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(71) Applicant(s)
UbiNetics Limited
(Incorporated in the United Kingdom)
Cambridge Technology Centre,
MELBOURN, Hertfordshire, SG8 6DP,
United Kingdom

(72) Inventor(s)
Paul Cook

(74) Agent and/or Address for Service
Sommerville & Rushton
45 Grosvenor Road, ST ALBANS, Herts.,
AL1 3AW, United Kingdom

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(56) Documents Cited
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WO 1996/004716 A1
US 5790589 A
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(54) Abstract Title
Pilot signal detection using varying window sizes

(57) Typically a 3G mobile device looks for new signals by searching over a fixed-size window centred around the position of the initial signal. However, depending on the size of the window, signals that appear or disappear quickly (i.e. interrupted signals) may never be spotted if the window size is large, and strong signals that have a time-offset far from the initial signal may not be spotted if the window is small in size. The invention provides a method of detecting a signal for a mobile telecommunications device by correlating with a common pilot channel, comprising the step of searching for a signal by running a sequence of varying window sizes covering different ranges of time-offsets from a given initial signal. This enables the detection of both fast fading signals and strong stable signals.

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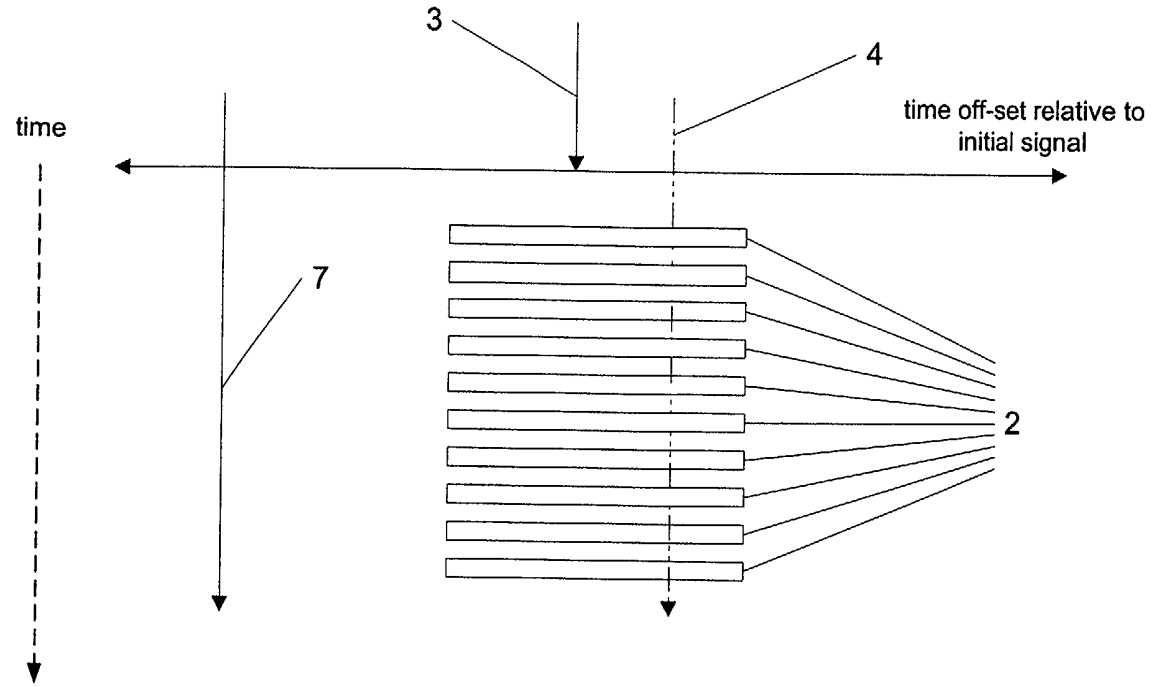
3
4
time
time off-set relative to
initial signal
7
2

