MICHLET 9.33

Examples and Templates

MICHLET IS RESEARCH CODE!

Please check all estimates generated by the program against experimental results before committing any time or funds to your project as no liability can be accepted by Cyberiad.

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1 INTRODUCTION

Example input files have been placed in the examples subdirectory. These files are described below and should be used as templates for your own designs.

To use the example files, you must save the indicated example file as in.mlt in the main Michlet directory (i.e. the directory that contains the executable file). This will overwrite the current in.mlt with the example input file. You may be required to save additional files in the directory before running some examples.

Remember to use the Esc key to escape from any screen when running the examples.

When you first install Michlet, the in.mlt file is a copy of the wigley_ex1a.mlt file described below.

2 MONOHULLS

2.1 Examples 1a, 1b, 1c, 1d, and 1e: Wigley Hull

These five examples use different methods to generate hull offsets.

- wigley_ex1a.mlt: The table of offsets is contained inside the input file.
- wigley_ex1b.mlt: Offsets are generated using hull Series 1.
- wigley_ex1c.mlt: Offsets are generated using hull Series 8.
- wigley_ex1d.mlt: Offsets are contained in a separate file. To run this example, first save the file wigley_ex1d.mlt as in.mlt in the same directory as the executable. You must also save the file wigley_useroff1.csv as useroff1.mlt in that directory.
- wigley_ex1e.mlt: Offsets are generated using splines that are defined in a separate file. To run this example, first save the file wigley_ex1e.mlt as in.mlt in the same directory as the executable. You must also save the file wigley_sploff1.mlt as sploff1.csv in that directory.

To calculate resistance, press R from the main screen, then choose one of the display options. (Remember. Keys are case-sensitive: press shift and r, not r by itself!)

To examine wave pattern plots, press Esc until you are back at the original screen. Now press W and choose the Transverse Cut view by pressing T. Note the small oscillations near the left-hand and right-hand edges of the graph. These are due to an insufficient number of θ-intervals being used in the calculations. If N_θ was increased to, say 1024, in the input file, these oscillations would not be apparent, however, calculations will take roughly twice as long.

Press Esc and then press R to see a contour plot of a rectangular region of the wave field. The striations inside the V-shape are due to an insufficient number of points being used. If the number of nodes in the x-direction and the y-direction were both increased to, say 301, the striations would disappear, but calculations would take almost nine times longer. Clearly, it is important to use as many points as is necessary for the particular task at hand.

Twenty-one stations and waterlines have been used in all five examples. When a table of offsets is used, as in examples 1a and 1d, it is not easy to increase (or decrease) the number of stations and/or waterlines. For the mathematical series (examples 1b and 1c) and the spline method (example 1e), all that is required is for the number of stations and the number of waterlines to be changed. Remember to use odd integers for both!

If you want a permanent copy of the input file you have just modified, save it using a meaningful filename in another directory. You should also save any associated files (e.g. useroff1.csv or sploff1.csv) in the same directory.

Note that there will be small differences between the hull parameters calculated for the five examples due to the different methods for representing hull offsets. Results will be most accurate for the method using the mathematical series. Less accurate are the methods using tables of offsets. The spline method is the least accurate of the five methods, but could be improved by using more nodes.

2.2 s9.mlt: Series 9 Hull

This input file uses Hull Series 9 to define a hemisphere. The calculation of resistance and other hydrodynamic quantities is of no real interest here: the purpose is to illustrate the effect of the section cut-off ratio. In any case, the example hull is not thin, so Michell's thin-ship theory is not applicable.

When this example is run, the hull shape is seen to be a simple hemisphere floating at its equator.

Change the last parameter of the line:
9, 0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.0,0.0
to 0.5. The line should now read:
9, 0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.0,0.5

When the example is now run it will be seen that the hull is a circular dish with flared sections.

2.3 nplxx.mlt: NPL Transom Stern Hull Series

This series of input files contains the details of small hulls with transom sterns investigated at the University of Southampton. Experimental trim and sinkage values have been included.

