on the ecosystem and consequently to determine the required policies accordingly. Studies in marine environments, especially far offshore, are comparatively costly and require the employment of new automatic techniques and merge of different studies for field researchers. In this sense, this study intends to help authorities and researchers with the automatic detection of offshore ISMMMOs using an advanced platform to fill some of this gap.

Fig. 17. APEM aircraft during an aerial survey.

The robustness of the platform was validated on a wide range of aerial maritime domains, providing a high level of empirical proof of concept with successful results (Table 11). Strictly speaking, the experimental results show that the proposed approach is efficient and effective for the detection and the segmentation of ISMMMOs in large scale aerial images. More specifically, the dynamic thresholding approach employed in the methodology increases Se from 0.85 to 0.97 and Sp from 0.82 to 0.99 when compared to the static optimum threshold value as displayed in Table 4. This increase is statistically significant *($p<0.01$)* by rejecting the null hypothesis (i.e., there is no significant difference between two results) using a paired-samples t-test. The ISMMMOs not detected by the methodology are all complete white objects. This issue is specified in Section 7 as a limitation of the study. Furthermore, the evaluation and validation results using the new data-sets (Table 10) that were not in the surveys used during the establishment of the methodology (Fig. 3) demonstrate that the methodology can work effectively on any aerial survey with high accuracy rates. In other words, during the evaluation phase, 55 out of 57 images with ISMMMOs were put into the positive folder and 4998 out of 5000 images with no ISMMMOs were placed into the negative folder. During the validation by field experts, 9 out of 9 images with ISMMMOs were put into the positive folder with all objects detected successfully and 50 out of 50 images with no ISMMMOs were placed into the negative folder successfully. It must be noted that the developed methodology neither classifies the detected ISMMMOs into groups nor determines the recognition of them, such as “ship”, “wind turbine” etc. Particular classification tools need to be developed to group the ISMMMOs that are placed in the positive directory by the proposed technique in this study, which is proposed as a future work in Section 6. Bespoke semi-supervised ML approaches (e.g., SelfMatch in (Xing et al., 2022a)) can be a good candidate for addressing this type of research question by extracting features from labelled data and comparing them with the features that are obtained from detected ISMMMOs based on the semantic information (e.g., (Xiao et al., 2022) and a feature/distance based matching scheme (e.g., (Xing et al., 2022b)) considering various pose compositions (e.g., (Çalıs¸kan, 2023)). The methodology not only distinguishes ISMMMOs from the blank background (sea canvas with waves in many different shapes), but also from other objects (e.g., different types of flying birds, sitting birds, big mammals (e.g., whales, dolphins), sharks, turtles, rays) in images with various shapes and characteristics successfully for which several examples can be reached in the technical report (e.g., Fig. 3 in MarineObjects_Man-made_Supplement_1.pdf) in the supplements. The results suggest that the saturation of maritime natural objects is significantly different from ISMMMOs. The processing time for each image varies from 7 s to 16 s, depending on the image size and the number of objects in the image and

Table 10: Detailed confusion matrix of the classifiers outlined in Table 11.

		A. Test Results (UCLAN)			B. Evaluation (UCLAN)			C. Validation (APEM)		
		Actual Class			Actual Class			Actual Class		
		Positive	Negative	%	Positive	Negative	%	Positive	Negative	%
Pred	Positive	140 (TP)	3 (FP)	0.9790 (PPV)	55 (TP)	2 (FP)	0.9649 (PPV)	9 (TP)	0 (FP)	1 (PPV)
	Negative	5 (FN)	4997 (TN)	0.9990 (NPV)	2 (FN)	4998 (TN)	0.9996 (NPV)	0 (FN)	50 (TN)	1 (NPV)
	%	0.9655 (Se)	0.9994 (Sp)	**0.9984 (ACC)**	0.9649 (Se)	0.9996 (Sp)	**0.9992 (ACC)**	1 (Se)	1 (Sp)	**1 (ACC)**

Table 11: Test, evaluation and validation results in summary detailed in Table 10.

Phase	*Positive*	Negative	*TP*	*FN*	*TN*	*FP*	*Se*	*SP*	*PPV*	*NPV*	*ACC*	*Location*	*Check*
Test	**145**	**5000**	140	5	4997	3	0.966	0.997	0.9790	0.9990	0.9984	UCLAN	✓
Evaluation	**57**	**5000**	55	2	4998	2	0.965	0.999	0.9649	0.9996	0.9992	UCLAN	✓✓
Validation	**9**	**50**	9	0	50	0	1	1	1	1	1	APEM	✓✓✓
Verification	**211**	**10,050**	**204**	**7**	**10,045**	**5**	**0.977**	**0.9987**	**0.9813**	**0.9995**	**0.9992**	**Average**	✓✓✓✓

their sizes, which is a very fast processing time for high-pixels-per-image (HPP) images up to 50 MB based on the camera system that is explained in Section 3. The overall computational complexity of the developed algorithms is O(n log n). It is important to point out that the supervised DL and ML approaches, designed by us in our previous work in (Kuru et al., 2023), that runs on similar images in the same surveys, can detect specific marine small natural objects (e.g., birds) in a few seconds (i.e., between 2 and 4 s). In this sense, we can conclude that DL and ML techniques slightly outperform the proposed non-supervised technique developed in this study considering the processing time.

