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(56) Documents Cited:
WO 2001/050151 A1
WO 2000/079703 A1
US 6016118 A
US 6012013 A
US 5774826 A

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(54) Abstract Title: **Determining position relative to a local origin**

(57) The invention provides a method and apparatus for determining local position. The local origin co-ordinates are generated from the most significant digits of the global positioning co-ordinates.

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The original documents included appendices that have not been reproduced here.

Positioning

The present invention relates to a system using wireless technology to estimate the position of a person or device.

The contents of GB0002404.2 and an application entitled Positioning filed 7th August 2000 in the name of Nokia Mobile Phones, with inventor Noel Lobo are incorporated herein by reference and attached as appendices.

Currently there is a global positioning system, GPS that allows location to be determined on a global basis. There are also local origin systems that select an origin locally and allow a location to be determined with coordinates from the local origin. Such local origin systems allow a location within a specific local region to be achieved more simply.

A problem encountered is how to provide and store both local and global position information.

Currently each local origin system defines its own local origin. It may be, for example the corner, or centre of an office block. A location within the local system is then determined in coordinates from the local origin. To determine a location in a local system, at least the local origin, the coordinates in that system and the direction of the coordinate axes need to be known.

The present invention provides a system for providing both local and global position information.

Abstract

This discussion document considers the selection local origin and how to store it . We highlight some the merits of local origin vs global origin.

Introduction

In the abstract storing the position relative to a local origin or using global coordinates are just two equivalent way of representing the same information. The necessary information to transform from local position to global position are the coordinates of the local origin and the coordinates of the object with respect to the local position. Since there are two coordinate systems, we need to have specified two sets of axes. One can simplify matters by having the same set of axes for both the local and global system

Why Local Origin?

The global coordinates may be less relevant than the local coordinates
In an office, the local coordinates may be more convenient.
The cost in capacity of transmitting the global coordinates may be too high.
Significant savings in capacity may be made if local coordinates are used.

What is a natural Origin?

Depends on Scale e.g. Astronomy, Town center, Office Building, Airport.
Depends on the circumstances, different points seem natural candidates for local origin. It would be clearly an advantage if there was an automatic way of selecting a local origin.

What is the natural local axes?

This depends on the application and use. In a rectangular building the natural axes may be the sides of the building. Sometimes the main feature of the local topology may be a road and one of the natural axis may be along the road. However, we note that the application service that utilizes the positioning information should present the information in a human friendly way. In this context, the local origin most suitable is the human user of the Bluetooth device.

What is the coverage of the local position coordinates ?
This depends on
Expected accuracy of algorithms.
Memory available to store the data
Expected usage of Local Positioning .
Note: Bluetooth could be a moving device
Expect that a local coordinate system 100 m x 100m might typically cover the useful applications

How to deal with multiple local origins?

Use a recognized global system like GPS to specify the coordinates of the local origin.

Resolution of GPS position.

We calculate the distance on the surface of the earth that point moves as one increases the latitude and longitude by one LSB

Latitude	**Bits 2' Complement**
Longitude	**32 Bits 2' Complement**

We show some of the Mathematica workings

```
<< Miscellaneous`PhysicalConstants`
Radius
EarthRadius
6.37814 ⊗ 10^6 Meter
Latitude
2^31. 1
2147483647
```

On the earths surface there are 2147483647 units of LSB to represent the distance

$$\frac{Pi}{2}\,\frac{EarthRadius}{2^{31}-1} = 0.00466535\,\text{Meter}$$

Thus each LSB represents 0.00466535 Meter.

A similar calculation on the longitude means that each bit represents 0.00466535 Meter on the equator.

Axes Selection

We note that on the surface of the earth, increasing the latitude by one LSB moves the point in a direction that orthogonal to the direction that the point moves when the longitude is increased by one LSB. The third direction can be obtained by taking the vector product of the two unit vectors used to represent these two directions .

Using the first 16 bits for the Latitude

$$\frac{Pi}{2}\,\frac{EarthRadius}{2^{16}-1} = 152.876\,\text{Meter}$$

Using the first 16 MSB, we get the worst resolution at the equator where one LSB represents a distance of 152.876 Meter

Using the first 17 bits for the Longitude

At the equator one LSB will represent 152.876 Meter
At England 50 degrees longitude one LSB represents about 98.2671 Meter.

With some of the newer systems (Ultra Wide Band) greater relative accuracies are possible than the resolution in the GPS system. However, these technologies do not have a global scope like GPS. So some form of local positioning system has to be adopted in order to deal with the increased accuracy.

The Proposal

Let the set of local origins be all the points on the surface of the earth with longitudes where the 15 LSB's are zero and latitudes where the 14 LSB's are zero.
Two coordinate systems are natural candidates
polar

Spherical appropriate for global references and local origins
Cartesian coordinates are appropriate for local positioning references
Note: It is possible to use either system for both global and local origin systems.

CoOrdinates for Local Origin Spherical Polar

Use 16 MSB of 2' Complement of GPS Latitude

Use 17 MSB of 2' Complement of GPS Longitude

Local Coordinates Cartesian

Use 16 Bit 2' Complement word x - axes, y - axes

Use 8? Bit 2' Complement word z- axes

It is the intention that largest 16 Bit word represents 127 Meters in the Cartesian co

Advantages

1)The local coordinates can be obtained from the GPS coordinates by a simple process from an accurate GPS position.

