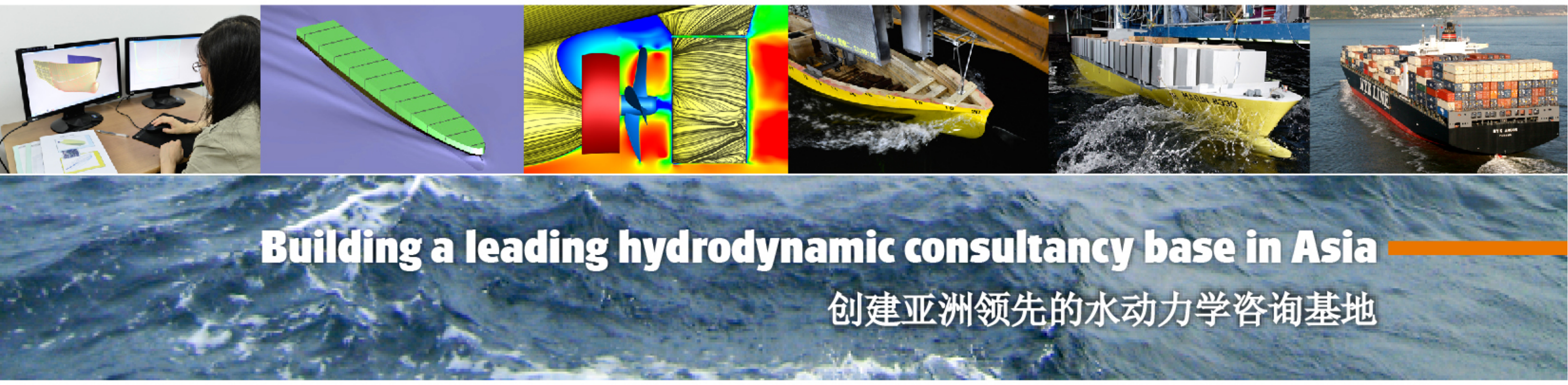

Fast-time simulation program for ship manoeuvring 船舶操纵性快速仿真软件

SHIPMA 7

Introduction SHIPMA model (version 7)SHIPMA 模型介绍（第 7 版）

The latest version of the fast–time simulation program SHIPMA is a joint development of MARIN's nautical centre MSCN and Deltares. The combined contribution of these institutes is leading to a fit for purpose program to simulate the manoeuvring behaviour of vessels in ports and fairways.

In SHIPMA the vessels are steered by an autopilot which is capable of operating in the track keeping mode and the harbour manoeuvring mode, making it possible to perform typical harbour manoeuvres like turning, reverse sailing and berthing.

最新版本的快速仿真软件 SHIPMA 是由 MARIN 航海中心 MSCN 和 Deltares 联合开发的。这些研究机构的联合贡献完成了这样一款通用软件以模拟船舶在港口和河道的操纵特性。

在 SHIPMA 中由自动驾驶仪操控船舶，自动驾驶仪能够以航迹保持模式和港口操纵模式来控制船舶，可以完成像回转、倒航和靠泊这样典型的港口操纵运动。

SHIPMA applications SHIPMA 应用范围

The application of SHIPMA is primarily in port and fairway design, referring to both approach channels and inland waterways. According to PIANC [1] a first estimate of the required channel width based on their methodology has to be followed by ship manoeuvring simulations.

These simulations give insight into the inherent possibilities and/or restrictions of vessels, infrastructure and environmental conditions including the effect of additional manoeuvring devices like bow and stern thrusters and the role of tugs. Based on the insights gained, mitigations, if needed, of the infrastructure design (channel layout, manoeuvring basin and terminal layout) and/or the admittance policy can be proposed. In the final stage of the design the SHIPMA study can be followed by a study on a real-time simulator. The flow diagram below gives an overview of the program structure.

