Harnessing Maritime Geospatial Information for InsurTech Advancements

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***Abstract*—The maritime industry plays a key role in global trade and transportation, but it also poses unique risks and challenges for insurers. In recent years, the availability of maritime geospatial information and advancements in satellite technology and remote sensing capabilities have opened up new opportunities for the insurance sector. This paper explores the potential of harnessing maritime geospatial information for InsurTech advancements. We examine the data sources, including satellite imagery and Automatic Identification System (AIS) that provide valuable insights into vessel movements, traffic patterns, risk factors, and environmental conditions. Furthermore, we explore the challenges and opportunities associated with integrating geospatial information into InsurTech workflows, including issues related to data quality, scalability, and data privacy. The application of data analytics and learning techniques in harnessing maritime geospatial information is also discussed. By leveraging the power of maritime geospatial information and InsurTech advancements, insurers can gain a comprehensive understanding of the maritime domain, enhance risk management strategies, optimize insurance products and pricing, and provide tailored insurance solutions to the maritime industry.**

***Index Terms*—Artificial intelligence, geospatial data, maritime data, insurance technology, InsurTech.**

I. Introduction

Maritime geospatial information refers to the collection, analysis, and utilization of spatial data related to maritime activities and the marine environment. It encompasses various geospatial data sources, such as Automatic Identification System (AIS) data, satellite imagery, bathymetric charts, navigational charts, and other relevant geospatial datasets [1]. This information provides valuable insights into vessel movements, traffic patterns, navigational hazards, weather conditions, ocean currents, marine ecosystems, and other geographically referenced aspects of the maritime domain. Maritime geospatial information is instrumental in enhancing maritime operations, risk assessment, navigation, safety and security, environmental monitoring, and insurance services within the maritime industry [2].

With the recent advancements in satellite technology and remote sensing capabilities, big data from space can be collected and analyzed to provide valuable insights and drive informed decision-making. The applications of maritime geospatial information are diverse. For instance, in the field of maritime transportation, this data can be utilized to optimize shipping routes, improve port operations, and enhance logistics management [3], [4]. By analyzing historical and real-time data, stakeholders can identify efficient routes, reduce fuel consumption, minimize carbon emissions, and mitigate the risk of accidents or collisions. Specifically, maritime geospatial information also plays a vital role in maritime safety and security [5]. By monitoring vessel movements, identifying potential risks, and detecting anomalies, authorities can enhance maritime surveillance, combat illegal activities such as piracy or smuggling, and respond swiftly to emergency situations [6].

Furthermore, maritime geospatial information contributes to environmental monitoring and management [7]. It helps track and assess the impact of human activities on marine ecosystems, such as pollution, oil spills, and coral reef degradation. By monitoring environmental factors, stakeholders can implement proactive measures for sustainable maritime practices, conservation efforts, and ecosystem preservation. Similarly, maritime geospatial information has a significant role in advancing sustainable finance within the maritime industry. For example, maritime geospatial data can aid in identifying vessels with low carbon emissions, monitoring compliance with environmental regulations, assessing the impact of marine activities on ecosystems, and evaluating the resilience of maritime infrastructure to climate change.

The insurance sector is an important area where maritime geospatial information is crucial. Insurers can leverage this data to assess risk exposure, underwrite policies, and streamline claims processes [8], [9]. By analyzing historical data, traffic patterns, and environmental conditions, insurers can develop accurate risk models, tailor insurance coverage to specific sectors, and provide more efficient claims handling. Particualrly, maritime geospatial information, including big data from space, is highly valuable in the context of InsurTech.

InsurTech, a portmanteau of "Insurance" and "Technology," refers to the use of technology and digital innovations to revolutionize and transform the insurance industry. InsurTech can leverage the advancements in big data, machine learning, artificial intelligence (AI), Internet of Things (IoT), and cloud computing to create new business models, streamline processes, and enhance customer experiences. InsurTech aims to address some of the fundamental challenges faced by the insurance industry, including complex operations, slow processes, limited customer engagement, and high costs. By

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leveraging technology, InsurTech can drive profound changes in the development, distribution, underwriting, and servicing of diverse insurance products [10].

II. Maritime Geospatial Data Sources

Maritime geospatial information relies on a variety of data sources to provide comprehensive insights into the maritime and InsurTech domains. Next, we explore several essential data sources commonly utilized in this context:

