INDOTECH
INDONESIAN JOURNAL OF EDUCATION AND COMPUTER SCIENCE

INDOTECH
Indonesian Journal of Education And Computer Science

Vol. 1, No. 2, Agustus 2023 Hal 48-55	E-ISSN : 2987-2650 P-ISSN : 2987-7644

Site : https://jurnal.intekom.id/index.php/indotech

Application of the Learning Vector Algorithm Quantization On Smart Barcodes

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Article Info

Article history:

Received August 15, 2023
Revised August 15, 2023
Accepted August 24, 2023

Kata Kunci:

Algoritma LVQ,
Barcode Cerdas,
Efisiensi,
Akurasi,

Keywords:

LVQ Algorithm,
Smart Barcodes,
Efficiency,
accuracy,

ABSTRAK

Penerapan algoritma *Learning Vector Quantization (LVQ)* pada barcode cerdas memiliki tujuan untuk meningkatkan efisiensi dan akurasi dalam pengenalan serta pelacakan data barang. Dalam konteks ini, barcode berfungsi sebagai representasi visual yang mengandung informasi penting tentang produk. Algoritma *LVQ* digunakan untuk mengoptimalkan proses klasifikasi dan pencocokan data *barcode* dengan referensi yang tepat. Melalui pelatihan berulang, algoritma ini mengadaptasi vektor pembelajaran untuk mengenali variasi *barcode* dengan lebih baik. Dalam penelitian ini, peneliti menganalisis dampak penerapan algoritma LVQ pada sistem barcode cerdas dalam hal akurasi identifikasi, efisiensi komputasi, dan kemampuan beradaptasi terhadap perubahan. Hasil eksperimen menunjukkan penerapan barcode pada sistem inventory barang membawa manfaat yang signifikan dalam pengelolaan stok dan efisiensi bisnis secara keseluruhan. Dengan pemanfaatan teknologi barcode, proses pelacakan dan pencatatan data produk menjadi lebih cepat, akurat, dan terotomatisasi. Penggunaan barcode meminimalkan kesalahan manusia, mengoptimalkan waktu, dan mengurangi biaya operasional. Dengan menggabungkan kecerdasan algoritma LVQ dan potensi barcode, penelitian ini mengilustrasikan perkembangan penting dalam domain integrasi teknologi untuk pengembangan sistem yang lebih canggih dan efektif.

ABSTRACT

The implementation of the Learning Vector Quantization (LVQ) algorithm on smart barcodes aims to enhance efficiency and accuracy in recognizing and tracking product data. In this context, barcodes serve as visual representations containing crucial product information. The LVQ algorithm is employed to optimize the classification and matching processes of barcode data with precise references. Through repeated training, this algorithm adapts learning vectors to better recognize barcode variations. In this study, researchers analyze the impact of LVQ algorithm implementation on smart barcode systems concerning identification accuracy, computational efficiency, and adaptability to changes. Experimental results demonstrate the significant benefits of applying barcodes to inventory systems in overall stock management and business efficiency. By utilizing barcode technology, the processes of tracking and recording product data become faster, more accurate, and automated. Barcode usage minimizes human errors, optimizes time, and reduces operational costs. By combining the intelligence of the LVQ algorithm with the potential of barcodes, this research illustrates a crucial advancement in the technology integration domain for the development of more sophisticated and effective systems.

E-ISSN : 2987-2650
P-ISSN : 2987-7644

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1. INTRODUCTION

The use of technology in an organization can increase the transparency and efficiency of a business that we do [1]. We have to realise that the ability of technology is very helpful to human work such as being able to reduce errors, improve precision, optimize efficiency, and also be able to speed up communication [2]. Many large and small companies often have trouble choosing strategies using the right technology to use in companies. This happens to employees who are unskilled or unfamiliar with the barcode system. Then the employees must be able to use the bar code system. If the employees cannot accept the technology, then the results or benefits of the technology that will be achieved will never be realized [4]. However, there is a solution to the problem, namely the barcode system. Barcode systems are now widely used to increase productivity and minimize human error in deposition. It's common for goods that are produced and distributed around the world to have a unique barcode, but in conventional barcodes, the information that can be stored is limited to that unique code. This creates a number of obstacles such as the difficulty of tracking goods, recording stocks, and ensuring the authenticity of goods. Intelligent barcodes can store additional information in addition to unique codes, such as serial numbers, expiry dates, production information, and photos of goods. For example, on a smart barcode used for tracking pharmaceutical products, information about origin, expiration dates, and batch numbers can be stored in a barcode. However, in order to produce a good efficiency of the production process using a barcode system, it is necessary to design an adequate working system [6].

