The Systematic Survey of Algorithms for Semantic Segmentation of Agricultural Products

Ishani Mishra, M Dhivya, L Sowmya,
Nadendla Lakshmi Prasanna, H Umadevi and Manisha Prem

December 8, 2021

THE SYSTEMATIC SURVEY OF ALGORITHMS FOR SEMANTIC SEGMENTATION OF AGRICULTURAL PRODUCTS

Ishani Mishra
Senior Assistant Professor
Electronics and Communication Engineering
New Horizon College of Engineering
Bangalore, Karnataka, India
mishra.ishani@gmail.com

Dr Dhivya M
Associate Professor
Electronics and Communication Engineering
New Horizon College of Engineering
Bangalore, Karnataka, India
saidhivya1@gmail.com

Sowmya L
Electronics and Communication Engineering
New Horizon College of Engineering
Bangalore, Karnataka, India
sowmyasonu0611@gmail.com

Nadendla Lakshmi Prasanna
Electronics and Communication Engineering
New Horizon College of Engineering
Bangalore, Karnataka, India
prasannanadendla9@gmail.com

Umadevi H
Electronics and Communication Engineering
New Horizon College of Engineering
Bangalore, Karnataka, India
umadevihiremath88@gmail.com

Manisha Prem
Electronics and communication Engineering
New Horizon College of Engineering
Bangalore, Karnataka, India
manisha.prem1800@gmail.com

***Abstract*-Semantic Segmentation is widely used in Home Automation, medical, seismic imaging,surgery planning,satellite imagery analysis, Machine vision etc. Semantic Segmentation classifies every pixel of the image to individual classes. Marinepredator's algorithm is the nature-inspired metaheuristic algorithm which inspired us to use for semantic segmentation towards agricultural products.Thispaper analyses various algorithms for segmentation and for comparing the pros and cons of various algorithms.Marine predator's algorithm has been finalized for semantic segmentation towards agricultural products.**

Keywords: Semantic segmentation, Marine predator's algorithm, Surgery Planning, Seismic imaging and Metaheuristic Algorithm.

I. INTRODUCTION

A. *Semantic Segmentation*

Semantic segmentation involves the process ofdetermining each pixel in a selected image. Image segmentation is also called semantic segmentation. In image segmentation the digital image is considered and multiple segments in that digital image is represented.The main goal of this segmentation is to cut down ormodify the rendering of images, this technique is useful for tracking down the object and lines or curves in the image. In this image segmentation every pixel collectively covers the entire image, each pixel in the image is similar with respect to some of the characteristics likeintensity,colour,texture.

In Semantic segmentation process to provide a higher level of understanding of the image we use algorithms to figure out the objects which is a part of the image. The main significance of image segmentation in agricultural field is to differentiate between the crops and weeds in a single image. Amongst many techniques that can be used for segmentation process, Two such techniques used in agricultural fields are K- means and super-pixels methods. Nature- inspired metaheuristic algorithmsamalgamated with Semantic segmentation is based on the principle of "Survival of the fittest", that explains how predators choose a strategy to maximize their encounter rates with the prey in the environment. For example, marine predators like marlins, tunas and swordfish exhibiting levy-like behaviour while searching for their prey.

B. Agricultural Products

In precision agriculture, the precise segmentation of crops and weeds has always been the focusinagronomic-imaging**.**Even after proposing several techniques, clean and sharp segmentation of crops and weeds is still a demanding topic. By using k-means and semantic segmentation we can reduce the complexity. Forthesegmentationalgorithms**,** agronomic images from two distinct databases were utilized.

Segmentation of different types of soils, seeds, weeds and crops can be done using semantic segmentation. In agriculture finding the problem and diseases of the plants needs to be taken care because crop production and income will vary based on the condition of the plant[1][2]. Segmentation helps us in finding the different seeds and unwanted plants or weeds in the crop[3].

II.EXISTING ALGORITHMS

A. Krill Herd Algorithm

Krill Herd algorithm, also known as KH algorithmis a nature inspired meta-heuristic algorithm established on duplicating the herding demeanour of krill creatures[7]. Main 3 factors of Krill individuals are

1. Motion produced by other creatures
2. Foraging Ventures
3. Random Dissemination[31]

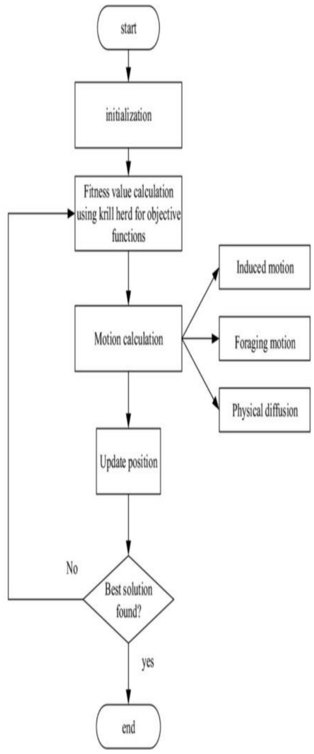

Fig. 1 An image depicting the flow of various steps of Krill Herd Algorithm

B. Cuckoo Algorithm

Cuckoo search algorithm is a recently developed meta-heuristic optimization algorithmis used for solving optimization problems. It isbased on brood parameters of some cuckoo species along with the levy random walks[4].

