

# A Method for Coverage Path Planning of Unmanned Vessels

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Unmanned vessel coverage path planning is one of the core technologies for

achieving autonomous navigation of ships.

**Standards for Coverage Path Planning** 

#### **Key Challenges to Address**

- Cover all areas except obstacles
- Avoid all obstacles during the traversal
- Prevent redundant traversal



Autonomous coverage path planning for ships faces key challenges such as discontinuous path planning and low efficiency in multi-vessel coordination.

#### **2. Technical Solution Description**

This project proposes a coverage path planning method for unmanned vessels that addresses the issues of discontinuous path planning and low efficiency in multi-vessel coordination found in existing technologies. The solution introduces the IBA\* and CCIBA\* coverage path algorithms. These algorithms offer significant improvements in terms of path length, number of turns, number of cells, and coverage rate compared to existing methods. They enable the planning of efficient and high-quality survey paths for unmanned measurement vessels.



#### 3. Key Technology——IBA\* algorithm



initialize the GT values of all grid cells as '*ue*' and import the static map, followed by updating the predefined map.

USMV outputs its own position information and obstacle information, initiating the map update process.

the system outputs the grid state list, known as  $GT\_list$ , and begins planning the path on the  $BL_0$ -level map. It then outputs the target point, tp.

If the path planning on the  $BL_0$ -level map becomes trapped in a local optimum, the system employs an approach to iteratively update the map at higher levels.



## **3.Key Technology**——Algorithm comparison



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Compared to traditional algorithms, IBA \* and CCIBA \* algorithms have an overall improvement of 15% in path length, number of turns, and coverage indicators.

### **3.Key Technology**—Algorithm application



Scanning survey of water near Hengliang Mountain in Zhoushan Islands

USMV<sub>1</sub> USMV<sub>3</sub> USMV, **USMV** USMV<sub>5</sub>

> Scanning survey of Gaoshan Bay water area north of Xinghua Bay

The core technology of this project is applied to various environmental survey tasks, resulting in a 20% increase in operational efficiency.

### **4.Technology Practicality**

This project belongs to the key technology of ship autonomous navigation, which can effectively cope with coverage path tasks in various complex environments and sea conditions.



This project can effectively improve water traffic safety and ensure safe navigation of ships, with broad application prospects

#### **4. Social and Economic Value**

#### As of June 30, 2022, the patent implementation has achieved a profit of 45 million yuan and license revenue of 160.35 million yuan

项目

After calculation, carrying the ship coverage path planning technology provided by this patent can improve the efficiency of coverage tasks by more than 20%





The relevant products of this patent have been tested by authoritative testing institutions for excellent performance,

**Obtaining certification and permission from the** classification society



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By Weihai Tianfan Intelligent Technology, China **Electronics Science and Technology Institute, etc** More than ten enterprises have transformed and applied, resulting in significant economic benefits



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Seize the Highland of International Ship Autonomous Navigation Technology Promote the intelligent transformation of the shipbuilding industry



Multi	-UAV coverage path planning
Offline segmentation	Offline planning Segmentation
Estimated time	Online planning
Estimated path	Task decomposition Map update
Device performance	Image: Second se
CCIBA	* coverage path planning algorithm

