



The Contribution of Geoinformatics Science to the Indian Army: An Exploring Study

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Abstract

The Indian Army uses the GSAT-7B satellite for communication purposes. This satellite is part of the GSAT-7 series, which was first launched in 2013. The GSAT-7 series was designed to provide a wide range of communication services, including low bit rate voice to high bit rate data communication. Geoinformatic science plays a crucial role in border surveillance. The Indian Army uses geospatial intelligence to monitor the borders and prevent any trespassing. Geoinformatic science provides navigation support to the Indian Army. This support is crucial for military operations, especially in areas where the network is poor. GIS mapping is used to create detailed maps of the terrain. This information is used to plan military operations and strategies. Geoinformatic science is used in military training to create simulated environments. This training is crucial for the military to prepare for real-life situations.

Keywords: Satellite, Indian Army, Border Surveillance, Navigation, Military Training.

1. Introduction

The Indian Army's adoption of geoinformatic science has been a gradual yet impactful journey, evolving alongside technological advancements and the changing nature of warfare. The use of aerial photography and manual map-making played a crucial role in planning troop movements and supply routes during the 1960s and 1970s. The advent of satellite imagery and the development of GIS software in the 1980s marked a significant turning point. The Indian Army embraced advanced remote sensing techniques, incorporating data from various sources, including radar, hyperspectral imaging, and LiDAR, to enhance its intelligence gathering capabilities [1].

1.1. GSAT-7B Satellite

This capability ensures reliable and uninterrupted communication across vast maritime areas. It is a geostationary orbit; this supports command and control functions, mission planning, and coordination of naval forces during peacetime and military operations. GSAT-7B provides backup communication capabilities in case of terrestrial network failures or disruptions. Its redundancy

ensures continuous connectivity and operational readiness, even in adverse conditions. GSAT-7B provides high-resolution imagery and geospatial data, which is analyzed using Geoinformatics tools to gather intelligence on enemy positions, terrain, and infrastructure, shown in Figure 1. Geoinformatics creates 3D models of battlefields using GSAT-7B data, enabling commanders to visualize terrain, plan strategies, and make informed decisions. Geospatial analysis helps identify potential targets, such as enemy installations, using GSAT-7B imagery and GIS data. GSAT-7B's navigation capabilities, combined with Geoinformatics, enable accurate navigation and tracking of troops, vehicles, and equipment. The combination of GSAT-7B and Geoinformatics aids in planning and managing military infrastructure development, such as building roads, bridges, and installations. GSAT-7B's communication capabilities, integrated with Geoinformatics, enable network-centric warfare, enhancing situational awareness and real-time decision-making [2].



Figure 1 GSAT-7B Satellite

1.2. Border Surveillance

Geoinformatic tools integrate data from various sources, including satellite imagery, aerial photography, sensor networks, and ground-based surveillance systems, to create a comprehensive picture of the border region. Geoinformatic systems enable real-time monitoring of border activities, detecting suspicious movements, unauthorized crossings, and potential threats [3]. By analyzing data patterns and anomalies, geoinformatic systems can generate early warnings of potential border breaches, allowing authorities to respond proactively. Geoinformatic tools support border security management by providing information on border infrastructure, patrol routes, and resource allocation, optimizing security operations. Geoinformatic science can monitor environmental changes along the border, detecting deforestation, illegal mining, or other activities that may impact border security. Geoinformatic science provides a powerful tool for enhancing border surveillance, enabling effective monitoring, early warning, and proactive response to threats, contributing to national security.

1.3. GIS Mapping

GIS maps provide detailed information about terrain features, including elevation, vegetation, and obstacles, allowing the army to identify strategic locations, plan routes, and assess potential risks [4]. GIS maps integrate real-time data from various sources, such as satellite imagery, sensor networks, and troop reports, providing a dynamic and

comprehensive picture of the battlefield, enhancing situational awareness. GIS maps facilitate mission planning by allowing commanders to visualize the battlefield, identify enemy positions, and plan troop movements, logistics, and fire support. GIS maps optimize logistics routes, manage resources, and ensure timely delivery of supplies to troops in the field, improving operational efficiency. GIS maps are used in disaster relief operations to assess damage, identify affected areas, and plan rescue and relief efforts, shown in Figure 2.



Figure 2 GSAT-7B Satellite

1.4. Navigation

Geoinformatics provides accurate location information, using GPS, GIS, and satellite imagery, to navigate troops, vehicles, and equipment, aids in planning optimal routes, considering terrain, weather, and other factors, to ensure safe and efficient movement. Geospatial analysis of terrain features, such as elevation, slope, and aspect, to identify potential obstacles and navigate challenging terrain. Geoinformatics integrates with GPS systems, enabling accurate navigation, tracking, and monitoring of troops and vehicles [5]. It creates accurate maps and charts, essential for navigation, using satellite imagery, aerial photography, and GIS data, provides geospatial intelligence, using satellite imagery and GIS data, to support navigation and tactical decision-making, enables network-centric navigation, sharing location information and navigation data across platforms and units.



