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(54) **METHODS AND APPARATUS FOR CHANNEL QUALITY INDICATOR DETERMINATION**

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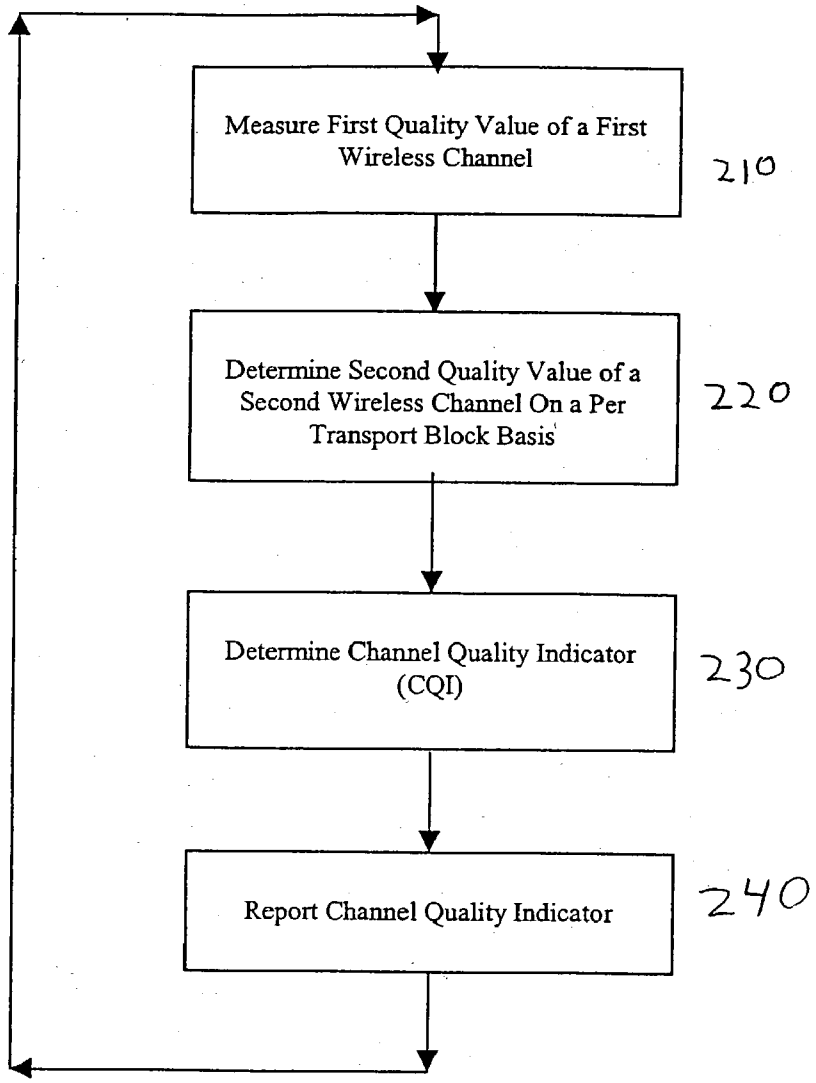
(57) **ABSTRACT**

A channel quality indicator value is determined on a per transport block basis. A signal-to-interference ratio estimate of a control channel and a channel quality estimate of user-data channel are employed in the determination of the channel quality indicator. The channel quality estimate of the user-data channel can include information about Automatic Retransmission Request (ARQ) processing, and the number of iterations of a Turbo decoder. Additionally, information about the Cyclic Redundancy Check (CRC), which is determined on a per transport block basis, can be employed in the channel quality indicator determination. The determined channel quality indicator is reported to the radio communication system.