- Automatic Identification System (AIS): AIS is a tracking system that uses transponders onboard vessels to broadcast their identity, position, and other relevant information. It provides real-time data on vessel movements, enabling authorities and stakeholders to monitor traffic, track ships, and ensure safety.
- Satellite Imagery: Satellite imagery offers a bird's-eye view of maritime activities and is a valuable source of geospatial information. High-resolution satellite images can capture detailed information on vessel locations, port activities, infrastructure, and even environmental conditions like sea surface temperature or algae blooms.
- Radar and Sonar Systems: Radar and sonar technologies are used for maritime surveillance and data collection. Radar can detect vessels, obstacles, and land masses, while sonar is employed for underwater mapping, measuring water depths (bathymetry), and identifying subsea structures.
- Geodetic Surveys: Geodetic surveys involve precise measurements of the Earth's surface and are used to create accurate navigational charts and maps. These surveys employ various techniques like Global Navigation Satellite Systems (GNSS) and terrestrial surveying to establish reference points and capture detailed topographic data.
- Meteorological and Oceanographic Data: Weather and oceanographic data, including wind patterns, sea currents, wave heights, and water temperatures, are crucial for maritime operations and risk assessment.
- Environmental Monitoring Sensors: Various sensors are deployed to monitor environmental parameters such as water quality, pollution levels, marine life, and ecological changes. These sensors collect data on factors like water salinity, dissolved oxygen levels, chlorophyll concentration, and pH levels, aiding in assessing the health of marine ecosystems.

By integrating and analyzing data from these diverse sources, a holistic understanding of maritime activities, vessel movements, risk factors, and environmental conditions can be achieved.

III. Geospatial Data in InsurTech

Incorporating maritime geospatial information into InsurTech platforms empowers insurers to make data-driven decisions. It enables insurers to better understand and manage risks, streamline operations, and provide efficient and effective insurance services to maritime clients. Below are several primary applications for utilizing maritime geospatial information in the realm of InsurTech, see Fig. 1 for an overview.

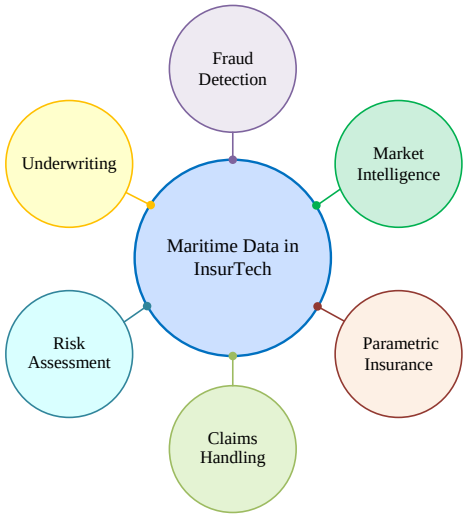

Fig. 1. Maritime geospatial information in InsurTech.

A. Risk Assessment and Underwriting

InsurTech companies can leverage maritime geospatial information to assess risk exposure for maritime assets, vessels, and operations. By analyzing historical data, traffic patterns, weather conditions, and other relevant factors, insurers can develop more accurate risk models and underwrite policies tailored to specific maritime sectors.

B. Claims Handling and Loss Assessment

Geospatial information can play an essential role in maritime insurance claims. Insurers can utilize data from space, i.e., satellite imagery and AIS datasets to assess damages, validate claims, and expedite the claims settlement process. This helps insurers reduce manual inspections, improve accuracy in loss assessment, and enhance claims handling efficiency.

C. Fraud Detection and Risk Mitigation

Maritime geospatial information can aid in detecting fraudulent activities and mitigating risks. By cross-referencing vessel movement data, AIS information, and satellite imagery, insurers can identify discrepancies or irregularities that may indicate fraudulent claims or misrepresentations. This enables insurers to prevent fraudulent activities, maintain fair practices, and mitigate financial risks.

D. Parametric Insurance

Parametric insurance, which utilizes predefined parameters and triggers for policy payouts, can benefit from maritime geospatial information. For example, insurers can develop parametric insurance products based on satellite-derived data on extreme weather events or natural disasters. This allows

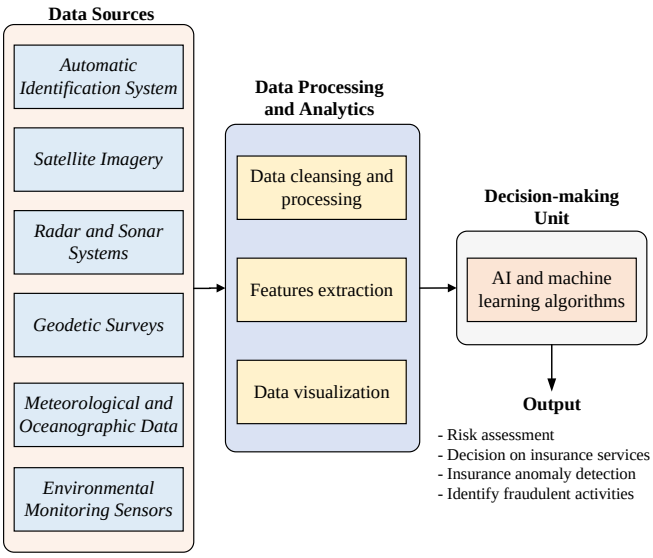

Fig. 2. AI Learning model for InsurTech Services.

for faster and more objective claims settlements, as payouts are triggered automatically based on predefined thresholds, reducing administrative costs and expediting recovery for policyholders.

E. Market Intelligence and Product Development

Geospatial information provides insurers with valuable market intelligence and insights into emerging risks and opportunities in the maritime sector. By analyzing data on vessel movements, traffic patterns, and economic activities, insurers can identify new market segments, develop innovative insurance products, and customize offerings to meet the evolving needs of maritime clients.

