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BOOK OF ABSTRACTS

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the proposed SRTR systems with and without TMR mitigation technique (right), where a single reader was positioned at the center of desire track for the conventional system. Both graphs are obtained from considering recording system without and with 5% position and size fluctuations at AD of 3.0 Tbpsi. It is clear that the SRTR system provides better BER performance. Moreover, when the TMR effects occurred, our proposed system with TMR mitigation method can yield better performance especially at high head offset levels.

[1] H. J. Richter, A. Y. Dobin, O. Heinonen et al., "Recording on bit-patterned media at densities of 1Tb/in^2 and beyond," IEEE Trans. Magn. 42(10), 2255–2260 (2006). [2] Y. Shiroishi et al., "Future options for HDD storage," IEEE Trans. Magn. 45(10), 3816 (2009). [3] L. N. He et al, "Estimation of track mis-registration by using dual stripe magneto resistive heads," IEEE Trans. Magn., 34(4), 2348(1998). [4] C. Warisarn et al., "Mitigation of TMR using energy ratio and bit-flipping techniques in multitrack multihead BPMR systems," IEEE Trans. Magn. 53(11), 2600104 (2017). [5] P. Kovintavewat et al., "Generalized partial-response targets for perpendicular recording with jitter noise," IEEE Trans. Magn. 38(5), 2340-2342 (2002).

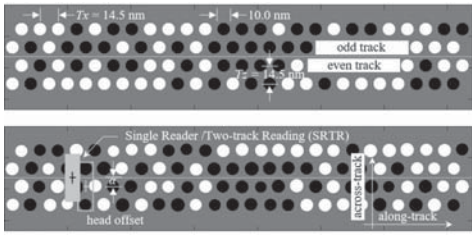

Fig. 1: The staggered bit-patterned media with SRTR scheme under the AD of 3.0 Tbpsi.

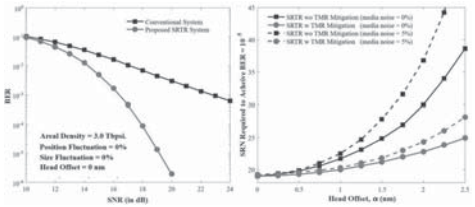

Fig. 2: BER performance of conventional and proposed SRTR systems (left) and SNR requirement to achieve BER = 10^{-5} of the proposed systems when the head offset was varied from 0 to 2.5 nm (right).

CQ-03. Modified 2D Viterbi Algorithm using 2D Modulation Encoding Constraint in Bit-Patterned Magnetic Recording. *T. Chumpuwiset*[1], C. Warisarn[1], L.M. Myint[3], S. Koonkarnkhai[2] and P. Kovintavewat[2]
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The 2D modulation code was adopted in multi-head multi-track bit-patterned magnetic recording (BPMR) system [1-2] to avoid severe inter-track interference (ITI), thus further improving the bit-error rate (BER) performance of the coded system. We propose a modified two-dimensional (2D) Viterbi algorithm (VA) using a 2D modulation encoding constraint. Generally, a conventional 2D Viterbi detector is a symbol-based detector, where the input symbol and the state of its trellis are defined based on the recorded bits from all tracks [3]. Because of the two delay taps in the target and the read head covers three tracks, each state will be composed by 6 symbols. Therefore, the trellis has $2^6 = 64$ states with 8 incoming branches at each state, whose complexity is extremely high. In this work, we consider a modified 2D Viterbi detector, where the number of states and branches are reduced by exploiting the constraint of the 2D modulation code [1]. Since the code constraint does not allow recording two specified bit patterns, i.e., $[-1\ +1\ -1]^T$ and $[+1\ -1\ +1]^T$ in across-track direction, the modified 2D Viterbi detector does not need to consider the input symbols and the states related to these patterns in the trellis structure. Because there remains only 6 possible input symbols, the trellis will have 6×6 = 36 states and 6 incoming branches at each state as shown in Fig. 1. Clearly, the trellis of the modified detector considers all 6 possible recorded bit patterns based on the code constraint; therefore, there is no performance loss due to the complexity reduction. Moreover, we also propose a bit-flipping technique that performs together with the joint 2D VA [4] to improve the performances of the upper and lower most tracks. Since the estimated user bits of the three inner tracks provide a high reliability due to the use of modulation code. Therefore, these estimated bits can be utilized as a flipping constraint in the bit-flipping process. Our proposed detector with bit-flipping technique does not only provide the lower complexity but also yields a superior performance, especially at ultra-high AD as shown in Fig. 2.

[1] C. Warisarn and P. Kovintavewat, "Soft-output decoding approach of 2D modulation code in bit-patterned media recording systems," IEICE Trans. Electron. vol. E98-C, no. 12, Dec. 2015. [2] C. D. Nguyen and J. Lee, "9/12 2-D modulation code for bit-patterned media recording," IEEE Trans. Magn., vol. 52, no. 3, pp. 3101207, Mar. 2017. [3] S. Karakulak, P. H. Siegel, J. K. Wolf, and H. N. Bertram, "Joint-track equalization and detection for bit patterned media recording," IEEE Trans. Magn., vol. 46, pp. 3639–3647, Sep. 2010. [4] L. M. M. Myint and C. Warisarn, "Reduced complexity of multi-track joint 2-D Viterbi detectors for bit-patterned media," AIP Advances 7, 056502 (2017).

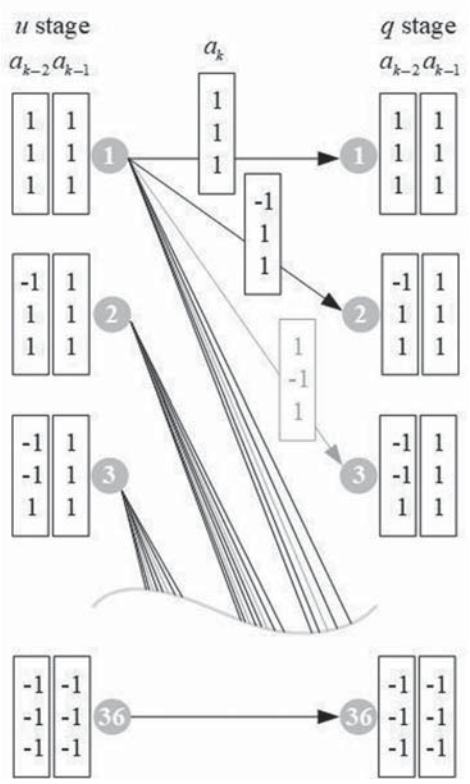

Fig.1 The trellis diagram of the modified 2D Viterbi detector.