Cuckoo Search Algorithm for Speech Recognition

Madhumita Dash, Ricky Mohanty

Abstract: Cuckoo search is one of the recent optimization algorithms in the league of nature based algorithm whose results are better than the PSO and ACO optimization algorithms. This paper is based on Cuckoo Search or Cuckoo Algorithm. Cuckoo Search (CS) is heuristic search algorithm which is inspired by the reproduction strategy of cuckoos. Cuckoo search algorithm via Lévy flights by Xin-She Yang and Saush Deb for optimizing a nonlinear function uses generation of random numbers with symmetric Lévy distribution obtained by Mantegna's algorithm. The applications of Cuckoo includes optimizing weights of neural networks, parameters of Support vector machines and Radial basis function, job scheduling, finding optimal cluster head in wireless sensor networks, finding shortest path and clustering and is aimed to understand the breeding behaviour of the cuckoo bird. In this research, it is applied in the field of Speaker Recognition systems and voice. Thus by applying this algorithm, the process of Speaker Recognition is optimized by a fitness function by matching of voices being done on only the extracted optimized features produced by the Cuckoo Search algorithm.

Keywords: Cuckoo Search, Levy flights, Feature extraction, Pattern matching.

1 INTRODUCTION

Today's world sees a lot of changes being done. These are a result of some modification or some innovation. During last few years, many nature inspired evolutionary algorithms have been developed for optimization. Various techniques are used to minimise the constraints associated with the problem in order to obtain a global optimum solution. The research is being done in the field of Swarm Intelligence or SI which deals with studying the behavior of organisms or swarms.

Mrs. Madhumita Dash, Professor, EN & TC, Orissa engineering College, Bhubaneswar, Odisha, India. Mobile No 9437158813

Mrs. Ricky Mohanty, Asst. Professor, EN & TC, Orissa engineering College, Bhubaneswar, Odisha, India. Mobile No. 9439062532

Swarms are individual entities which are working on their own, yet their combined or aggregate behaviour yields some great results. When the behaviour is understood it is then converted in the form of an algorithm. This algorithm not only studies the behaviour of the organisms like fish, ants, bees, cuckoo bird or something like water drops but also provides some principles which can help in providing solutions to real world applications .These algorithms work on the basis of random search in some suitable search region depending on the problem. Though it is a random search, it is not truly random because there is a mechanism in the algorithm which guides the search in such a manner that the solution vector gets improved step by step. Two crucial characteristics of these modern meta-heuristics are intensification (exploitation) and diversification (exploration).

2 CUCKOO SEARCH ALGORITHM (CSA)

Cuckoos are attractive birds. The attractiveness is owing to the beautiful sounds produced by them and also due to their reproduction approach which proves to be combative in nature. These birds are referred to as brood parasites as they lay their eggs in communal nests. They remove the eggs in the host bird nest in order to increase the hatching probability of their own eggs. There are three types of brood parasites - the intraspecific brood parasite, cooperation breed and nest take over type. The host bird involves in direct combat with the encroaching cuckoo bird. If the host bird discovers the presence of an alien egg, it either throws away the egg or deserts the nest. Some birds are so specialized that they have the characteristic of mimicking the colour and the pattern of the egg which reduces the chances of the egg being left out thereby increasing their productivity [7]. The timely sense of egg laying of cuckoo is quite interesting. Parasitic cuckoo birds are in search of host bird nests which have just laid their own eggs. In general the cuckoo birds lay their eggs earlier than the host bird's eggs in order to create space for their own eggs and also to ensure that a large part of the host bird feed is received by their chicks.CSA is one of the modern nature inspired meta-heuristic algorithms. The

ISSN: 2278 – 1323

Greek terms "meta" and "heuristic" refer to "change" and "discovery oriented by trial and error" respectively. CS algorithm is based on the obligate brood parasitic behavior of some cuckoo species in combination with the Levy flight behaviour of some birds and fruit flies. Some species of Cuckoo birds lay their eggs in communal nests. If a host bird discovers the eggs are not their own, they will either throw these alien eggs away or simply abandon its nest and build a new nest elsewhere.

