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The Application of a VTS Decision Support Tool based on Artificial Intelligence

# summary

Considering the task of Update Guideline 1110 on Decision Support Tools for VTS Personnel (take into account emerging concepts and technologies) (VTS Task Plan 2018-2022--1.2.2) will be launched at the VTS 49meeting, China Maritime Safety Administration is willing to share the usage of the autonomous detection system for ships’ abnormal behaviours, a decision support tool for VTS personnel based on AI (Artificial Intelligence).

## 1.1 Purpose of the document

The purpose of this document is to introduce the work carried out by China Maritime Safety Administration in the use of AI technology to upgrade VTS decision support tools, and to provide input for the VTS Committee to update Guideline 1110 on Decision Support Tools for VTS Personnel (Task 1.2.2).

## Related documents

IALA Guideline 1110 - Use of Decision Support Tools for VTS Personnel

# background

IALA issued Guideline 1110 on Use of Decision Support Tools for VTS personnel in 2014, which provides guidance for VTS personnel to use decision support tools.

On the basis of demand analysis, model establishment, etc, China Maritime Safety Administration completed the research and development of AI-based autonomous detection system for ships’ abnormal behaviours in 2018, and put it into use as a VTS decision support tool in some VTS centres. The system improves the accuracy of identifying and predicting vessel’s unsafe behaviours in the VTS area, and provides intelligent decision support for VTS personnel to respond in time and intervene in possible accident risks in advance.

# discussion

## The concept of ships’ abnormal behaviours

The abnormal behaviours of a ship refer to the behaviours that the track, speed, navigation area or AIS equipment status of the ship under specific conditions are different from that of similar ships. It may be a symptom of potential risks or a specific manifestation of violations. For example, if the ship's speed drops significantly within a short period of time, it is an abnormal behaviour of the ship's speed. Such behaviour may be caused by the failure of the ship's main engine or a collision or a rock hitting accident.

## Recognition of ships' abnormal behaviours

The core function of the autonomous detection system for ships’ abnormal behaviours is to establish rules to identify ships’ abnormal behaviours. There are three main ways to establish rules:

1. Knowledge-driven, that is, navigation rules set for specific waters in accordance with laws and regulations, experience and emergency needs, such as speed limits, prohibited anchorage, exclusion zone, ships’ routeing.
2. Data-driven, that is, the use of big data technology, through the analysis of historical data of ships navigation in a specific area, calculate the rules of ships activity, and then use AI technology to independently formulate and automatically update ships’ navigation rules.
3. Engineering-driven, that is, integrating knowledge-driven and data-driven to achieve complementary advantages.

## Introduction of the autonomous detection system for ships’ abnormal behaviours

The autonomous detection system for abnormal behaviours of ships developed by China Maritime Safety Administration adopts an engineering-driven approach. Based on the autonomous learning of the system, through manual intervention of the abnormal behaviours of ships discovered by the system, the system continuously improves its autonomous learning capabilities and improves the accuracy of judging abnormal behaviours.

### System Features

The autonomous detection system for ships’ abnormal behaviours provides intelligent support for VTS decision-making, enabling VTS personnel on duty to detect abnormal ships earlier and more accurately, thereby responding to unsafe conditions in development in a timely manner, improving the effectiveness and pertinence of VTS service and reducing the risk of accidents. Compared with traditional VTS decision support tools, it has the following characteristics:

1. There are more types of ships’ abnormal behaviours. Through data mining and AI technology, 14 types of abnormalities such as abnormal heading, abnormal speed, entering unconventional areas, abnormal AIS equipment, anchoring in unconventional areas, near miss, and violation of navigation rules can be detected.
2. The recognition of ships’ abnormal behaviours is smarter. Taking entering an abnormal area as an example, the traditional VTS decision support tool needs to set the prohibited area in advance, but the autonomous detection system can autonomously judge that the ship has entered an area that others usually does not enter through data mining, and provide support for VTS personnel to discover ships’ abnormal behaviours in time. As shown in Figure 1, the ship "Ocean Glory" entered an area that ships would not normally enter. The system generated an alarm. After verification by the VTS personnel, the ship was out of control due to the main engine failure.



1. Alarm of "Ocean Glory" entering an area that ships usually does not enter
2. The rules of ships’ abnormal behaviours can be optimized independently. The system can continuously monitor and analyse the ship traffic situation in the VTS area, and independently learn according to the processing results (processing or ignoring) of the alarm by VTS personnel, and continuously modify or adjust the abnormal behaviours recognition rules to conform to the VTS regional vessel traffic characteristics and VTS management service requirements.
3. Higher alarm accuracy rate. The traditional VTS system has a certain probability of false alarms, and there is a possibility that abnormal conditions may be missed. The autonomous detection system for abnormal behaviours of ships introduces AI algorithms based on deep data mining to make the navigation rules more closely match the actual navigation status of the ships and achieve lower missing alarm rate and false alarm rate. After testing, the recognition rate of abnormal behaviours in the system trial operation phase exceeds 95%, and the false alarm rate is 0. With the increase of stored data and the deepening of the system’s independent learning, the alarm accuracy rate will be further improved.

### Typical Application

1. Provide support for decision-making of VTS personnel. The autonomous detection system for ships’ abnormal behaviours is a new VTS decision support tool based on big data technology and AI technology. Compared with the alarm function of traditional VTS decision support tools, it can provide better decision support for VTS personnel to respond to unsafe behaviours in development, so as to better contribute to safety of life at sea, safety and efficiency of navigation and the protection of the environment within the VTS area
2. Provide support for the formulation of vessel traffic regulations. The autonomous detection system for ships’ abnormal behaviours can generate data products such as analysis reports on ships’ navigation rules, distribution statistics of ships’ abnormal behaviours for different vessels, different time periods and different regions, and can provide data support for formulating and adjusting traffic rules (such as introducing ships’ routeing system), maritime planning, predicting high-risk areas, and discovering high-risk ships for VTS and stakeholders.

# ACTION REQUESTED OF THE COMMITTEE

The committee is requested to consider the information provided above when updating IALA Guideline 1110 on Decision Support Tools for VTS Personnel (Task 1.2.2).

1. Input document number, to be assigned by the Committee Secretary [↑](#footnote-ref-1)
2. Leave open if uncertain [↑](#footnote-ref-2)