Enhancement of the W-CDMA Scheme based on Parallel Matched Filters

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Abstract: - The basic structure of the W-CDMA system is investigated first in this paper together with its characteristics which have been provided previously by the authors. The advantages of the W-CDMA are wide spreading and coherent detection with a pilot channel. The pilot channel is optimized to give the best performance of Bit Error Rate. New structure of W-CDMA receiver is then studied to increase transmission data rate and capacity of mobile communications. This structure, with parallel matched filter, has been proposed for synchronization and demodulation under multipath environments. Parallel matched filter is configured by analog MOS LSI instead of conventional digital components. The power consumption and dimension of the LSI are reduced by the combination of system and hardware approaches.

Key-Words: - Synchronization, Pilot signal, Matched filter, W-CDMA, Mobile communications.

1 Introduction

DS-CDMA system provides high-speed data transmission over radio channels. Due to multipath propagation and Doppler effect, it is important to establish accurate synchronization. It is also necessary to perform demodulation without distortion, as rapid phase rotation exists in radio channels.

Pilot signal is transmitted continuously together with data signal in this system. Accurate initial acquisition and precise tracking is achieved by continuous pilot transmission (pilot channel). Estimation and compensation of phase rotation is achieved effectively with high resolution using continuous pilot signal. And highly improved demodulation of received data is also provided using the received pilot signal.

This paper describes configuration of enhanced W-CDMA system and its characteristic evaluation and a novel configuration of analog matched filters to realize compact system with low power consumption. The coherent demodulation using continuous pilot signal was proved to be advantageous for high-speed data transmission.

2 Radio System Configuration

2.1 Transmitter

The transmitter in the reverse or the forward link is shown in Fig.1.

Data signal is fed to I and Q-channels of QPSK modulator. The pilot signal is fed to I-channel only. They are fed to QPSK modulator. The pilot signal is composed of Walsh-0 and PN codes. I and Q components of data signal are composed of Walsh-1 and PN codes.

In this system, pilot signal transmitted continuously via a pilot channel merged in the I-channel of data channels.

2.2 Receiver

The receiver in the reverse or forward link is shown in Fig.2. One correlator is provided for synchronization with long correlation of 8-16 bit-data-length. Acquisition and tracking are achieved precisely using continuous pilot signal. The other correlator is provided for coherent demodulation with short-term correlation of 1-bit-data-length based on phase estimation and compensation using the vectors *u* and *v*.

3 Synchronization and Demodulation

Coherent radio transmission scheme is shown in Fig.3. The (i)Continuous pilot signal is transmitted through a pilot channel, (ii) the pilot channel is composed of O-QPSK and QPSK for reverse and forward links respectively, (iii) pilot signal is added in each I channel of O-QPSK and QPSK, (iv) coherent demodulation is achieved by estimation and compensation of phase rotation using the pilot channel.

3.1 Parallel matched filter for synchronization

Fast initial acquisition of cell synchronization is provided together with precise tracking of path synchronization using pilot signal and parallel matched filter. For cell synchronization, a single sample point and correlation of 8-bit-data-span are used. For path synchronization, 4 points over sampling over 1 chip is used to get precise resolution. An analog matched filter system is considered for correlation calculation of received and the pilot signal to provide compact and low power receiver. Estimation and compensation of phase rotation with highly improved demodulation of received traffic data have been achieved by utilizing received pilot signal.

This structure, with parallel matched filter, has been proposed for synchronization and demodulation under multipath environments. Parallel matched filter is configured by analog MOS LSI instead of conventional digital components. The power consumption and dimension of the LSI are reduced by the combination of system and hardware approaches.

3.2 Coherent demodulation

The proposed scheme is shown in Fig.5. The process is as follows; (i) estimation of rapid phase rotation caused by multipath radio propagation with high-speed Doppler shift in frequency is well realized by the use of continuous pilot transmission. (pilot channel), (ii) compensation of rapid phase rotation is well done by simplified logic operations, (iii) high performance for high speed data transmission is realized by coherent demodulation. This system will be applied to wireless LANs with high performances and simplified configurations.