This algorithm explains how some species of cuckoos such as Ani and Guira cuckoos lay their eggs in the nests of other birds and remove other eggs to improve their chances of hatching their eggs[5].

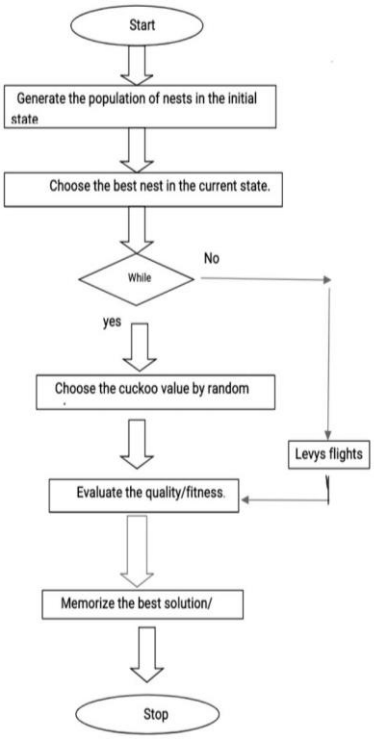

Fig. 2 Flowchart of Cuckoo Algorithm

C. Particle Swarm Optimization Algorithm

Particle swarm optimization (PSO) algorithm can efficiently optimize non-linear and multidimensional issues by providing great solutions while needing the slightest parameterization[6]. The fundamental notion of this algorithm is to design a swarm of particles that travels in the space (the problem space) looking for a place that matches their requirements provided by a fitness function.[32][33][34] Two major ideas behind its optimization properties are:

a) A single particle (that could be perceived as a solution to the issue) can decide the suitability of its current location. The particle is benefitted from its problem space knowledge and from the knowledge gained and provided by different particles[35].
b) Particles travel through unspecified problem space regions due to a stochastic factor in each of their velocities. This property incorporated with a suitable initial distribution of the swarm paves way for a suitable exploration of the problem space and provides good chances of achieving the finest solutions deftly[36].

Fig. 3 The primitive principle of swarm optimization draws inspiration in preceding trials at reproducing perceived behaviours of animals in their natural habitat similar to bird flocking and fish schooling depicted in the above images respectively.

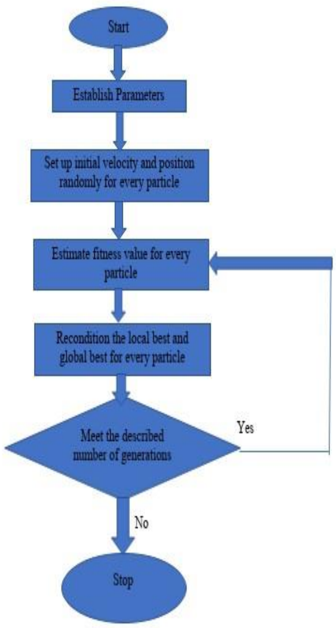

FIG 4 .PSO FLOWCHART

D. K-means Clustering Algorithm

K-means clustering algorithm works the principle of minimizing the distance between the object in the image to the cluster centroid[37][38]. In k-means algorithm the image resolution will be X*Y and K will the number of clusters. P(X,Y) is considered as the input pixel and Ck stands for the centers of the cluster[8][9][10]. The main aim of this algorithm is to separate weeds and crops in the agricultural fields. The flow chart for the k-means algorithm is given below.

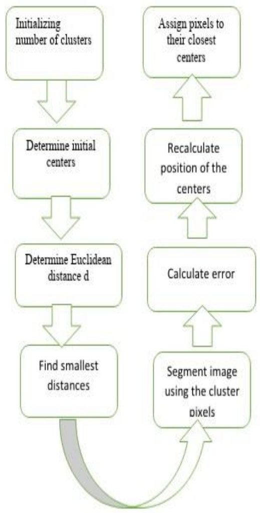

FIG 5 .K-means clustering flow chart

This algorithm can be easily implemented and the random selection of the initial cluster affects the quality of final output cluster. Finalizing initial cluster will give varying answers for various initial centers[11]. Based on the initial center we can acquire the desired segmentation of the input pixels provided. The complexity of this algorithm relies on the number of clusters, number of successions and number of data elements[12][13].