Geoinformatics supports dismounted soldier navigation, using handheld GPS devices and mobile apps, for precise locationing and navigation. It aids in vehicle navigation, using GPS and GIS data, to ensure safe and efficient movement of troops and equipment. Helps in navigation training and simulation, using virtual reality and GIS data, to enhance soldier skills and readiness [6]. By leveraging geoinformatics, the Indian Army has enhanced its operational capabilities, improved decision-making, and increased situational awareness, leading to more effective and efficient military operations. The Indian Army utilizes geoinformatic science through advanced mapping for strategic planning and operations, satellite imagery for real-time intelligence and surveillance, disaster management support for rapid response and relief efforts, infrastructure monitoring and security, simulation for training in various terrains, and cybersecurity measures to protect sensitive data and communication networks. Geoinformatics enhances operational effectiveness by providing accurate spatial analysis and decision-making support across diverse military activities [7].

2. Methods

2.1. Geographic Information Systems (GIS)

Data Integration: GIS integrates various types of data, such as topographic maps, satellite imagery, and reconnaissance data, into a single framework. This integration provides a comprehensive view of the operational environment.

Spatial Analysis: GIS tools allow for spatial analysis, including terrain modeling, visibility analysis, and line-of-sight calculations. This helps in understanding how terrain features affect military operations. **Geospatial Data Management:** GIS manages vast amounts of geospatial data, allowing for efficient storage, retrieval, and analysis. This is crucial for maintaining up-to-date information on changing battlefield conditions.

2.2. Remote Sensing

Satellite Imagery: High-resolution satellite imagery provides detailed views of large areas, enabling monitoring of enemy movements, infrastructure, and terrain conditions. This imagery can be used for reconnaissance and strategic planning.

Aerial Photography: Drones and aircraft equipped with cameras capture high-resolution aerial images. These images are used for real-time surveillance, target identification, and situational awareness. **Change Detection:** Remote sensing technology can detect changes in the environment, such as new construction or modifications to terrain, which can indicate changes in enemy activity or infrastructure.

2.3. Global Navigation Satellite Systems (GNSS)

Positioning and Navigation: GNSS technology, including GPS, provides precise positioning and navigation capabilities for troops, vehicles, and equipment. This is essential for coordinated movements and operational accuracy.

Mapping and Surveying: GNSS is used for creating accurate maps and conducting surveys of military areas, ensuring that all spatial data is precise and reliable.

2.4. Spatial Data Analysis and Modeling

Terrain Analysis: Using digital elevation models (DEMs), terrain analysis helps in understanding the impact of terrain on military operations, including identifying choke points, natural obstacles, and optimal routes.

Scenario Simulation: Geoinformatics enables the simulation of various scenarios, such as battle conditions or logistical operations, to predict outcomes and plan strategies effectively. **Risk Assessment:** Spatial data is analyzed to assess risks related to terrain, weather conditions, and potential threats, aiding in strategic planning and risk management.

2.5. Data Visualization

Maps and Charts: GIS and remote sensing data are visualized through maps and charts, providing a clear and intuitive understanding of complex spatial information. This aids in communication and decision-making.

Interactive Platforms: Interactive GIS platforms allow military personnel to visualize and manipulate geospatial data in real time, facilitating dynamic decision-making and situational awareness.

3. Discussion

3.1. Strategic Impact

Enhanced Situational Awareness: The integration



of GIS, remote sensing, and GNSS provides a comprehensive understanding of the operational environment. This situational awareness is crucial for making informed decisions and adapting strategies in real time.

Improved Operational Efficiency: By optimizing routes, managing resources, and planning logistics with the help of geospatial data, the Indian Army can enhance operational efficiency and reduce costs.

Advanced Intelligence Capabilities: Remote sensing and GIS tools improve intelligence gathering, allowing for better monitoring of enemy activities and more accurate target identification. This enhances the effectiveness of military operations and minimizes risks.

3.2. Tactical Benefits

Effective Planning and Execution: Terrain analysis and scenario simulations help in planning military operations with greater precision. Understanding terrain features and potential obstacles allows for more effective execution of tactics and strategies.

Enhanced Mobility and Coordination: GNSS technology improves navigation and coordination among troops, vehicles, and equipment. This leads to better synchronization and reduces the risk of miscommunication or operational errors.

Challenges and Considerations Data Security: The use of geospatial data involves risks related to data security and privacy. Ensuring the protection of sensitive information and preventing unauthorized access is critical.

Technology Integration: Integrating new geoinformatics technologies with existing military systems requires careful planning and adaptation. Ensuring compatibility and training personnel are essential for successful implementation.

Resource Requirements: Advanced geoinformatics tools and technologies require significant investment in infrastructure and training. Balancing these requirements with other operational needs is important for effective resource management.

Conclusion

Geoinformatics science has profoundly enhanced the Indian Army's capabilities by providing advanced tools for comprehensive data integration, precise navigation, real-time situational awareness, and

effective risk management, thereby improving operational efficiency, strategic planning, and tactical execution.

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