4 Evaluation

4.1 Synchronization time

Fig.6 shows the characteristics of synchronization to a target cell. The horizontal and the vertical axis show the calculation time (ms) and acquisition success rate respectively. Acquisition success rate is defined the ratio of success times and total times of synchronizing events. The synchronization is achieved within about 30 ms.

4.2 Bit Error Rate vs. Eb/N0

Fig.7 shows the characteristics of Bit Error Rate vs. E_b/N_0. The maximum ration combining is utilized. Possible number of paths for combining are 1 path, 2paths, and 3 paths. Transmitter power control has been applied for each number of paths conducted. The required E_b/N_0 is about 4dB for BER $1x10^{-3}$.

5 Conclusion

It has been clarified in this paper, that coherent transmission of data using continuous pilot signals. The parallel matched filter is quite effective to realize the reliable synchronization and coherent demodulation under multipath radio environment.

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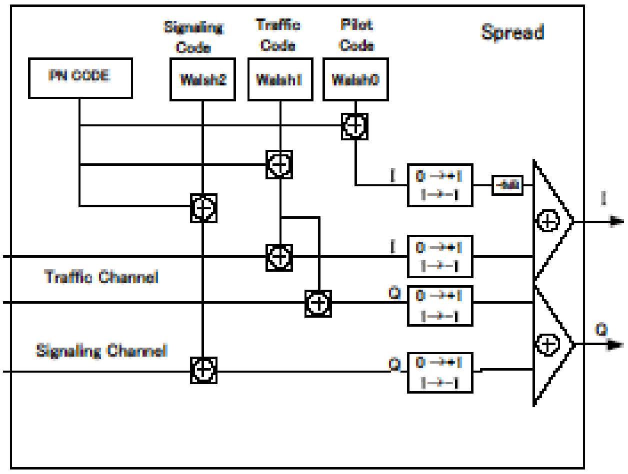

Fig.1 Transmitter of reverse link.

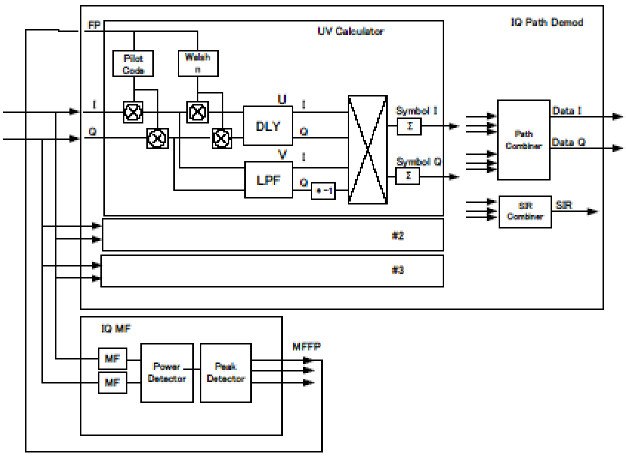

Fig.2 Receiver and Sync. of reverse link.

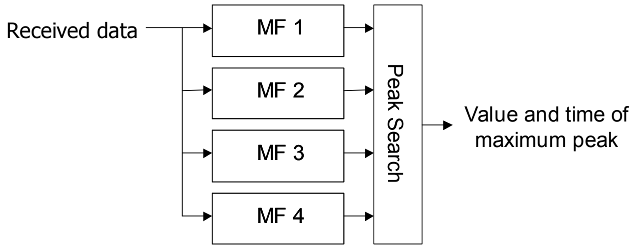

Fig.4 Matched filter for synchronization.