SHIPMA 的应用范围主要是在涉及进港航道和内河航道的港口和航道设计方面。参考 PIANC[1]，基于他们的研究方法所需航道宽度的初步估算必须遵循船模操纵仿真的规则。

这些仿真可以深入了解船舶自身固有特性（或者）限制条件、基础设施和环境条件，包括像艏尾推进器和扮演拖船角色的这些额外操纵设备的影响。基于获得的见解，如果需要，可以针对缓解基础设施的设计（航道布局、操纵水池和码头布局）和（或者）对准入政策提出建议。在设计的最后阶段，SHIPMA 研究内容可以与实时仿真模拟器相结合。下面的流程图给出了软件结构的一个概述。

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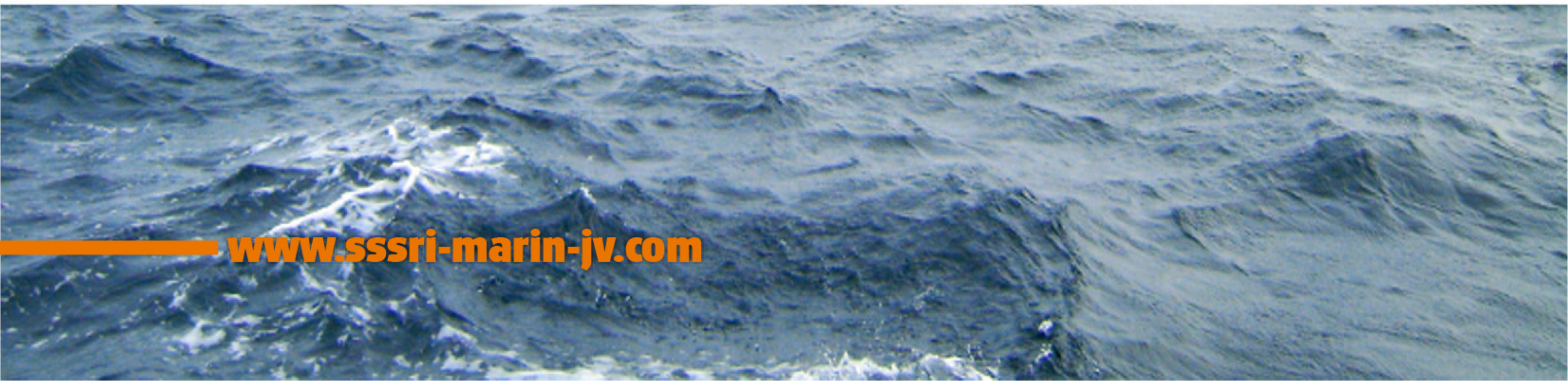
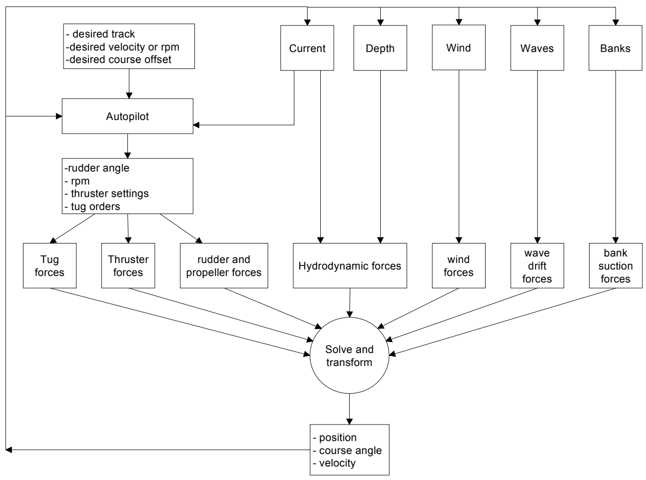




