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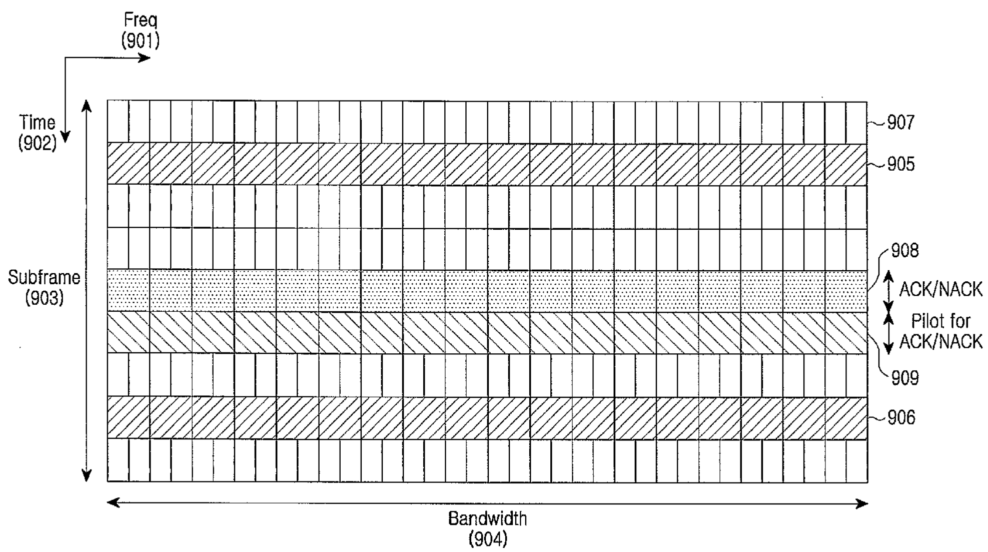
(54) Title: METHOD AND APPARATUS FOR TIME MULTIPLEXING UPLINK DATA AND UPLINK SIGNALING INFORMATION IN AN SC-FDMA SYSTEM



(57) Abstract: Provided is a method and an apparatus for transmitting uplink information items having various characteristics by using a single FFT block. The method includes determining if there is uplink signaling information to be transmitted when there is uplink data to be transmitted; time multiplexing the uplink data and a first pilot for the uplink data and transmitting the multiplexed uplink data and first pilot, when there is no uplink signaling information; and time multiplexing the uplink data, the first pilot for the uplink data, and a second pilot for the uplink data and the uplink signaling information, and transmitting the multiplexed uplink data, first pilot, and second pilot, when there is the uplink signaling information.

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METHOD AND APPARATUS FOR TIME MULTIPLEXING UPLINK DATA AND UPLINK SIGNALING INFORMATION IN AN SC-FDMA SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method and an apparatus for transmitting/receiving uplink signaling information and uplink data in a Frequency Division Multiple Access (FDMA) wireless communication system using a single carrier.

2. Description of the Related Art

Recently, active research is being conducted in an Orthogonal Frequency Division Multiplexing (OFDM) scheme or a Single Carrier-Frequency Division Multiple Access (SC-FDMA) scheme similar to the OFDM scheme as a scheme available for high speed data transmission through a wireless channel in a mobile communication system.

The OFDM scheme, which transmits data using multiple carriers, is a special type of a Multiple Carrier Modulation (MCM) scheme in which a serial symbol sequence is converted into parallel symbol sequences, and the parallel symbol sequences are modulated with a plurality of mutually orthogonal subcarriers (or subcarrier channels) before being transmitted.

FIG. 1 is a block diagram illustrating a structure of a transmitter of a typical OFDM system.

Referring to FIG. 1, the OFDM transmitter includes a channel encoder 101, a modulator 102, a serial-to-parallel converter 103, an Inverse Fast Fourier Transform (IFFT) block or a Digital Fourier Transform (DFT) block 104, a parallel-to-serial converter 105, and a Cyclic Prefix (CP) inserter 106.

The channel encoder 101 receives and channel-encodes an input information bit sequence. In general, a convolutional encoder, a turbo encoder, or a Low Density Parity Check (LDPC) encoder is used as the channel encoder 101. The modulator 102 modulates the channel-encoded bit sequence according to a modulation scheme, such as a Quadrature Phase Shift Keying (QPSK) scheme, 8PSK scheme, 16-ary Quadrature Amplitude Modulation (16QAM) scheme, 64QAM, 256QAM, etc. Although not shown in FIG. 1, it is obvious that a rate matching block for performing repetition and puncturing may be inserted between the channel encoder 101 and the modulator 102.

The serial-to-parallel converter 103 receives output data from the modulator 102 and converts the received data into parallel data. The IFFT block 104 receives the parallel data output from the serial-to-parallel converter 103 and performs an IFFT operation on the parallel data. The data output from the IFFT block 104 is converted to serial data by the parallel-to-serial converter 105. The CP inserter 106 inserts a Cyclic Prefix (CP) into the serial data output from the parallel-to-serial converter 105, thereby generating an OFDM symbol to be transmitted.

The IFFT block 104 converts the input data of the frequency domain to output data of the time domain. In the case of a typical OFDM system, because input data is processed in the frequency domain, a Peak to Average Power Ratio (PAPR) of the data may increase when the data has been converted into the time domain.

