SYSTEM AND METHOD FOR DETERMINING OF MOVEMENTS AND OSCILLATIONS OF MOVING STRUCTURES

The invention concerns a system and a method for monitoring of movements of a structure.

Movable structures as, for example, buildings and large machines may be set into motions or oscillations by environmental influences or by their own operational movements, which may damage the structure or hinder the operation. To prevent damages, to plan maintenance, or to estimate the residual lifetime such movements can be observed and monitored.

For monitoring of wind turbines known sensors such as uniaxial acceleration sensors with piezo technology, strain gauges, photometry systems or laser measuring systems are used. By these means, simple position changes and frequency analysis of the structure-born sound can be carried out, which allow a detection of possible damages of parts of the turbine such as bearings, gear parts or rotor blades.

Here, there is a disadvantage that the measured values detect a movement of the system only uniaxially and only for selected measurement locations.

Embodiments of the invention provide a system and a method for monitoring of movements of a structure that allow an effective and secure monitoring of the structure and that provide a basis for repair measures, maintenance planning, and/or estimation of the residual lifetime of parts of the structure.

According to a first aspect of the present invention, there is provided a system for monitoring of movements of a structure comprising: at least one inertial measurement device mounted to the structure for determining of rotation rates and acceleration values in a earth fixed reference system, a central unit for determining a monitoring value on the basis of the rotation rate and acceleration values by means of an inertial navigation algorithm, and an output unit for outputting of the monitoring value, wherein the central unit is configured to determine and/or correct a measurement error of the inertial measurement device on the basis of a boundary condition predetermined by the structure, and the central unit is configured to determine the boundary conditions on the basis of at least one information of a group comprising a substantially stationary position of the structure, a constraint of a degree of freedom of a movement of at least a part of the structure, an inclination angle of at least a part of the structure, a mean value of a movement of at least a part of the structure and/or of the inertial measurement device.

According to a second aspect of the present invention, there is provided a method for monitoring of movements of a structure comprising: determining of rotation rates and acceleration values in an earth fixed reference system of at least one inertial measurement device mounted to the structure, determining of a monitoring value on the basis of the rotation rates and acceleration values by means of an inertial navigation algorithm, determining and/or correcting a measurement error of the determined rotation rates and acceleration values on the basis of a boundary condition predetermined by the structure outputting of the monitoring value, wherein a measurement error of the inertial measurement device is determined and/or corrected on the basis of a boundary condition predetermined by the structure, and the boundary condition is determined on the basis of at least one information of a group comprising a substantially stationary position of the structure, a constraint of a degree of freedom of a movement of at least a part of the structure, an inclination angle of at least a part of the structure, a mean value of a movement of at least a part of the structure and/or of the inertial measurement device.

The structure may be an arbitrary object that can be set into motion and/or oscillations by means of outer influences (environmental influences) or inner

influences (operating behavior). For example, it might be a building, such as a multi-story building or a transmission tower, or it might be a machine, such as a construction machine, a crane or the like. Further, it might also be a structure that is constructed like a building and operated like a machine, such as for example a Ferris wheel, an offshore platform or a wind turbine.

On the one hand, such structures may be set into motions by environmental influences such as wind, sea current, wave impact or movements of the surface of the earth, e.g. during an earth quake. On the other hand, such structures may also be set into motions by their own operational movements such as a working motion of a part of the structure, drive oscillations or gear vibrations. Moreover, interactions may be present between environmental influences and internal movements of the structures, which may lead to a complex motion behavior.

Such movements and oscillations may damage the structure and may lead to material fatigue such as fatigue cracks or fractures. Furthermore, they may influence the operating behavior of the structures and limit in this manner the field of applications or the operation efficiency.

Further, it is also possible that the structure changes during time, for example by aging, wear-out, structural damages, mechanical damages or by environmental influences. For example, in complex moving structures such as wind turbines icing on or water accumulation in the rotor blades may occur. Due to stress and material fatigue the material characteristics may change, parts of the structure may become softer or get cracks. Such changes of the structure are reflected in the motion behavior of the structure. For example, frequency or amplitudes of oscillations or movements may change. The changes can be detected based on the rotation rates and acceleration values measured by the inertial measurement device. This allows recognizing the necessity of measures for example for maintenance, upkeep or operation and to carry out such measures before significant damages occur.