E. Simple Linear Iterative Clustering Algorithm

Pixels which depict similar attributes are regarded as Super-pixels. These attributes could be colours or some different small level attribute such as Intensity[14][15]. Super-pixels supply more information than single pixels; they give a noncognitive meaning since they have some resemblance with pixels belonging to the same lot; they capture redundancy and minimizes the computational expenses particularly in enormous images.[28][29][30] They are proven to be extremely helpful for image segmentation. Simple Linear Iterative Algorithm (SLIC) was introduced to produce super-pixels of high quality; super-pixels that are compact, quick, convenient to use and is consistent in shape and size[39][40]. SLIC algorithm creates super-pixels by clustering pixels according to their colour similitude and vicinity in the same plane. A novel distance estimation imposes compactness and uniformity in the shape of super-pixels and ideally harbours grayscale and colour images. SLIC is easy to execute and is remarkably more methodical than other techniques while generating segmentation of uniform or much improved quality as estimated by standard boundary recall and under-segmentation error estimations[16][17].

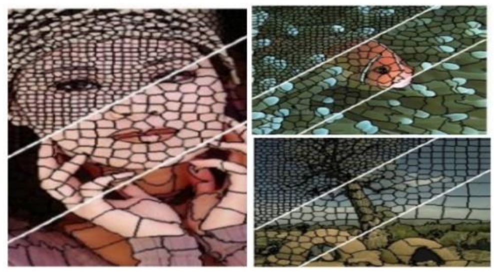

Fig 6.Images segmented by SLIC algorithm into super-pixels of sizes 64,256 and 1024 pixels respectively(clockwise from left). The super-pixels are compact, consistent in size and fits perfectly into the geographical boundaries.

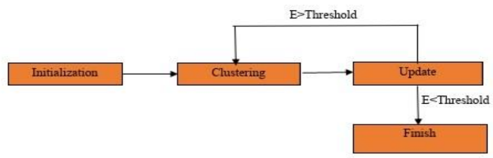

Fig 7.BLOCK DIAGRAM OF SLIC ALGORITHM

TABLE 1:COMPARISION OF ALGORITHMS

serial	Name of Algorithm	Author	Published year	Advantage	Drawbacks
1.	PSO	Kennnedy and Eberhert	1950	Simple concept and easy implementation	It is easy to f into local optimum in high dimensional space.
2.	Krill Herd	Gandomi and alavi	2012	It requires few control variables to regulate.	Sometimes t technique w turn out to b complex
3.	Cuckoo	Xin-sheyang and suash deb	2009	Easier applications and fewer tuning parameters.	Slower convergence
4.	k-clustering	James macqueen	1967	Easy to implement	Random selection of initial centre affects the quantity of f clustering.
5.	Slic (Superpixel)	Achanta	2010	Faster and more memory efficient than existing methods.	Sometimes t accuracy var

III. RESULTS AND DISCUSSIONS

A. *Marine predator's Algorithm(MPA)*

Marine Predators Algorithm is nature-inspired metaheuristictechnique**.**The foremost intention of MPA is to identify theglobal foraging Master plans-Levy and Brownian movements in marine predators along with absolute encounter rate policy in biological cooperation amidst predators and preys[18][19][20].

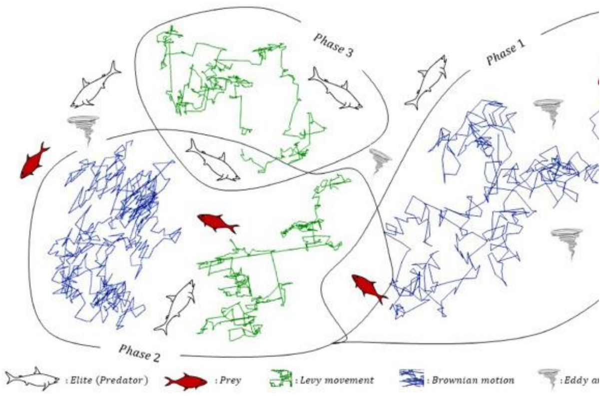

FIG 8.REAL LIFE EXAMPLE OF MPA

- Brownian Motion

  The primary Brownian motion is the time dependent technique where step length is established from the probability function described by Gaussian distribution having mean value as 0 and variance equalto probability density function calculated for the same according to the values[24][25].

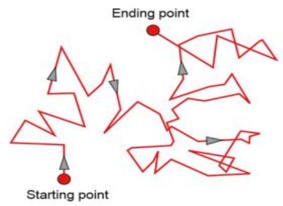

FIG 9. MECHANISM OF BROWNIAN MOTION

- Levy Flight

  The term 'Levy Flight' devised by '**Benoit Mandelbrot**' is a common behavior among marine predators (e.g. sharks, marlines) while looking for suitable prey in a prey-scarce environment, but while foraging in a prey-abundant environment,[26][27] the behaviour is notably redirected to Brownian motion in the same process[21][22][23].