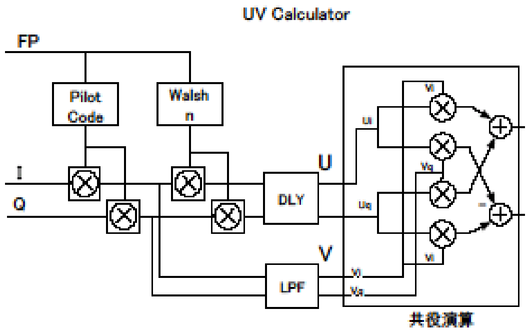

Fig.5 Demodulation with estimation and compensation of phase rotation. (*u*, *v* calculators)

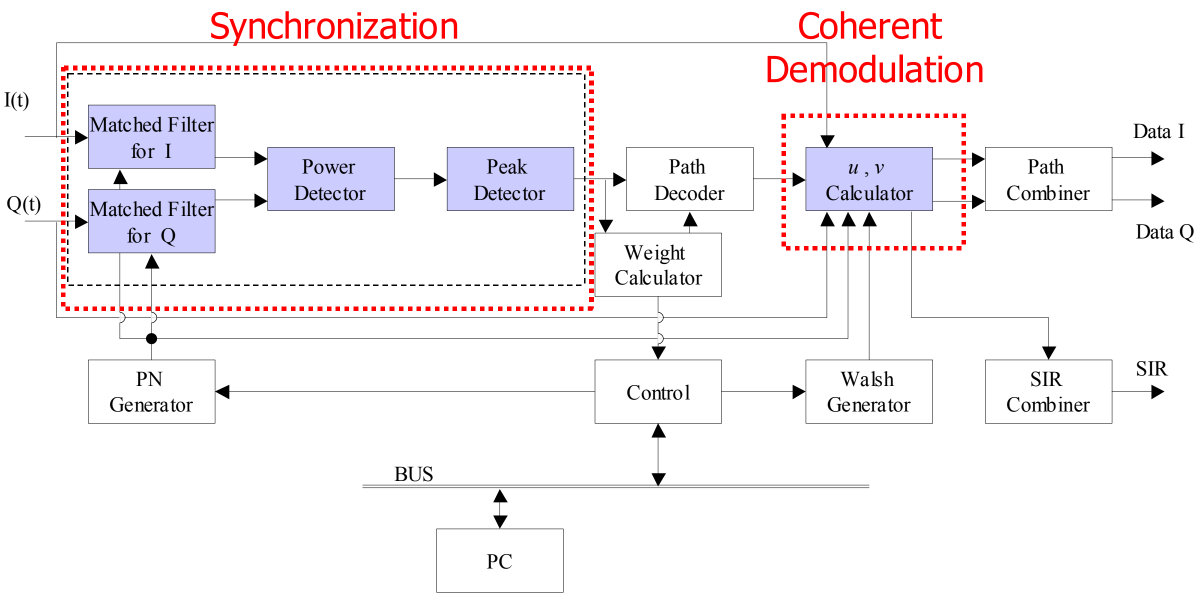

