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AN IMPROVED DECODING METHOD OF HAMMING PRODUCT CODES

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Summary. *Product codes are preferred in high data rate wireless communication systems to achieve good error performance. However, to conceive a proper decoding method, which can correct all the potential errors pattern that within the half of the code distance for the product code, is not easy. In this paper, an improved decoding method of hamming product code has proposed. The proposed method can correct all the combinations of errors that less than four. As a result, it has a good performance in BER and WER.*

Over half a century, the using of error-correcting coding (ECC) is one of the effective methods which improves the performance of noise immunity in information transmitted of communication systems and networks. The most widely used coding are those methods based on Hamming codes, various cyclic codes, BCH codes, product codes and others, allowing to correct random and dependent errors [1]. In Error control coding, parity check bits are calculated based on the input data. The input data and parity check bits are transmitted across a noisy channel. In the receiver, an ECC decoder is used to detect or correct the errors induced during the transmission. The number of parity bits depends upon the number of information bits. At present, the most successful coding schemes are turbo codes and low-density parity-check codes, since their excellent capability, closely to the Shannon limit. Under some specific requirement (typically, code-rates near to the unity and low error rates required), product codes may turn into competitive. Product codes [2, 3], which can be easily realized by concatenating simple component codes, have a good protection capability against both random and burst errors. Product codes, whose component codes are Hamming or extended Hamming product codes (BCH product codes), BCH product codes can be constructed to improve the error correction capability, but a more complex decoding process is required. The simplest two-dimensional product codes are single parity check (SPC) product codes, assured to correct only one error by inverting the intersection bit in the erroneous row and column [3].

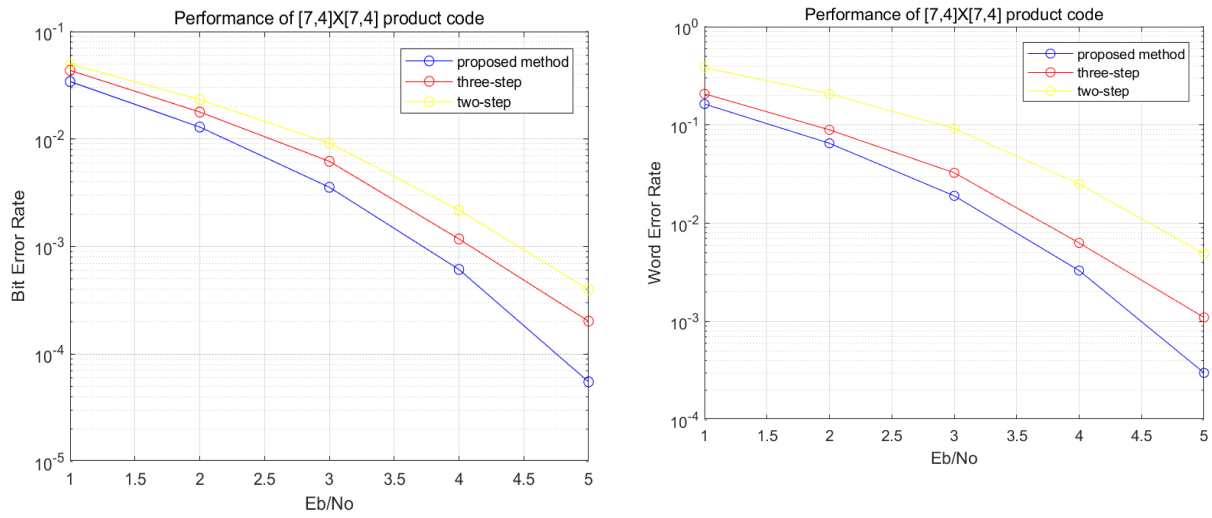
Product codes are formed in the verification codes $\mathrm{C}_1\left(n_1,k_1,d_1\right)$ and $\mathrm{C}_2\left(n_2,k_2,d_2\right)$ for the rows and columns of the source code matrix $n_1 \times n_2$, respectively, where *n* is the length of the code; *k* is the number of information symbols. The random-error-detecting and random-error-correcting capabilities of code are determined by its minimum distance $d_{\min}$, if the component codes C_1 and C_2 have minimum Hamming distances d_1 and d_2, accordingly, then the minimum Hamming distance of the two-dimensional product codes C_{pc} is the product d_1 and d_2 ($d_{\mathrm{pc}} = d_1 \times d_2$), and at the same time $d_{\mathrm{pc}} \geq 2t+1$, t is the multiplicity of corrected errors [1], which greatly increases the error correction capability.