The current rate of global environmental alteration necessitates the quantification of

Appendix B. Examples for objects not detected by the proposed approach

Algorithm 3: Function titled startSplittingManMadeObjects:Main methodology: Phases of the operations to detect man-made objects in images.

```
Data: The target directory of a survey with images (imageDir)
Result: Two directories, one of which is for images with man-made objects, and the other is for other images.
− >Variables;
Rmin = 12.5; Rmax = 1000; curCount = 0; counter = 0; posImageCount = 0; hAdjust = 180; sAdjustPer = 0.25; files=dir(strcat(imageDir,';'*.jpg')); path =
  strcat(imageDir,''); steps = numel(files);
foreach k=1:numel(files) do
    file_name=files(k).name; image_name=strcat(path,file_name);
    − > Get positive image name and change it by adding _ at the end to move changed and not changed ones into same directory;
    [pathstr,name,ext] = fileparts(file_name); name = strcat(name,'_'); new_file_name = strcat(name,ext);
    Irgb=imread(image_name);
    figure; imshow(Irgb);
    index = k; index_image = k;
    newImage = HSVadjustManMade(Irgb, hAdjust,sAdjustPer);
    imshow(newImage);
    ImgR = newImage(:, :, 1); ImgG = newImage(:, :, 2); ImgB = newImage(:, :, 3); [M N] = size(ImgR);
    − >Get location of pure red pixels;
    Rmask = logical(zeros(M, N)); Rmask = ((ImgR < 0.25 & ImgG < 0.80 & ImgB > 0.35) & (ImgR < (ImgB) & ImgG < (ImgB)));
    − >Replace the pixels with some other colour;
    ImgR(Rmask) = 255; ImgG(Rmask) = 255; ImgB(Rmask) = 255; ImgR(Rmask==0) = 0; ImgG(Rmask==0) = 0; ImgB(Rmask==0) = 0;
    − >Combine into a new image;
    Img_new(:, :, 1) = ImgR; Img_new(:, :, 2) = ImgG; Img_new(:, :, 3) = ImgB;
    figure; imshow(Img_new);
    − >create indexed image from binary;
    BW = im2bw(Img_new,0.05);
    − >loop over ICE_threshold;
    ICE_threshold = 0.1; ICE_sigma = 2; img_edge = edge(BW, 'canny', ICE_threshold, ICE_sigma);
    − >create 3x3 array of 1s for dilate mask;
    SE = ones(3);
    − >dilate image to create closed boundary for birds with incomplete boundaries defined;
    img_dilate = imdilate(img_edge, SE); img_dilate2 = imdilate(img_dilate, SE);
    − >fill objects with closed boundaries;
    img_fill2 = imfill(img_dilate2,'holes');
    L = bwlabeln(img_fill2);
    − >get the centroid of each object to use as seeds for local neighbourhood definitions;
    stats = regionprops ('table', L, 'Area', 'BoundingBox', 'Centroid', 'MajorAxisLength','MinorAxisLength'); stats1 = regionprops (L, 'Area',
      'BoundingBox', 'Centroid', 'MajorAxisLength','MinorAxisLength'); statsDetected = stats1;
    − >Get centers and radii of the circles;
    centers = stats.Centroid; centers diameters = mean([stats.MajorAxisLength stats.MinorAxisLength],2); radii = diameters/2; radiiDedected =
      diameters/2; centersDetected = centers;
    − >count the number of objects in the image;
    no_objects = size(stats, 1);
    if no_objects < 11 then
        Rmin = 7.5;
    else if no_objects > 10 && no_objects < 101 then
        Rmin = 12.5;
    else
        Rmin = 20.5;
    imshow(Irgb);
    for object = 1:no_objects do
        if (diameters(object) > Rmin*2) && (diameters(object) < Rmax*2) && (stats1(object).MajorAxisLength < Rmax*2) &&
          (stats1(object).MinorAxisLength > Rmin*2) then
            − > Save image x and y coordinates into variable 'seed';
            posImageCount = posImageCount + 1; seed(object,1) = round(stats1(object).Centroid(1)); seed(object,2) =
              round(stats1(object).Centroid(2));
            − > Signify the object;
            hold on; plot(stats1(object).Centroid(1), stats1(object).Centroid(2), 'g+'); hold off;
    if (posImageCount > 0) then
        curCount = str2double(get(handles.edtPosCount,'String'))+1; set(handles.edtPosCount, 'String', num2str(curCount));
        − > Save the updated image with the signified objects;
        saveHighResolution(posSubFolder,new_file_name); − > remove the original image from processing folder;
        movefile(image_name,posSubFolder); delete(image_name)
    close All; clear All;
    − > Set the variable to 0 for next image;
    posImageCount = 0;
    − > Update the progress;
    waitbar(k / steps,h,'Man-made object detection is procesing...');
result = 'Man-made objects are tagged on the image';
```

