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Smith

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[54] **METHOD FOR LOCATING A MOBILE STATION**

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[73] Assignee: **AT&T Wireless Svcs. Inc.**, Redmond, Wash.

[*] Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

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[51] **Int. Cl.**[7] **H04Q 7/20**

[52] **U.S. Cl.** **455/456**; 455/457; 342/357.01

[58] **Field of Search** 455/404, 456, 455/457, 517, 521, 524, 426; 342/357.01, 457, 357.13

[56] **References Cited**

U.S. PATENT DOCUMENTS

5,055,851	10/1991	Sheffer .	
5,208,756	5/1993	Song	364/449
5,218,367	6/1993	Sheffer et al. .	
5,327,144	7/1994	Stilp et al. .	
5,388,147	2/1995	Grimes .	
5,394,158	2/1995	Chia .	
5,396,540	3/1995	Gooch	379/59
5,508,708	4/1996	Ghosh et al. .	
5,542,100	7/1996	Hatakeyama	455/56.1
5,561,840	10/1996	Alvesalo et al. .	
5,570,412	10/1996	LeBlanc .	
5,594,425	1/1997	Ladner et al. .	
5,613,205	3/1997	Dufour	455/33.2
5,678,194	10/1997	Grube et al.	455/456
5,844,522	12/1998	Sheffer et al.	342/457
5,854,981	12/1998	Wallstedt et al.	455/439
5,859,612	1/1999	Gillhousen	342/457
5,873,040	2/1999	Dunn et al.	455/456
5,913,170	6/1999	Worthham	455/457
5,946,611	8/1999	Dennison et al.	455/404
5,960,341	9/1999	LeBlanc et al.	455/426
5,970,414	10/1999	Bi et al.	455/456
5,991,758	12/1999	Ellard	707/6

FOREIGN PATENT DOCUMENTS

2295591	8/1997	Canada .

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[57] **ABSTRACT**

A method provides for the detection of the geographic location of a mobile station within a mobile network. The mobile station detects signal characteristics for signals generated by neighboring cells to create a report of signal characteristics corresponding to the location at which the mobile station resides. This report is then compared against the database of signal signatures identifying geographic locations within the cell in which the mobile station is known to be positioned. The signal signatures are then used to detect either an exact match or an approximate match to give position information of the mobile station within the cell.

