

A Novel Logo-Based Document Retrieval Using Hybrid Fuzzy Based CSA

Raveendra K, T. Karthikeyan, Vinothkanna Rajendran, PVN Reddy

Abstract: Logo based document analysis plays an important role in many organizations for collecting information from massive number of administrative documents so that it can be summarized easily. Many researches are going on for improving the excellence of system, but the issues increase as the logos are similar to each other with minor differences. Conventional methods would not suitable for such complex process of identifying exact match so optimized models plays a vital role in this process. Cuckoo search algorithm is used in many cluster-based applications and it provides better convergence results than other optimization models. This proposed research model uses hybrid cuckoo search algorithm using global search procedure for enhancing its performance in analysing the logo-based document retrieval from the data set and proves its effectiveness in terms of fitness function and classification accuracy.

Index Terms: Hybrid Cuckoo Search Algorithm (HCSA), Global Search, Deep Learning Neural Networks (DLNN), Ant Colony Metaheuristic, Ant Colony Optimization (ACO).

I. INTRODUCTION

Implementation of digital mailrooms is common now a days in public and private organizations to improve the efficiency of workflows and also it reduces the human burden in sorting such documents as a separate process. Administrative documents such as forms, invoices, monthly and weekly reports and other mail related documents are need to be summarized to maintain a sustainable continuity of the workflow and also it will increase the response to the query placed to the organization. Managing large set of documents and retrieving the same is performed in conventional system using the serial number and company name and this process doesn't cover the organize process. Since the system will collect data from the data base based on these two factors so that chances of missing important or relevant data is possible in such models. Over the decade many applications are developed in sorting such documents so that finding data from such document and obtaining relevant information will be easier particularly identifying the correct document in the database is performed through indexing is the conventional model in practice for document extraction process. With advancement of technologies automatic indexing in the

digital mailrooms performs automatic classification and an easy access to data in future. Using textual information in indexing the documents is a common practice used based on the context information and other distinct features. Apart from indexing and textual information the many features such as stamps, logos, barcodes refer to corresponding organizations are used in sorting of documents. In this logo-based logo-based document retrieval system is evolved in data management system performs better than conventional search process. Manual identification of logo is a tedious task as the organization grows day by day with increased documents. Facilitating such documents based on the logo needs an automatic system which must be reliable and appropriate. Since the logo is a mixture of text, graphics and complex symbols. In digital transmission the noise degradation also involves and reduces the quality of logo so detecting and organizing such logo needs more accurate system. Figure 1 depicts the different types of logos and is categorized into graphical logo, textual logo and combination of these two.



Figure 1 Different types of logos: (a) A graphical logo, (b) a textual logo, and (c) Combination of text and graphics

In the recognition process the features and logo characteristics are considered and it is categorized into groups as statistical logo and structural logo recognition. The statistical logo recognition model used geometric and statistical information to obtain the relationship between the documents. While graphical model used sub graph matching process to match the relevant documents. SIFT, shape context approaches are one among them which uses inter relation features to define the characters of the logo.

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Based on the features these representations are further divided into local and global and in that based on the input domain features are summarized in local mode and in global model a set of pixels in the document is considered for recognition.

II. RELATED WORKS

A short survey has been made to identify the issues in existing document retrieval systems and it is noted that the research in this domain increases day by day. The researches in the document retrieval model starts with indexing and then using the distinct logo the retrieval is performed now a days. In some organizations seal which is used for identifying the document from the data base. *Matteo Cristani.et.al.*, discussed about the future document management system and its needs as well as the issues present in retrieval process. The literature describes about the various opportunities in research for enhancing the document management system in terms of automatic system. *Alireza Alaei.et.al.*, provided a survey work on discussing various logo and seal-based document retrieval models in his research work. The highlights in the survey discusses about the classification models based on machine learning and other optimization model presently available for retrieval process. *Simone Bianco.et.al.*, and *Nabin Sharma.et.al.*, reports about the issues present in existing document retrieval models and the solution for the issues using deep learning neural networks. Since common retrieval model lags in performance while graphical logo is used in the retrieval process and neural network-based system achieves better classification and detection rates. *Umesh D. Dixit.et.al.*, and *Sina Hassanzadeh.et.al.*, proposed a document retrieval process using singular value decomposition features. By selecting the features in the logo this retrieval model performs the detection process.