impacts in species abundance in order to evaluate the effects on the ecosystem. To assess the extent of the decline, effective long-term surveillance of populations and trends is required, which is rarely the case for most species (Rosenberg et al., 2019). Environmental models work better when they are based on the findings of more up-to- date data analysis on specific domains. It is essential to continuously monitor species and ISMMMOs in an automated manner cost-efficiently, which necessitates the utilisation of sophisticated equipment with effective intelligent surveillance methods. In this regard, WILDetect, which is a new non-parametric platform by utilising a combination of supervised ML and Reinforcement Learning (RL) methods, was built in our previous work in (Kuru et al., 2023) to carry out automated wildlife censuses in highly dynamic marine environments. With similar automated platforms, one of which is proposed in this research for detecting ISMMMOs, existing labour-intensive and costly censuses performed over long periods of time can be replaced by cost-efficient and highly automated computerised systems and they can be repeated automatically in regular, shorter periods. In this way, the environmental models, equipped with near-real-time outcomes for both marine wildlife and man- made presence, can foretell future trends with more realistic projections based on human footprint, which, in turn, help mitigate the potential damaging effects of human footprint.

The large number of surveys, that were conducted in the various geographical regions and in the various time zones and seasons, on which our methodology was built, represent the key features of aerial surveys, which made our approach powerful and resilient in detecting ISMMMOs with very high accuracy rates

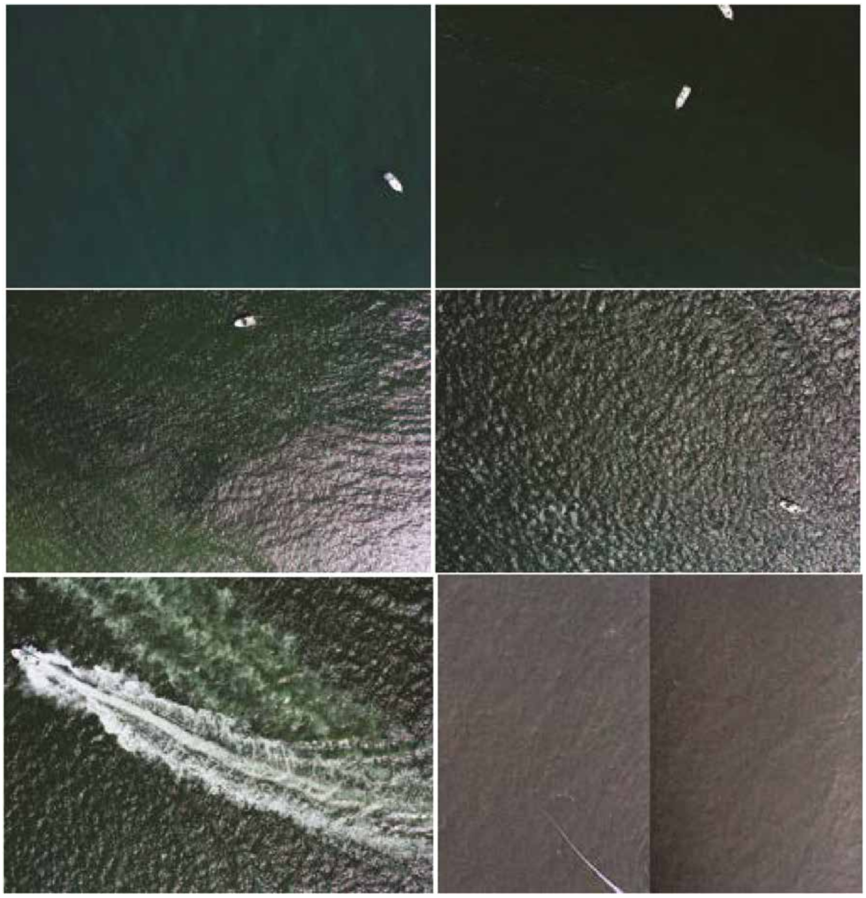

Fig. 18. Examples for objects not detected:

6. Conclusions and future work

A novel methodology, the so called ISMMMOD, that detects and splits ISMMMOs automatically in large-scale images in typical large marine surveys is built. The ISMMMOD is developed using the HSV colour space and statistical analysis of histograms of the channels in this space based on the ROC curve analysis. The techniques in the methodology differ man-made structures from natural maritime habitats (i.e., waves, sea animals, birds, seawater) in various aspects, in particular, composition, features of the surface and saturation of light. The large number of surveys, that were conducted in the various geographical regions and in the various time zones and seasons, on which our methodology was built, represent the key features of aerial surveys, which made our approach powerful and resilient in detecting ISMMMOs with very high accuracy rates. The successful results obtained in this research (Table 11) is an indication that using an automated computer- based system could be an effective alternative to labour-intensive approaches. The approach built in this study can be employed for several reasons, in particular, will provide researchers and policymakers with the ability to monitor maritime industries and ensure their proper deployment through the implementation of a suitable legal and regulatory framework that takes into account the changing dynamics of marine ecosystems. Additionally, this study will direct the researchers who would like to establish similar systems using unsupervised approaches.

