Title: ACOUSTIC LOCATION DETERMINATION METHOD AND SYSTEM

Abstract: A location determination method and system is described. The system comprises a beacon (20) and a receiver (30). The beacon (20) is arranged to broadcast an inaudible sonic signal within the location (10). The signal includes data for identifying the location (10). The receiver (30) is arranged to receive the signal when in the location (10) and determine the location (10) in dependence on the data.
Declaration under Rule 4.17:

Published:
— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
DESCRIPTION

ACOUSTIC LOCATION DETERMINATION METHOD AND SYSTEM

The present invention relates to a method and system that allows a device to determine its location within a number of predetermined locations.

There exist many methods and systems available for use in determining one’s location. The cost, level of accuracy and availability of these method and systems depend primarily on the general location, such as whether you are indoors or outdoors and whether you are in a developed urban environment or in a more rural environment. Coverage of systems that can be used to determine one’s location is typically dependent on the location and environment.

The Global Positioning System (GPS) is well known for allowing a person to triangulate their position in dependence on a number of received signals from satellites. However, the cost overhead of implementing and maintaining the satellites along with the cost of components to construct the necessary receivers means that systems based on this technology will remain relatively expensive. Furthermore, accuracy of the system is reduced in certain locations due to signals slowing down as they pass through the ionosphere and troposphere. System accuracy is also reduced in built-up areas where signals bounce off sky scrapers and the like.

Various systems have also been suggested that use cells within portable cellular telephone systems to determine the position of a mobile telephone. Again, accuracy depends on the availability of signals from enough cells to triangulate the phone’s position. Furthermore, such systems rely on existing infrastructure and would prove prohibitively expensive to implement purely for determining one’s position.

Due to shielding from signals, location determination from GPS and cellular systems is poor or unavailable in indoor locations.

The Oxygen Project at Massachusetts Institute of Technology have developed a system called Crickets (http://nms.lcs.mit.edu/cricket/). The
system is an indoor location system allowing applications to be location-aware. In this manner, applications run on an appropriate device can operate or deliver information based on the position and/or orientation of the device. Location determination is achieved using a combination of RF and ultrasound technologies. Wall and ceiling mounted beacons are spread throughout a building, publishing information on an RF signal operating in the 418 MHz AM band. With each RF advertisement, a beacon also transmits a concurrent ultrasonic pulse. Upon receipt of an RF signal, devices listen for the corresponding ultrasonic pulse. An estimate of distance between the device and beacon is then determined using the difference in RF and ultrasound propagation times. Where several beacon signals are received, the beacon with the closest distance estimate is selected. The goal of the system is to achieve a close to 100% precision of determining location with a granularity of a few feet. However, the system has several disadvantages. Firstly the system is expensive to install as each beacon requires an ultrasonic and RF transmitter and each receiver requires an ultrasonic and RF receiver. Secondly, extra hardware is required on the receiving device. Typically, such systems will be implemented for use with small form factor receiving devices such as personal digital assistants (PDAs) or other devices designed to be used on the move. The integration of extra hardware on such devices is not possible in many cases and even if it is possible is not desirable as it makes the devices more cumbersome to carry and use.

According to a first aspect of the present invention, there is provided a location determination system comprising a beacon and a receiver, the beacon being arranged to broadcast an inaudible sonic signal within a location, said signal including data for identifying the location, wherein the receiver is arranged to receive the signal when in the location and determine the location in dependence on the data.

Determining location to a high accuracy level, particularly in small-scale indoor environments, is not often needed in day to day applications. The present invention seeks to provide a simple, low cost, system and method
allowing a device to determine its location within a reasonable level of accuracy.

The inaudible sonic signal may comprise an ultrasound signal.

The inaudible sonic signal may comprise audio-encoded data transmitted at a frequency higher than human hearing range.

The inaudible sonic signal may comprise audio-encoded data transmitted at a power level undetectable by a human ear.

The receiver may comprise a mobile telephone.

The receiver may comprise a PDA.

According to another aspect of the present invention, there is provided a method permitting determination of location of a receiver within a set of predetermined locations comprising:

- positioning a beacon within each predetermined location; and,
- broadcasting, from each beacon, an inaudible sonic signal within the respective predetermined location for identifying the location.

According to further aspects of the present invention there are provided respectively a beacon and a receiver as defined in the attached claims, the disclosures of which are incorporated herein by reference.

An example of the present invention will now be described, with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of a system according to an embodiment of the present invention.

Figure 1 is a schematic diagram of a system according to an embodiment of the present invention.

A location 10 includes a number of audio beacons 20a-20e. Each beacon 20a-20e is installed in a sub-location 10a-10e and is arranged to broadcast audio-encoded data within the respective sub-location 10a-10e. A receiver 30 includes a microphone 35 or other suitable device for receiving the audio-encoded data.
The audio-encoded data is preferably transmitted so that it is inaudible. This may be achieved by transmitting at a frequency higher than the average human hearing range, at an ultrasonic frequency and/or at a power low enough that it that cannot be detected by the average human ear.