Note that the offsets for the NPL examples use the spline input method to generate offsets. Before running an example, make sure that you have saved the file npl_sploff1.csv as sploff1.csv in the same directory as the Michlet executable. The same spline file can be used for all NPL series hulls. (This is an advantage of using non-dimensional values).

2.4 Rowing Shells

2.4.1 lm1x.mlt: Lightweight Men's Single Rowing Shell

This input file contains the offsets and details of a small rowing shell.

2.5 Naval Surface Platforms

2.5.1 ffg8.mlt: Frigate

This input file contains the offsets of a U.S. frigate. Offsets (in spline format) are contained in the file named ffg8_sploff1.csv. Remember to save the file as sploff1.csv in the main Michlet directory before running the program.

2.5.2 ddg51.mlt: Destroyer Hull with Sonar Dome

This input file contains the offsets of a destroyer with a transom stern and a large sonar dome. Dimensions are those of the US vessel, Arleigh Burke.

2.5.3 iihr5512.mlt: IIHR 521 Model Destroyer Hull ($L = 3.048$ m)

This input file contains the offsets of a model destroyer hull with a transom stern and a large sonar dome used by the ITTC as part of its extensive towing tank comparison project.

Remember to save the dtmb5415_sploff1.csv file as sploff1.csv in the michlet directory.

2.5.4 insean2340.mlt: INSEAN 2340 Model Destroyer Hull ($L = 5.72$ m)

This input file is set up for a larger model of the DTMB 5415 model destroyer hull used by INSEAN.

Remember to save the dtmb5415_sploff1.csv file as sploff1.csv in the michlet directory.

2.5.5 ddgsig.mlt: Pressure Signature of DDG51 Destroyer

This input file is identical to the ddg51.mlt file, except that water depth has been set to 120.0m, and the rectangular patch dimensions are different. For many studies, we would like to know the pressure on the bottom of the seabed around the entire ship, not just behind the vessel.

Run this example and press P from the opening screen to invoke the Pressure Signature menu. Then press R to calculate the bottom pressures. The maximum absolute pressure (above atmospheric) is about 590 Pa.

Press c and then enter 200. The high pressure zone forward of the bow should now be more apparent.

You can save the pressure data by pressing s. You can also save the contour plot as a .pcx file by pressing S.

2.6 Submarines and Axi-Symmetric Bodies

2.6.1 s4collins.mlt: Series 4 Collins-like Submarine Body

This input file uses Hull Series 4 to define an axi-symmetric body with a bluff forebody, a parabolic tail and an extensive amount of parallel middle body. Proportions are similar to the Australian Navy's Collins Class submarine without the long turtleback or conning tower.

Submergence depth (i.e. the distance from the free-surface to the top of the hull) has been set to 7.8 m. This is achieved by setting Course Particulars to 1, and then specifying the submergence depth on the next line. A comment line (starting with #) precedes that line.

2.6.2 s4joubert2026.mlt: Series 4 Joubert-like Submarine Body

This input file uses Hull Series 4 to define an axi-symmetric body with an elliptical forebody, a parabolic tail and an extensive amount of parallel middle body. Proportions are similar to the "next generation" submarine proposed by Joubert [2].

The submergence depth has been set to 9.6 m.

2.6.3 s5470.mlt: DARPA SUBOFF Submarine

This input file contains details of a submarine-like body (without fairwater) used in the DARPA SUBOFF. Offsets are created by using hull Series 5470 with values of $f_0 = 0.233236$ and $f_1 = 0.255102$.

Submergence depth (i.e. the distance from the free-surface to the top of the hull) has been set to 0.1095 m. This is achieved by setting Course Particulars to 1, and then specifying the submergence depth on the next line. A comment line (starting with #) precedes that depth value.

The effect on the resistance of the boundary layer displacement thickness can be investigated by changing the value of N_θ to a positive value. (Remember: -ve N_θ means no BL effects; +ve values mean the BL displacement thickness is included in calculations).

This hull has a rounded bluff nose that violates the thin-ship assumption, so we cannot expect predictions to be very accurate at low Froude numbers. Predictions can be brought more into line with experiments by using a form factor of about 1.04 applied to the skin-friction, and a wave resistance form factor of about 1.20.

