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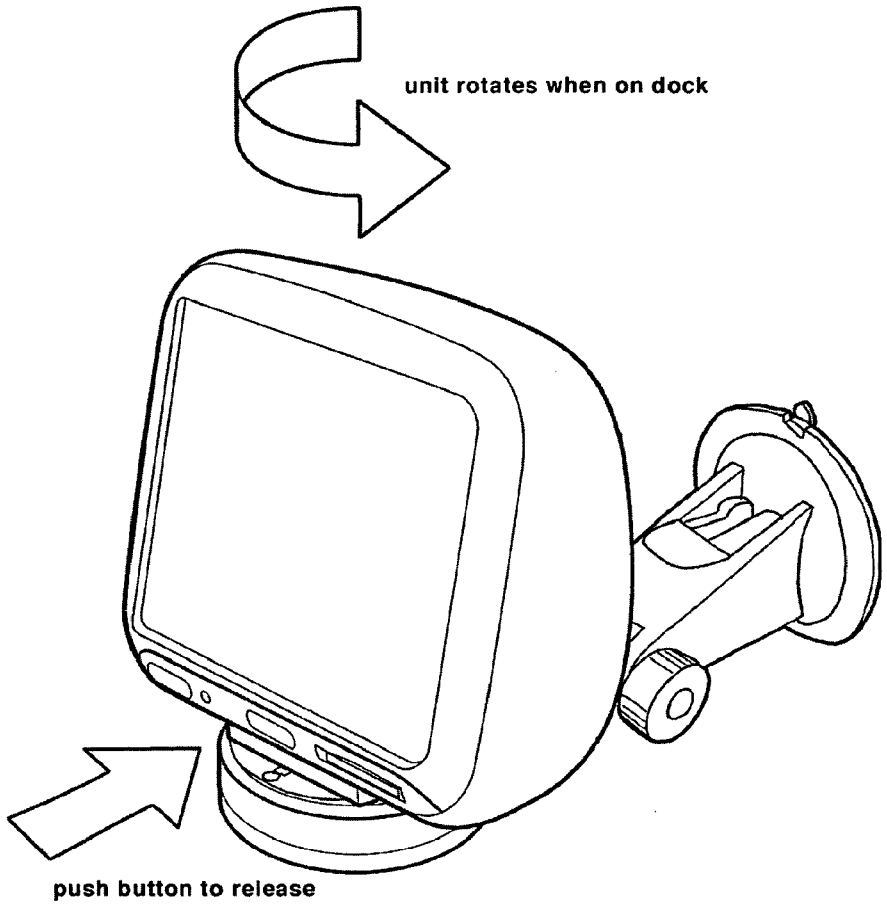
(54) Title: PORTABLE NAVIGATION DEVICE WITH ACCELEROMETER



(57) Abstract: A portable navigation device comprises an accelerometer, a GPS receiver, and a calibration module The calibration module generates calibration parameters that enable acceleration data from the accelerometer to be accurately converted into speed and heading data and integrated over time to give distance data The calibration parameters are calculated from GPS derived speed and heading data and resolve or otherwise compensate for (i) the attitude of the portable device with respect to the horizontal plane ("pitch") and (ii) the angle between the forward direction of the device and the driving direction of a vehicle the device is mounted in ("yaw")

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PORTABLE NAVIGATION DEVICE WITH ACCELEROMETER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a portable navigation device comprising an accelerometer, a GPS receiver, and a calibration module. The calibration module generates calibration parameters that enable acceleration data from the accelerometer to be accurately converted into speed and heading data and integrated over time to give distance data. The term GPS refers to the GPS satellite navigation system, and any equivalent or similar system, such as Galileo.

2. Description of the Prior Art

It is well known to integrate GPS with dead reckoning systems and for the GPS to be used to calibrate the output from the dead reckoning sensors. Reference may be made to "Integration of GPS and Dead-Reckoning Navigation Systems" by Wei-Wen Kao, Vehicle Navigation & Information Systems Conference Proceedings P-253 ISBN 1-56091-191-3. The basic approach there is to use the absolute position accuracy of GPS to provide feedback signals to correct the dead-reckoning errors, while the smoothness and constant availability of the dead-reckoning signals are used to correct GPS position errors (e.g. due to multipath propagation and the selective availability that was imposed at the time the paper was written, 1991). Later systems were designed to correct for the inclination ('pitch') and tilt ('roll') in embedded or built in automotive systems; reference may be made to EP 1096230, which is also helpful in providing a detailed background. The contents of this publication are incorporated by reference.

However, most current generation automotive navigation devices are not embedded systems at all, but instead portable systems. These pose significant challenges because they are typically removably mounted on suction mounts against the vehicle windshield. These devices are therefore rarely fixed with the same orientation (i.e. pitch, roll or yaw) and in fact any of these factors can alter even during a drive.

SUMMARY OF THE INVENTION

The invention is a portable navigation device comprising an accelerometer, a GPS receiver, and a calibration module. The calibration module generates calibration parameters that enable acceleration data from the accelerometer to be accurately converted into speed and heading data, in which the calibration parameters are calculated from GPS derived speed and heading data and resolve or otherwise compensate for (i) the attitude of the portable device with respect to the horizontal plane ('pitch') and (ii) the angle between the forward direction of the device and the driving direction of a vehicle the device is mounted in ('yaw').

The angle between the forward direction of the device and the driving direction of the vehicle the device is mounted in (i.e. 'yaw') can be altered at any time by a user of the device and the calibration module will automatically calculate calibration parameters that resolve or otherwise compensate for this changed angle. Modelling yaw is important but prior art systems concentrated on compensating for just pitch and roll, principally because they were focussed on embedded systems. But for portable navigation systems, yaw is a surprisingly important attribute to resolve.

In one implementation, the device calculates calibration parameters for each successive valid GPS-derived speed and heading fix. The device then stores the calculated calibration parameters, and clears any stored calibration parameters that are of more than a predefined age (e.g. 5 seconds old).

Unlike typical prior art system that combine GPS and dead-reckoning systems at the same time, the device may determine its position exclusively using data derived from the accelerometer if the GPS signal is lost and valid calibration parameters are available; when a GPS fix is available, then no assistance from the accelerometer is provided.

In operation, one implementation stores a predefined number of samples of speed and heading calibration parameters together with time and accelerometer data. The device checks that at least n seconds of data is stored and then compares stored GPS and accelerometer data for each n second epoch is compared against thresholds of speed and age.

The portable navigation device can be a touch-screen controlled automotive navigation device. This can be removably mounted onto a vehicle windscreen using a suction mount. It could also be a handheld device, and may also operate as a mobile telephone.

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