The proposed method was tested on large-scale aerial images acquired by aeroplanes and we would like to observe the results of our method on satellite images wherever datasets are available, which may reduce the cost significantly regarding the detection of ISMMMOs and may provide a real-time and quick evaluation of ISMMMOs in marine ecosystems. This study may direct other studies about the automatic classification of marine ISMMMOs. We will be developing other novel nonparametric approaches to detect maritime life (e.g., different types of flying birds, sitting birds, big mammals (e.g., whales, dolphins), sharks, turtles, rays) automatically in large number of images in surveys using supervised approaches (e.g., (Kuru et al., 2023)) to help evaluate the maritime industry and natural ecosystem together within well- prepared models. We aim to incorporate the built methodology with camera systems used in aeroplanes and unmanned aerial vehicles (UAVs) and to employ it in real-time rescue missions on high seas and open oceans as a future work, in particular, after aeroplane crashes and maritime accidents to find wreckages and survivals.

7. Limitations of the study

Complete white ISMMMOs as displayed in Appendix B (Fig. 18) have the same characteristics as waves (R = 255, G = 255, B = 255) with respect to HSV conversion, in particular, saturation. As it can be readily noticed in Table 1, zero is assigned to the hue and saturation during the conversion from RGB to HSV colour space when the values for the RGB colour space is 255, 255, 255 for the three channels. Our techniques perform successfully where the hue and saturation values are distinctive (i.e., $H > 0$ and $S > 0$) and therefore, these types of objects can not be detected using the approach built in this study.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix C. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecoinf.2023.102285.

End notes

[1] https://apem-inc.com

[2] https://www.apemltd.co.uk

[3] APEM Ltd. is an environmental company and proposes novel solutions for environmental problems (https://www.apemltd.co.uk).

[4] The reports from 1 to 7 titled as MarineObjects_Man-made_Supplement are for ISMMMOs and the reports from 1 to 5 titled as MarineObjects_Man-made_Supplement_Blank are for blank images.

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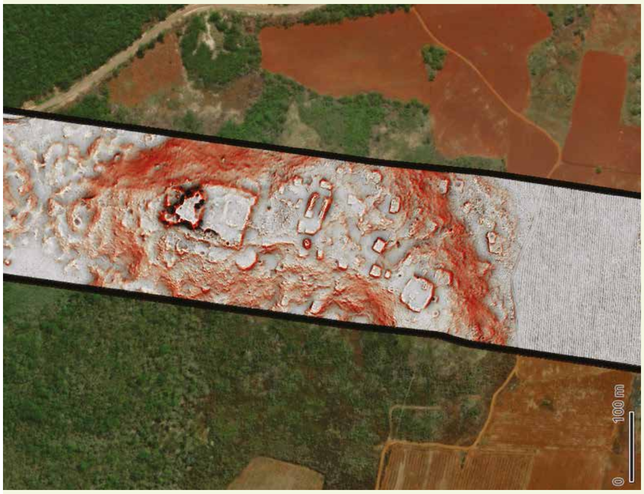
Lidar helps uncover lost Mayan city

Using laser-guided imaging to peer through dense jungle forests, Tulane University researchers have uncovered vast unexplored Maya settlements in Mexico and a better understanding of the ancient civilization's extent and complexity.

The new research, published in the journal Antiquity, was led by Tulane University anthropology doctoral student Luke Auld-Thomas and his advisor, Professor Marcello A. Canuto.

The team used lidar, a laser-based detection system, to survey 50 square miles of land in Campeche, Mexico, an area largely overlooked by archaeologists. Their findings included evidence of more than 6,500 pre-Hispanic structures, including a previously unknown large city complete with iconic stone pyramids.



Ancient buildings clustered on a hilltop are revealed by a narrow transect of lidar survey data. Lidar technology uses laser pulses to measure distances and create 3D models of specific areas. (Photo courtesy Luke Auld-Thomas)

"Our analysis not only revealed a picture of a region that was dense with settlements, but it also revealed a lot of variability," said Auld-Thomas, a doctoral student in Tulane's Anthropology Department and instructor at Northern Arizona University. "We didn't just find rural areas and smaller settlements. We also found a large city with pyramids right next to the area's only highway, near a town where people have been actively farming among the ruins for years. The government never knew about it; the scientific community never knew about it. That really puts an exclamation point behind the statement that, no, we have not found everything, and yes, there's a lot more to be discovered."

The Middle American Research Institute (MARI) at Tulane University has been pioneering the use of lidar technology in archaeological research. Over the past decade, MARI has built a state-of-the-art GIS lab, to analyze remote sensing data, such as lidar. The lab is managed by Francisco Estrada-Belli, a research professor in Tulane's Department of Anthropology.

Lidar technology uses laser pulses to measure distances and create three-dimensional models of specific areas. It has allowed scientists to scan large swaths of land from the comfort of a computer lab, uncovering anomalies in the landscape that often prove to be pyramids, family houses and other examples of Maya infrastructure.

This research may also help resolve ongoing debates about the true extent of Maya settlements.

The study highlights the transformative power of lidar technology in unveiling the secrets of ancient civilizations. It also provides compelling evidence of a more complex and varied Maya landscape than previously thought. *https://news.tulane.edu*

Russian rocket launches Iranian satellites

A Russian rocket blasted off successfully to carry a pair of Iranian satellites into orbit, a launch that reflected growing cooperation between Moscow and Tehran.