The PAPR is one of the most important factors to be considered in the uplink transmission. As the PAPR increases, the cell coverage decreases, so that the signal power required by a User Equipment (UE) increases. Therefore, it is necessary to first reduce the PAPR, and it is thus possible to use an SC-FDMA scheme, which is a scheme modified from the typical OFDM scheme, for the OFDM-based uplink transmission. It is possible to effectively reduce the PAPR by enabling processing in the time domain without performing processing (channel encoding, modulation, etc.) of data in the frequency domain.

FIG. 2 is a block diagram illustrating a structure of a transmitter in a system employing an SC-FDMA scheme, which is a typical uplink transmission scheme.

Referring to FIG. 2, the SC-FDMA transmitter includes a channel encoder 201, a modulator 202, a serial-to-parallel converter 203, a Fast Fourier Transform (FFT) block 204, a sub-carrier mapper 205, an IFFT block 206, a parallel-to-serial converter 207, and a CP inserter 208.

The channel encoder 201 receives and channel-encodes an input information bit sequence. The modulator 202 modulates the output of the channel encoder 201 according to a modulation scheme, such as a QPSK scheme, an 8PSK scheme, a 16QAM scheme, a 64QAM scheme, a 256QAM scheme, etc.

A rate matching block (not shown) may be included between the channel encoder 201 and the modulator 202.

The serial-to-parallel converter 203 receives data output from the modulator 202 and converts the received data into parallel data. The FFT block 204 performs an FFT operation on the data output from the serial-to-parallel converter 203, thereby converting the data into data of the frequency domain. The sub-carrier mapper 205 maps the output data of the FFT block 204 to the input of the IFFT block 206. The IFFT block 206 performs an IFFT operation on the data output from the sub-carrier mapper 205. The output data of the IFFT block 206 is converted to parallel data by the parallel-to-serial converter 207. The CP inserter 208 inserts a CP into the parallel data output from the parallel-to-serial converter 207, thereby generating an OFDM symbol to be transmitted.

FIG. 3 is a block diagram illustrating in more detail the structure for resource mapping shown in FIG. 2. Hereinafter, the operation of the sub-carrier mapper 205 will be described with reference to FIG. 3.

Referring to FIG. 3, data symbols 301 having been subjected to the channel encoding and modulation are input to an FFT block 302. The output of the FFT block 302 is input to an IFFT block 304. At this time, a sub-carrier mapper 303 maps the output data of the FFT block 302 to the input data of the IFFT block 304.

The sub-carrier mapper 303 maps the information symbols of the frequency domain data converted by the FFT block 302 to corresponding input points or input taps of the IFFT block 304 so that the information symbols can be carried by proper sub-carriers.

During the mapping procedure, if the output symbols of the FFT block 302 are sequentially mapped to neighboring input points of the IFFT block 304, the output symbols are transmitted by sub-carriers that are consecutive in the frequency domain. This mapping scheme is referred to as a Localized Frequency Division Multiple Access (LFDMA) scheme.

Further, when the output symbols of the FFT block 302 are mapped to input points of the IFFT block 304 having a predetermined interval between them, the output symbols are transmitted by sub-carriers having equal intervals between them in the frequency domain. This mapping scheme is referred to as either an Interleaved Frequency Division Multiple Access (IFDMA) scheme or a Distributed Frequency Division Multiple Access (DFDMA) scheme.

Although FIGs. 2 and 3 show one method of implementing the SC-FDMA technology in the frequency domain, it is also possible to use various other methods, such as a method of implementing the technology in the time domain.

Diagrams (a) and (b) of FIG. 4 illustrates comparison between the positions of sub-carriers used for the DFDMA and the LFDMA in the frequency domain.

Referring to diagram (a) of FIG. 4, the transmission symbols of a UE using the DFDMA scheme are distributed with equal intervals over the entire frequency domain (that is, the system band). Referring to diagram (b) of FIG. 4, the transmission symbols of a UE using the LFDMA scheme are consecutively located at some part of the frequency domain.

According to the LFDMA scheme, because consecutive parts of the entire frequency band are used, it is possible to obtain a frequency scheduling gain by selecting a partial frequency band having good channel gain in the frequency selective channel environment in which severe channel change of frequency bands occurs. In contrast, according to the DFDMA scheme, it is possible to obtain a frequency diversity gain as transmission symbols have various channel gains by using a large number of sub-carriers distributed over a wide frequency band.

In order to maintain the characteristic of the single carrier as described above, simultaneously transmitted information symbols should be mapped to the IFFT block such that they can always satisfy the LFDMA or DFDMA after passing through a single FFT block (or DFT block).

In an actual communication system, various information symbols may be transmitted. For example, in the uplink of a Long Term Evolution (LTE) system using the SC-FDMA based on a Universal Mobile Telecommunications System (UMTS), uplink data, control information regulating a transport scheme of the uplink data (which includes Transport Format (TF) information of the uplink data and/or Hybrid Automatic Repeat reQuest (HARQ) information), ACK/NACK for an HARQ operation for downlink data, Channel Quality Indication (CQI) information indicating the channel status reported to be used for scheduling of a node B, etc. may be transmitted. These enumerated information items have different transmission characteristics.

Uplink data can be transmitted in a situation in which a UE has data in a

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