6 Claims, 3 Drawing Sheets

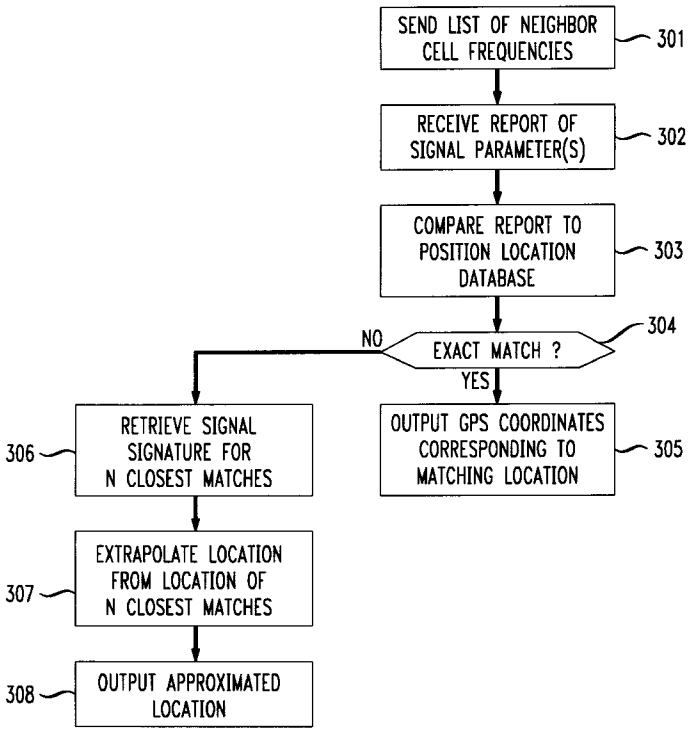


FIG. 1

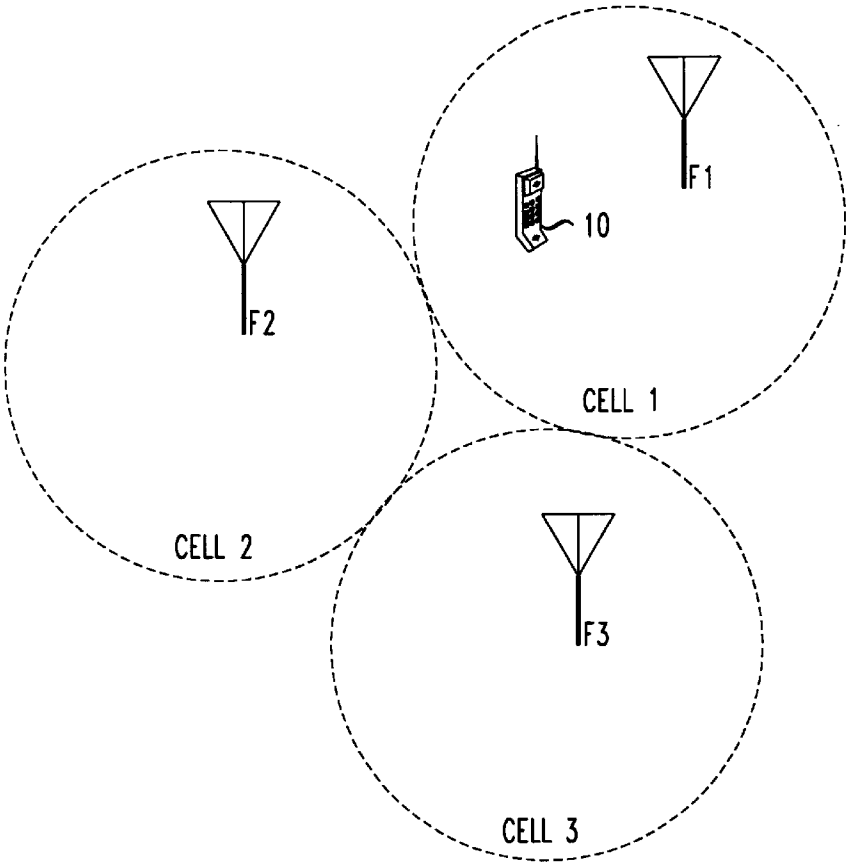


FIG. 2

FREQUENCY	SIGNAL STRENGTH
F_1	
F_2	⋮
F_3	
⋮	

FIG. 3

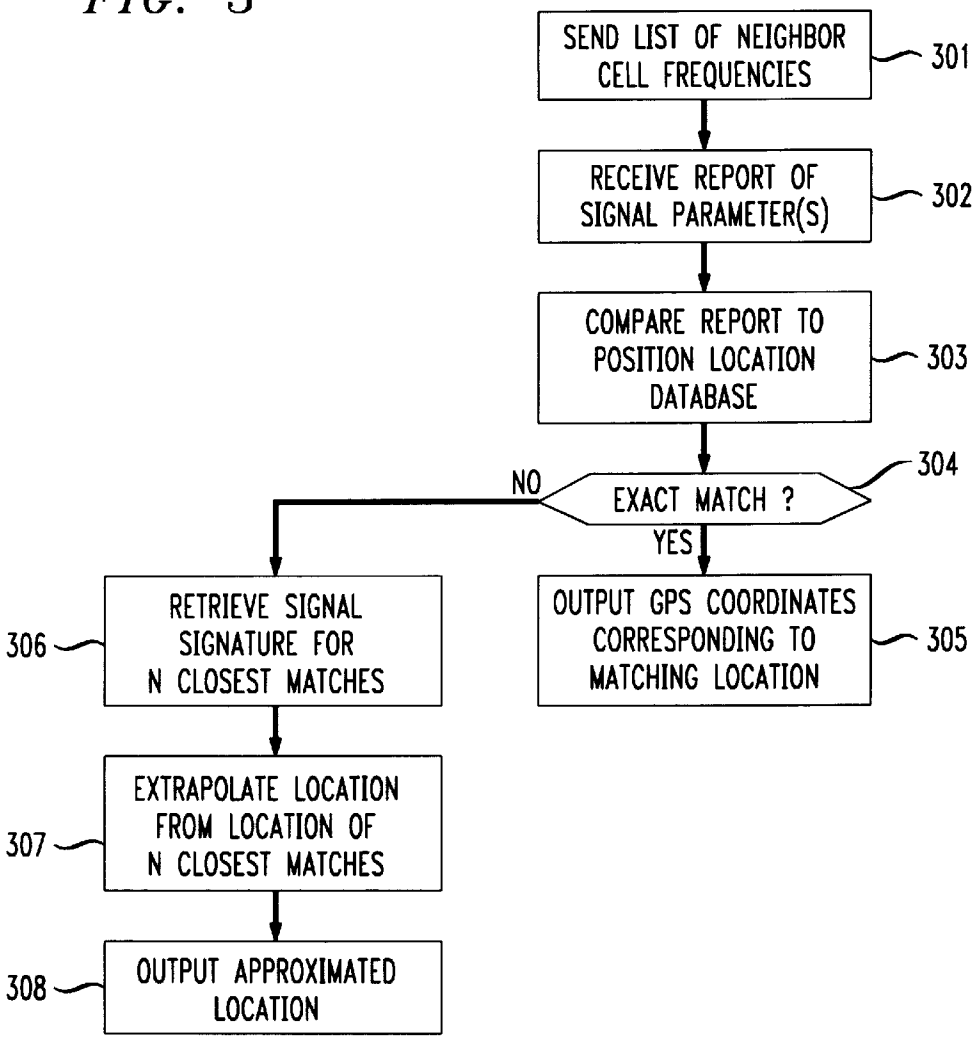


FIG. 4

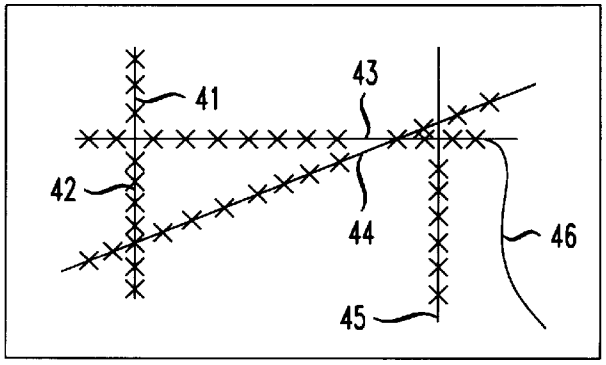


FIG. 5

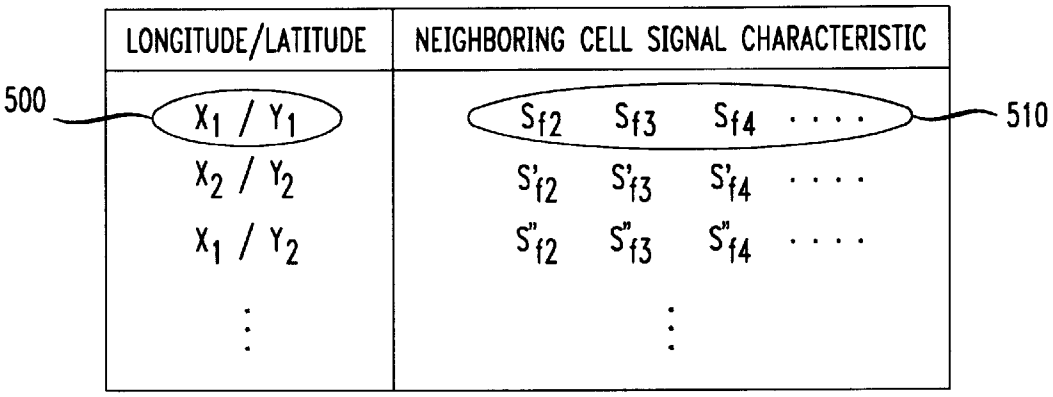
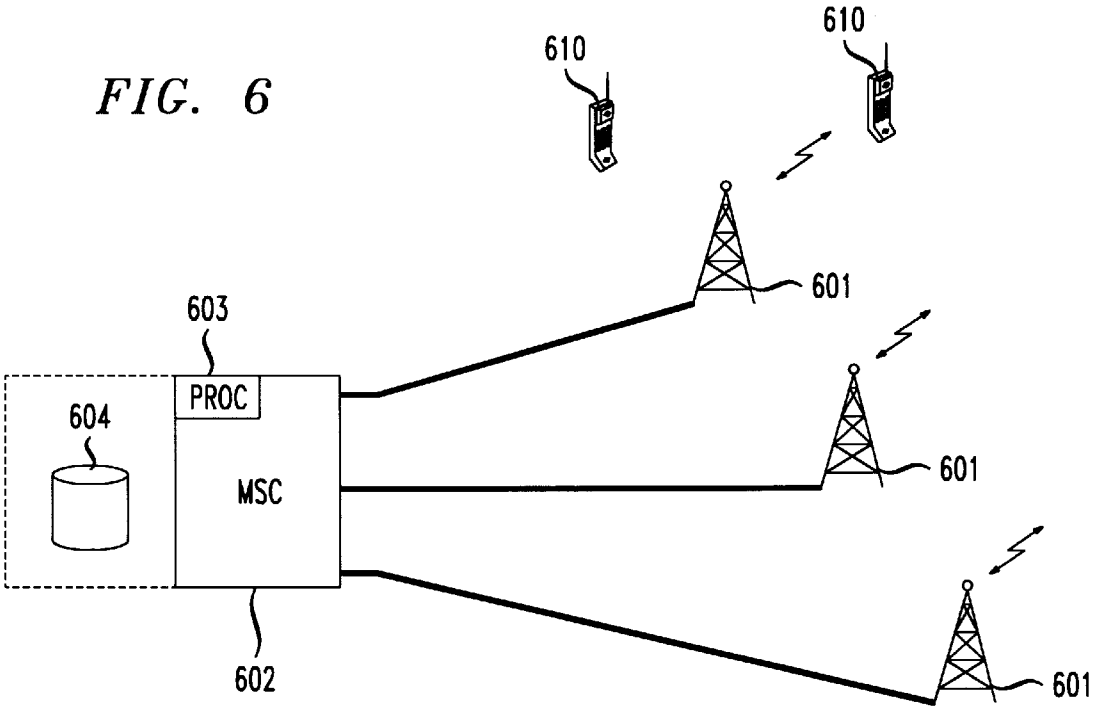


FIG. 6



METHOD FOR LOCATING A MOBILE STATION

BACKGROUND OF THE INVENTION

The present invention relates to a method for locating a mobile station. More particularly, the present invention relates to detecting the position of a mobile station in a cell area based on certain received signal characteristics.

In emergency situations it is critical to know the location of the emergency and where help needs to be sent. This is easily done with communication systems that are wired. For instance, it is well known that when a wire line subscriber activates an emergency code such as "911" facilities can determine the location of the user so that assistance can be sent to that location.

It is equally important to provide emergency assistance to those who may not have access to a wire line connection, such as a person in a vehicle. Such persons may utilize mobile communication devices such as mobile cellular phones. However, it is more difficult to provide such assistance just by the nature of the communication instrument, in that the instrument can be moved to many different locations. Thus, it would be desirable to provide a method by which the location of a mobile station could be determined quickly and simply.

A number of prior systems for mobile system location identification have detected signal strengths to perform triangulation. This is a complex solution which requires real time calculations related to signal strength measurements. A more simple solution to the problem is desirable.