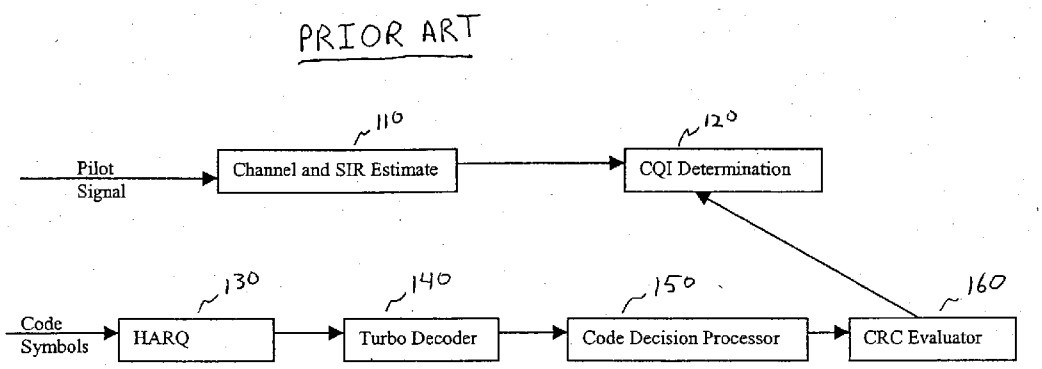


Figure 1A

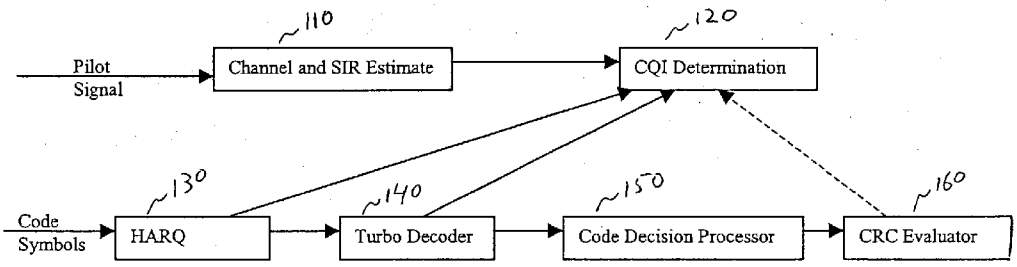


Figure 1B

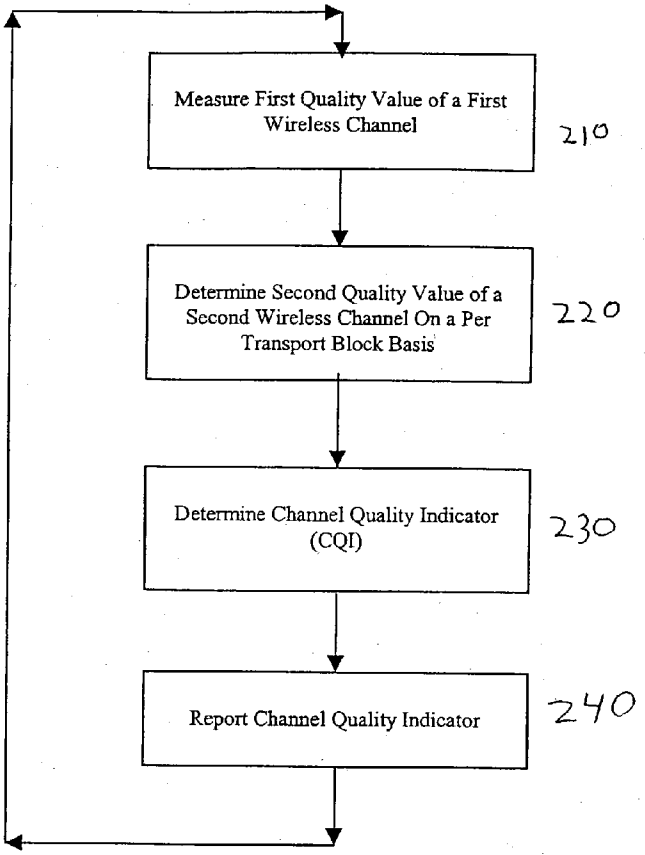


Figure 2

Signal-to-Interference Ratio	Channel Quality Indicator
SIR_0	CQI_0
SIR_1	CQI_1
SIR_2	CQI_2
SIR_3	CQI_3
SIR_4	CQI_4
SIR_n	CQI_n

Figure 3A

SIR	HARQ Info	Turbo Decoder Info	CQI
SIR_0	$HARQ_0$	TD_0	CQI_0
		TD_1	CQI_1
		TD_2	CQI_2
		.	.
		.	.
		TD_p	CQI_{p-1}
	$HARQ_1$	TD_0	CQI_p
		TD_1	CQI_{p+1}
		TD_2	CQI_{p+2}
		.	.
		.	.
		TD_p	CQI_{2p-1}
	.		
	.		
	$HARQ_m$	TD_0	CQI_{mp}
		TD_1	CQI_{mp+1}
		TD_2	CQI_{mp+2}
		.	.
		.	.
		TD_p	$CQI_{(m+1)p-1}$
SIR_1	$HARQ_0$	TD_0	$CQI_{(m+1)p}$
		TD_1	$CQI_{(m+1)p+1}$
		TD_2	$CQI_{(m+1)p+2}$
		.	.
		.	.
		TD_p	$CQI_{(m+2)p-1}$
	$HARQ_1$	TD_0	$CQI_{(m+2)p}$
		TD_1	$CQI_{(m+2)p+1}$
		TD_2	$CQI_{(m+2)p+2}$
		.	.
		.	.
		TD_p	$CQI_{(m+3)p}$
	.		
	.		
	$HARQ_m$	TD_0	$CQI_{(2m+1)p}$
		TD_1	$CQI_{(2m+1)p+1}$
		TD_2	$CQI_{(2m+1)p+2}$
		.	.
		.	.
		TD_p	$CQI_{(2m+2)p-1}$
SIR_2	$HARQ_0$	TD_0	$CQI_{(2m+2)p}$
		TD_1	$CQI_{(2m+2)p+1}$
		TD_2	$CQI_{(2m+2)p+2}$
		.	.
		.	.
		TD_p	$CQI_{(2m+3)p-1}$
	$HARQ_1$	TD_0	$CQI_{(2m+3)p}$
		TD_1	$CQI_{(2m+3)p+1}$
		TD_2	$CQI_{(2m+3)p+2}$
		.	.
		.	.
		TD_p	$CQI_{(2m+4)p-1}$
	.		
	.		

