CLAIMS

1. A hydrofoil height control device configured to control a flap for adjusting a height of a hydrofoil craft from a water surface, comprising:

a normal-manipulated-variable acquisition unit configured to acquire a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal manipulated variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water surface;

a target wave image acquisition unit configured to acquire a target wave image of a wave captured from at least one imaging position on the hydrofoil craft;

a determination unit configured to determine whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable and the target wave image;

an additional-manipulated-variable acquisition unit configured to, if it is determined that the additional operation is necessary, acquire an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation; and

an operation unit configured to output an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable,

wherein the learning data further includes a non-operation image of the wave captured from a position corresponding to the imaging position when the operator does not perform the manual operation, and

wherein the determination unit determines whether the additional operation is necessary for the target wave image, based on a necessary determination model learned with the learning data including the non-operation image.

2. A hydrofoil height control device configured to control a flap for adjusting a height of a hydrofoil craft from a water surface, comprising:

a normal-manipulated-variable acquisition unit configured to acquire a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal manipulated variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water surface;

a target wave image acquisition unit configured to acquire a target wave image of a wave captured from at least one imaging position on the hydrofoil craft;

a determination unit configured to determine whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable and the target wave image;

an additional-manipulated-variable acquisition unit configured to, if it is determined that the additional operation is necessary, acquire an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation;

an operation unit configured to output an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable; and

a model correction unit configured to correct the additional-manipulated-variable derivation model based on a comparison result between the additional manipulated variable obtained by inputting the target wave image to the additional-manipulated-variable derivation model and the manual manipulated variable of the operator for the target wave image input to the additional-manipulated-variable derivation model.

3. A hydrofoil height control device configured to control a flap for adjusting a height of a hydrofoil craft from a water surface, comprising:

a normal-manipulated-variable acquisition unit configured to acquire a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal manipulated variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water surface;

a target wave image acquisition unit configured to acquire a target wave image of a wave captured from at least one imaging position on the hydrofoil craft;

a determination unit configured to determine whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable and the target wave image;

an additional-manipulated-variable acquisition unit configured to, if it is determined that the additional operation is necessary, acquire an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation; and

an operation unit configured to output an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable,

wherein the target wave image acquisition unit is configured to acquire a plurality of the target wave images captured at a plurality of the imaging positions, and

wherein the additional-manipulated-variable acquisition unit is configured to acquire the additional manipulated variable, based on one or more target wave images having no halation among the plurality of target wave images.

4. A hydrofoil height control device configured to control a flap for adjusting a height of a hydrofoil craft from a water surface, comprising:

a normal-manipulated-variable acquisition unit configured to acquire a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal

manipulated variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water surface;

a target wave image acquisition unit configured to acquire a target wave image of a wave captured from at least one imaging position on the hydrofoil craft;

a determination unit configured to determine whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable and the target wave image;

an additional-manipulated-variable acquisition unit configured to, if it is determined that the additional operation is necessary, acquire an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation; and

an operation unit configured to output an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable,

wherein the additional-manipulated-variable derivation model outputs one of a plurality of previously classified additional-manipulated-variable candidates as the additional manipulated variable.

5. A hydrofoil height control device configured to control a flap for adjusting a height of a hydrofoil craft from a water surface, comprising:

a normal-manipulated-variable acquisition unit configured to acquire a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal manipulated variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water surface;

a target wave image acquisition unit configured to acquire a target wave image of a

wave captured from at least one imaging position on the hydrofoil craft;

a determination unit configured to determine whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable and the target wave image;

an additional-manipulated-variable acquisition unit configured to, if it is determined that the additional operation is necessary, acquire an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation;

an operation unit configured to output an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable; and

an output unit configured to output a manipulated variable that preferentially controls the flap, instead of or in addition to the actual manipulated variable of the flap output from the operation unit.

6. The hydrofoil height control device according to any one of claims 1 to 5,

wherein the additional-manipulated-variable derivation model derives a value adjusted from the normal manipulated variable as the additional manipulated variable.

7. A hydrofoil craft comprising:

the hydrofoil height control device according to any one of claims 1 to 6;

at least one imaging device for acquiring a target wave image of a wave captured from at least one imaging position on the hydrofoil craft; and

one or more flaps controlled by the hydrofoil height control device for adjusting a height of the hydrofoil craft from a water surface.

