CLAIMS

1. A periodic disturbance suppressing control apparatus comprising:

a periodic disturbance sensing section to sense a periodic disturbance of a controlled object as a sensed periodic disturbance of a direct current component;

a periodic disturbance estimating section to estimate the periodic disturbance by determining a difference between a signal obtained by multiplication of the sensed periodic disturbance with a multiplier using a reciprocal of a transfer characteristic from a periodic disturbance suppressing command to the sensed periodic disturbance, determined according to a transfer characteristic of a control system, and a signal obtained by adding only a detection delay to the periodic disturbance suppressing command;

an adder to calculate the periodic disturbance suppressing command by calculating a deviation between an estimated periodic disturbance estimated by the periodic disturbance estimating section and a periodic disturbance command to suppress a disturbance; and

a learning control section to correct the reciprocal of the transfer characteristic in accordance with a quantity obtained by dividing a difference of the periodic disturbance suppressing command during one sample interval by a difference of the sensed periodic disturbance during the one sample interval, by regarding a difference of the transfer function of the control system and a difference of the periodic disturbance of the controlled object during the one sample interval as being approximately equal to zero.

2. The periodic disturbance suppressing control apparatus as recited in Claim 1, wherein the periodic disturbance suppressing apparatus is arranged to suppress the periodic disturbance by superposing the

control apparatus are arranged in parallel and configured to suppress periodic disturbances of a plurality of orders.

8. The periodic disturbance suppressing control apparatus as recited in one of Claims 1, wherein the learning control section is configured to stop a learning control and output the reciprocal of the transfer characteristic just before stoppage when the difference during the one sample interval of the sensed periodic disturbance is smaller than or equal to a threshold value.

9. A periodic disturbance suppressing control process comprising:

a periodic disturbance sensing operation of sensing a periodic disturbance of a controlled object as a sensed periodic disturbance in a form of a direct current component;

a periodic disturbance estimating operation of determining an estimated periodic disturbance by calculating a difference between a signal obtained by multiplication of the sensed periodic disturbance by a reciprocal of a transfer characteristic from a periodic disturbance suppressing command to the sensed periodic disturbance, and a signal obtained by adding only a detection delay to the periodic disturbance suppressing command;

a producing operation of producing the periodic disturbance suppressing command from the estimated periodic disturbance; and

a learning control operation of correcting the reciprocal of the transfer characteristic in accordance with a quantity determined by dividing a variation of the periodic disturbance suppressing command by a variation of the sensed periodic disturbance.

10. The periodic disturbance suppressing control process as claimed in Claim 9, wherein the variation of the sensed periodic disturbance is a

difference between a previous value of the sensed periodic disturbance determined in a previous cycle of the learning control operation performed periodically and a current value of the sensed periodic disturbance determined in a current cycle next to the previous cycle of the learning control operation, and

the variation of the periodic disturbance suppressing command is a difference between a previous value of the periodic disturbance suppressing command determined in a previous cycle and a current value of the periodic disturbance suppressing command determined in the current cycle.

11. The periodic disturbance suppressing control process as claimed in Claim 10, wherein the previous value of the sensed periodic disturbance is a previous average value of the sensed periodic disturbance determined by averaging values of the sensed periodic disturbance sampled during the previous cycle of the learning control operation performed periodically, the current value of the sensed periodic disturbance is a current average value of the sensed periodic disturbance determined by averaging values of the sensed periodic disturbance sampled during the current cycle next to the previous cycle, the previous value of the periodic disturbance suppressing command is a previous average value of the periodic disturbance suppressing command determined by averaging values of the periodic disturbance suppressing command sampled during the previous cycle of the learning control operation and the current value of the period disturbance suppressing command is a current average value of the periodic disturbance suppressing command determined by averaging values of the periodic disturbance suppressing command sampled during the current cycle of the learning control operation.

12. The periodic disturbance suppressing control process as claimed in one of Claims 9-11 wherein the learning control operation is stopped and a most recent value of the reciprocal of the transfer characteristic just before stoppage is outputted when the variation of the sensed periodic disturbance is smaller than or equal to a predetermined threshold value.

13. A periodic disturbance suppressing control apparatus comprising:

a periodic disturbance sensing section to sense a periodic disturbance of a controlled object as a sensed periodic disturbance in a form of a direct current component;

a periodic disturbance estimating section to determine an estimated periodic disturbance by calculating a difference between a signal obtained by multiplication of the sensed periodic disturbance by a reciprocal of a transfer characteristic from a periodic disturbance suppressing command to the sensed periodic disturbance, and a signal obtained by adding only a detection delay to the periodic disturbance suppressing command;

a producing section to produce the periodic disturbance suppressing command from the estimated periodic disturbance; and

a learning control section to correct the reciprocal of the transfer characteristic in accordance with a quantity determined by dividing a variation of the periodic disturbance suppressing command by a variation of the sensed periodic disturbance.

14. The periodic disturbance suppressing control apparatus as claimed in Claim 13, wherein the learning control section is configured to set the variation of the sensed periodic disturbance equal to a difference between a previous value of the sensed periodic disturbance

determined from a previous sample of date collected in a previous cycle of the learning control operation performed periodically and a current value of the sensed periodic disturbance determined from a current sample of data collected in a current cycle next to the previous cycle of the learning control operation, and to set the variation of the periodic disturbance suppressing command equal to a difference between a previous value of the periodic disturbance suppressing command determined from the previous sample in the previous cycle and a current value of the periodic disturbance suppressing command determined from the current sample in the current cycle.

15. The periodic disturbance suppressing control apparatus as claimed in Claim 14, wherein the learning control section is configured to use, as the previous value of the sensed periodic disturbance, a previous average value of the sensed periodic disturbance determined by averaging values of the sensed periodic disturbance sampled during the previous cycle of the learning control operation, to use, as the current value of the sensed periodic disturbance, a current average value of the sensed periodic disturbance determined by averaging values of the sensed periodic disturbance sampled during the current cycle next to the previous cycle, to use, as the previous value of the periodic disturbance suppressing command, a previous average value of the periodic disturbance suppressing command determined by averaging values of the periodic disturbance suppressing command sampled during the previous cycle of the learning control operation and to uses as the current value of the period disturbance suppressing command, a current average value of the periodic disturbance suppressing command determined by averaging values of the periodic disturbance suppressing command sampled during the current cycle of the learning control operation.

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