III. PROPOSED MODEL

Proposed model is obtained based on the basic characteristics in cuckoo search optimization along with the fuzzy logic as a hybrid model in document retrieval using logo. The mathematical model starts from cuckoo basic fitness function and also the implementation of fuzzy logic at necessary conditions. This fuzzy based cuckoo search algorithm uses uniform binary pattern which is similar to the nests in the cuckoo algorithm which is selected for next generations. The membership function is used in CSA to minimize the fitness function and features dimensionality in the local and global descriptors. The selected binary patterns used in fuzzy based CSA similar to the breeding behaviour of cuckoo and in solving nonlinear optimization this model is applied. The process starts from cuckoo bird search suitable nest for laying eggs in other bird nest for survival and it places one egg at a time in each nest. Eggs having high quality and lifetime survive gets into next generation. Since the process is related to probability as the eggs is identified by the host bird then it breaks by removing from the nest. So, cuckoo has to search the suitable best environment and this fuzzy based model uses this metaheuristic model as formulation to find the optimal solution.

Step 1: obtain the feature vectors for the document and logo and each solution is represented by the D-dimensional vector.

Based on this egg laying radius the optimized area is defined for an array and the one-dimensional optimization for current position is defined as

$$CP_i = (E_1, E_2, E_3 \dots \dots E_N) \quad (1)$$

Step 2: Generate the Core Population of N Features of the Host Nest randomly to get the solutions.

The evaluation process of the present position and the survival percentage is obtained based on the profit function and it is given as

$$PF = F_p(CP_i) = F_p(E_1, E_2, E_3 \dots \dots E_N) \quad (2)$$

The egg laying radius is defined as

$$\text{Egg Laying Radius} = \delta \times \frac{\text{Number of Current eggs}}{\text{Total Number of Eggs}} \times i_{\text{High}} - i_{\text{low}} \quad (3)$$

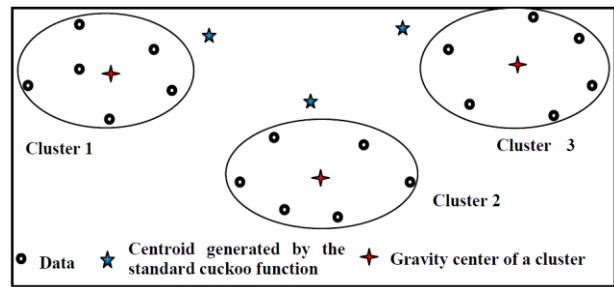


Figure 2 local search Process in CSA

Step 3: Select the ith Specific Nest Position Features and Choose the Best Local Position from Current Solution

In the hybrid model the step size is not fixed value since the object is a moving object and based on the assumption the final value is fixed after finding the good solution for the problem. The value is determined as follows

$$\rho = \begin{cases} \rho_{il} + (i_{\text{High}} - i_{\text{low}}) \frac{F_p \leq F_{\text{avg}}}{F_{\text{avg}} \leq F_{\text{min}}} \\ \frac{\rho_{ih}}{\sqrt{x}} \end{cases} \quad (4)$$

Where ρ_{il} is the minimum step size and the ρ_{ih} is the maximum step size.

Step 4: Calculating the Step Size

In random walk, step size for distribution function is formulated as follows

$$PF_{i,g+1} = PF_{i,g} + \beta \oplus \text{levy}(\rho) \quad (5)$$

Where β is step size which is relevant to problem scales and entry wise multiplication for large steps is give as

$$\text{levy}(\alpha\rho) \sim x = t^{1-\rho}, 0 < \rho < 1 \quad (6)$$

For searching new locations cuckoo search algorithm uses LFRW for obtaining optimum solution and new solution is obtained from equation (6.4)

$$H_{i,g+1} = H_{i,g} + \rho_0 \times \frac{\varphi \times x}{\|u\|^{\frac{1}{\alpha}}} \times (H_{i,g} - H_{\text{best}}) \quad (7)$$

Where β_0 is factor and generally its value are is 0.01 and N_{best} represents the best solution obtained.