Flow diagram of the SHIPMA model

SHIPMA 模拟流程图

Methodology of SHIPMA use SHIPMA 研究方法使用

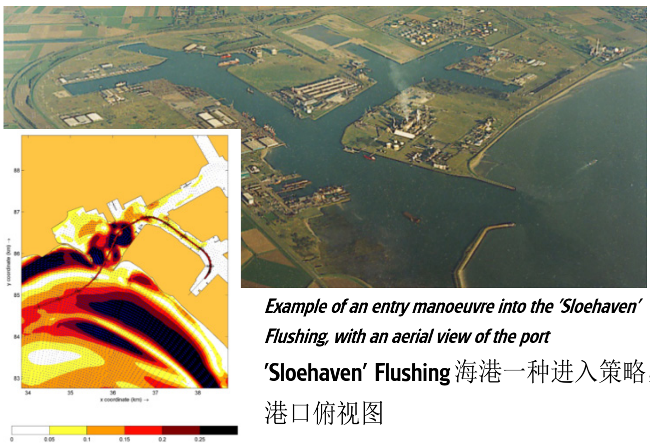
SHIPMA relies on the use of an autopilot, which also includes a tug and thruster allocation algorithm. The choice for using an autopilot rather than hands-on steering by a pilot or Master allows the engineer to clearly judge and compare the results of different simulations on technical and physical aspects. The use of an automatic pilot in desktop simulation assures repeatability and a consistent nautical assessment procedure. The hands-on mode often seen in other models (actively steering the ship over a chart displayed on a screen) would put a civil engineer in a position where he is in fact playing the role of a pilot or Master. Alternatively, one could ask a pilot to do the runs, but the chart display offered to him is rather different from his normal sailing practice. This will jeopardise the result of the manoeuvres. Furthermore, runs have to be repeated to guarantee consistency.

SHIPMA 依赖于自动驾驶仪的使用，其中还包括拖船和推进器分配算法。选择使用自动驾驶仪而不是由驾驶员或者船长手动驾驶是为了基于技能和体能方面的考虑让工程师能够清楚地判断和比较不同仿真的结果。仿真平台中使用自动驾驶仪可以确保重复性和航海评估程序的一致性。在其它模拟器中（屏幕上显示了主动操控船舶的一张图表）所见到的手动驾驶模式经常会在一个位置上安排一名土木工程师，这位工程师事实上扮演了驾驶员或者船长的角色。也许，有人要求驾驶员去操控，但是提供给驾驶员的图表与他常规的经验完全不同。这将破坏操纵仿真的结果。此外，此操作必须反复进行以保证一致性。

Ship characteristics 船舶特性

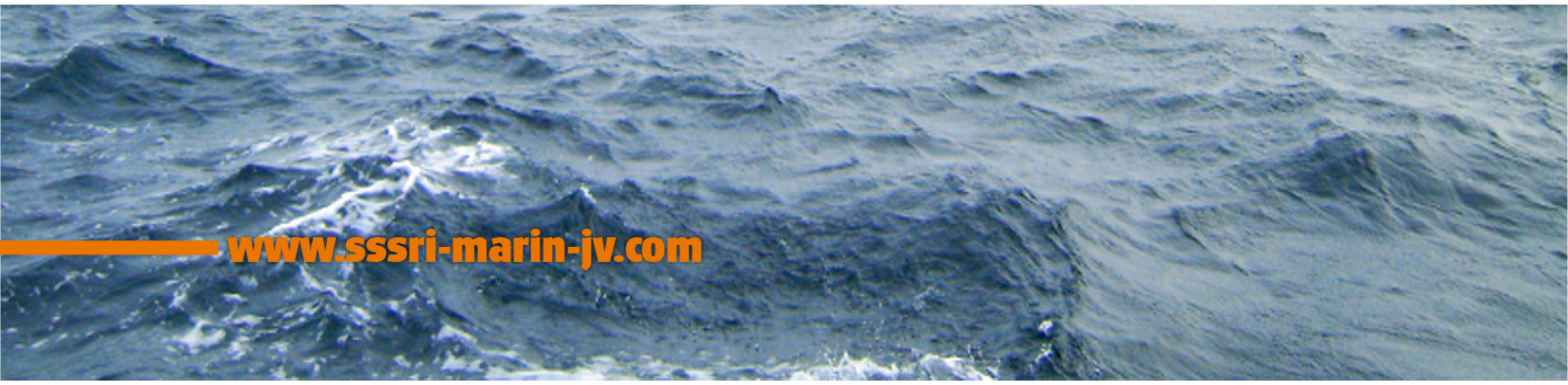
The mathematical ship models, consisting of sets of hydrodynamic derivatives (Abkowitz type [2]), are specific for each ship. They are determined either by scale model test, through scaling from other models or by calculation (SURSIM [3]). Models can be chosen from an existing list of over 100 high-quality ship models covering the latest ship designs. Specific models can be made according to the client's wishes. The models include wind coefficients, bank suction coefficients, second-order wave drift forces and shallow water effects.

