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Advanced Vessel Monitoring System for A Safer Ocean

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Abstract

The Vessel Monitoring System (VMS) is a satellite-based technology that enables real-time tracking, control, and surveillance of fishing vessels to enhance maritime safety, sustainable fisheries management, and law enforcement. Comprising onboard vessel monitoring units, satellite communication systems, and shore-based monitoring centers, VMS provides accurate data on vessel identity, position, speed, and heading, allowing authorities to guide navigation, prevent entry into restricted zones, detect illegal fishing, and support search and rescue operations. While challenges such as intentional signal disabling and technical limitations persist, emerging solutions like edge computing and multi-sensor integration are improving reliability and operational efficiency. As an evolving tool, VMS plays a vital role in ensuring safe navigation, protecting marine resources, and strengthening compliance with maritime regulations.

Introduction

Vessel Monitoring System is the satellite-based technology system used for the monitoring, location, movement, surveillance, control and tracking of the commercial fishing vessels operating at the sea. It involves use of satellite and very high frequency communication systems for the monitoring of vessels in territorial waters and beyond the economic exclusive zones where the communica

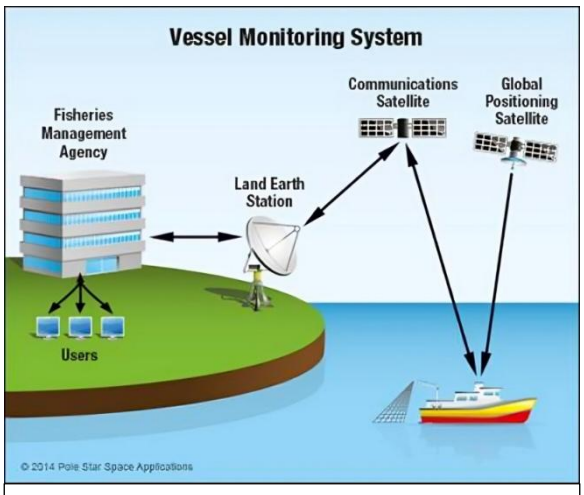

Fig. *vessel monitoring system*

VMS is installed on the fishing vessel and provides the accurate and timely information

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about the vessel's unique identifier code, location, speed, status and directions of its heading to monitor and control by the nearest coastal authorities and centers for the management of the vessels at sea. VMS are equipped with integrated global positioning system to gain real time information about the coordinates of vessels to track the movement of various vessels at the sea for monitoring and guiding them to maneuver in busy traffic areas.

How it works

The vessels are equipped with onboard transponders that automatically transmit data (e.g., location, speed, course) to authorities at regular intervals via satellite. The purpose of VMS is to ensure compliance with fishing regulations, to Support the sustainable fisheries management and to combat illegal, unreported and Unregulated (IUU) fishing.

Components of vessel monitoring system

VMS consist of different system to operate efficiently in the territorial and non-territorial waters. It basically consists of

1. Vessel Monitoring Unit (VMU)

A specialized equipment which is installed on the vessel and used to transmit the positioning information of the vessel to the designated satellite.

2. Satellite Communication System (SCS)

A communication system which involves satellites to receives emitted data from the Vessel Monitoring Units and transmits that data from VMU to the monitoring center nearest to the vessels. for estimating the positioning of the vessel, it uses Global Navigational Satellite System (GNSS) and for the transmission of data it uses satellites such as the Inmarsat, Iridium, Argos and AIS

3. Monitoring Center or Control Room

Designated centers and hubs that receives and analyzes data coming from the VMS and provides current information back to vessel activities

To better understand the process and workflow of different components of the vessel monitoring system, the following flowchart can be seen.

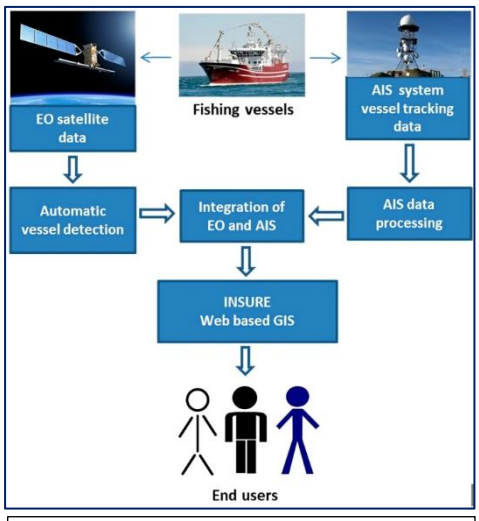

Fig. flowchart of VMS operation

Benefits of VMS

There are various beneficial impacts of VMS in marine environment, which includes tracking and monitoring of vessel, prevention of vessels to enter in restricted zones and areas, for the security and safety of fishing vessels in distress

and hazard situation, Enhanced maritime safety and Surveillance and Efficient fisheries enforcement.

1. Fisheries Management

VMS are used in monitoring of the vessel by accessing information about the vessel's location, speed and direction of the vessel from monitoring units installed in vessel and that data is used for the safety and security of the vessels by preventing collisions and grounding of the vessel in between them. the data also used in the management of the vessels by monitoring the activities and implementing various SOLAS laws and regulations for the management.

2. Safety of Sea

VMS provides authorities of data about the vessels which are in distress situation and the vessels which have any distress situation can be tracked by the information related to their last known positions recorded gained by the VMS to effectively implementing search and rescue operations. Forecasting of bad weathers and hazards can be informed to the vessels by the coastal authorities prior to any disaster to be happen to prevent the situation in time.

3. Law Enforcement

detection of unreported, illegal and unregulated fishing activities can be monitored through VMS. it can identify suspicious vessel operating in the restricted areas or the vessels which are 'going dark" by switching off their VMS systems or exceeding operating hours.It allows authorities to track illegal and criminal activities ongoing in the maritime zones to enforce liable actions.

Limits and Recommendations

VMS may be intentionally disabled, creating surveillance gaps. Enforcement systems are based on the identification of missing communications, which might result in investigations.

Data accuracy is influenced by a number of factors, including transmission frequency, communication costs, and the dependability of onboard sensors and signal processing. Edge computing and multi-sensor integration, which improve context and streamline data flow, mitigate these problems.

Conclusion

Vessel monitoring systems have evolved into essential tools for sustainable fisheries management, law enforcement, and maritime safety. Technological developments like edge computing and multi-sensor integration are making continuous system design more effective, even if it still has to overcome limitations like non-reporting and technological gaps

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