According to the coding theory, it is need to add supervisory symbols to the information symbol sequence for reducing the appearance error. The result after conducting such opera-

tion is that the code-word sequence and the redundancy increases. But if there is a need to maintain the same rate of information symbols, the transmission rate of the communication system will boost. However, the rise of the bandwidth of the system may enlarge the noise of the system and then reduce the signal-to-noise ratio. The decreasing of the signal-to-noise ratio may generate more errors in the received symbol sequence of the system.

Existing decoding method for (7, 4, 3) hamming product code are two-step iterative decoding method [3] and three-step decoding method [4]. However, both of them fail to correct all the combination of four errors. Therefore, an improved method based on two-step and three-step decoding processing is proposed. Instead of directly using the syndrome decoding table to decode the error bits, we count the number of row errors and the number of column errors. If the number of the mistake row is above the number of mistake column, a row-column-row three step decoding will conduct. By contrary, a column-row-column three step decoding will conduct when the number of mistake column surpass number of mistake row. When the number of abnormal columns is equal to the number of abnormal row and this value is not larger than 2, then we will direct erase the potential error bit and followed by a row decoding. This decoding method guarantee all the combinations constitute by all the errors that less than or equal to four can be properly decoded.

Figure 1 shows the bit error rate (BER) curve and word error rate of using (7, 4, 3) Hamming product codes apply three different decoding methods with BPSK modulation.



(a) Bit error rate *(b)* Word error rate

Fig. 1 Performance of (7,4) Hamming product code in AWGN channel

From the Fig.1, it can be seen that the proposed method has a better performance when compare with the three step method and two-step method. From the fig.1-*a*, when the SNR is five, the bit error rate of the proposed method is roughly 4 10-4, which is less than the three-step method and two-step method. From the fig.1-*b*, the word error rate of the proposed method is also superior to the others.

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ОЦЕНКА ЛИКВИДНОСТИ ПРЕДПРИЯТИЯ С ИСПОЛЬЗОВАНИЕМ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА

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Summary. *The importance of regular assessment of the liquidity of an enterprise for the purpose of its successful and sustainable development has been investigated. The use of artificial intelligence serves as a tool for creating effective financial strategies.*

Пандемия и последовавшие за ней локдауны резко сократили передвижение товаров и людей. Это негативно сказалось на секторе услуг, малом и среднем бизнесе, сервисной экономике. Некоторые компании находятся на грани разорения или прекратили свою работу и обанкротились. В такой ситуации необходимо проводить регулярную оценку платежеспособности предприятия или оценку ликвидности баланса. Для этого сравниваются средства по активу, сгруппированные по степени их ликвидности с обязательствами по пассиву, сгруппированные по срокам их погашения.

Таблица 1 – Определение ликвидности баланса

АКТИВ	Условие абсолютной ликвидности	ПАССИВ
А1 − денежные средства	А1≥П1	П1 − кредиторская задолженность
А2 − оборотные активы	А2≥П2	П2 − краткосрочные кредиты
А3 − долгосрочные финансовые вложения	А3≥П3	П3 − долгосрочные заемные средства
А4 − внеоборотные активы	А4≥П4	П4 − собственный капитал

Если равенство соблюдается, то баланс считается абсолютно ликвидным. При отсутствии деятельности предприятия сохраняются текущие расходы. Через короткий промежуток времени равенство абсолютной ликвидности может быть нарушено.

Избежать финансовых проблем позволит еженедельный анализ деятельности компании. Для этого потребуется рассчитать точку безубыточности.

Точка безубыточности = Постоянные издержки / ((Стоимость 1 ед. продукции – Переменные затраты на 1 ед. продукции) / Стоимость 1 ед. продукции.

Далее вычислить сколько предприятие может тратить в неделю. Для этого доход прошлого года разделить на 52 недели и не допускать перерасход этой суммы.

Следующий шаг – это распоряжение нераспределенным доходом.

Для эффективного использования сложившейся ситуации, предприятие может получать рекордную доходность от инвестиционной деятельности. Искусственный интеллект служит инструментом успешных финансовых стратегий. Тесное взаимодействие банков и их клиентов в данных условиях может положительно влиять на их развитие.

Согласно мнению Китайской банковской ассоциации и ведущих университетов, финансовая отрасль усиленно наращивает в области управления цифровым капиталом. Использование финансовых технологий может помочь в инновационном маркетинге за