CS can be described using following three idealized rules:

a) Each cuckoo lays one egg at a time, and dumps its egg in randomly chosen nest;
b) The best nests with high quality of eggs will carry over to the next generations;
c) The number of available host nests is fixed, and the egg laid by a cuckoo is discovered by
the hosts birth a probability pa Є [0, 1].

3 PRINCIPLE BEHIND CUCKOO SEARCH ALGORITHM

Each cuckoo bird lays a single egg at a time which is discarded into a randomly chosen nest. The optimum nest with great quality eggs is carried over to next generations. The number of host nests is static and a host can find an alien egg with a probability (Pa) [0, 1], whose presence leads to either throwing away of the egg or abandoning the nest by the host bird [8].
One has to note that each egg in a nest represents a solution and a cuckoo egg represents a new solution where the objective is to replace the weaker fitness solution by a new solution.

The flowchart for CSA is as shown which involves the following steps:
Step (1) - Introduce a random population of n host nests, Xi .
Step (2) - Obtain a cuckoo randomly by Levy flight behaviour, i.
Step (3) - Calculate its fitness function, Fi .
Step (4) - Select a nest randomly among the host nests say j and calculate its fitness, Fj .
Step (5) - If Fi < Fj , then replace j by new solution else let j be the solution.
Step (6) - Leave a fraction of Pa of the worst nest by building new ones at new locations using Levy flights.
Step (7) - Keep the current optimum nest, Go to Step (2) if T (Current Iteration) < MI (Maximum Iteration).
Step (8) - Find the optimum solution.

the alien egg, as a result of which it may throw the egg or forsake the nest.

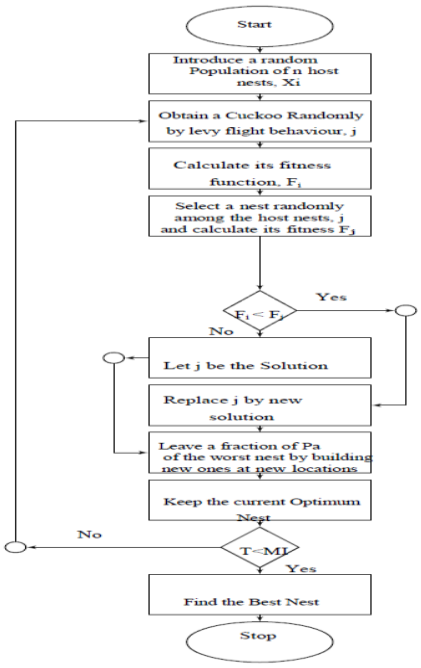


Fig.1 Flow Chart of Cuckoo Search Algorithm

Important Stages involved in CSA are:
i) Initialization: Introduce a random population of n host nest (Xi = 1, 2, 3...n).
ii) Levy Flight Behaviour: Obtain a cuckoo by Levy flight behaviour equation which is defined as follows:

$$Xi\ (t + 1) = Xi\ (t) + \alpha \oplus Levy\ (\lambda),\ \alpha > 0 \quad (1)$$

$$Levy\ (\lambda) = t\ (-\lambda),\ 1 < \lambda < 3 \quad (2)$$

iii) Fitness Calculation: Calculate the fitness using the fit- ness function in order to obtain an optimum solution. Select a random nest, let us say j. Then the fitness of the cuckoo egg (new solution) is compared with the fitness of the host eggs (solutions) present in the nest. If the value of the fitness function of the cuckoo egg is less than or equal to the fitness function value of the randomly chosen nest then the randomly chosen nest (j) is replaced by the new solution.
Fitness Function = Current Best Solution – Previous Best Solution (3)
Since the Fitness function = Current best solution - Previous best solution, the value of the fitness function approaching the value zero means that the deviation between solutions decreases due to increase in the number of iterations.
The conclusion is that if the cuckoo egg is similar to a normal egg it is hard for the host bird to differentiate between the eggs. The fitness is difference in solutions [10] and the new solution is replaced by the randomly chosen nest. Otherwise when the fitness of the cuckoo egg is greater than the randomly chosen nest, the host bird recognizes

iv) Termination:

ISSN: 2278 – 1323

In the current iteration the solution is compared and the best solution is only passed further which is done by the fitness function. If the number of iterations is less than the maximum then it keeps the best nest. After the execution of the initialization process, the levy flight and the fitness calculation processes, all cuckoo birds are prepared for their next actions. The CSA will terminate after maximum iterations [MI], have been reached.

