

Hierarchical Information Acquisition Scheme on the Local Broadcasting System

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Abstract: In this paper, it is proposed the information delivery system that the transmission signal embraces together the wide-area information and the local area information. The distant user from the base station receives the wide-area information only and the nearby user receives together the wide-area information and the local-area information. The proposed system uses the code shift keying(CSK) for transmitting the local-area information and the amplitude shift keying(ASK) for the wide-area information. In the proposed system, the broadcast information is hierarchized by combining ASK with CSK.

1. Introduction

In recent years, there has been increasing interests in Intelligent Transport System (ITS). Road to Vehicle Communication (RVC) and Inter-Vehicle Communication (IVC) are the important components of ITS [1][2][6]. In this paper, we focus on RVC. RVC is used to provide vehicles with access to fixed networks. In RVC, there are two major schemes; that is, one-way communication broadcast and two-way communications. Two-way communications are used to be connected to the Internet and various servers through the base station for RVC. One-way communications are used to broadcast the wide-area information and local-area information such as traffic accident and traffic jam, information of parking lot and neighbor shops, and the surrounding information of the base station. Considerable researches have been carried out on the broadcast (program), the transmission schemes [5] and the error control schemes for users [3][4]. The conventional transmission system supposed that all users received the totally same information. However, we consider that the information to receive of nearby users is different from the information that distant users from the base station receive because the incident of information depends on the location. For example, the distant users receive the voice data only and the nearby users receive together the voice data and the image data. Then it is necessary for the base station to broadcast the information packet including the voice data and the image data. One of the important problems is to design the transmission system that embraces information of the different transmission data.

In this paper, we propose the system combined amplitude shift keying (ASK) with code shift keying (CSK) hierarchical. The CSK is one of the M -ary modulation methods. In the proposed system, CSK has more than one extended Prime code. The bit data for CSK are represented by the pattern

of the pseudo-noise code, and the bit data for ASK are did by the amplitude value of CSK signal. Moreover, data for CSK and data for ASK can demodulate individually. In the proposed system, we consider that CSK is used for the high transmission rate information and ASK is used for the low transmission rate information.

2. Proposed System

The model of hierarchical information delivery is illustrated in Fig.1. The transmission signal embraces together the ASK data and the CSK data. The distant user "A" demodulates ASK data only and the nearby user "B" demodulates together the ASK data and CSK data. We suppose the followings; 1) The image data and voice data are broadcasted simultaneously by the base station. 2) The image data, which are high transmission rate information, are represented by CSK signal. The voice data, which are the low transmission rate information, are represented by ASK signal.

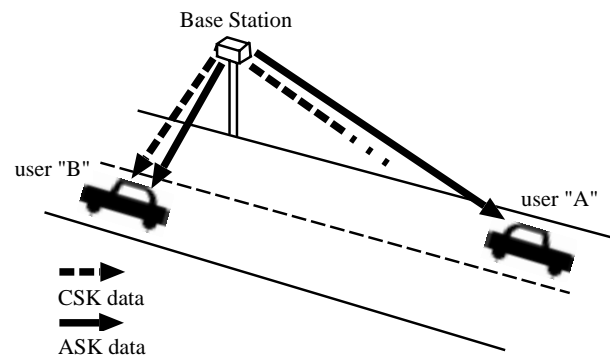
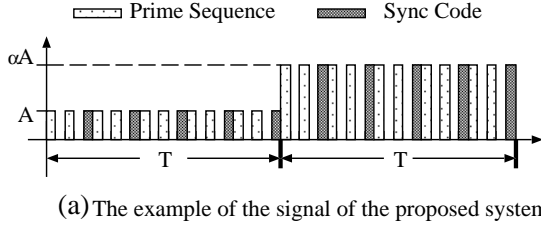


Figure 1. The model of hierarchical information delivery.

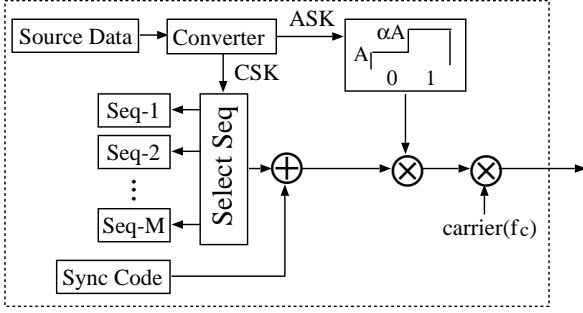
In the proposed system, CSK is used for the high transmission rate information, and ASK is used for the low transmission rate information. The signal structure that combines ASK signal with CSK signal is shown in Fig.2.

