Constructive ITI Coded PRML System Based on Two Track Model for Perpendicular Magnetic Recording

Y. KURIHARA[1], **Y. TAKEDA**[1], **Y. TAKAISHI**[1], **Y. KOIZUMI**[1], **H. OSAWA**[2], **M.Z. AHMED**[3], **and Y. OKAMOTO**[2]

1) Niihama National College of Technology, Niihama, Japan, kurihara@ect.niihama-nct.ac.jp

2) Ehime University, Matsuyama, Japan, {osawa, okamoto}@rec.ee.ehime-u.ac.jp

3) University of Plymouth, Plymouth, U.K., mahmed@plymouth.ac.uk

I. INTRODUCTION

Constructive inter-track interference (CITI) codes based on readback level have been investigated not to have the transitions which give readback pulses of opposite polarity from adjacent tracks in the perpendicular magnetic recording (PMR) channel with a differentiator [1]. Because it is however impossible to design such CITI codes for the PMR channel without a differentiator, CITI codes based on equalized level were also investigated [2]. In this paper, we study not only the new CITI code based on the equalized level of class-I partial response (PR1) [3] but also Viterbi detection using new algorithm taking account the ITI from adjacent tracks.

II. CONSTRUCTIVE ITI CODE BASED ON PR1 TARGET FOR TWO TRACK MODEL

Table I shows the CITI code based on the equalized level so that the opposite polar levels after PR1 equalization can not occur simultaneously. According to this table, 5 bits of the user bit data are converted into a pair of 3 symbols of the codewords respectively. This code is designed so that the opposite polar levels after PR1 equalization can not occur simultaneously.

Table I Look up table of CITI code based on PR1 equalized level.

Data	Codes		Data	Codes		Data	Codes		Data	Codes	
	Main-	Sub-		Main-	Sub-		Main-	Sub-		Main-	Sub-
00000	001		01000	010	010	10000	100		11000	101	
	001			100	000		100			100	
00001	001		01001	010	000	10001	100	000	11001	101	
	010			101	001		001	101		101	
00010	001		01010	010	100	10010	100	000	11010	101	
	011			110	000		010	010		110	
00011	001	001	01011	011		10011	100		11011	110	000
	100	000		001			101			010	100
00100	001	111	01100	011		10100	100		11100	110	110
	101	011		010			110			011	111
00101	010		01101	011	111	10101	101	011	11101	110	
	001			101	101		001	111		100	
00110	010		01110	011	111	10110	101	111	11110	110	
	010			110	010		010	110		101	
00111	010		01111	011		10111	101	101	11111	110	
	011			011			011	111		110	

III. TWO TRACK SIMULATION MODEL AND PROPOSED VITERBI DETECTION

Fig. 1 shows the block diagram of two track read/write model in PMR. The CITI encoder converts an input data sequence $\{a_{k'}\}$ into two track sequences, $\{b_{1k}\}$ and $\{b_{2k}\}$, respectively. In PMR combining MR head and double layered media, we assume that the isolated reproducing waveform for a unit step write current at each transition is given by

$$h(t) = A \cdot \tanh\left(\frac{\ln 3}{T_{50}} t\right), \tag{1}$$

Yoshitake KURIHARA
Niihama National College of Technology
E-mail: kurihara@ect.niihama-nct.ac.jp
fax: +81-897-37-7763
tel: +81-897-37-7765
7-1 Yagumo, Niihama 792-8580, Japan
Preferred category: # 5

where A is the saturation level and T_{50} is the rise time from $-A/2$ to $+A/2$. User density $K_{\rm p}$ is defined as T_{50} normalized by the user bit interval $T_{\rm b}$. In Fig. 1, assume that each track width in the two track model is half of that in the ordinary single track model. The readback peak level therefore reduces to half. We also assume that n_{1k} and n_{2k} are additive white Gaussian noise sequences with zero-mean and variance σ^2. The signal-to-noise ratio SNR at the reading point is defined as $20\log_{10} A/\sigma$ [dB]. As the PR channel response is equalized to a PR1 target, each transversal filter with tap number N_t makes the connection between $b_{i\,k}$ and $c_{i\,k}$ as follows:

$$\left.\begin{array}{l} c_{1k} = b_{1k} + b_{1\,k-1} - 1 + \alpha(b_{2k} + b_{2\,k-1} - 1) \\ c_{2k} = b_{2k} + b_{2\,k-1} - 1 + \alpha(b_{1k} + b_{1\,k-1} - 1) \end{array}\right\}, \tag{2}$$

where c_{1k} and c_{2k} are noiseless equalized sequences, and α is the weight of ITI. Using equation (2), we investigate the Viterbi detection taking account the ITI from adjacent tracks. Then we obtain the output sequence $\{\hat{a}_{k'}\}$ through the Viterbi detector and CITI decoder.

IV. SIMULATION RESULTS AND CONCLUSION

Fig. 2 shows the relationship between the required SNR to achieve a bit error rate (BER) of 10^{-4} and the weight of ITI α obtained by computer simulation, where $K_{\rm p} = 1.5$ and $N_t = 7$. The symbols • and □ show the performances of the proposed Viterbi detection and the conventional CITI coded Viterbi detection with PR1 target [2], respectively. The dotted line also shows the performance for the single track model.

The permissible percentage of ITI for the conventional Viterbi detection to attain a better performance compared with the case of single track is 26%, while the percentage for the proposed one is improved up to 50%.

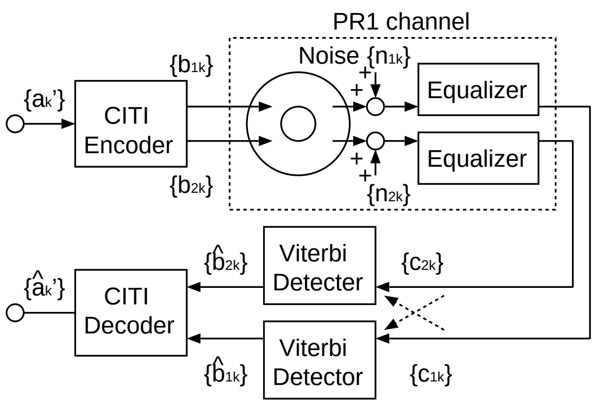

Fig. 1 Block diagram.

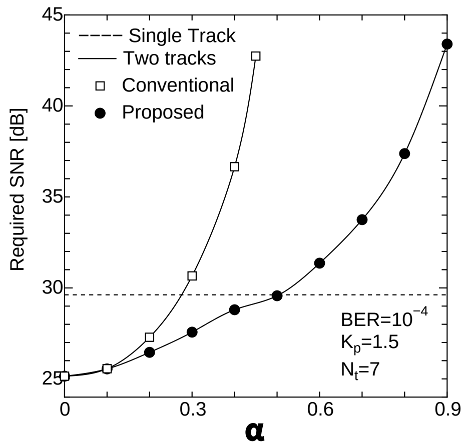

Fig. 2 Required SNR vs. ITI.

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