These steps can be matched any optimization problem. Each cuckoo egg and cuckoo nest plays an important role in such problems. Therefore as per this algorithm: a)Egg in a Nest b)Solution or the Available Voice Samples Cuckoo Egg c)New Solution or the Voice Sample to be matched Each Nest d) One Egg, One Solution or Features of Voice Samples

3.1 *Steps of Speaker Recognition using Cuckoo Search Algorithm*

The following steps will elaborate how a speaker is verified using Cuckoo Search algorithm.

$$i>0.3 \;||\; i<-0.3 \qquad (1)$$

where i = voice sample or values in it
The signal values in this range are selected. The optimized or the best features will be fetched from these values. Cuckoo Search will reduce the number of these extracted features to get the best available features from this voice. The best features are selected as per a Fitness Function. This Fitness Function is based on mean. From every voice the mean is calculated and it is subtracted from each value of that sample. This will fetch the required best values from each voice sample. The required features thus extracted are stored in the database and will be used for speaker recognition. Hence, this Fitness Function is providing the required optimization.

The following formula is used:

$$FF = a_i - (\Sigma N\ i=1\ a_i/N) \qquad (2)$$

Where FF = Fitness Function
a = Voice Signal
as described above. Match above the threshold will be accepted. The matched voice will have a high correlation otherwise a low value below the threshold is neglected; hence the speaker is not allowed the access. In this research text dependent speaker recognition is used, in which the enrolment and test security codes are same [4]. The following This begins by inputting a voice sample and following the steps as shown to recognize or authenticate a speaker as:

i) Voice Recording

In this the speaker speaks and his voice is recorded for either feature matching or feature extraction. This voice sample if matches with the already existing voice samples, then the speaker will be authenticated.

ii) Feature Extraction

As Cuckoo Search will work on only few best features, so there is a need to initially extract the features from the voices. In this step the features will be extracted from the inputted voice. This voice pattern will be in the form of spectrograms consisting of various frequencies as per time.
For feature extraction, the unwanted signal as voice or other disturbances have to be removed as these will create hindrance in the next process. Hence, for this purpose a threshold value is used which will extract only the voice signal and therefore neglecting the other induce unwanted signal.

The following formula is used:
N= Total values in the voice sample
a_i/N = Mean of Voice

iii) Pattern Matching

Till this step the system will not only be having the stored voice patterns, but also its extracted features. These extracted features will be matched with the inputted voice's features. For matching purpose, Correlation is used. The extracted features closest to the stored features will be the one that will be matched. To avoid the voice matching in all scenarios, even in case of un- authenticated speaker, a threshold value is used to increase security and to correctly authenticate or neglect a speaker. This threshold value specifies a likelihood ratio, which will signify the extent of match of speaker recognition

iv) Decision

Then the voice will either be accepted or rejected. Acceptance means that the speaker is authenticated as the voice is matched otherwise it will be rejected. This decision is taken as per correlation diagram explains the process of Text Independent Speaker Recognition using Cuckoo Search Algorithm.

Flowchart of Speaker Recognition using Cuckoo Search Algorithm The following diagram clearly explains the process of speaker recognition.