Figure 3B

METHODS AND APPARATUS FOR CHANNEL QUALITY INDICATOR DETERMINATION

BACKGROUND

[0001] The invention relates to the determination of channel quality in communication systems, and more particularly to a determination of a channel quality indicator in a radio communications network.

[0002] As the popularity of communication in radio communications networks continues to grow, there has been increased interest in providing packet data communications in radio communications networks. High-Speed Downlink Packet Access (HSDPA) is a service which is currently being developed for providing packet data communications in radio communications networks.

[0003] Due to the differences between voice communications and packet data communications, the design of these systems can be quite different. For example, since voice communications in radio communications networks are treated as a single stream of information, a single channel is typically reserved for each voice communication. In contrast, packet data communications can be discontinuous, and hence, many packet data communications can share access to a single channel.

[0004] Accordingly, the HSDPA service provides for adaptive modulation in the downlink, i.e., the channel from the communication network to a radio receiver. Specifically, the transport format, (i.e., the channel coding and modulation), that is to be used for transmission by the radio communications network is determined for each transmitted packet. The choice of transport format selected by the radio communications network is based upon a Channel Quality Indicator (CQI) value reported by a radio receiver. The transport format may also be based on the received power control commands or on other information that can be estimated by the base station, e.g., power and quality of the data symbols on the uplink.

[0005] The determination of the CQI is based on two components. The first component is likely to be based on a signal-to-interference ratio (SIR) measurement of a pilot channel. The second component of the CQI determination requires that the determined CQI result in a transport block error probability which is approximately 10 percent, without exceeding 10 percent. Therefore, it would be desirable to provide methods and apparatus for determining a particular CQI value which will result in a transport block error probability which is approximately 10 percent, without exceeding 10 percent.

SUMMARY

[0006] It should be emphasized that the terms "comprises" and "comprising", when used in this specification, are taken to specify the presence of stated features, integers, steps or components; but the use of these terms does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

[0007] In accordance with one aspect of the present invention, a channel quality indicator is determined on a per transport block basis. Specifically, a channel quality value of quality indicator. The channel quality value of the user-data channel can be determined based on Hybrid Automatic Retransmission (HARQ) processing and/or Turbo decoder processing. The channel quality value of the user-data channel can also be determined based on Cyclic Redundancy Check (CRC) processing, or based on a combination of HARQ, Turbo decoder and CRC processing.

[0008] In accordance with another aspect of the present invention, the channel quality indicator is determined. A first channel quality value is based on a channel quality of a pilot channel, a second channel quality value is based on a channel quality of a user-data channel, and a third channel quality value is determined based on a transport block integrity check. The first and second channel quality values are employed in the determination of the channel quality indicator. The third channel quality value can also be employed in the determination of the channel quality indicator.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The objects and advantages of the invention will be understood by reading the following detailed description in conjunction with the drawings in which:

[0010] **FIG. 1A** is a block diagram of a conventional receiver.

[0011] **FIG. 1B** is a block diagram of a receiver in accordance with one embodiment of the present invention.

[0012] **FIG. 2** is a flow diagram of the Channel Quality Indicator (CQI) determination in accordance with the present invention.

[0013] **FIG. 3A** is an exemplary table used in the CQI determination in accordance with an embodiment of the present invention.

[0014] **FIG. 3B** is a portion of an exemplary table used in the CQI determination in accordance with another embodiment of the present invention.

DETAILED DESCRIPTION

[0015] The various features of the invention will now be described with reference to the figures, in which like parts are identified with the same reference characters.

[0016] The various aspects of the invention will now be described in greater detail in connection with a number of exemplary embodiments. To facilitate an understanding of the invention, many aspects of the invention are described in terms of sequences of actions to be performed by elements of a computer system. It will be recognized that in each of the embodiments, the various actions could be performed by specialized circuits (e.g., discrete logic gates interconnected to perform a specialized function), by program instructions being executed by one or more processors, or by a combination of both. Moreover, the invention can additionally be considered to be embodied entirely within any form of computer readable carrier, such as solid-state memory, magnetic disk, optical disk or carrier wave (such as radio frequency, audio frequency or optical frequency carrier waves) containing an appropriate set of computer instructions that would cause a processor to carry out the tech-

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