船舶的数学模型，包括水动力导数的设定（**Abkowitz** 类型[2]）是具体到每一艘船的。这些模型要么由来自其它模型缩放之后开展的船模试验所决定，要么由计算所决定（**SURSIM**[3]）。船模可以从现有的 **100** 多艘高质量船模列表中选择，其中涵盖了最新的船型设计。特殊的船模依据客户要求可以制作。模型包括风压系数、近岸吸力系数、二阶波浪力和浅水效应。



Example of an entry manoeuvre into the 'Sloehaven' Flushing, with an aerial view of the port

'Sloehaven' Flushing 海港一种进入策略，港口俯视图

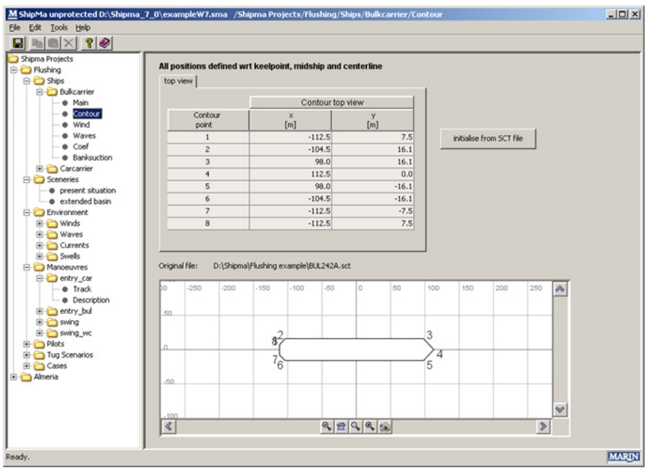


SHIPMA input and output SHIPMA 输入和输出

The input of the SHIPMA model is organised through the Graphical User Interface. The Shipma GUI organises all data for a project in a hierarchical tree. A Shipma project tree consists of a number of subordinate "nodes", each defining some aspect of the project:

- A set of nodes containing a description of the manoeuvre, desired track, setting of autopilot, time step, starting position, tugs etc.
- A set of nodes in which the ship is represented by dimensions, mass, windage area, etc. and the manoeuvring characteristics of the ship, to be expressed in hydrodynamic derivatives
- Nodes to describe several external conditions such as:
  - bottom level
  - current pattern
  - wind field
  - wave field

Note that for this type of data Shipma offers the possibility of choosing for a simple set-up with constant wind, waves or current or to import self prepared environmental grids in which the number of grid points is practically unlimited.



The main output consists of:

- track, position, course and heading of the ship
- course deviation and distance to the desired track
- rudder angle and number of propeller revolutions
- for wind and waves: direction, velocity/height and forces acting, on the ship
- water depth at the centre of gravity
- current velocities on the ship
- bank suction forces
- tug forces

The track and the output data can be plotted using D3D-Quickplot.

SHIPMA 模型的输入由图形用户界面进行管理。SHIPMA 图形用户界面以层次树结构为一个项目管理所有数据。一个 SHIPMA 项目树包含了一些下一层节点，每个节点定义了项目的某些方面内容：