Fig. 1

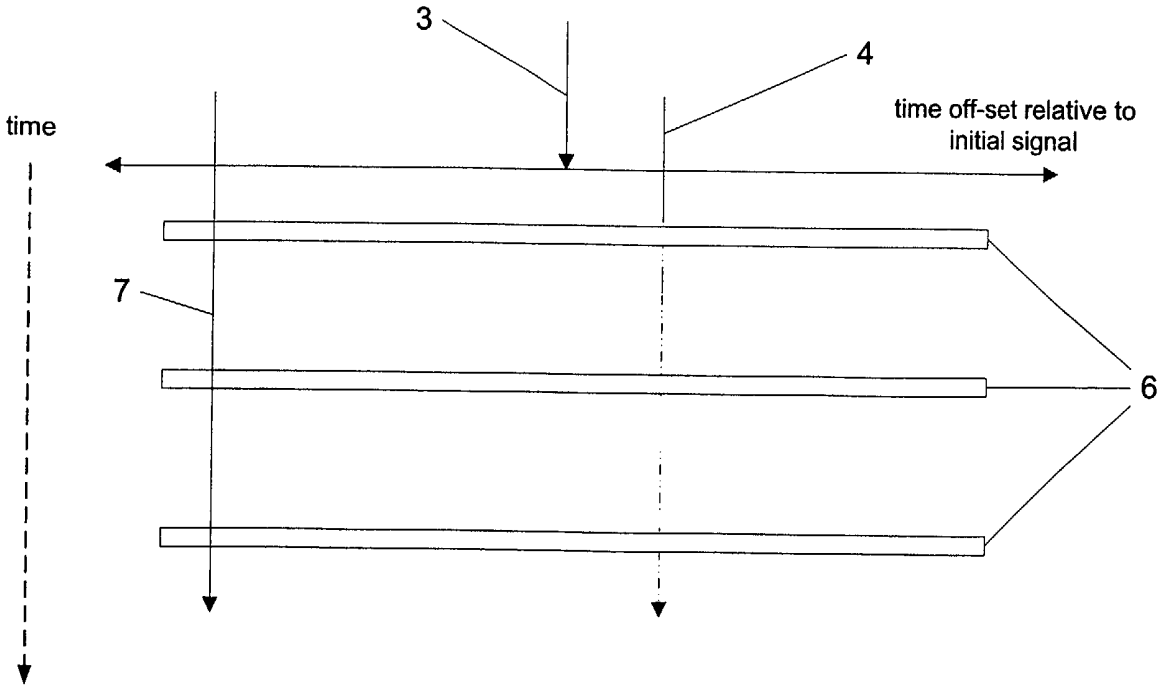
3
4
time
time off-set relative to
initial signal
7
6

Fig. 2

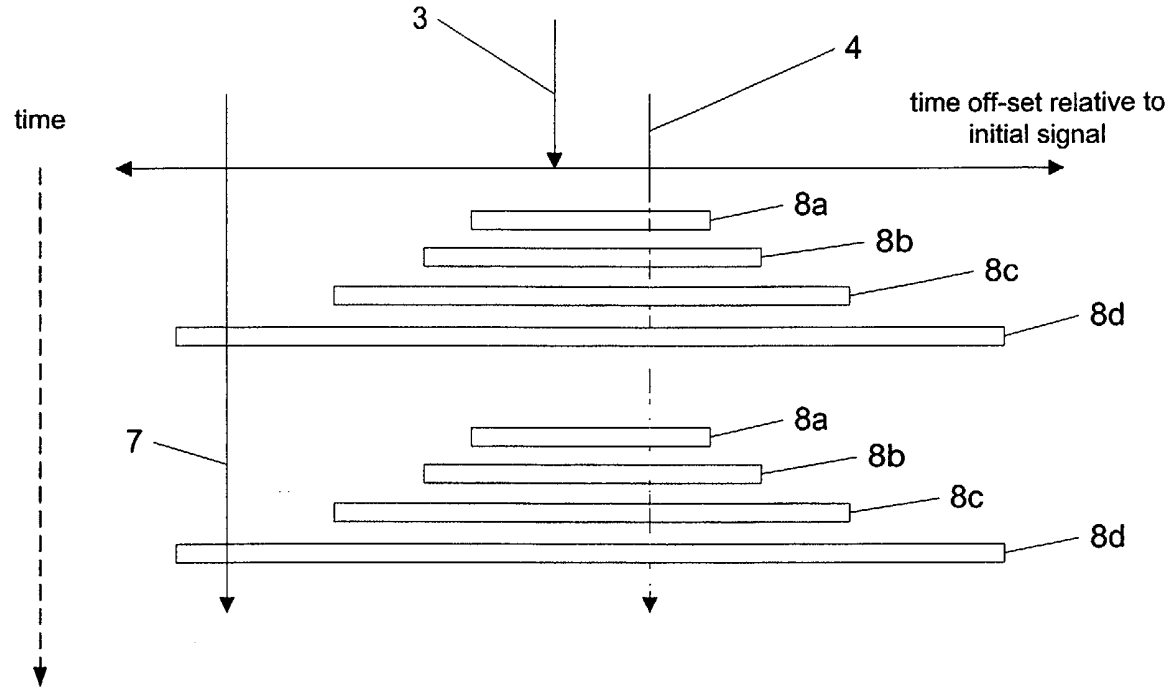
3
4
time
time off-set relative to
initial signal
8a
8b
8c
8d
7
8a
8b
8c
8d