Fig.3

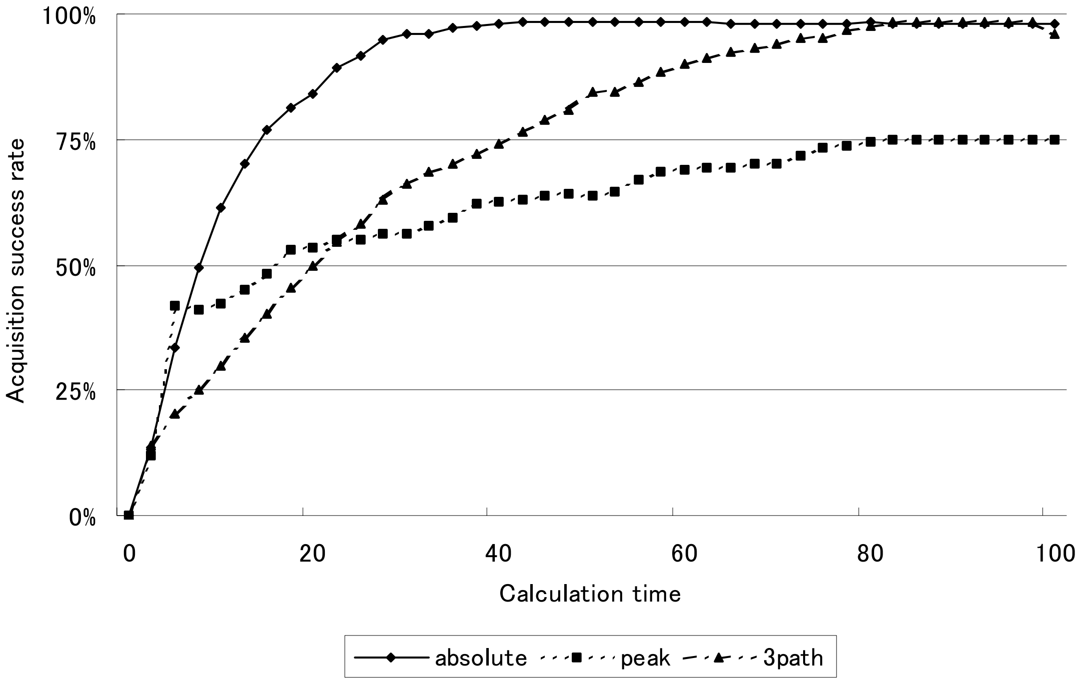

Fig.6 Characteristics of synchronization.

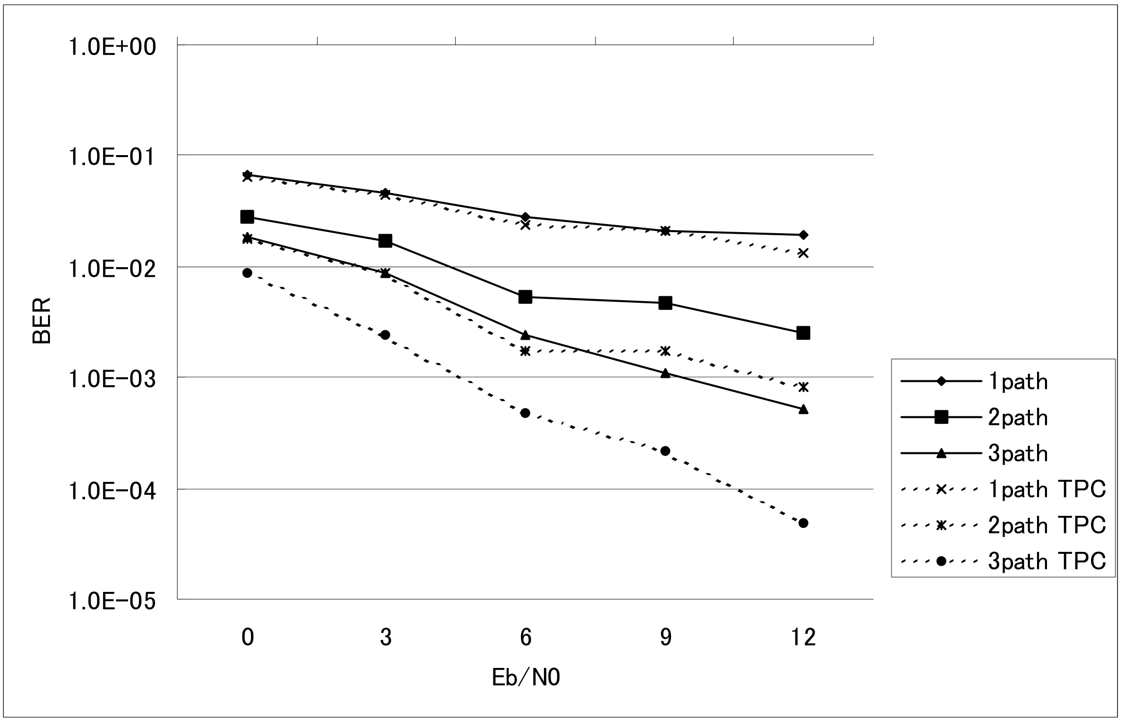

Fig.7 Characteristics of BER vs. E_b/N_0.