Step 5: calculating fitness function

Once Cuckoo Selects the Nest Features, then Evaluate the Egg Laid by a Cuckoo using Fitness Function and it is given as

$$\rho = \left(\frac{(1+\rho) \times \sin(\pi \times \rho) / 2}{(1+\rho) / 2 \times \rho \times 2^{(1-\rho) / \alpha}} \right)^{1/\rho} \quad (8)$$

Where α a constant and its values is are in the range of 1 to 1.5. figure 2 gives the illustration of proposed Hybrid cuckoo search model for logo-based document retrieval. The process starts from providing logo as input to the query station and the system pre-process the logo and removes the noise and selects the suitable features and by analysing logo based on fuzzy logic and optimize the selection process using cuckoo search algorithm. The process continues by selecting similar document from the data base and organize for the user. Figure 2 gives the illustration of proposed Hybrid model for logo-based document retrieval.

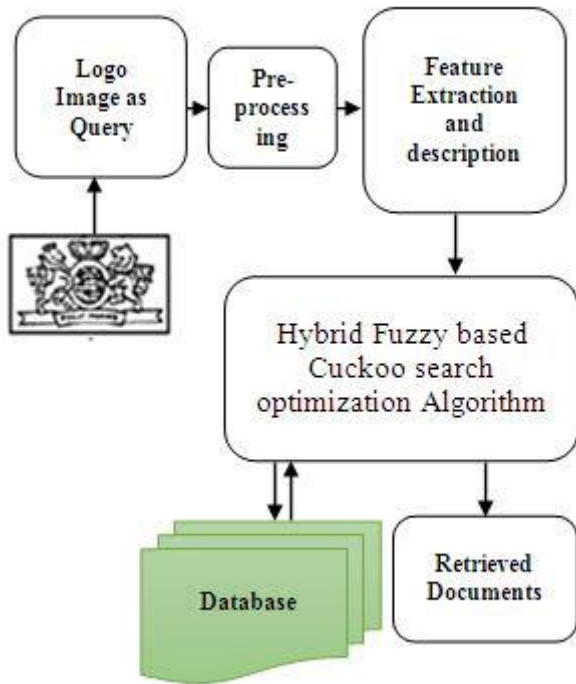


Figure 3 Proposed Model for Document Retrieval

Pseudocode for proposed Hybrid Cuckoo Search Algorithm

Set the initial parameters:

- Probability of worst Nest W_n
- Number of Host Nest H_n
- Population N

for $i = 1$ to N do

Generate probability for selection of good nest.
Use fuzzy to initialize the population of improved cuckoo search.
end for

$N * H_n$ represents the total number of initial solutions.

Evaluate the fitness of solutions by using fuzzy fitness function to maximize the variance of inter Nest probability to obtain the best solution.

while $t < \text{Max Generation}$ do

Create N new solutions using improved cuckoo search.

The fitness of the N new solutions is calculated.

Compare new and old solution.

if the new solution is better then

Replace the old one by the new solution.




end if

Replace for worse solutions, by new solutions.
Perform the comparison between these solutions and old one to get the best solution.
end while
Print the best solution and its fitness

IV. RESULT AND DISCUSSION

The proposed logo-based document retrieval model using hybrid fuzzy based cuckoo search algorithm is experimented in MATLAB 14.1 with different logo sets and its retrieval process in the data set. To obtain the best pair for the input the data set from Maryland university is used and it consists of 30 numbers of text logo and 10 numbers of text and graphical mixed logo and the entire data set consists of 110 images. During the retrieval process a query image is used as an input in order to retrieve the similar documents in the database. The selection and classification are performed based on the hybrid algorithm and table 1 gives the detection rate of proposed model with existing models.