When the length of the orthogonal PN code for CSK, is 8, the number of the orthogonal codes, M , is also 8, and the amplitude values for ASK are A and αA ($\alpha > 1$). First, in CSK, one of the M orthogonal PN codes is selected by high transmission rate information data. Next, the amplitude value of CSK signal is decided by the ASK data, that is, low transmission rate information data. When the ASK data is "0", the amplitude value is A . When the ASK data is "1", the amplitude value is αA . In the CSK demodulator, the magnitude of M correlator outputs corresponding to the orthogonal PN codes are examined and the largest one is selected. Then CSK

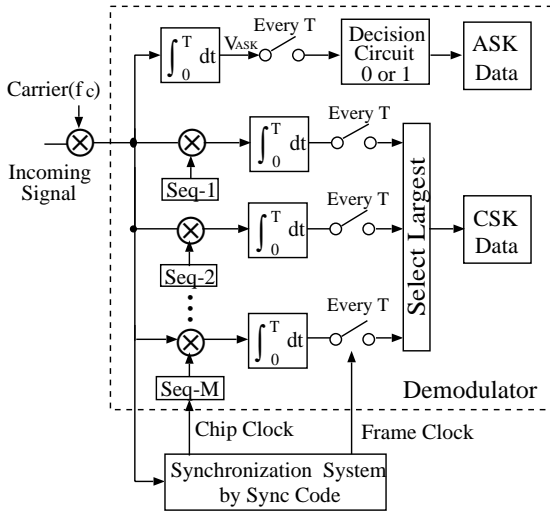
data is extracted by the estimated orthogonal PN code. In the ASK demodulator, the magnitudes of envelope of CSK signal are examined, ignoring the orthogonal PN code pattern.



(a) The example of the signal of the proposed system.



(b) Transmitter of the proposed system.



(c) Receiver of the proposed system.

Figure 2. The system model of the proposed system.

In Fig.2(b) the transmitter acts as follows. Firstly, source data are divided into two data; CSK data and ASK data. Secondly, one of M orthogonal sequences is selected by CSK data and the amplitude value of the transmitted signal is decided by ASK data. The extended Prime code sequences[7] are used as the orthogonal sequence. When a prime number is P , P^2 extended Prime code sequences are generated. Then the extended Prime code sequences consist of P sets which contain P orthogonal codes. In this system, $M=2^{\lceil \log_2 P \rceil}$.

In Fig.2(c), the receiver operates as follows. In the ASK demodulator, the magnitudes of envelope of CSK data are examined. If the magnitude V_{ASK} exceeds the threshold T_h , the transmitted ASK data is estimated to be 1. If $V_{ASK} < T_h$, the transmitted ASK data is estimated to be 0. In CSK demodu-

lator contains M correlators, each one corresponds to one of M orthogonal sequences. Each correlator consists of a multiplier that multiplies one of M orthogonal sequences by the received signal and an integrator that integrates the product over the sequence period(T). The outputs of M correlators are all sampled at time T . The magnitudes of the correlator outputs are examined and the largest one is selected. The transmitted CSK data is estimated by the estimated sequence. The frame timing is tracked by the synchronization system with the sync code. One of P orthogonal sequences is used as the sync code.

3. Performance Analysis

We analyze the performance of the proposed system. It is assumed that the receiver input noise is white Gaussian noise with PSD of $N_0/2$ and there is free-space propagation loss, $\lambda/4\pi r$, where λ is a wavelength and r is communication distance. In ASK, the decision as to whether 0 and 1 was present at the input depends on whether $V_{ASK} < \text{or} > T_h$, where T_h is the optimum threshold.

When the transmitted ASK data is 1, the error rate of ASK signal, denoted P_{ASK1} , is expressed as

$$P_{ASK1} = \int_{-\infty}^{T_h} \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x - \alpha AT)^2}{2\sigma^2}\right) dx$$

$$= \frac{1}{2} \operatorname{erfc}\left(\sqrt{\frac{(\alpha - 1)^2(1 + \log_2 M)}{2(1 + \alpha^2)}} \left\{\frac{\lambda}{4\pi r}\right\}^2 \frac{E_{bT}}{N_0}\right) \quad (1)$$

where, $(1 + \log_2 M)E_{bT} = \frac{\alpha^2 + 1}{2}A^2T$, $T_h = \frac{\alpha + 1}{2}AT$, $\sigma^2 = \frac{N_0T}{2}$ and $\operatorname{erfc}(x)$ is the complementary error function; $\operatorname{erfc}(x) = \frac{2}{\sqrt{\pi}} \int_x^{\infty} \exp(-u^2) du$. When the transmitted ASK data is 0, the error rate of ASK signal, P_{ASK0} , is equal to P_{ASK1} . Then the average error rate of ASK signal, P_{ASK} , is $(P_{ASK0} + P_{ASK1})/2$.