The Soyuz rocket lifted off as scheduled from Vostochny launchpad in far eastern Russia and put its payload into a designated orbit nine minutes after the launch. It was carrying two Russian Ionosphere-M Earth observation satellites and several dozen smaller satellites, including the two Iranian ones.

Iran's two satellites, named Kowsar and Hodhod, were the first launched on behalf of the country's private sector. In 2022, a Russian rocket launched an Iranian Earth observation satellite called Khayyam that was built in Russia on Tehran's order, and in February Russia put another Iranian satellite named Pars-1 into orbit. *apnews.com*

China launches new group of remote-sensing satellites

China successfully sent a new group of remote-sensing satellites into space from the Jiuquan Satellite Launch Center in northwest China on November 9, 2024.

The four satellites of PIESAT-2 were launched at 11:39 a.m. (Beijing Time) by a Long March-2C carrier rocket and entered its planned orbit successfully. They will mainly provide commercial remote-sensing data services.

Microsatellite Project to Monitor Objects in Space Over Canada, South Pole – Brantford Expositor

An exciting new satellite project to monitor and protect the Earth's orbital environment is underway. University of Manitoba (UM) and Magellan Aerospace (Magellan), in collaboration with Canada's Department of National Defence (DND) science and technology organization, Defence Research and Development Canada (DRDC), and the United Kingdom's Defence Science and Technology Laboratory (Dstl), are working together to make it a reality.

Magellan and UM, both based in Winnipeg, Manitoba, are currently partnered on the DND-funded Redwing space domain awareness microsatellite project. Redwing is a research and development (R&D) microsatellite valued at $15.8 million, that is being designed, built, and operated in Canada. Redwing will monitor objects orbiting Earth to help reduce future risks to Canada's space infrastructure from space debris or human-caused interference. Magellan is responsible for designing, building, and testing the Redwing spacecraft as well as for mission operations. Other Redwing mission partners include ABB Inc (main optical payload), C-CORE (operations support), as well as York University and UM (R&D support).

In April 2024, Canada's DND signed a contract option with Magellan for $900,000 to add a companion nanosatellite to the Redwing mission. The nanosatellite, known as Little Innovator in Space Situational Awareness (LISSA), will be integrated with the Redwing satellite and will be deployed from Redwing sometime after launch, once the two spacecraft have achieved an orbit at the designated altitude.

Leveraging the expertise provided by Ferguson and UM's STARLab, Magellan is contracting the design and build of LISSA with UM. LISSA will follow in the same orbit as Redwing, operating some distance from it in a tandem in-track formation. In addition to performing its own observations, LISSA will serve as a convenient nearby object with which to exercise Redwing's own monitoring and imaging capabilities.

LISSA will focus on observing satellites as they pass over the Earth's South Pole, a region that is not well-covered by ground-based space surveillance sensors. Reflected light from ice and clouds during the Antarctic summer presents a significant technical challenge when imaging other space objects in visible light. For this reason, the UK's Dstl is providing a short-wave infrared camera to be hosted on the LISSA nanosatellite, which will be less impacted by light scattered from the ice sheet. Also, many satellite materials are more reflective in the short-wave infrared increasing the likelihood of detecting them.

Both Redwing and LISSA are expected to launch in 2027. Both satellites will be operated by Magellan with support from UM's STARLab, communicating through ground antenna stations owned by C-CORE in Inuvik, Northwest Territories and Happy Valley-Goose Bay, Newfoundland and Labrador. Mission data will be analyzed by DRDC and Dstl. *https://nationtalk.ca*

Snow returns to Mount Fuji

Mount Fuji, Japan's highest peak, has seen its first snowfall after one of the longest periods without snow since records began 130 years ago.

The Copernicus Sentinel-2 mission captured this image of Mount Fuji's iconic snowcap on Nov. 7, 2024, a day after snow was first spotted by the Japan Mereological Agency's Shizuoka branch.

Sentinel-2 carries a high-resolution multispectral imager to deliver optical images from the visible to the shortwave-infrared region of the electromagnetic spectrum.

CREDIT: contains modified Copernicus Sentinel data (2024), processed by ESA

Quantum-sensing technology for alternative PNT by Royal Navy

The Royal Navy, UK has successfully tested a new quantum sensing technology designed for underwater detection. Conducted off the coast of Plymouth aboard HMS Magpie, the trials aimed to evaluate the effectiveness of this quantum-sensing system in identifying submerged objects.

The technology leverages ultra-cold atoms to measure subtle variations in the Earth's magnetic field, which indicate underwater objects. This method allows for the detection of items that traditional sonar systems might miss, enhancing the precision of underwater surveys.

During the tests, the system identified various targets, including a concrete block weighing one ton, and demonstrated sensitivity sufficient enough to detect objects as small as a soccer ball.

This project is part of a broader collaboration involving the Royal Navy, the Defense Science and Technology Laboratory (Dstl) and industry partners. It reflects ongoing efforts to integrate advanced technologies into naval operations, aligning with the UK's strategic focus on quantum technologies.

