Claims

[Claim 1]

A crane deformation state estimation system,

the system comprising an arithmetic processing unit for estimating a virtual deformation state of an attachment which is connected to a crane main body so as to perform a derricking motion in a crane and is deformed according to each of external force and inertial force,

wherein the arithmetic processing unit comprises:

an input processing element configured to recognize an acting force factor for specifying an acting state of force on the attachment and a posture factor for specifying a posture of the attachment, which are inputted through an input interface;

an estimation processing element configured to estimate, as a deformation state of the attachment, where an attachment element constituting the attachment being expressed as a line segment, an amount of change in an elevation angle of the attachment element relative to a horizontal plane indicating the deformation state of the attachment in a condition where the force is acting on the attachment in the state specified by the acting force factor with the posture specified by the posture factor for the attachment as a reference, according to a crane model indicating a correlation among the acting force factor, the posture factor and the amount of change in the elevation angle of the line segment relative to a horizontal plane, based on the acting force factor and the posture factor recognized by the input processing element; and

an output processing element configured to make an output interface output information indicating the deformation state of the attachment estimated by the estimation processing element.

[Claim 2]

The crane deformation state estimation system according to claim 1,

wherein the input processing element recognizes, as the posture factor, each of an elevation angle relative to a horizontal plane of a first attachment element as the attachment element connected to the crane main body so as to perform the derricking motion and an elevation angle relative to a horizontal plane of a second attachment element as the attachment

element directly or indirectly connected to the first attachment element so as to change at least one of the posture and a position, and

the estimation processing element estimates, as the deformation state of the attachment, the amount of change in the elevation angle of the first attachment element relative to the horizontal plane and the amount of change in the elevation angle of the second attachment element relative to the horizontal plane in the condition where the force is acting on the attachment in the state specified by the acting force factor with the posture specified by the posture factor for the attachment as the reference.

[Claim 3]

The crane deformation state estimation system according to claim 2,

wherein the estimation processing element is configured to estimate, as the deformation state of the attachment, where an entirety of a boom as the first attachment element being expressed as a line segment and an entirety of a jib as the second attachment element being expressed as a line segment, an amount of change in elevation angle of the entirety of the boom as the first attachment element relative to a horizontal plane and an amount of change in elevation angle of the entirety of the jib as the second attachment element relative to a horizontal plane, in a condition where the force is acting on the attachment in the state specified by the acting force factor with the posture specified by the posture factor for the attachment as a reference, according to the crane model indicating a correlation among the acting force factor, the posture factor and the amount of change in elevation angle of the line segment relative to a horizontal plane.

[Claim 4]

The crane deformation state estimation system according to any one of claims 1 to 3, wherein the input processing element recognizes weight of a suspended load lifted by the attachment as the acting force factor.

[Claim 5]

The crane deformation state estimation system according to any one of claims 1 to 3,

wherein the input processing element recognizes, as the acting force factor, at least one of a time change state of a turning angular velocity and a turning angular acceleration of the crane main body, or at least one of a time change state of an angular velocity and angular acceleration of the elevation angle of the attachment element relative to the horizontal plane.

[Claim 6]

The crane deformation state estimation system according to any one of claims 1 to 3,

wherein the estimation processing element, in a state where a force is acting on the attachment in a state specified by the acting force factor, estimates, as the deformation state of the attachment, according to the crane model in which a line segment connecting centers of gravity of a plurality of points at one end of the attachment element and centers of gravity of a plurality of points at the other end of the attachment element, both obtained by finite element method, is expressed as the line segment representing the attachment element.