8. A hydrofoil height control method for controlling a flap for adjusting a height of a hydrofoil craft from a water surface, comprising:

a normal-manipulated-variable acquisition step of acquiring a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal manipulated variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water surface;

a target wave image acquisition step of acquiring a target wave image of a wave captured from at least one imaging position on the hydrofoil craft;

a determination step of determining whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable and the target wave image;

an additional-manipulated-variable acquisition step of, if it is determined that the additional operation is necessary, acquiring an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation; and

an operation step of outputting an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable,

wherein the learning data further includes a non-operation image of the wave captured from a position corresponding to the imaging position when the operator does not perform the manual operation, and

wherein the determination step includes determining whether the additional operation is necessary for the target wave image, based on a necessary determination model learned with the learning data including the non-operation image.

9. A hydrofoil height control method for controlling a flap for adjusting a height of a hydrofoil craft from a water surface, comprising:

a normal-manipulated-variable acquisition step of acquiring a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal manipulated

variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water surface;

a target wave image acquisition step of acquiring a target wave image of a wave captured from at least one imaging position on the hydrofoil craft;

a determination step of determining whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable and the target wave image;

an additional-manipulated-variable acquisition step of, if it is determined that the additional operation is necessary, acquiring an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation;

an operation step of outputting an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable; and

a model correction step of correcting the additional-manipulated-variable derivation model based on a comparison result between the additional manipulated variable obtained by inputting the target wave image to the additional-manipulated-variable derivation model and the manual manipulated variable of the operator for the target wave image input to the additional-manipulated-variable derivation model.

10. A hydrofoil height control method for controlling a flap for adjusting a height of a hydrofoil craft from a water surface, comprising:

a normal-manipulated-variable acquisition step of acquiring a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal manipulated variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water surface;

a target wave image acquisition step of acquiring a target wave image of a wave

captured from at least one imaging position on the hydrofoil craft;

a determination step of determining whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable and the target wave image;

an additional-manipulated-variable acquisition step of, if it is determined that the additional operation is necessary, acquiring an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation; and

an operation step of outputting an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable,

wherein the target wave image acquisition step includes acquiring a plurality of the target wave images captured at a plurality of the imaging positions, and

wherein the additional-manipulated-variable acquisition step includes acquiring the additional manipulated variable, based on one or more target wave images having no halation among the plurality of target wave images.

11. A hydrofoil height control method for controlling a flap for adjusting a height of a hydrofoil craft from a water surface, comprising:

a normal-manipulated-variable acquisition step of acquiring a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal manipulated variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water surface;

a target wave image acquisition step of acquiring a target wave image of a wave captured from at least one imaging position on the hydrofoil craft;

a determination step of determining whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable

and the target wave image;

an additional-manipulated-variable acquisition step of, if it is determined that the additional operation is necessary, acquiring an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation; and

an operation step of outputting an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable,

wherein the additional-manipulated-variable derivation model outputs one of a plurality of previously classified additional-manipulated-variable candidates as the additional manipulated variable.

12. A hydrofoil height control method for controlling a flap for adjusting a height of a hydrofoil craft from a water surface, comprising:

a normal-manipulated-variable acquisition step of acquiring a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal manipulated variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water surface;

a target wave image acquisition step of acquiring a target wave image of a wave captured from at least one imaging position on the hydrofoil craft;

a determination step of determining whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable and the target wave image;

an additional-manipulated-variable acquisition step of, if it is determined that the additional operation is necessary, acquiring an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image

of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation;

an operation step of outputting an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable; and

an output step of outputting a manipulated variable that preferentially controls the flap, instead of or in addition to the actual manipulated variable of the flap output in the operation step.

13. A program configured to cause a computer to function as:

a normal-manipulated-variable acquisition unit configured to acquire a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal manipulated variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water surface;

a target wave image acquisition unit configured to acquire a target wave image of a wave captured from at least one imaging position on the hydrofoil craft;

a determination unit configured to determine whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable and the target wave image;

an additional-manipulated-variable acquisition unit configured to, if it is determined that the additional operation is necessary, acquire an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation; and

an operation unit configured to output an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable,

wherein the learning data further includes a non-operation image of the wave captured

from a position corresponding to the imaging position when the operator does not perform the manual operation, and

wherein the determination unit determines whether the additional operation is necessary for the target wave image, based on a necessary determination model learned with the learning data including the non-operation image.