SUMMARY OF THE INVENTION

The present invention provides a method for locating mobile stations which uses signal strength information in a new manner. In particular, in an embodiment of the present invention a mobile station is advised of the channel frequencies of the neighboring cells. The station then measures signal parameters with respect to these neighboring cell frequencies. The compiled signal measurements are transmitted back to a central processing station via the mobile communications network. A database at that central processing station stores signal measurements corresponding to locations within the cell in which the mobile station is located. The central processor searches the database for a signal measurement that matches the received signal measurements. If a match is found then the geographic location corresponding to the signal measurement is selected as the geographic location of the mobile station. If, however, the central processor does not detect an exact match for the signal signature then the processor may select the closest matching signal signature and use the corresponding location as being representative of the location of the mobile station. Alternatively the processor could calculate an approximate location based on location information corresponding to the N closest signal measurements.

The present invention reduces the location operation to a simple task of searching a database for matching information. Such a technique could also be used to enhance the accuracy of a triangulation technique.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates an example of a mobile cellular configuration in which the present invention may be employed.

FIG. **2** illustrates an example of a table of information which can be utilized in an embodiment of the present invention.

FIG. **3** illustrates a flow chart of a method in accordance with an embodiment of the present invention.

FIG. **4** illustrates a sample map of a region within a cell for purposes of explaining how to create a database to be used in conjunction with the present invention.

FIG. **5** illustrates an example of a database entry in an embodiment of the present invention.

FIG. **6** illustrates, in block diagram form, an example of a system employing the present invention.

DETAILED DESCRIPTION

FIG. **1** illustrates in schematic form the layout of a cellular network in which the present invention can be employed. Three cells are shown: cell **1**, cell **2**, and cell **3**. Each cell has its own set of channels, for example a control channel and voice channels, for providing over-the-air communications with mobile stations. In the example shown, cell **1** has a channel having frequency f1, cell **2** has a channel with frequency f2 and cell **3** has a channel with frequency f3. Each cell may have multiple frequencies, but only one frequency is shown here for ease of description. In the example, a handheld device **10** is shown located within cell **1**.

The present invention provides a method for locating the mobile station **10** at some geographic position within the geographic serving area of the cellular system of cell **1**.

It is known in existing mobile systems to advise the handheld device **10**, while it is in cell **1**, of the frequencies used by the cells neighboring cell **1**, for example, frequency f2 for cell **2** and frequency f**3** for cell **3**. This information is useful in at least two situations.

First, the mobile station may be registered in the mobile network, but may not presently be involved in a communication, that is, it is in an idle mode. In that mode the mobile selects a control channel based on certain signal criteria. Under those circumstances while the mobile is being moved, it is possible that a time will come when the mobile is located such that it is more optimal to select the control channel of either cell **2** or cell **3** rather than the control channel of cell **1**. This is known as a re-selection process. The mobile makes this determination by periodically measuring the signal strengths of the control channels of the neighboring cells. An algorithm is performed using those measurements and the mobile then determines whether to re-select the frequency of one of the neighboring cells. This information can be sent back to the system to aid in channel allocation. This is referred to as Mobile Assisted Channel Allocation (MACA).

A second situation in which the signal characteristics of the neighboring cell channels are useful relates to those occasions when a mobile station is involved in a communication while moving through a given cell and reaches the outer perimeter of that cell and needs to be handed-off to a neighboring cell. This is referred to as Mobile Assisted Hand Off (MAHO). In this situation, the mobile station detects signal characteristics of the neighboring cells and transmits that characteristic information back to the cellular system so that the system can coordinate a hand-off of the mobile station from one cell to another as it traverses cells.

These two operations MACA and MAHO are described in detail in the IS-136 protocol specifications. (TIA/EIA/IS-136.1-A October 1996).

The present invention takes advantage of these known operations that detect the signal strength of signals from neighboring cells. An embodiment of the present invention

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