Future plans include further development and miniaturization of the quantum sensing system to enable its deployment on various naval platforms, such as ships and submarines, as well as autonomous underwater vehicles. The successful trials indicate that this technology could significantly improve the Royal Navy's capabilities in maritime security and underwater exploration. *www.royalnavy.mod.uk*

Space Force's new GPS satellites are months behind schedule

The Pentagon's first batch of advanced GPS satellites, part of the GPS IIIF program, is experiencing significant delays. The initial batch is now projected to be eight to eleven months behind schedule, with the U.S. Space Force citing manufacturing issues from contractor Lockheed Martin, particularly with complex components critical to the satellites' functionality. The first satellite, originally slated for launch in April 2026, is now expected to be delivered by November 2026.

The GPS IIIF program, a $9.2 billion initiative, aims to deploy up to 22 next-generation satellites. The first ten satellites in the series are designed to improve the GPS system with greater accuracy and enhanced jamming resistance. These upgrades will benefit both defense applications and civilian uses like navigation.

The new F-model satellites are expected to offer better navigation accuracy, compatibility with European satellites, enhanced cyberattack and jamming resistance, and improved search-and-rescue capabilities for detecting emergency beacons.

The primary challenge appears to be production delays in the Mission Data Unit, a key component for improved navigation, which is being manufactured by subcontractor L3Harris Technologies. The company is reportedly facing technical issues with this part.

Despite these setbacks, Lockheed Martin is said to be on track to meet its contracted delivery dates, though it may miss the Space Force's preferred launch schedule. The Space Systems Command also notes that global inflation and supply chain disruptions have contributed to the delays, though it stresses that Lockheed Martin, as the primary contractor, is responsible for managing all aspects of satellite development and production.

Europe's first verified GNSS data stream service

The National Standards Authority of Ireland's National Metrology Laboratory (NSAI NML) launched the Europe's first ever verified GPS/GNSS Data Stream (VGDS) service, an extension to the National Timing Grid of Ireland (www.ntg.ie). This initiative developed in partnership with Timing Solutions, marks a significant step forward in ensuring secure and reliable GNSS data, vital for government organisations, public institutions and business sectors as a source of accurate time.

The VGDS service provides verified GNSS data in the form of Radio Technical Commission for Maritime Services (RTCM) packets via the internet, allowing users to verify their own GNSS data streams.

As Ireland's national authority for measurement standards, NSAI NML is responsible for creating, maintaining and developing the national measurement standards for physical quantities (e.g. kilogram, second, meter, etc.) and making these standards available to Irish users. The VGDS service is being delivered by NSAI NML and led by specialist partner Timing Solutions, a NovaUCD and ESA BIC Ireland client company. *www.nsai.ie*

JAXA picks ArkEdge for LEO PNT study

ArkEdge Space, a Japanese space start-up based in Tokyo, has been selected by the Japan Aerospace Exploration Agency (JAXA) as the project provider for the Feasibility Study (Part 1) on the Low Earth Orbit PNT (Position, Navigation, Timing) System (LEO-PNT) to be conducted by JAXA. The project commenced on the 11th of October, 2024.

LEO-PNT is a constellation of small satellites, orbiting at an altitude of 900-1,200 km. This is lower than the conventional Global Navigation Satellite System (GNSS) orbiting at an altitude of approximately 20,000 km. The system is expected to provide high-precision PNT information worldwide.

LEO-PNT's high-intensity positioning signals are expected to complement the weak signal strength of conventional GNSS signals reaching the Earth's surface, which are more susceptible to various types of interference, both natural and human-made. The more accurate positioning information provided by LEO-PNT is also expected to be used in many other fields, such as autonomous driving. *arkedgespace.com*

Aerodata receives EASA STC

Aerodata AG has been granted a Supplemental Type Certificate (STC) by the European Union Aviation Safety Agency (EASA) for its advanced GPS Anti-Jamming and Anti-Spoofing solution. This certification applies to installations integrated with Garmin 5000 avionics in a Cessna® Citation Latitude® jet.

With the growing threat of GPS jamming and spoofing in both civil and military aviation, Aerodata has developed a robust solution to ensure continuous GPS availability. As attacks on GPS systems continue to increase, this Anti-Jamming and Anti-Spoofing technology is crucial in maintaining safe and reliable aviation operations, by ensuring GPS based systems remain unaffected under GPS denied conditions. *www.aerodata.de*

Xona Space Systems, QASCOM advance resilient PNT

Xona Space Systems has partnered with QASCOM to integrate Xona PULSAR into QASCOM's GNSS software-defined radio (SDR), the QN400-P. The partnership seeks to deliver security, jamming and spoofing resistance and next-gen accuracy for industries such as UAV navigation and defense. The QN400-P receiver offers multi-frequency, multi-constellation GNSS capabilities, including GPS and Galileo. Additionally, it includes measures for the mitigation of jamming and spoofing and is compatible with low-Earth orbit (LEO) PNT services, such as Xona's PULSAR. *www.xonaspace.com*

WingXpand, Raytheon AI collaboration

WingXpand has collaborated with RTX's Raytheon. The partnership aims to enhance the capabilities of WingXpand's smart planes. The smart planes' open systems architecture allows for the seamless integration of organic and third-party applications and payloads, designed for mission flexibility as threats and tactics evolve. Raytheon's advanced infrared technology seeks to enhance the capabilities of WingXpand's smart planes by improving their ability to detect and identify potential threats at greater distances.