Nevertheless, the integration of geospatial data in InsurTech presents its own set of challenges that need to be adequately addressed to harness its potential. One key challenge is the complexity and volume of geospatial data, requiring advanced data management and processing capabilities. Additionally, data quality and consistency issues across various sources can pose difficulties in accurate risk assessment and claims handling. Furthermore, ensuring data privacy and security is crucial when working with sensitive geospatial information. To overcome these challenges, novel solutions are required, such as advanced data analytics techniques, AI, and machine learning algorithms. Ultimately, the integration of big data, machine learning, and AI in InsurTech drives efficiency, enhances risk management, and creates a more customer-centric and data-driven insurance industry.

IV. AI and Learning Techniques

In the context of maritime geospatial information in InsurTech, several cutting-edge technologies can be employed to unlock its full potential. Data analytics, machine learning, and AI can facilitate extracting valuable insights from large volumes of data, enabling accurate risk assessments, automated decision-making, and fraud detection [11]. Advanced data processing techniques ensure efficient handling and analysis of diverse geospatial datasets. By leveraging these techniques, InsurTech companies can significantly improve the offered insurance solutions to the maritime industry. In the following, we are highlighting the most relevant and applicable techniques.

- Parallel computing, cloud computing, and distributed processing enable scalable and real-time analysis of geospatial data. Data preprocessing techniques, including data cleansing, integration, and fusion, ensure the quality and consistency of geospatial datasets used for risk assessment, underwriting, and claims handling.
- Data analytics techniques enable the extraction of meaningful insights from large volumes of maritime geospatial data. By applying statistical analysis, data mining, and visualization techniques, insurers can identify patterns, trends, and anomalies in vessel movements, traffic patterns, and other relevant geospatial information.
- Machine learning algorithms can be employed to develop predictive models and automate decision-making processes. Machine learning algorithms can also assist in fraud detection by identifying suspicious patterns in geospatial data and alerting insurers to potential fraudulent activities.
- AI technologies can enhance the analysis and understanding of maritime geospatial data. For instance, AI algorithms can extract relevant information from unstructured data sources like vessel logs, incident reports, and weather forecasts. AI-powered computer vision algorithms can analyze satellite imagery to detect objects, classify vessel types, and monitor changes in maritime infrastructure or environmental conditions.
- Internet of Things (IoT) devices, such as sensors and beacons, can be deployed in maritime environments to collect real-time data on vessel conditions, cargo status, environmental parameters, and safety measures. This data can be integrated with geospatial information to enhance InsurTech capabilities and processes.

Figure 2 presents an overview of the learning model for InsurTech. This model follows a distinct three-phase process. The initial phase involves the aggregation of diverse data collected from various sources. Subsequently, in the second phase, this gathered data is processed through a combined processing and data analytics module. The purpose of this module is to cleanse the data to eliminate discrepancies or inaccuracies, distill vital pieces of information, and render data visualization for enhanced comprehension and analysis. Following this stage, the refined data is then transitioned to a decision-making unit, which encompasses AI and machine learning algorithms. The principal function of this crucial module is to offer strategic decision-making support for insurance services and conduct risk assessments.

V. Scenarios and Use Cases

In the context of maritime geospatial information, "dark vessels" refer to vessels that intentionally disable or manipulate their AIS signals, making them undetectable or unidentifiable by traditional tracking systems. Dark vessels pose challenges in the maritime insurance sector. However, the studied concept in this paper to utilize big data from space along with advanced data analysis techniques can help identify and track dark vessels. These technologies can analyze and combine alternative data sources, such as satellite imagery or AIS signals, to detect and monitor vessels that attempt to evade detection. By leveraging these innovative approaches, InsurTech companies can enhance their risk assessment capabilities and mitigate the potential risks associated with dark vessels.

An interesting case study, recently published in an article by The New York Times [12], which discusses the implications of international sanctions on Russia's oil shipping industry. The article highlights how satellite imagery and geospatial data play a crucial role in monitoring and enforcing these sanctions. It showcases the use of advanced technologies to track the movements of oil tankers and identify potential violations of the sanctions regime. The article also emphasizes the challenges faced in gathering and interpreting this geospatial data accurately. By leveraging satellite imagery and geospatial analysis, authorities can enhance their ability to monitor compliance and address potential violations, ultimately shaping global trade and geopolitical dynamics.

VI. Conclusion

This paper advocates for the adoption of novel solutions for the big data from space to fully leverage the potential of maritime geospatial information for InsurTech advancements. Specifically, the integration of maritime geospatial information in InsurTech offers significant opportunities for advancements in risk assessment, underwriting, claims handling, and fraud detection. By leveraging alternative data sources, such as satellite imagery, alongside data analytics and AI techniques, insurers can gain a comprehensive understanding of vessel movements and environmental conditions. Addressing challenges of data quality and privacy is crucial for maximizing the potential of maritime geospatial information in InsurTech. Collaborative efforts between stakeholders are key to drive innovation in this field and delivering tailored insurance solutions to the maritime industry.

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