Fig. 3

APPARATUS AND METHOD FOR DETECTING SIGNALS FOR A MOBILE TELECOMMUNICATIONS DEVICE

The present invention relates to mobile telecommunications technology, and in particular, to an apparatus and method of detecting signals by correlating with the common pilot channel (CPICH) for Third Generation (3G) technology.

The common pilot channel CPICH is a continuous loop broadcast of the base station (BS) scrambling code which provides identification of the BS transmission. A mobile telecommunications device uses the CPICH as a coherent reference for precise measurement of the BS time reference, as well as to determine the signal strength of surrounding base stations before and during cell site handover. It is important for the mobile telecommunications device to be able to detect this signal, as it must correlate against this reference signal before any other channels can be received.

As the signals making up the common pilot channel CPICH broadcast travel along their path, they may encounter objects such as trees and buildings which they bounce off. This results in the path length as well as path direction of some of the signals changing. Thus the 3G mobile device will be encountering signals which arrive at different times due to the interrupted and differing path lengths travelled by the signals. So as to minimise errors in reading the signal being broadcast by the BS, the 3G mobile device seeks to detect as many signals as it can.

When a 3G mobile device searches for new signals, it correlates with the common pilot channel (CPICH) over a range of time-offsets from a given initial signal, referred to in this specification as a window.

Typically a 3G mobile device looks for new signals by searching over a fixed-size window centred around the position of the initial signal. However, depending on the size of the window, signals that appear or disappear quickly (i.e. interrupted signals) may never be spotted if the window size is large, and strong signals that have a time-offset far from the initial signal may not be spotted if the window is small in size.

The ability to spot potential signals, both 'fast' and 'slow' as well as having time-offsets near and far from an initial signal, is critical to the overall performance of 3G mobile devices. Hence there is a pressing need to address these problems.

The present invention seeks to address or significantly mitigate one or more of the afore-mentioned problems.

According to a first aspect of the invention there is provided a method of detecting a signal for a mobile telecommunications device by correlating with a common pilot channel, comprising the step of: searching for a signal by progressing through a sequence of varying window sizes covering different ranges of time-offsets from a given initial signal. This advantageously enables the detection of both fast fading signals and strong stable signals.

In a preferred embodiment the sequence progresses in steps from a small window size to a large window size relative to the time-offset from the initial signal.

In a further embodiment the sequence progresses in steps from a large window size to a small window size relative to the time-offset from the initial signal.

Preferably, the sequence is a short sequence comprising three to six steps.

Preferably still, the step of searching for the signal is carried out by moving through the sequence in cycles.