WingXpand has also introduced a new vertical takeoff and landing (VTOL) capability for its xRAI smart plane. This feature expands the operational versatility of the aircraft, which is designed to be compact enough to fit in a backpack. The VTOL option allows the xRAI to take off and land vertically, making it ideal for operations in tight spaces and challenging environments. WingXpand's smart planes can be used in both defense and civil missions. *www.wingxpand.com*

ideaForge for Operation DRONAGIRI

ideaForge Technology Limited, India announced its role as a data provider for Operation DRONAGIRI, a pioneering pilot project launched under the National Geospatial Policy 2022. The first phase of the operation will take place in Uttar Pradesh, Haryana, Assam, Andhra Pradesh, and Maharashtra, where pilot projects will showcase the real-world applications of these technologies. The initiative also introduces the Integrated Geospatial Data Sharing Interface (GDI), which will enable seamless access to geospatial data, fostering collaboration and innovation among stakeholders. As a critical data provider, ideaForge will supply high-resolution drone data that will be used by various stakeholders, including government departments, industry leaders, and startups, to drive more informed decision-making and enhance project outcomes. *www.ideaforgetech.com*

Japan Standards Association publishes standards for drone services

The Japan Standards Association (JSA) has announced the issuance of a Japanese Industrial Standard (JIS) for drone service providers to define the processes and requirements necessary to ensure a certain level of quality in the services they provide.

The draft of this JIS was developed by the Fukushima Innovation Coast Framework Promotion Organization, which served as the secretariat. The standard specifies guidelines for building a service provision system, delivering services, and conducting reviews for continuous improvement.

The association expects that the issuance of this JIS will lead to an increase in the quality and reliability of drone services, further expanding and revitalizing the drone service market.The original draft of this JIS was prepared by the Fukushima Innovation Coast Initiative Promotion Organization, a public interest incorporated foundation, which served as the secretariat.

As the range of services offered expanded and the number of services provided increased, there were concerns that the lack of standards to ensure quality would hinder expanded use due to the possibility of aircraft crashes, dangerous flights, illegal activities, and other issues.

Now, with the aim of enabling drone service providers to satisfy a certain level of quality in their services, METI has established the new JIS, which stipulates requirements on business processes and other matters that drone service providers should implement (e.g., development of a service provision system, provision of services, review for continuous improvement). *www.uasvision.com*

Astranis is the prime contractor for the U.S. Space Force

Astranis has been selected as a prime contractor for the U.S. Space Force (USSF) Space Systems Command's (SSC) new Resilient GPS (R-GPS) program. It is one of four awarded an agreement to produce design concepts for R-GPS' Lite Evolving Augmented Proliferation program.

The R-GPS program was created by Secretary of the Air Force Frank Kendall to build and launch small, low-cost PNT (positioning, navigation, and timing) satellites to bolster the existing GPS fleet. The R-GPS satellites will include the latest GPS signals, including M-Code, for assured performance even in contested regions. USSF has asked contractors to prepare the first eight R-GPS satellites for launch by 2028, a fast turnaround that shows the importance of developing this new capability for America's warfighters. *www.astranis.com*

Septentrio partnership with GNSS Store

Septentrio is collaborating with GNSS OEM Store. A variety of new evaluation boards, dongles, compact smart antennas and other plug-and-play systems have been developed by GNSS Store. These new products are based on the renowned mosaic GNSS module, including the mosaic-X5 positioning module, mosaic-H heading module and the mosaic-T timing module. *www.septentrio.com*

BAE Systems introduces M-code GNSS tracking technology

BAE Systems has successfully demonstrated M-code signal tracking using an Increment 2 GNSS receiver powered by its Next-Generation Application Specific Integrated Circuit (ASIC). This breakthrough is part of the Military GPS User Equipment Increment 2 Miniature Serial Interface program, which was awarded a $247 million contract from the U.S. Space Force Space Systems Command in 2020. *www.baesystems.com*

ANELLO awarded Space Force laser gyro contract

SpaceWERX has awarded ANELLO Photonics a Small Business Innovation Research (SBIR) Phase I contract to develop a resonator laser gyroscope, which seeks to address critical challenges faced by the Department of the Air Force (DAF).

By leveraging its expertise in integrated photonics and artificial intelligence (AI) based solutions, ANELLO aims to support the Space Force's mission of providing capabilities to joint forces operating in GPS-challenged environments. *spacewerx.us*

Tronics launches MEMS Gyro Product

Tronics Microsystems has upgraded its GYPRO4000 product line, which consists of tactical-grade digital MEMS gyroscopes. The GYPRO4300 features a ±300 °/s input range, 200 Hz bandwidth and 1 ms latency, making it ideal for dynamic environments. With a bias instability of 0.4 °/h and an Angular Random Walk of 0.07 °/√h, the GYPRO4300 offers high-performance sensing in a compact, digital and low size, weight and power (SWaP) package.