ISSN: 2278 – 1323

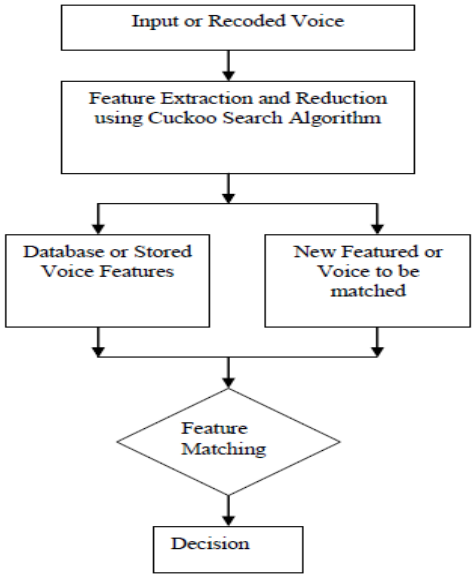


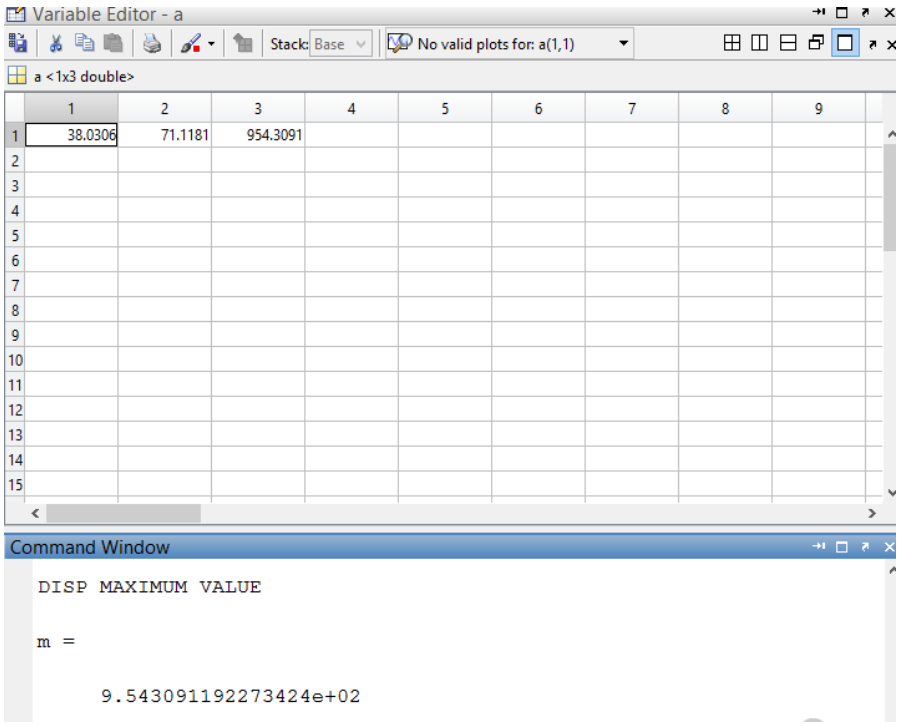
Fig. 2 Flow chart for Process of Speaker Recognition

3.2 Algorithm for Speaker Recognition using Cuckoo Search Algorithm

1) Input the voice for speaker recognition.
2) Extract features using threshold as described in the above section
3) Generate host nests n.
n= number of solutions or features extracted from the voice pattern.
4) Repeat while (j<MG)
i = loop variable MG = maximum generation ck = number of cuckoos or feature subset
(i) for (i=0; i<ck;i++)
a) Get a cuckoo and move it to nest. b) Choose a Fitness Function F if (Fi>Fm) Fm=Fi;
End for
(ii) Abandon the nest and build new ones or build new feature set. (iii) Keep the remaining solutions. (iv) Rank these as per F. (v) pass these to next generations or iterations.
Input or Recoded Voice
Feature Extraction and Reduction using Cuckoo Search Algorithm
Database or Stored Voice Features
Feature Matching
New Featured or Voice to be matched
Decision
5) Get the nest with best solution as per F.
6) This is the result or the best optimized features.
7) This optimized feature subset will be matched with the already stored best features and as per the correlation and threshold a speaker will be authenticated or recognized. Hence with these steps cuckoo search can recognize a speaker.

4 RESULTS

The system was tested for stored voices and then for voice input in real time. After the implementation it is very clear that a speaker is recognized only if his voice sample is already present in the database. As per the following snapshot, the maximum value is 9.54, so the voice will be matched with the third voice sample.



ISSN: 2278 – 1323

5 CONCLUSION

In this paper speaker recognition is optimized using Swarm Intelligence algorithm, Cuckoo Search. This algorithm will aim at finding and short listing the features from voice which can uniquely identify it. After feature extraction using a threshold to remove the unwanted signal or disturbance and considering only the voice sample, a Fitness Function is applied based on mean of the individual sample, which will fetch few unique and best features and will discard the remaining. As a result, there is no need to match a speaker's voice through all the features. To increase the security a threshold value is added to correlation in the matching phase. As only optimized features are extracted, so this will not only optimize this technique but will also save resources.