According to a second aspect of the invention there is provided an apparatus for detecting a signal for a mobile telecommunications device by correlating with a common pilot channel, comprising: searching means for searching for a signal by progressing through a sequence of varying window sizes covering different ranges of time-offsets from a given initial signal.

In a preferred embodiment the searching means comprises: window sizing means for evaluating and setting the size of the windows in the sequence; and window sequencing means for progressing through the window sizes in an ordered sequence of steps covering the ranges of time-offsets from the initial signal.

According to a third aspect of the invention there is provided a computer readable storage medium storing instructions that, when executed by a computer, cause the computer to perform the method according to the first aspect.

Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of the specific embodiments of the invention in conjunction with the accompanying figures.

Embodiments of the invention will now be described by way of example only, with reference to the drawings in which:

Figure 1 is a schematic diagram representing a ray-search algorithm with a small, fixed-sized window centred around an initial signal, as presently being used in the prior art;

Figure 2 is a schematic diagram representing a ray-search algorithm with a large, fixed-sized window centred around an initial signal, as presently being used in the prior art; and

Figure 3 is a schematic diagram representing a ray-search algorithm according to an embodiment of the invention, where the search involves searching over a window whose size steps through a short sequence from small to large.

As mentioned earlier, when a 3G mobile device searches for new signals, it correlates with the common pilot channel (CPICH) over a range of time-offsets from a given initial signal. This window of time-offsets must be of finite size, and Figures 1 and 2 illustrate the effects of using ray-search algorithms with such fixed-size windows.

The effect of using a ray-search algorithm with a small, fixed-size window 2 centred around an initial signal 3 is shown in Figure 1. A 'fast fading' signal 4, i.e. a signal that appears and disappears quickly, that has a time-offset relatively close to the initial signal 3, has a good chance of being detected by the mobile device. Whereas, a strong stable signal that has a time-offset relatively far from the initial signal 3 is less likely to be detected as it does not coincide with the search window.

The effect of using a similar ray-search algorithm but with a large, fixed-size window 6 centred around the initial signal 3 is shown in figure 2. Here it may be seen that the strong stable signal 7 that has a time-offset relatively far from the initial signal 3 will be detected. However, the fast fading signal 4 that has a time-offset relatively

near to the initial signal 3 is much less likely to be detected due to the increased time taken to search the larger window 6.

A preferred embodiment is shown in Figure 3, and involves searching over a window whose size varies in steps 8a, 8b, 8c, 8d in a short sequence from a relatively small window size 8a to a relatively large window size 8d, with respect to the initial signal 3. It may be seen from Figure 3 that the strong stable signal 7 that has a time-offset relatively far from the initial signal 3 will be detected eventually. In addition, the fast fading signal 4 which has a time-offset relatively close to the initial signal 3 is more likely to be detected than in the case of the large, fixed-size window 6 of figure 2.

By cycling through the sequence of window sizes 8a, 8b, 8c, 8d, fast fading signals 4 are searched more frequently thereby giving these signals a better chance of being detected. Signals having large time-offsets will also be searched, albeit less often, allowing strong stable signals 7 having these large time-offsets to be detected.

The sequence of varying window sizes 8a, 8b, 8c, 8d effectively allows both small time-offsets and large time-offsets to be searched for by the 3G mobile device.

Instead of the sequence of window steps going from a relatively small time-offset to a large time-offset with respect to the initial signal 3, the sequence may go from a relatively large time-offset to a relatively small time-offset with respect to the initial signal 3. Alternatively, the sequence of window steps may run in some other order that is not graded according to size, and which allows both small and large time-offsets to be searched.

The application of the invention is by no means limited to 3G mobile phones, and may instead be realised in, amongst other things, personal digital assistants, laptop computers and other mobile/portable electronic devices incorporating wireless telecommunications functions.

Although the embodiments of the invention described with reference to the drawings comprise computer apparatus and processes performed in computer apparatus, the invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in

the form of source code, object code, a code intermediate source and object code such as in partially compiled form, or in any other form suitable for use in the implementation of the processes according to the invention. The carrier be any entity or device capable of carrying the program.