14. A program configured to cause a computer to function as:

a normal-manipulated-variable acquisition unit configured to acquire a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal manipulated variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water surface;

a target wave image acquisition unit configured to acquire a target wave image of a wave captured from at least one imaging position on the hydrofoil craft;

a determination unit configured to determine whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable and the target wave image;

an additional-manipulated-variable acquisition unit configured to, if it is determined that the additional operation is necessary, acquire an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation;

an operation unit configured to output an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable; and

a model correction unit configured to correct the additional-manipulated-variable derivation model based on a comparison result between the additional manipulated variable obtained by inputting the target wave image to the additional-manipulated-variable derivation

model and the manual manipulated variable of the operator for the target wave image input to the additional-manipulated-variable derivation model.

15. A program configured to cause a computer to function as:

a normal-manipulated-variable acquisition unit configured to acquire a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal manipulated variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water surface;

a target wave image acquisition unit configured to acquire a target wave image of a wave captured from at least one imaging position on the hydrofoil craft;

a determination unit configured to determine whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable and the target wave image;

an additional-manipulated-variable acquisition unit configured to, if it is determined that the additional operation is necessary, acquire an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation; and

an operation unit configured to output an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable,

wherein the target wave image acquisition unit is configured to acquire a plurality of the target wave images captured at a plurality of the imaging positions, and

wherein the additional-manipulated-variable acquisition unit is configured to acquire the additional manipulated variable, based on one or more target wave images having no halation among the plurality of target wave images.

16. A program configured to cause a computer to function as:

a normal-manipulated-variable acquisition unit configured to acquire a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal manipulated variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water surface;

a target wave image acquisition unit configured to acquire a target wave image of a wave captured from at least one imaging position on the hydrofoil craft;

a determination unit configured to determine whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable and the target wave image;

an additional-manipulated-variable acquisition unit configured to, if it is determined that the additional operation is necessary, acquire an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation; and

an operation unit configured to output an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable,

wherein the additional-manipulated-variable derivation model outputs one of a plurality of previously classified additional-manipulated-variable candidates as the additional manipulated variable.

17. A program configured to cause a computer to function as:

a normal-manipulated-variable acquisition unit configured to acquire a normal manipulated variable of the flap used in a normal operation of the hydrofoil craft, the normal manipulated variable being determined based on a deviation between an actual height of the hydrofoil craft from the water surface and a target height of the hydrofoil craft from the water

surface;

a target wave image acquisition unit configured to acquire a target wave image of a wave captured from at least one imaging position on the hydrofoil craft;

a determination unit configured to determine whether an additional operation is necessary for the flap in addition to the normal operation, based on the determined normal manipulated variable and the target wave image;

an additional-manipulated-variable acquisition unit configured to, if it is determined that the additional operation is necessary, acquire an additional manipulated variable of the flap according to the target wave image, based on an additional-manipulated-variable derivation model learned with learning data including a relationship between a manual operation image of the wave captured from a position corresponding to the imaging position when an operator performs a manual operation and a manual manipulated variable in the manual operation;

an operation unit configured to output an actual manipulated variable of the flap, based on the normal manipulated variable and the additional manipulated variable; and

an output unit configured to output a manipulated variable that preferentially controls the flap, instead of or in addition to the actual manipulated variable of the flap output from the operation unit.

18. A model construction device configured to construct an additional-manipulated-variable derivation model used for acquiring an additional manipulated variable of a flap for adjusting a height of a hydrofoil craft from a water surface, comprising:

a manual operation image acquisition unit configured to acquire a manual operation image of a wave captured form one or more positions on the hydrofoil craft;

an analysis unit configured to analyze a relationship between the manual operation image of the wave captured on the hydrofoil craft when at least one operator performs a manual operation and a manual manipulated variable in the manual operation; and

a model construction unit configured to construct the additional-manipulated-variable derivation model for acquiring the additional manipulated variable of the flap according to the

target wave image, based on an analysis result of the analysis unit.