Table 1 Comparison of Logo Detection Rate

Logo Type	No. of Documents	Detection Ratio		
		HSVDM-DLNN (BPNN)	HACO	HCSA
	60	93	94	95
	80	86	92	94
	90	89	93	95

From Figure 4 and tabulation 2, it is obvious that the proposed hybrid algorithm has better convergence behaviour of fitness function for the given data set. Thus, the performance is accurate and it is higher than the existing BPNN model and HACO model.

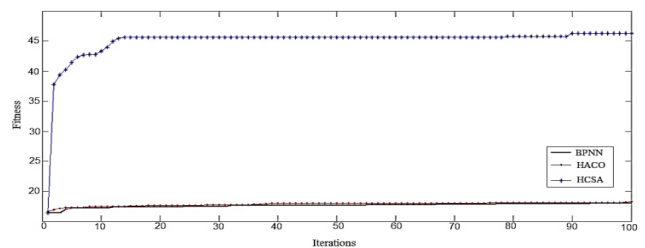


Figure 4 fitness function of proposed model for data set

Figure 5 gives the comparison for three models document retrieval ratio as its efficiency level and it is observed that the proposed model is compared with BPNN model and HACO. The results high lights that the proposed hybrid CSA model has better percentage in terms of efficiency. A data from sample is given as input to all the three algorithms and the proposed model retrieves documents exactly from the entire database.



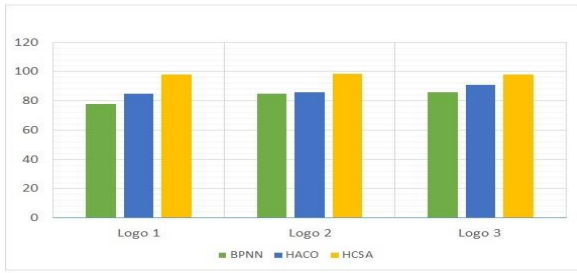


Figure 5 efficiency comparison of proposed model

The performance metrics of proposed model is calculated based on the parameters such as computation time, error convergence, accuracy and efficiency. It is depicted in table 2 and it is observed that the proposed model has better efficiency and detection rate efficiency in terms of 96.87% and 98.44% respectively which is better than ACO model.

Table 2 performance comparison of proposed model

S.NO	Parameter	BPNN	ACO model	Proposed HCSA model
1	Computation time	35sec	30sec	25sec
2	Error convergence	0.00013	0.0000012	0.000001
3	Accuracy	92.14%	95.86%	96.87%
4	Efficiency	94.21%	97.67%	98.44%

Figure 6 gives the comparison of accuracy ratio for the proposed model with BPNN and HACO model and it is observed that proposed HCSA model achieves better accuracy ratio of 96.87%.

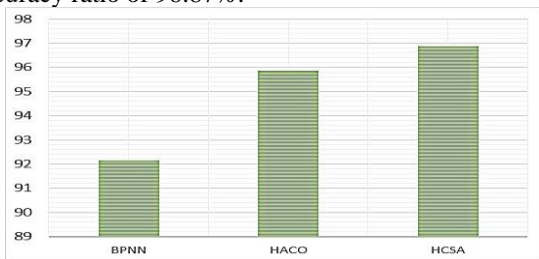


Figure 6 Accuracy Comparison of proposed model

V. CONCLUSION

This research model is experimented based on hybrid fuzzy based cuckoo search algorithm for extraction of documents from the database using their logo as input. existing deep learning and HACO models are used to compare the efficiency and accuracy of proposed model and it could be seen that proposed nature inspired hybrid model has better classification and detection accuracy with an efficiency percentage of 98.44 and accuracy of 96.87%. This mechanism aids in providing efficient document retrieval system to the large-scale organizations. Future work could be focused on improving the efficiency by for combining different data sets and multiple features.

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