The error rate of CSK signal, denoted P_{CSK} , is given by

$$P_{CSK} = \frac{(P_A + P_{\alpha A})}{2} \quad (2)$$

$$P_A = 1 - \int_{-\infty}^{\infty} \frac{1}{\sqrt{\pi}} \exp(-z^2)$$

$$\left\{ \frac{1}{2} \operatorname{erfc}\left(-z - \sqrt{\frac{2(1 + \log_2 M)}{1 + \alpha^2}} \left\{\frac{\lambda}{4\pi r}\right\}^2 \frac{E_{bT}}{N_0}\right) \right\}^{M-1} dz. \quad (3)$$

$$P_{\alpha A} = 1 - \int_{-\infty}^{\infty} \frac{1}{\sqrt{\pi}} \exp(-z^2)$$

$$\left\{ \frac{1}{2} \operatorname{erfc}\left(-z - \sqrt{\frac{2\alpha^2(1 + \log_2 M)}{1 + \alpha^2}} \left\{\frac{\lambda}{4\pi r}\right\}^2 \frac{E_{bT}}{N_0}\right) \right\}^{M-1} dz. \quad (4)$$

Figure 3 shows the communication distance for E_{bT}/N_0 (the ratio of the transmission signal energy per bit and the noise power spectral density) when $P_{ASK} = P_{CSK} = 10^3$. The number of orthogonal PN codes for CSK is 8, the number of amplitudes of ASK is 2, and $\alpha = 2.5$ and 4.0. When

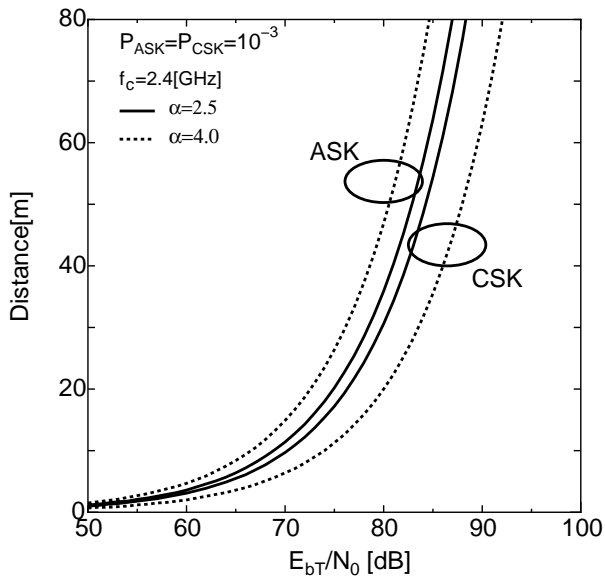


Figure 3. The communication distance versus E_{bT}/N_0 required for $P_{ASK}=P_{CSK}=10^{-3}$ and the carrier frequency is 2.4[GHz], the number of orthogonal PN codes of CSK is 8, and the number of amplitudes levels of ASK is 2.

E_{bT}/N_0 is 85[dB] and α is 4.0, the communication distance of ASK and CSK is 80[m] and 35[m], respectively. It is found that ASK data and the CSK data can transmit hierarchical.

Figure 4 shows the communication distance for α when P_{ASK} and P_{CSK} achieve 10^{-3} , The carrier frequency(f_c) is 2.4[GHz], $M=8$, $\frac{E_{bT}}{N_0}$ is 80, 85, 90[dB]. From Fig.4, it is necessary to adjust α to three or more to achieve a satisfactory distance difference between ASK and CSK for hierarchizing.

4. Conclusion

In this paper, we proposed the system combined the amplitude shift keying (ASK) with code shift keying (CSK) hierarchical and we analyzed the performance of the proposed system. Consequently, ASK data and the CSK data can transmits hierarchical.

Acknowledgement

This study was supported in part by Grant-in-Aid for Scientific Research (C) in Japan.

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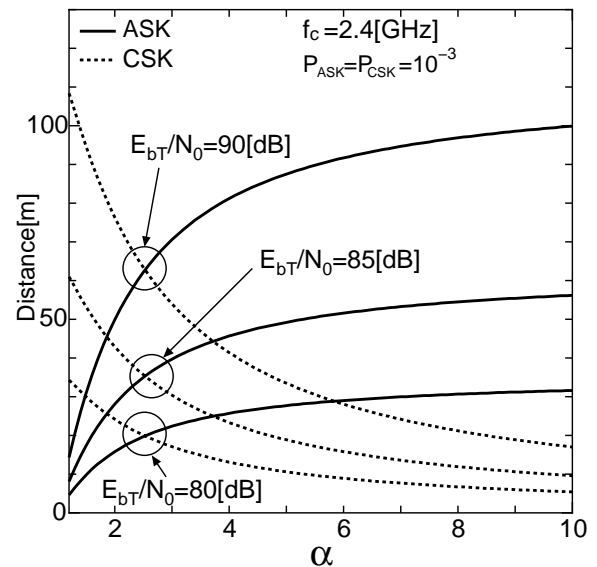


Figure 4. α versus The communication distance required for $P_{ASK}=P_{CSK}=10^{-3}$ and the carrier frequency is 2.4[GHz], $M=8$.

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