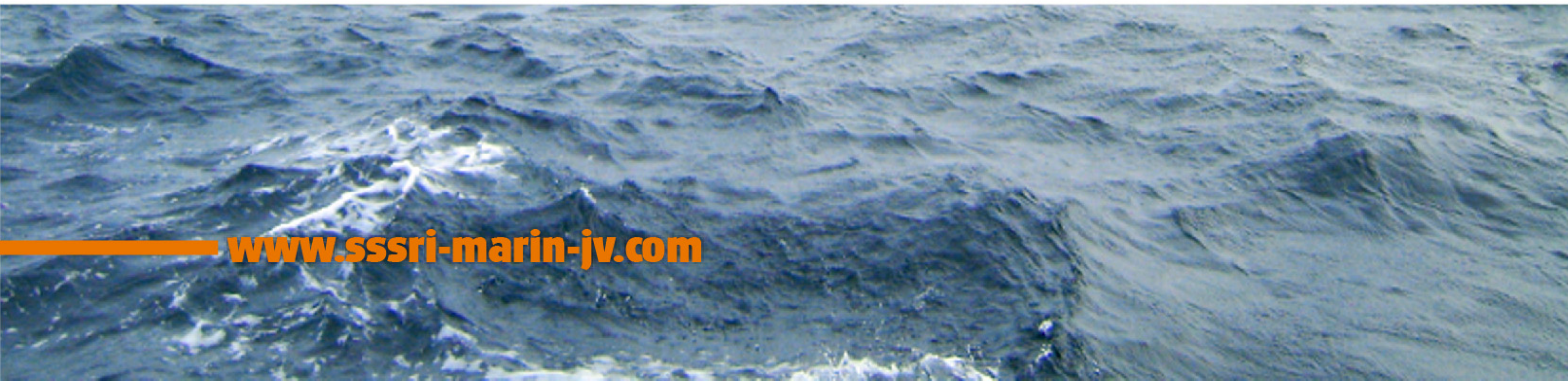
- 一组节点包含了对操纵、所需航向、自动驾驶仪设置、时间步长、起始点、拖车等内容的描述；
- 一组节点可描述船舶的尺寸、质量、受风面积等，还有船舶操纵特性以及水动力导数的表述。
- 一些节点用来形容外部条件，如：
  - 底部标高
  - 流的形式
  - 风场
  - 波浪场

说明：对于这种类型的数据，SHIPMA 针对带有恒定的风、波浪或者流或者导入自定义的环境网格的简单设置提供了选择的可能性，其中对于网格节点数目实际上没有限制。

主要输出包括：

- 轨迹、位置、航向和船舶航向角
- 航向偏差和偏航距离
- 舵角和螺旋桨转速
- 对于风和波浪：方向、速度/波高和作用在船体上的力
- 重心处的水深
- 船体上的流速
- 近岸吸力
- 拖力

航迹和输出数据可以使用 D3D-Quickplot 绘制。

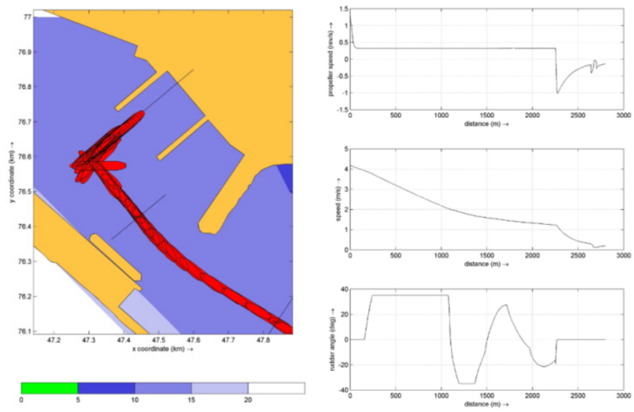


Examples 案例

Included are two examples of a computation with the new SHIPMA model. One example (see previous page) shows an entry manoeuvre into the ‘Sloehaven’, Flushing. The manoeuvre is executed under maximum current conditions, the current is computed with the Delft3d-flow model and imported in SHIPMA, together with bathymetry and the results of wave penetration calculations.

运用新 SHIPMA 模型计算了两个例子。一个例子（参见上页）显示了入‘Sloehaven’, Flushing 港口时一种进入操作路径。这种操作路径是在最大流速环境下执行的，由 Delft3D-flow 模型计算的流连同海洋水深和波渗透计算结果输入到 SHIPMA 中。The 2 plots below show another example of an entry and berthing manoeuvre with a twin propeller twin rudder vessel equipped with a bow thruster.