For example, the carrier may comprise a storage medium, such as ROM, for example a CD ROM or a semiconductor ROM, or a magnetic recording medium, for example a floppy disc or hard disk. Furthermore, the carrier may be a transmissible carrier such as an electrical or optical signal which may be conveyed via electrical or optical cable or by radio or other means.

When the program is embodied in a signal which may be conveyed directly by a cable or other device or means, the carrier may be constituted by such cable or other device or means.

Alternatively, the carrier may be an integrated circuit in which the program is embedded, the integrated circuit being adapted for performing, or for use in the performance of, the relevant processes.

Although the invention has been shown and described with respect to a best mode embodiment thereof, it should be understood by those skilled in the art that the foregoing and various other changes, omissions and additions in the form and detail thereof may be made therein without departing from the scope of the invention as claimed.

CLAIMS

1. A method of detecting a signal for a mobile telecommunications device by correlating with a common pilot channel, comprising the step of:

searching for a signal by progressing through a sequence of varying window sizes covering different ranges of time-offsets from a given initial signal.

2. A method according to claim 1, wherein the sequence progresses in steps from a small window size to a large window size relative to the time-offset from the initial signal.

3. A method according to claim 1, wherein the sequence progresses in steps from a large window size to a small window size relative to the time-offset from the initial signal.

4. A method according to any one of claims 1 to 3, wherein the sequence is a short sequence comprising 3 to 6 steps.

5. A method according to any one of claims 1 to 4, wherein the step of searching for the signal is carried out by moving through the sequence in cycles.

6. An apparatus for detecting a signal for a mobile telecommunications device by correlating with a common pilot channel, comprising:

searching means for searching for a signal by progressing through a sequence of varying window sizes covering different ranges of time-offsets from a given initial signal.

7. An apparatus according to claim 6, wherein the searching means comprises:

window sizing means for evaluating and setting the size of the windows in the sequence; and

window sequencing means for progressing through the window sizes in an ordered sequence of steps covering the ranges of time-offsets from the initial signal.

8. A method as substantially described herein with reference to Figure 3 of the accompanying drawings.

9. An apparatus as substantially described herein with reference to Figure 3 of the accompanying drawings.

10. A computer readable storage medium storing instructions that, when executed by a computer, cause the computer to perform a method of detecting a signal for a mobile telecommunications device according to Claim 1.

Application No: GB 0200171.7 **Examiner:** Adam Tucker
Claims searched: 1-10 **Date of search:** 27 June 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): H4L LRCMP, LRPMA, LRPMW, LDCC, LDSS, H4P PAL, PPF

Int Cl (Ed.7): H04B 7/26, H04L 7/00, 7/027, 7/04, 7/08, 7/10, 27/26, H04Q 7/32, 7/38

Other: Online: WPI, EPODOC, PAJ, IEEE

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X, Y	WO 00/79749 A1	AT&T Wireless Services, See in particular page 4 line 3-page 5 line 3 and Fig 17	X: 1, 3, 5-7 Y: 1, 3, 5-7
Y	WO 96/31959 A1	OKI Telecom, See in particular page 2 line 18-page 3 line 14	1-7
X, Y	WO 96/04716 A1	Qualcomm Inc., See in particular he abstract, page 2 line 18-page 3 line 13, page 4 line 29-page 6 line 18 and page 7 lines 15-37	X: 1, 3-7 Y:1, 3-7
X, Y	US 5966402	Yamamoto, See in particular claim 1	X: 1, 2 Y: 1, 2
X, Y	US 5790589	Hutchinson IV et al., See in particular the abstract, claims 1 and 2 and col 2 line 61-col 3 line 63	X: 1, 2, 4, 6 Y: 1, 2, 4, 6
X, Y	US 5781543	Ault et al., See in particular the abstract, col 3 lines 5-47, col 5 line 58-col 7 line 5 and col 9 line 13-17	X: 1, 3-7 Y: 1, 3-7
X, Y	US 4905302	Childress et al., See in particular claim 1	X: 1, 2, 4 Y: 1, 2, 4

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.