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Performances of Forward Error Correction Methods in Very Shallow Water Multipath Channel

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1. Introduction

In very shallow water multipath channel, underwater acoustic (UWA) communication channel is known to exhibit fading due to time-varying multipath delay spread[1,2]. In other words, UWA channel is frequency selective fading. This induces an inter-symbol-interference (ISI) resulting in bit error increase, which degrades the UWA system performance[3,4].

In this study, the performances of Forward Error Correction (FEC) codes are examined to find out their effects in very shallow water multipath channel. The convolution code (CC) and Reed-Solomon (RS) code are adopted.

2. Sea experimental procedure

Figure 1 shows block diagram of UWA communication system. **Figure 2** shows schematic layout of the sea experiment for performance of FEC and sound velocity profile (SVP) of experimental site. The experiments were conducted in the bay of the Geoje island in August 6, 2014. The experimental parameters are shown in **Table I**.

The effective wave height of sea surface is about 0.2 ~ 0.5 m. Bottom sediment is mud. The ranges between the transmitter (ITC 1001) and receiver (B&K 8106) are set to be 100, and 400 m, respectively.

The depth of transmitter and receiver are 7 and 10 m, respectively. **Figure 3(a)** and **3(b)** show channel responses obtained using linear frequency modulation (LFM) signal for 100 and 400 m.

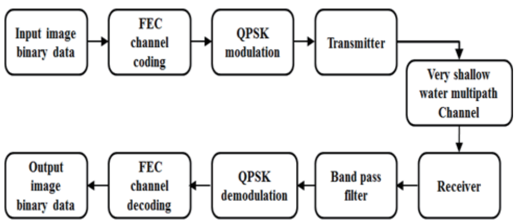

Fig. 1 Block diagram of UWA communication system

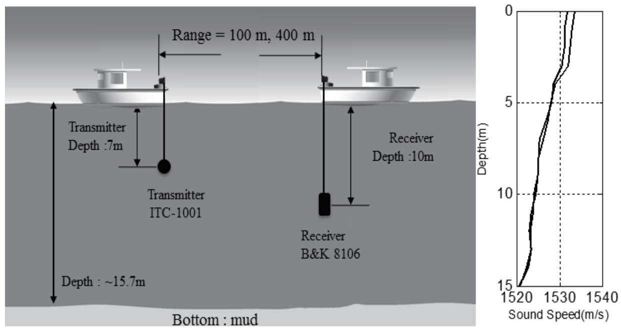

Fig. 2 Sea experimental configuration and SVP

Table I. Sea experimental parameters

Modulation	QPSK
Carrier frequency (kHz)	16 kHz
Channel coding	convolutional code (2,1) Reed-Solomon code (7,3)[5]
Symbol rate (sps)	100, 200, 400
Tx-Rx Range (m)	100, 400
Tx-Rx depth (m)	7, 10
Water depth (m)	~15.7
Bottom property	mud
Data (bits)	Image 10,000 bits

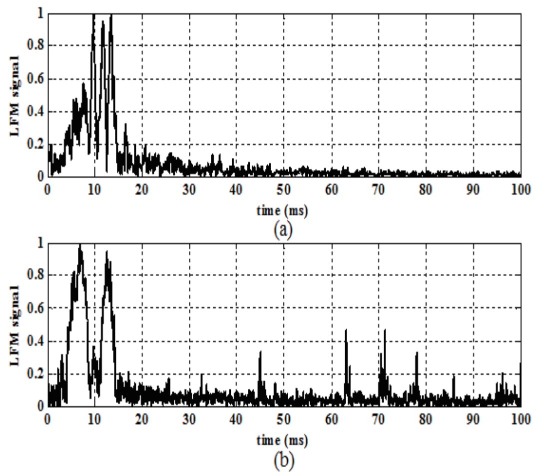

Fig. 3 Channel responses; (a) 100 and (b) 400 m

3. Results

In authors' previous work of CC and RS[5] in water tank experiment, it was found that error correcting capability of QPSK/RS is worse than

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QPSK/CC in frequency non selective multipath fading channel. However in frequency selectivity multipath fading, error correcting capability of QPSK/RS is better than QPSK/CC.

Table II. Performance of FEC (range = 100 m, 100 sps)

Data rate 100 sps	QPSK	CC	RS
Image			
Error Bits	223	11	33
BER	0.023	0.0011	0.0034

Table III. Performance of FEC (range = 100 m, 200 sps)

Data rate 200 sps	QPSK	CC	RS
Image			
Error Bits	558	179	74
BER	0.06	0.018	0.0076

Table IV. Performance of FEC (range = 400 m, 100 sps)

Data rate 100 sps	QPSK	CC	RS
Image			
Error Bits	243	136	609
BER	0.025	0.014	0.062

Table V. Performance of FEC (range = 400 m, 200 sps)

Data rate 200 sps	QPSK	CC	RS
Image			
Error Bits	1514	501	18
BER	0.155	0.05	0.0018

Table II and III show the performances of FEC for two different transmitter and receiver ranges (100 and 400m) and two different symbol rates (100 and 200 sps). CC shows better performance in 100 sps in both ranges but RS shows better performance in 200 sps in both ranges. In the case of symbol rate 100 sps in ranges of 100 and 400 m, the channel could be frequency non selective but it could be frequency selective for symbol rate 200 sps in both ranges. This result is consistent to authors' previous water tank experimental result such that FEC capability of RS is better than that of CC in frequency selective multipath channel [5] .

For a given frequency selective fading channel, performances of CC and RS are highly dependent on symbol rate which controls frequency selectivity of the channel.

4. Conclusion

Performance of FEC is examined through sea experiments. FEC improves performance of UWA communication system in very shallow water multipath channel. For a given frequency selective fading channel, performances of CC and RS are highly dependent on symbol rate which controls frequency selectivity of the channel. CC is better in frequency non selective multipath channel but RS is better in frequency selective channel. Therefore a suitable channel coding should be chosen on the basis of frequency selectivity of the multipath channel.

Acknowledgment

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References

1. R. J. Urick: *Principles of Underwater Sound* (McGraw-Hill, New York, 1983) 3rd ed., p. 129
2. B. A. Tan, M. Motani, M Chitre and S. S Quek: Proc. ACOUSTIC 2006 (2006), p. 515.
3. J. Park, C. Seo, K. Park and J. R. Yoon: Jpn. J. Appl. Phys. **52** (2013) 07HG01.
4. J. Kim, K. Park, J. Park and J. R. Yoon, Jpn. J. Appl. Phys. **50** (2011) 07HG05.
5. C. Seo, J. Park, K. Park and J. R. Yoon, Jpn. J. Appl. Phys. **53**, (2014) 07KG02.