6 REFERENCES

[1] X.-S. Yang And S. Deb, "Cuckoo Search Via Levy
flights," In Proceedings Of The Nabic - World Congress On Nature & Biologically Inspired Computing, pp. 210–214, 2009

[2] 2D Giveki, H Salimi, GR Bahmanyar, Y Khademian ,Automatic detection of diabetes diagnosis using feature weighted support vector machines based on mutual information and modified cuckoo search, arXiv preprint arXiv:1201.2173, 2012 .

[3] Srishti, "Technique Based On Cuckoo's Search Algorithm For Exudates Detection In Diabetic Retinopathy", Ophthalmology Research: An International Journal Vol.2(1), pp.43-54, 2014, Article No. Or.2014.005.

[4] Miloš Madić, Miroslav Radovanović, Application Of Cuckoo Search Algorithm For Surface Roughness Optimization In Co 2 Laser Cutting. ,Annals of the Faculty of Engineering Hunedoara-International Journal of Engineering, Volume 11(1), 2013.

[5] Ivona Brajevic, Milan Tuba, Nebojsa Bacanin ,"Multilevel Image Thresholding Selection Based On The Cuckoo Search Algorithm*",*Advances in Sensors, Signals, Visualization, Imaging and Simulation, pp. 217-222, 2012.

[6] M. Prakash, R.Saranya, K. Rukmani Jothi And A. Vigneshwaran, "An Optimal Job Scheduling In Grid Using Cuckoo Algorithm",International Journal Of Computer Science And Telecommunications, Vol. 3(2), pp. 65-69, February 2012.

[7] Manian Dhivya, Murugesan Sundarambal, Loganathan Nithissh Anand , "Energy Efficient Computation Of Data Fusion In Wireless Sensor Networks Using Cuckoo Based Particle Approach (CBPA)", Int. J. Communications, Network And System Sciences, Vol.4, pp. 249-255, 2011.

[8] Koffka Khan & Ashok Sahai , "Neural-Based Cuckoo Search Of Employee Health And Safety (Hs)", I.J. Intelligent Systems And Applications, Vol.02, pp. 76-83, 2013.

[9] Walid Mohamed Aly, Hany Atef Kelleny, "Adaptation Of Cuckoo Search For Documents Clustering", International Journal Of Computer Applications, Vol.86(1), pp. 4-10, January 2014.

[10] Moe Moe Zaw And Ei Ei Mon, "Web Document Clustering Using Cuckoo Search Clustering Algorithm Based On Levy Flight", International Journal Of Innovation And Applied Studies Issn 2028-9324 Vol. 4(1), pp. 182-188, Sep. 2013.

[11] Kullawat Chaowanawatee, Apichat Heednacram, "Implementation Of Cuckoo Search In RBF Neural Network For Flood Forecasting", Fourth International Conference On Computational Intelligence, Communication Systems And Networks, pp. 22-26, 2012.

[12] Monica Sood, Gurline Kaur , "Speaker Recognition Based On Cuckoo Search Algorithm", International Journal Of Innovative Technology And Exploring Engineering (Ijitee) Vol. 2(5), pp.311-313, April 2013.

[13] Rui Tang, Simon Fong, Xin-She Yang, Suash Deb, "Integrating Nature-Inspired Optimization Algorithms To K-Means Clustering",ICDIM, pp. 116-123, 2012.

[14] Akajit Saelim, Suwanna Rasmequan, Pusit Kulkasem, Krisana Chinnasarn, Annupan Rodtook, "Migration Planning Using Modified Cuckoo Search Algorithm" , 13th International Symposium On Communications And Information Technologies (Iscit), pp. 621-626, 2013.

[15] Ehsan Valian, Shahram Mohanna And Saeed Tavakoli , "Improved Cuckoo Search Algorithm For Feedforward Neural Network Training", International Journal Of Artificial Intelligence & Applications (Ijaia), Vol.2(3), pp. 36-43, July 2011.