In developing intelligent barcode technology, an algorithm is needed that can recognize and process additional information stored in a barcode. Learning Vector Quantization (LVQ) is one of the methods that can be used to design barcode identification using the learning vector quantizations method. Learning vector quantitations are a method of classifying patterns in which each output represents a specific category or class [7]. In addition, the LVQ algorithm is one of the classification algoritms that is able to recognize and imitate a specified input output [8]. In the smart barcode context, the LVQ algorithm can be used to classify additional information stored in the barcode [9]. Therefore, research on the application of LVQ algorithms to smart barcodes is very relevant to do. The Learning Vector Quantization (LVQ) algorithm aims to find the appropriate weight value for the grouping of vectors into the target class that was initialized at the time of the formation of the LVQ network. While the test algority is to calculate the output value (vector class) that is closest to the input vector, or can also be equated with the process of classifying (decomposition) [10].

Based on the above description, a smart barcode design needs to be built to store additional information besides the unique code, such as serial number, expiry date, production information, and photo of goods. The system is equipped with scanning and printing barcodes for each item, making it easier to check each item. The steps taken in the development of this system are the analysis of system needs, the design of the system, implementation and testing [11].

2. METHOD

The Learning Vector Quantization (LVQ) algorithm aims to find the appropriate weight value for the grouping of vectors into the target class that was initialized at the time of formation of the LVQ network. While the testing algoritm is to calculate the output value (vector class) that is closest to the input vector, or can also be equated with the classification process [12]. Explanations that can be used are as follows:
x : training vector (input) (x1,......,xi,.....,xn)
T : the correct category or class for training vectors
Wj : vector weight for the output unit j (w1j,......,wij,.......,wnj)
Cj : category or grade shown by the outputs unit j
| |-x-wj | | : euclidean distance between the input vector and the weight of the vector for output layer j
Following are the learning algorithms LVQ :
Step 0 : initialization of the reference vector ; initialisation of learning rating α (0)
Step 1 : when the stop condition is false, do step 2 to 6
Step 2 : for each training input vector x do step 3 – 4
Step 3 : tick up to | -x - wj | Minimum
Step 4 : perbar wjui as following :
If T = Cj, then
Wj(new) = Wj (old) + α[x-wj(old)];
if T ≠ Cj, then
WJ(New) =Wj(long) – α[x-wJ(old));
Step 5 : Less rating
Step 6 : Stop condition test: condition that may set a fixed number of iterations or learning ratings to reach sufficiently small values. After the learning process LVQ eat the next step that will be done is the process of taking output Learning Vector Quantization. Data collection is done only on the test process. Basically, this phase only enters the final weight input and then finds the nearest distance with the closest distance calculation.

2.1 Flowchart

As for the process design that will be built in the development of smart barcode applications with the learning algorithm vector quantization will have the flowchart as follows:

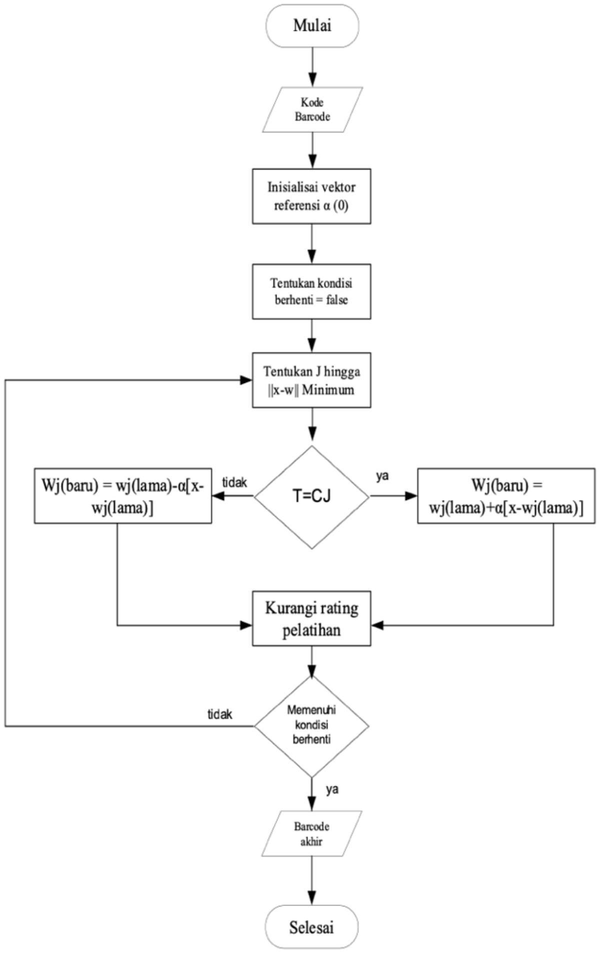

Figure 1. Flowchart System

2.2 Activity Diagran Input Barcode

The activity diagram starts with the first step, "Barcode Builder". At this stage, the steps to be taken are to design the barcode structure, determine the type of barcode to be used, and generate the code to be represented in a barcode. Then, the next step is "Encoding Data", in which the data that you want to represent in a Barcode is converted into a format that corresponds to the types of barcodes used. After the encoding process, the following step is to "Printing Barcode". In this phase, the generated barcode is printed on the appropriate media, such as a label or paper, using the correct barcode printer device. This printing process should ensure that the bar code is printable in good quality so that it can be read well at the time of scanning. Once the barcode has been printed, the next step is "Distribution of barcode". At this stage, the printed and ready-to-use barcode is distributed to places that require it, such as stores, warehouses, or factories. Such barcodes can be used to identify and track relevant products, inventories, or other objects. Here's the Activity Diagram User input barcode designed.

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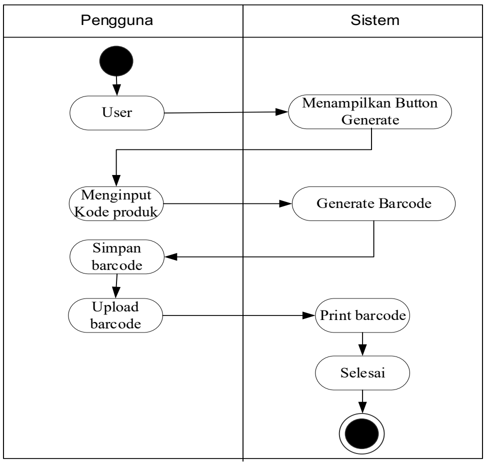

Figure 2. Activity Diagram input Barcode

3. RESULTS AND DISCUSSION

The results of the program's testing showed satisfactory performance in the identification and storage of product data. Using the learning algorithm vector quantization, the program can recognize and differentiate each product based on the information contained in the intelligent barcode. The ability of this program to store product photos also helps users to more easily identify items with clear visual. In testing, the intelligent barcode program has also proven to work quickly and efficiently in processing data, thus allowing users to carry out inventories in real time without experiencing significant impediments. The accuracy of the data stored in this smart barcode is also guaranteed, thus minimizing errors in product stock management.

In addition, the program is equipped with an intuitive and easy-to-use interface, making it easier for store officers or wholesalers to interact with the system. With a simple and informative interface, users can easily add or remove product data, as well as update information related to stock and expiration dates. Although this smart barcode program shows positive results, we are also aware that there are still some potential improvements to be developed in the future. Further development could focus on improving the speed and efficiency of barcode recognition processes, optimizing memory usage, and integrating with wider inventory management systems. Overall, the application of vector quantization learning algorithms to this intelligent barcode program is promising and has great potential in supporting wholesale or mini-market inventories management. With this program, it is expected that product inventory management will be more efficient and accurate, as well as assisting users in making the right decisions about supply management.

3.1 Form View

The program interface has a primary form that displays the GUI elements relevant to product stock management using barcodes. This primary format contains various components such as buttons to access application features, DataGridView to display product data, labels to display current product information, and PictureBox to display related product photos. The interface view can be seen in the image below:

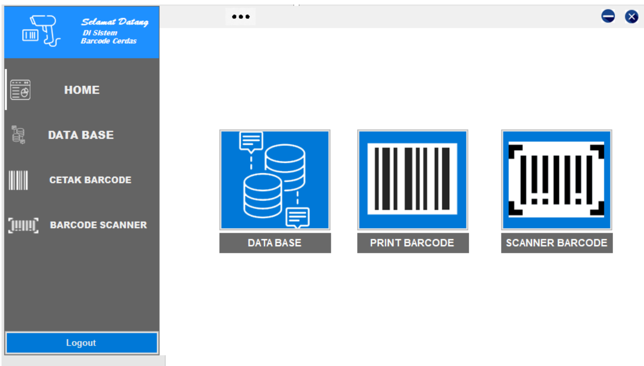

Figure 3. Main form display

3.2 Database View

The interface on this part of the program has a form that displays the GUI elements that are relevant to the management of product stocks using barcodes. This main form contains various components such as input of product code, product name, production date, expiration date, DataGridView to display product data, and PictureBox to display related product photos. The interface view can be seen in the image below:

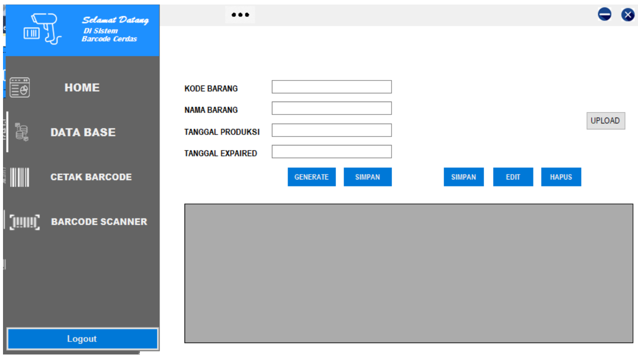

Figure 4. Database View

3.3 Barcode Print Display

The interface on this part of the program has a form that displays the elements of the GUI used to print barcodes in a large amount, just by entering the barcode you want to print.

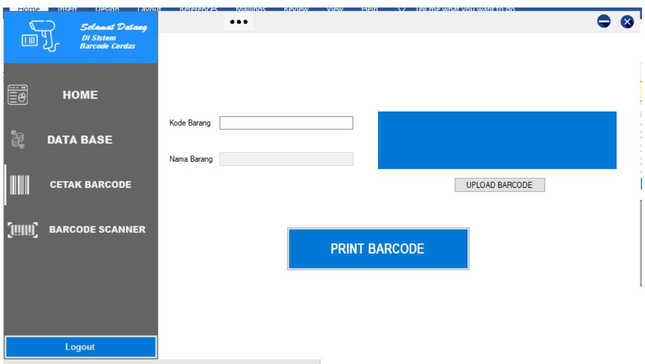

Figure 5. Barcode print display

3.4 Barcode Scanner Display

The interface on this part of the program has a form that displays the GUI elements that are used to see if the barcodes that have been created match the ones that are in the database system.

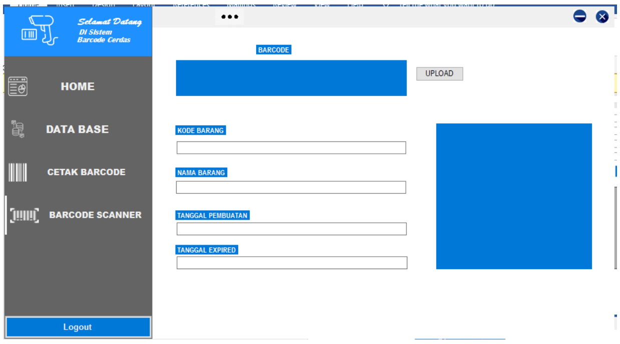

Figure 6. Barcode Display

The implementation of the LVQ balgorithm on the Intelligent Barcode system has brought a significant transformation in the efficiency and accuracy of stock management. By leveraging smart barcode technology, the process of tracking and recording product data is faster and easier. Each item is labeled with a unique barcode that contains key information, such as product code, name, photo, production date and expiration date, just scan the barcode with a dedicated scanner, and the data will be directly accessed and updated in a centralized database. This reduces the potential for human error and saves the time and effort that is usually needed in manual recording.

With the application of LVQ algorithms to intelligent barcode systems, pickup or delivery errors can be minimized, creating greater efficiency in the supply chain. Overall, barcode technology has improved accuracy, speed, and overall control in inventory management, bringing significant benefits to in increasing productivity and customer satisfaction.

4. CONCLUSION

Implementation of the barcode application to the goods inventory system brings significant benefits in stock management and overall business efficiency. With the use of barcode technology, the process of tracking and recording product data is faster, more accurate, and more automated. Using barcode minimizes human error, optimizes time, and reduces operating costs. An easily generated stock report provides a better insight into product availability, turnover, and profitability. In addition, enhanced mobility and visibility capabilities help stock managers access data anywhere and anytime, improving responsiveness and efficiency in decision-making.

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