2)The local origin to use is selected automatically. Thus in the Nokia building, as an accurate measurement of the position of the building can be made , one can select the GPS local origin nearest the building. Bluetooth devices are programed to use this origin. Visiting Bluetooth devices acquire the local origin to use by communicating with devices that have accurate positioning information. In a large building, there may be more than one local origin that falls within it. Nothing precludes some Bluetooth devices using one origin at one place in the building and then swapping to the more convenient origin. when the Bluetooth device moves.

Note2: Just the 8MSB of the x and and z coordinate need be transmitted.

Note3: Similar system can be obtained by using fewer e.g. 16 MSB for longitude or more bits e.g 18 MSB for longitude. What this adjusts is the density of virtual origins on the earth surface.

The invention suggests that instead of each local system defining its own local origin, a set of local origins are determined. Advantageously these are a set of coordinates recognised in the Global Positioning System. The spacing of the local origins is a matter of some design choice and need not be uniform over the entire globe. In the example above with the latitudes of the local origins being the GPS coordinates with the 14 LSBs zeros and the longitude with the 15 LSBs zeros the local origins would be 156 m apart in latitude at the equator. They would be 152m spaced in longitude at the equator and 98m apart in the UK.

Once the local origins have been globally defined, by using cartesian coordinates using the north pole and increasing longitude for the directions of the two axes, the location can be readily defined from any local origin.

The beauty of this system is that instead of having to provide a local origin and a GPS location, the local origin is derived from the GPS location. Less information is necessary. Also by defining the direction of the local origin axes globally, or at least for all local systems there is no need for additional information to be provided giving the axes directions in addition to the local origin coordinates.

The present invention includes any novel feature or combination of features disclosed herein either explicitly or any generalisation thereof irrespective of whether or not it relates to the claimed invention or mitigates any or all of the problems addressed.

In view of the foregoing description it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention.

Claims

1. An electronic device capable of determining its position in a local area comprising means for determining position coordinates having respective first numbers of significant digits in a global positioning system;
means for determining a local origin from a subset of the most significant digits of the coordinates in the global positioning system; and
means for determining a position relative to the local origin.

2. A transceiver arranged to determine its location by receiving messages transmitted from a plurality of proximal transceivers comprising
a memory for storing the transceiver's position as a first set of coordinates in a first system;
means for determining a local origin for a second system from the first set of coordinates;
means for determining a location in coordinates of the second system from received messages; and
a memory for storing the transceiver's position as a second set of coordinates.

3. A transceiver according to claim 2 wherein the first system is a global positioning system.

4. A transceiver according to claim 3 wherein the global positioning system is GPS.

5. A transceiver according to any one of claims 2 to 4 wherein the coordinates of the first system are spherical coordinates

6. A transceiver according to any one of claims 2 to 5 wherein the coordinates of the second system are cartesian coordinates.

7. A transceiver according to claim 6 wherein the cartesian coordinates have axes towards polar north and orthogonal to the lines of longitude

8. A transceiver according to any one of claims 2 to 7 wherein the transceiver determines its position using the blue tooth protocol.

9. A transceiver according to any one of claims 2 to 8 wherein a local origin is a point on the surface of the earth with a longitude where the 15 least significant digits are zero and latitudes where the 14 least significant digits are zero.

10. A method for providing a location in a local region and over a more extensive area, the location in the more extensive area being determined in coordinates having respective first numbers of significant places, the local origins of the local regions being determined from the coordinates in the more extensive region using a reduced number of the significant places of the locating coordinates.

11. A local system suitable for determining location comprising providing a local origin from a reduced number of significant places of coordinates providing

positioning information in a second more extensive positioning system, and providing coordinates with respect to the local origin.

12. A transceiver as substantially hereinbefore described.

13. A method as substantially hereinbefore described.

14. A local system as substantially hereinbefore described.

Amendments to the claims have been filed as follows

Claims

1. A transceiver arranged to determine its location by receiving messages transmitted from a plurality of proximal transceivers comprising:
a memory for storing the transceiver's position as a first set of coordinates in a first system;
means for determining a local origin for a second system from the first set of coordinates;
means for determining a location in coordinates of the second system from received messages; and
a memory for storing the transceiver's position as a second set of coordinates.

2. A transceiver according to claim 1 wherein the first system is a global positioning system.

3. A transceiver according to claim 2 wherein the global positioning system is GPS.

4. A transceiver according to any preceding claim wherein the coordinates of the first system are spherical polar coordinates.

5. A transceiver according to any preceding claim wherein the coordinates of the second system are cartesian coordinates.

6. A transceiver according to claim 5 wherein the Cartesian coordinates have axes towards polar north and orthogonal to the lines of longitude.

7. A transceiver according to any preceding claim wherein the transceiver determines its position using the Bluetooth (RTM) protocol.

8. A transceiver according to any preceding claim wherein a local origin is a point on the surface of the earth with a longitude where the 15 least significant digits are zero and latitudes where the 14 least significant digits are zero.

9. A transceiver capable of determining its position in a local area as substantially hereinbefore described.

Application No: GB0418710.0 **Examiner:** Richard Kerslake

Claims searched: 1,10-14 **Date of search:** 29 September 2004

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	US5774826 A (McBRIDE
A	-	US6016118 A (JACKSON et al.)
A	-	US6012013 A (McBURNEY)

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[W] :

H4D

Worldwide search of patent documents classified in the following areas of the IPC[07]

G01S

The following online and other databases have been used in the preparation of this search report

EPODOC, JAPIO, WPI