

Claims

1. A method of controlling a propulsion system (102) of a marine vehicle (100), characterized by forming (800), by a controller (112), data on a pitch angle ($\gamma(\theta)$) of at least one foil (108, 108'), which is individually controllable and in a rotatable manner attached with a foil wheel (106, 106'), based on an angularly variable wake field ($W(\theta)$) affecting the at least one foil (108, 108') and an angle (θ) of a rotation of the foil wheel (106, 106'); and

setting (802), by an actuator arrangement (110) receiving the data from the controller (112), the at least one foil (108, 108') at the pitch angle ($\gamma(\theta)$) based on the data.

2. The method of claim 1, characterized by forming the data on the pitch angle ($\gamma(\theta)$) of the at least one foil (108, 108') under influence of the wake field (W), which is caused by propulsion of the propulsion system (102).

3. The method of claim 2, characterized by forming the data on the pitch angle ($\gamma(\theta)$) of a foil of the at least one foil (108) under influence of the wake field (W), which is caused by at least one other foil (108), which is different from the foil for which the data on the pitch angle is formed, the at least one foil (108) being attached to the foil wheel (106) to which the foil for which the data on the pitch angle is formed is also attached.

4. The method of claim 1, characterized by forming the data on the pitch angle ($\gamma(\theta)$) of the at least one foil (108) under influence of the wake field (W), which is caused by a hull of the marine vehicle (100).

5. The method of claim 1, characterized by forming the data on the pitch angle ($\gamma(\theta)$) of the at least one foil (108) under influence of the wake field (W), which is caused by environment of the marine vehicle (100).

6. The method of claim 1, characterized by forming the data on the pitch angle ($\gamma(\theta)$) for each of a plurality of foils (108) individually controllable and attached in a rotatable manner with the foil wheel (106).

7. The method of claim 1, characterized by forming the data on
5 the pitch angle ($\gamma(\theta)$) of the at least one foil (108, 108') under influence of the wake field (W) caused by a plurality of propulsion sub-systems (104, 104') of the propulsion system (102), the propulsion sub-systems (104, 104') comprising foils (108, 108') attached therewith including the at least one foil (108, 108').

8. The method of claim 1, characterized in that the wake field
10 (W) is based on a simulation of the propulsion system (102) in the water.

9. The method of claim 1, characterized by measuring the wake field (W) with at least one sensor (122) when the marine vehicle (100) is in the water, and communicating data on the wake field (W) to the controller (112).

10. The method of claim 1, characterized by forming the data on
15 the pitch angle ($\gamma(\theta)$) of the at least one foil (108, 108') while keeping an absolute angle of attack (α) of the at least one foil (108, 108') constant within a tolerance for a maximized length of rotation of the foil wheel (106, 106').

11. The method of claim 1 or 10, characterized by forming the data on the pitch angle ($\gamma(\theta)$) of the at least one foil (108, 108') while keeping an
20 angle of attack (α) of the at least one foil (108, 108') at two alternative constants within a tolerance for a maximized length of rotation of the foil wheel (106, 106'), the constants having opposite signs.

12. The method of claim 1, characterized by decomposing a scaled wake field into a sum of an undisturbed contribution () and an extra
25 contribution induced by the foils (108, 108');

setting the induced scaled contribution caused by the every foil (108, 108') constant; and

determining an approximate of the wake field (W) based on the induced scaled contribution that is locally constant.

13. The method of claim 1, characterized by forming the data on the pitch angle ($\gamma(\theta)$) by optimizing an efficiency and/or a thrust of a model formed
5 of a set of second-order continuous periodic functions of the pitch angle ($\gamma(\theta)$), angle of attack (α) and the wake field (W) with or without an operational demand and/or a constraint.

14. A propulsion system (102) of a marine vehicle (100), characterized in that the propulsion system (102) comprises a foil wheel
10 (106, 106'), at least one foil (108, 108'), which is individually controllable and in a rotatable manner attached with the foil wheel (106, 106'), an actuator arrangement (110) and a controller (112);

the controller (112) comprising one or more processors (114) and one or more memories (116) including computer program code;

15 the one or more memories (116) and the computer program code configured to, with the one or more processors (114), cause at least the controller (112) to form data on a pitch angle ($\gamma(\theta)$) of at least one foil (108, 108') based on an angle (θ) of a rotation of the foil wheel (106, 106') and an angularly variable wake field ($W(\theta)$) affecting the at least one foil (108, 108'), and communicate the
20 data on the pitch angle ($\gamma(\theta)$) to the actuator arrangement (110), which is configured to set the at least one foil (108, 108') at the pitch angle ($\gamma(\theta)$) based on the data.

15. A marine vehicle (100), characterized in that the marine (100) vehicle comprises the propulsion system of claim 14.