下面第二幅图显示了另一个例子，具有艏侧推的双桨双舵船的驶入和停泊策略。



Track plot and Data plot (propeller revolutions, forward speed and rudder angle)

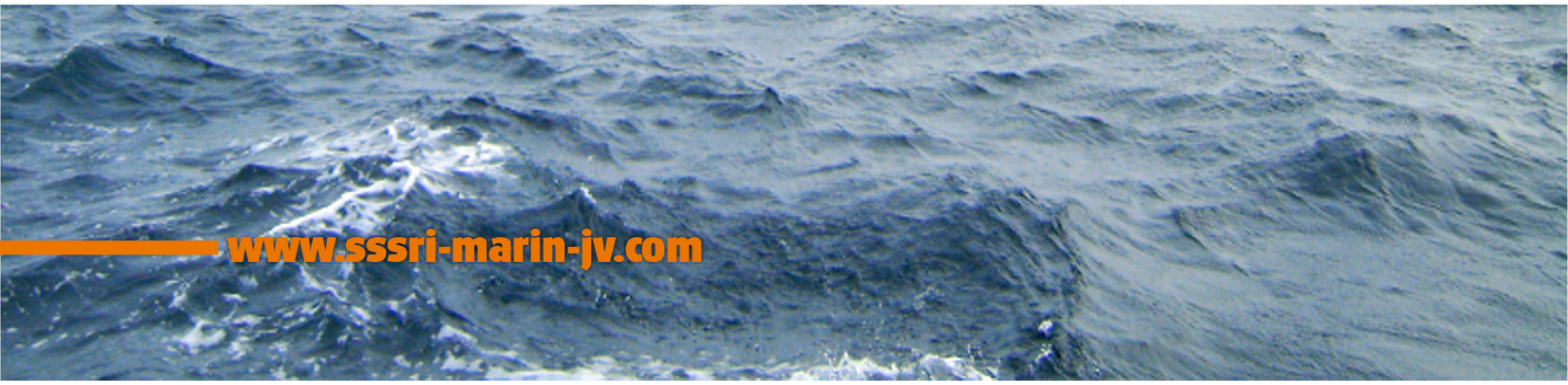
轨迹图和数据图（螺旋桨转速、前进速度和舵角）

SHIPMA is also capable of simulating inland waterway situations. Mathematical models are available for various types of ships. The algorithm for simulating tug assistance has been improved considerably. Tugs are capable of controlling the ship speed in combination with the track keeping mode.

SHIPMA 还能进行内河航道情况的模拟。数学模型适用于各类船舶。模拟拖船辅助的算法已大为改进。拖船结合航迹保持模式能够控制船舶速度。

Computer requirements 计算机要求

- Computer with a 2GHz or faster processor
- Microsoft Windows XP with service pack 2, 32 bit operating system or Microsoft Windows 7 Professional with service pack 1, 32 and 64 bit operating system
- 2 GByte of installed memory (RAM) or more
- 2 GByte of available hard-disk space
- DVD-Rom drive
- 1024x768 or higher resolution display with 256 colors
- Keyboard and Microsoft Mouse or compatible pointing device
- Microsoft Internet Explorer 8 or later



- 拥有 **2GHz** 或更快处理器的计算机
- **Microsoft Windows XP with service pack 2，32** 位操作系统或 **Microsoft Windows 7 Professional with service pack 1，32** 位和 **64** 为操作系统
- **2GByte** 安装内存（**RAM**）或以上
- **2GByte** 可用硬盘空间
- **DVD-ROM** 驱动
- **1024×768** 或更高分辨率的 **256** 色显示器
- 键盘和鼠标或者兼容的指向设备
- 微软 **IE 8** 浏览器或更高版本

References 参考文献

[1] PIANC-IAPH Working Group II-30, APPROACH CHANNELS; “A Guide for Design”.

[2] Abkowitz, M.A.; “Lectures on Ship Hydrodynamics, Steering and Manoeuvrability, Hydro- and Aerodynamics Laboratory”, Rep. No. HY-5, 1962, Copenhagen, Denmark.

[3] SURSIM; “Computer Program for the Calculation Hydrodynamic Reaction Forces”, MARIN.

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