[16] S. Walton; O. Hassan, K. Morgan and M.R. Brown, "Modified Cuckoo Search : A new gradient free optimisation algorithm". Chaos, Solitons & Fractals. doi:10.1016/j.chaos.2011.06.004, 30 June 2011.

[17] D.Rodrigues, L.A.M. Pereira, A. N. Souza, C. C.Ramos, Xin-She Yan "Binary Cuckoo Search : A Binary Cuckoo Search Algorithm For Feature Selection", IEEE International Symposium on Circuits and Systems (ISCAS), pp. 465 - 468 ,2013.

[18]X. -S. Yang., S. Deb."Cuckoo search via LévyFlights",inProceedings of World Congress on Nature & Biologically Inspired Computing (NaBIC 2009), India, IEEE publications, USA, pp 210-214.

[19]http://cambridge.academia.edu/XinSheYang/Teaching

[20]http://people.unipmn.it/scalas/report1_eng.pdf

ISSN: 2278 – 1323

[21] H.Soneji., R. C.Sanghvi. "Towards the Improvement of Cuckoo Search Algorithm", in Proceedings of World Congress on Information and Communication Technologies (WICT), 2012, pp. 878-883.
[22]S. Walten., O. Hassan., K. Morgan., M. R. Brown. "Modified Cuckoo Search: A new Gradient Free
Optimization Algorithm", Chaos, Solitons and Fractals, Vol. 44, issue 9, pp. 710-718.
[23]H. Salimi., D. Giveki.,M.Settanshahi., J. Hatami. "Extended Mixture of MLP Experts by Hybrid of
Conjugate Gradient Method and Modified Cuckoo Search", International Journal of Artificial Intelligence & Applications (IJAIA), Vol. 3, No. 1, Jan. 2012, pp. 1-13.
[24]A. Kaveh., T. Bakshpoori."Optimum Design of Space Trusses using Cuckoo Search algorithm with Lévy Flights", IJST Transactions of Civil Engineering, Vol. 37, No. C1, pp. 1-15.
[25]A. R. Yildiz. "Cuckoo Search Algorithm for the Selection of Optimal Machining Parameters in Milling Operations", The International Journal of Advanced Manufacturing Technology, Vol. 64, issue 1-4, pp. 55-61.
[26] R. G. Babukartik and P. Dhavachelvan (2012) "Hybrid Algorithm using the advantage of ACO and Cuckoo Search for Job Scheduling", International Journal of Information Technology Convergence and Services (IJITCS) Vol.2, No. 4, August 2012.
[27] Vipinkumar Tiwari, "Face Recognition Based on Cuckoo Search Algorithm", Indian Journal of Computer Science and Engineering (IJCSE), June-July 2012.
[28] Xin-She Yang and Suash Deb, "Cuckoo Search via Levy Flights", In: Proc. Of World Congress son Nature & Biologically Inspired Computing (NaBIC 2009), December 2009, India. IEEE Publications, USA, pp. 210-214(2009).
[29] H.B. Kekre, Vaishali Kulkarni, Prashant Gaikar and Nishant Gupta, "Speaker Identification using Spectrograms of Varying Frame Sizes", International Journal of Computer Applications (0975-8887) Volume 50- No. 20, July 2012.

Dr **Madhumita Dash** completed her PhD(Engg) From Sambalpur University in 2007and ME From NIT Rkl. Presently She is working as Professor In Orissa Engineering College. He is a member of the ACM, IEEE, Fellow of IE , Fellow Of IETE,LM Of ISTE. Her research interests include distributed systems, data replication and Internet technologies in Orissa Engg. College, Bhubaneswar, India. Her major research interests include sensor networks, mobile communications, and Signal Processing. She is live member in Indian Society for Technical Education(ISTE).

Mrs. **Ricky Mohanty** received her M.tech degree from Biju Patnaik University of technology, Bhubaneswar, India, in 2010 and her B.E. degree in Electronics & Telecommunication from BPUT, BBSR, India in 2003 and now is Asst. professor in Orissa Engg. College, Bhubaneswar, India. Her major research interests include sensor networks, mobile communications, and Signal Processing. She is live member in Indian Society for Technical Education(ISTE).

ISSN: 2278 – 1323