Autonomous vessels, Remotely operated underwater vehicles

Research on autonomous berthing / docking

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Abstract

In Japan, a shortage in human resources has recently become a critical issue in coastal shipping due to the aging of ship crews. Therefore, the automation in domestic shipping is highly required. In order to realize autonomous ships in the near future, automatic berthing/docking is one of key technologies, and it is well known that the automatic berthing/docking is a challenging problem. In our laboratory, this problem has been investigated. Automatic berthing is not an easy task because of some complexities that are included in the problem, such as wind disturbance, the nonlinearity of the low-speed maneuvering model, danger of collision with berth, etc. In this research, as a first step, the authors solved the off-line automatic berthing problem.

In our research group, control theory, optimization technique, and machine learning are utilized to establish the automatic berthing/docking.

Background & Results

Recently, autonomous operation is now proceeding in other vehicle areas such as cars, and in our field, many research projects are in progress. Although, so far, various studies have been conducted on the automatic berthing problem from 1980s, the autonomous berthing/docking technology has not been completed because of the difficulties in this problem. The key technologies of the automatic berthing/docking to be solved are listed as follows:

i) Off-line trajectory planning
ii) On-line trajectory modification
iii) Mathematical modelling of low-speed vessel
iv) On-line control

In our laboratory, all the above technologies have been explored with the use of control theory, optimization technique, and machine learning. The left panel of following figures shows the simulation result of the automatic berthing algorithm. The control algorithm is validated at the experimental pond in Osaka university with the use of the ship model as shown in the right panel.

Significance of the research and Future perspective

The automatic berthing/docking has a key role to play in the autonomous operation of oceangoing vessel. With the progress of the autonomous operation, it is considered that the modal shifts (changing the modes of cargo transportation) will be accelerated.

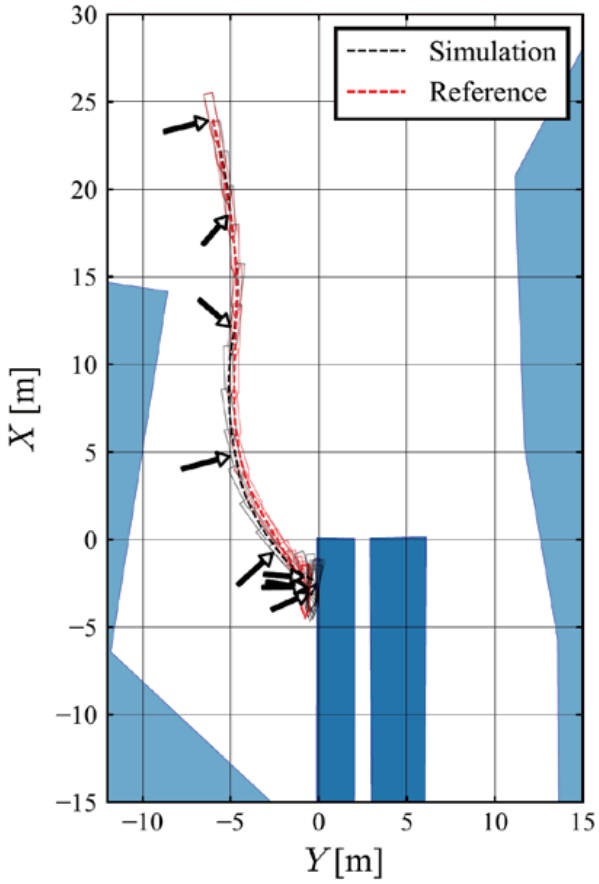

Fig. 1 Numerical result of automatic berthing/docking

Fig. 2 Model ship at experimental pond of Osaka university

Patent
Treatise Maki, A; Sakamoto, N; Akimoto, Y. et al. Application of optimal control theory based on the evolution strategy (CMA-ES) to automatic berthing. Journal of Marine Science and Technology. 2020; 25: 221–233. doi: 10.1007/s00773-019-00642-3.
URL http://www.naoe.eng.osaka-u.ac.jp/naoe/naoe5/jp/
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