APPARATUS FOR MEASURING THE VERTICAL MOTION OF A FLOATING PLATFORM

This invention relates to apparatus for measuring the vertical motion of a floating platform caused by wave action or swell on the sea surface.

The invention in particular, but not exclusively, relates to heave compensation in marine surveying. Echo sounders are used to measure the depth of the sea bed below the ocean surface. Inaccuracies can occur in these measurements if the survey vessel moves up and down due to the wave motion at the ocean surface. Known means of solving this problem are by using an apparatus in which an accelerometer is mounted vertically on an assembly which is kept horizontal even as the survey vessel rolls and pitches. The accelerometer can be mounted on a float in an oil bath which finds its own level or mounted on a mechanical device, gravitationally biased to keep the accelerometer vertical, for example it can be mounted in gimbels, or a gyroscopically stabilised platform, so that the accelerometer is effectively isolated from the rolling and pitching movement of the ship.

A problem associated with these known systems is that if the vessel is pitching and rolling with a high frequency and with large angles then the mechanical stabilisation systems do not respond fast enough to keep the accelerometer in its vertical axis.

Furthermore these systems are fitted to large survey ships which provide a generally stable platform for charting the sea floor. It would be an advantage if such devices could be fitted to small vessels (less than 10 meter in length) which were carried by a larger mother ship. However, because of the tendency of small vessels to pitch and roll the above described compensation apparatus are not suitable.

The present invention provides an apparatus that overcomes the above problems.

Accordingly there is provided apparatus for measuring the vertical motion of a floating platform and which comprises a sensor having three accelerometers arranged on mutually perpendicular axes so that one accelerometer is in a substantially vertical plane and the other two accelerometers are in a substantially horizontal plane, the output signals from the three accelerometers being continually sampled and the sample outputs processed in a data processor unit to provide a signal indicative of the vertical position of the platform.

Preferably there is further provided in the sensor a reference signal transmitter which produces a reference signal which is processed with the three accelerometer signals to provide said signal indicative of the vertical position of the platform.

Preferably the reference signal is a zero voltage signal that undergoes the same operational path through the apparatus as the accelerometer signals.

There is also provided a method of compensating for the vertical rise and fall of a floating platform due to wave action, said method including measuring the horizontal and vertical components of acceleration by using three accelerometers arranged mutually perpendicular to each other to produce three accelerometer output signals, passing the three output signals, preferably together with a reference signal into an analogue digital converter to produce a digital signal representation of each of the three output signals and the reference signal, and then combining the four signals in such a way as to produce a resultant signal representative of the vertical motion of the platform.

Preferably the reference signal is produced from a zero voltage signal which takes the same operational path as the three accelerometer output signals so as to allow the removal of the voltage offsets.

A well known error in vertical acceleration measurements is caused by a significant horizontal component of acceleration such as when a vessel is turning. The prior art equipment which uses gravity as a vertical reference cannot separate the horizontal and vertical components, for example in an apparatus in which a vertical accelerometer is mounted in gimbals the horizontal acceleration will cause its pendulum to tilt so that the accelerometer will in fact measure a reduced vertical component and will also measure a portion of the horizontal component of acceleration. Similarly with other known apparatus that utilise a gyroscope to maintain stability of the horizontal platform, the platform is maintained in a horizontal plane by erector motors controlled by inclinometers which are again susceptible to errors caused by horizontal acceleration.

The error due to the horizontal acceleration is the same for both prior art apparatus and the present invention using triaxial accelerometers. Therefore the method of the present invention offers equal accuracy but removes the disadvantages associated with the known mechanical self levelling apparatus when a vessel is pitching and rolling.

It is considered that a heave compensation apparatus and method as described above will also have applications other than marine survey work, for example:

a. Towed-body applications. When a body is towed behind a ship it is usually desirable to maintain it at a constant depth. However the wave motion of the ship tends to be transmitted down the cable to the towed body. This can be prevented by measuring the vertical speed of the towing point and using the data to control a variable speed winch.

b. Floating cranes. Cranes mounted on floating platforms can be difficult to control when the platform is rolling and pitching. If the vertical motion of the jib can be measured, then the position of the hook and the tension in the cable can be controlled more accurately.

The invention will be described by way of example and with reference to the accompanying drawings in which:

FIG. **1** is a schematic drawing of a boat showing the triaxial accelerometer sensor located on the pitch and roll axes of the vessel and a triaxial magnetometer located on the mast.

FIG. **2** is a schematic drawing illustrating the sensor means for processing the accelerometer signals into digitalised format.

FIG. **3** is a schematic drawing illustrating the data processing of the signals from the triaxial accelerometers.

With reference to FIG. **1**, three accelerometers **11**, **12**, **13**, are mounted in a sensor **5** on three mutually perpendicular axes in a block which is to be located on a floating platform, illustrated for convenience is a boat, at the intersection of roll and pitch axes. The accelerometers **11**, **12**, and **13** are mounted so that one accelerometer measures forces in a substantially vertical axis Az and the other two accelerometers measure forces in a substantially horizontal plane showing axes Ax and Ay. The accelerometers **11**, **12**, **13** are preferably inertial grade accelerometers such as Sundstrand Data Control