Each beacon 20a-20e broadcasts different audio-encoded data, each including location information concerning the respective sub-location. Alternatively, the audio-encoded data may include some form of identifier in dependence on which the location information can be derived or obtained. For example, the location information could be a set of Cartesian coordinates, a postcode, a URL to a website containing information on the sub-location, a predetermined position on a map or some other form of location specification. The information could be encoded or encrypted and access may be limited to subscribers of the respective service. Alternatively the information may denote the type of room such as meeting room, which may trigger a predetermined mode of operation by the receiver. For example, if the receiver had telephony capabilities, information received indicating that it is in a meeting room may set it to silent or vibrate only on incoming calls.

In operation, the audio-encoded data is broadcast throughout the respective sub-location 10a-10e. In the example, the receiver 30 is positioned in sub-location 10c. Therefore, audio-encoded data from beacon 20c is received by the microphone 35 and the receiver is able to determine it is in sub-location 10c and act appropriately. If the receiver 30 was to be moved out of the sub-location 10c into a sub-location that lacked a beacon 20a-20e such as location 40, no audio-encoded data would be received and the receiver would act appropriately. When the receiver enters a sub-location 10a-10e with an installed beacon 20a-20e, the microphone 35 would again receive the respective audio-encoded data and the receiver 30 would be able to determine its location and act appropriately.

The frequency of broadcasts is dependent on the intended application and the environment. For example, if a user is expected to spend some time in a sub-location 10a-10e then the broadcast rate can be set at a relatively low level. However, where users are expected to move quickly then the broadcast
rate may be set at a higher level. Lower transmission rates will lead to lower power consumption by the beacons 20a-20e. A similar consideration must be made when setting the frequency of polling by the receiver 30. The amount of time the microphone 35 is active must be balanced against power consumption.

Preferably, each sub-location 10a-10e is a room. In this situation, the audio-encoded data signals can be flooded throughout the room as walls will prevent the majority of the signals escaping the room. Furthermore, the location of the beacon 20a-20e can be hidden away and does not need detailed consideration as the signals will propagate around the room by bouncing off of walls and other objects.

Preferably, the receiver 30 is a PDA, mobile telephone or similar device that is portable and incorporates a microphone.

It will be apparent that there are many potential applications for non-intrusive, low cost, location determination systems such as that described in the present invention. For example, such a system could be implemented in an office to enable location-aware services such as selecting which printer to print to. In another example, beacons could be installed by areas of interest and receivers could be issued to tourists or visitors to guide them around the location.
Claims

1. A location determination system comprising a beacon and a receiver, the beacon being arranged to broadcast an inaudible sonic signal within a location, said signal including data for identifying the location, wherein the receiver is arranged to receive the signal when in the location and determine the location in dependence on the data.

2. A location determination system according to claim 1, wherein the inaudible sonic signal comprises an ultrasound signal.

3. A location determination system according to claim 1, wherein the inaudible sonic signal comprises audio-encoded data transmitted at a frequency higher than human hearing range.

4. A location determination system according to claim 1 or 3, wherein the inaudible sonic signal comprises audio-encoded data transmitted at a power level undetectable by a human ear.

5. A location determination system according to any preceding claim, wherein the receiver comprises a mobile telephone.

6. A location determination system according to any of claims 1 to 4, wherein the receiver comprises a PDA.

7. A beacon (20a) for use in a system as claimed in claim 1, the beacon (20a) being operable to broadcast an inaudible sonic signal within a location (10a), said signal including data for identifying the location (10a).

8. A beacon (20a) according to claim 7, wherein the inaudible sonic signal comprises an ultrasound signal.
9. A beacon (20a) according to claim 7, wherein the inaudible sonic signal comprises audio-encoded data transmitted at a frequency higher than human hearing range.

10. A beacon (20a) according to claim 7 or 9, wherein the inaudible sonic signal comprises audio-encoded data transmitted at a power level undetectable by a human ear.

11. A receiver (30) for use in a location determination system as claimed in claim 1, wherein the receiver (30) is operable to receive the inaudible sonic signal when in said location (10a-10e) and determine the location (10a-10e) in dependence on the included identifying data.

12. A receiver (30) according to claim 11, wherein the inaudible sonic signal comprises an ultrasound signal.

13. A receiver (30) according to claim 11, wherein the inaudible sonic signal comprises audio-encoded data transmitted at a frequency higher than human hearing range.

14. A receiver (30) according to claim 11 or 13, wherein the inaudible sonic signal comprises audio-encoded data transmitted at a power level undetectable by a human ear.

15. A receiver (30) according to any of claims 11 to 14, further comprising a mobile telephone.

16. A receiver (30) according to any of claims 11 to 14, further comprising a PDA.

17. A method permitting determination of location of a receiver within a set of predetermined locations comprising:
positioning a beacon within each predetermined location; and,
broadcasting, from each beacon, an inaudible sonic signal within the respective predetermined location for identifying the location.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G01S/72

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>WO 02 45273 A (HART ALAN MICHAEL ; HOSKING IAN MICHAEL (GB); MORLAND ROBERT JOHN ( ) 6 June 2002 2002-06-06) page 42, line 24 - line 29 page 83, line 29 - line 31 page 52, line 15 -page 55, line 19</td>
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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
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Name and mailing address of the ISA:
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Ó Donnabháin, C

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| KONINKLIJKE PHILIPS ELECTRONICS N.V. is entitled as employer of the inventor, RANKIN, Paul, J. |

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| KONINKLIJKE PHILIPS ELECTRONICS N.V. is entitled as employer of the inventor, EGNER, Sebastian |

| (ix) |
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