The GYPRO4050 is a specialized North-seeking gyro for low-dynamics applications. This derivative offers 2° azimuth accuracy and is currently in the customer sampling stage. *www.tronics.tdk.com*

Leica BLK2FLY Autonomous Indoor Scanning

Leica Geosystems has released upgrades for its BLK2FLY autonomous flying laser scanner. It is a semi-autonomous flying laser scanner ideal for architects, engineers and designers to capture the exterior features and dimensions of buildings and environments that would otherwise require a UAV with a lidar payload or a traditional photogrammetry UAV. To operate the BLK2FLY, a user makes a few simple taps on a tablet and it captures a structure's complete external dimensions, such as rooftops and facades, in the form of colorized 3D point clouds. *leica-geosystems.com*

Expansion of Topnet Live coverage by Topcon

Topcon Positioning Systems has significantly expanded its Topnet Live reference station service, adding 180 full-wave geodetic reference stations across California, Hawaii, Oregon, Nevada, Utah and Washington. This expansion is designed to enhance network corrections, providing centimeter-level accuracy for various industries such as engineering, surveying, construction, and agriculture. The improved service can also benefit specialized applications, including automated mowing, line marking and UAV operations for mapping and delivery in sectors such as the turf industry. *www.topconpositioning.com*

Trimble expands collaboration with The HALO Trust on landmine clearance efforts

Trimble has expanded support for The HALO Trust, the world's largest humanitarian landmine-clearance nonprofit organization. It is donating an additional 175 Trimble Catalyst GNSS systems, including Trimble DA2 GNSS receivers, to help The HALO Trust further its demining operations worldwide.

The Catalyst GNSS system provides The HALO Trust with a solution for deploying precise mapping capabilities to large field teams across broad geographic areas. More field teams can now be equipped with the necessary tools to safely and efficiently clear landmines, thereby accelerating the pace of landmine clearance globally. *www.trimble.com*

u-blox unveils X20

u-blox new X20 is an all-band high-precision GNSS platform that raises the bar for accuracy, performance, and security. Building on the success of the company's popular F9 high-precision GNSS platform, this new generation

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December 2024

OHOW 2024 (One Health One World Symposium)
10 - 12 December 2024
Universiti Putra Malayasia (UPM), Malaysia
https://ikp.upm.edu

Workshop on GNSS
10 -13 December 2024
Hanoi, Vietnam
https://soict.hust.edu.vn/navis

February 2025

DGI (Defence Geospatial Intelligence)
10 - 12 February, 2025
London, UK
https://dgi.wbresearch.com

Geo Week 2025
10 - 12 February
Denver, USA
www.geo-week.com

MENA Geospatial Forum
24 - 25 February 2025
Dubai, UAE
https://menageospatialforum.com

March 2025

Munich Satellite Navigation Summit
26 - 28 March 2025
Munich, Germany
www.munich-satellite-navigation-summit.org

April 2025

Geo Connect Asia
09 - 10 April 2025
Singapore
www.geoconnectasia.com

GISTAM 2025
1-3 April
Porto, Portugal
https://gistam.scitevents.org

May 2025

GeoIgnite
12-14 May2025
Ottawa, Canada
https://geoignite.ca

June 2025

GEO Business 2025
04-05 June
London, UK
www.geobusinessshow.com

July 2025

Esri User Conference
14-18 July 2025
San Diego, USA
www.esri.com

September 2025

Commercial UAV Expo 2025
2-4, September
Las Vegas
www.expouav.com

ION GNSS+
08-12 September 2025
Baltimore, USA
www.ion.org

addresses the current high-precision GNSS needs around the world. X20 is an all-band (L1/L2/L5/L6) platform with an integrated L-band receiver. *www.u-blox.com*

CSU Professor Sandra Durán leads $299K NSF-funded project

Sandra Durán, an Assistant Professor in the Forest and Rangeland Stewardship Department, housed in the Warner College of Natural Resources at Colorado State University, is leading a groundbreaking research project funded by the National Science Foundation with a $299,551 grant.

Her project, "Linking functional biodiversity and airborne imaging to improve predictions of terrestrial ecosystem productivity across climatic gradients," seeks to integrate multiple dimensions of plant biodiversity with airborne remote sensing as a basis for testing biodiversity-ecosystem functioning hypotheses at regional scales.

Biodiversity faces unprecedented threats from climate change, habitat loss, and other human-induced factors. In controlled experiments, the loss of plant biodiversity has been shown to reduce the productivity of terrestrial ecosystems.

Durán's research addresses a crucial knowledge gap by examining the importance of biodiversity in naturally assembled communities. While controlled experiments provide valuable insights, understanding how biodiversity impacts the functioning of real-world ecosystems is essential for effective conservation and management strategies. *warnercnr.source.colostate.edu*

Inertial Labs unveils RESEPI Ultra LITE

Inertial Labs has launched the RESEPI Ultra LITE, the lightest complete payload to feature both LiDAR and camera technology. It offers ease of use, precision, and adaptability. It integrates the XT-32 LiDAR scanner, providing surveyors with top-tier data accuracy, a high point density, and the versatility to perform in various operational modes. *inertiallabs.com*