Another approach would be to include the boundary layer displacement thickness and use a wave form factor of about 1.15.

Setting the submergence depth to a very large value will result in the wave resistance vanishing.

Experimental total resistance for this hull is available in the paper by Dawson et al [1].

2.6.4 lasub.mlt: LA Class Submarine

This input file contains details of a submarine which is submerged to the top of the conning tower. Offsets (in spline form) are contained in the file named lasub_sploff1.csv.

If you have read the previous two submarine examples you should know how to submerge the hull to a specified value below the surface.

3 DIHULLS

3.1 tagos.mlt: Model SWATH

This input file contains the details of a model of the SWATH T-Agos.

Better predictions of the total resistance are possible if the strut and the torpedo-like portion are treated separately in the calculation of viscous resistance. For example, use Michlet to calculate the wave resistance, but perform calculations of the skin-friction off-line using separate Reynolds numbers for the strut and the torpedo-like pod. That would probably best be done in a spreadsheet program.

3.2 proa.mlt: Proa with Wigley Amas

A one tonne dihull with a 0.75 tonne main hull and a 0.25 tonne outrigger.

3.3 weinblum.mlt: Asymmetric SWATH

The shape of the demihulls, and the lateral and longitudinal spacing have been chosen to almost completely eliminate waves on the starboard side of the vessel at 3.875 ms^{-1}.

This example calculates elevations at $151 \times 151 = 22801$ field points using $N_\theta = 512$ which should take about 30 seconds on a 1GHz PC.

Remember to save wave elevation plots and data from the Waves screen before you exit the program if you require a permanent copy of the output.

4 TRIHULLS

4.1 arrow.mlt: Arrow-Shaped Trihull with Wigley Amas

6.0 tonne trihull; the central hull is a 5.0 tonne T-Agos hull, the 0.5 tonnes amas are Wigley hulls.

4.2 leaning3.mlt: PEP Demihulls

This example illustrates the effects of large sinkage of the demihulls of a trihull. As speed increases, one ama lifts out of the water, the sinkage of the other ama increases by as much as the other ama emerges. At the highest speed, the starboard ama has emerged completely and the vessel is behaving like a proa.

4.3 flying3.mlt : Flying trihull with PEP hulls

This file is identical to leaning3.mlt, except that all demihulls lift out of the water. At a speed of 6 ms^{-1}, the amas have both left the water completely. As speed increases further the central hull emerges more and more, until, at 12.0 ms^{-1}, it too leaves the water. At that point the resistance of the submerged portion of the vessel drops to zero.

5 TETRAHULLS

5.1 diamond.mlt: Diamond-Shaped

This vessel has four LL4 demihulls in a diamond arrangement. The vessel was designed to produce very low waves on both sides at 3.875 ms^{-1}. Compare with the Weinblum example which produces low waves on only one side of the vessel at the same speed.

This example calculates elevations at $301 \times 301 = 90601$ field points using $N_\theta = 1024$ which should take about 4 minutes on a 1GHz PC. Since the wave field is (laterally) symmetric, that time could be halved by considering only one side of the vessel.

5.2 slice.mlt: SLICE with SWATH Demihulls

A four-hulled vessel with two pairs of SWATH demihulls.

6 PENTAHULLS

6.1 vpenta.mlt: V-Shaped

This vessel has five Wigley demihulls arranged in a V-shape. The input file can be used as a template for a pentahull or for comparing five different individual hull designs.

6.2 frig5sig.mlt: Pressure Signature of Five Frigates

This input file shows how to calculate the bottom pressures created by five identical frigates travelling close together.

References

[1] Dawson, E., Anderson, B., Van Steel, S., Renilson M. and Ranmuthugala, D., "An experimental investigation into the effects of near-surface operation on the wave-making resistance of SSK type submarines", Proc. MAST 2010, 9-11 Nov. 2010, Rome, Italy, pp. 1-8.

[2] Joubert, P.N., "Some Aspects of Submarine Design Part 2. Shape of a Submarine 2026", Australian Defence Science and Technology Organisation Report DSTOTR1920, Dec. 2006, pp 36.