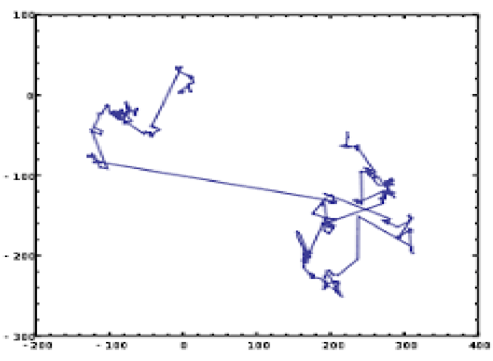

FIG 10 .LEVY'S FLIGHT

References

[1] H. Krähmer, C. Andreasen, G. Economou-Antonaka, J. Holec, D. Kalivas, M. Kolářová, *et al.*

Weed surveys and weed mapping in Europe: State of the art and future tasksCropProt, 129 (2020),p. 105010, 10.1016/j.cropro.2019.105010.

[2]
J.W. Lu, C. Ma, C. Zuo, J.P. Guillemin, P. Gouton, J.C. Coquille

Distinguishing onions and weeds in field by using color image. Trans CSAE, 17 (5) (2001), pp. 153-158

[3]Adhikary P., Roy P. K., Mazumdar A. Optimal Renewable Energy Project Selection: A Multi-Criteria Optimization Technique Approach 2015 Global Journal of Pure and Applied Mathematics volume 11 Article Scopus

[4]Dharmambal V., Nisha K.C.R., Bhavana C. Piezo film based renewable energy system 2016 Proceedings of IEEE International Conference on Circuit, Power and Computing Technologies, ICCPCT 2016 Conference PaperScopus

[5]L.C. Ngugi, M. Abelwahab, M. Abo-Zahhad

Recent advances in image processing techniques for automated leaf pest and disease recognition-a review Inform Process Agric, 8 (1) (2021), pp. 27-51

[6]R.S. Concepcion II, J.D. Alejandrino, S.C. Lauguico, R.R. Tobias, E. Sybingco, E.P. Dadios, *et al.*

Lettuce growth stage identification based on phytomorphological variations using coupled colorsuperpixels and multifold watershed transformation

Int J AdvancIntell Inf, 6 (3) (2020), p. 261

[7]K. Arai, A.R. Barakbah

Hierarchical K-means: an algorithm for centroids initialization for K-means Rep Fac Sci Eng, 36 (1) (2007), pp. 25-31

[8]M.N. Reza, I.S. Na, S.W. Baek, K.-H. Lee

Rice yield estimation based on K-means clustering with graph-cut segmentation using low-altitude UAV images BiosystEng, 177 (2019), pp. 109-121

[9]D.S. Tan, R.N. Leong, A.F. Laguna, C.A. Ngo, A. Lao, D.M. Amalin, *et al.*

AuToDiDAC: Automated tool for disease detection and assessment for cacao black pod rot

Crop Prot, 103 (2018), pp. 98-102

[10]P. Lottes, J. Behley, A. Milioto, C. Stachniss

Fully convolutional networks with sequential information for robust crop and weed detection in precision farming. IEEE Rob Autom Lett, 3 (4) (2018), pp. 2870-2877

[11]A. Yang, H. Huang, X. Zhu, X. Yang, P. Chen, S. Li, *et al.*

Automatic recognition of sow nursing behaviour using deep learning-based segmentation and spatial and temporal features.BiosystEng, 175 (2018), pp. 133-145

[12]W. Shi, R. van de Zedde, H. Jiang, G. Kootstra

Plant-part segmentation using deep learning and multi-view vision. BiosysEng, 187 (2019), pp. 81-95

[13]J. Ma, K. Du, F. Zheng, L. Zhang, Z. Sun

A segmentation method for processing greenhouse vegetable foliar disease symptom images. Inf Process Agric, 6 (2) (2019), pp. 216-223

[14]Y. Majeed, J. Zhang, X. Zhang, L. Fu, M. Karkee, Q. Zhang, *et al.*

Deep learning based segmentation for automated training of apple trees on trellis wires

Comput Electron Agric, 170 (2020), p. 105277

[15] Y. Xiong, L. Liang, L. Wang, J. She, M. Wu

Identification of cash crop diseases using automatic image segmentation algorithm and deep learning with expanded dataset. Comput Electron Agric, 177 (2020), p. 105712,

[16]M. Kerkech, A. Hafiane, R. Canals

Vine disease detection in UAV multispectral images using optimized image registration and deep learning segmentation approach. Comput Electron Agric, 174 (2020), p. 105446

[17]J. Ma, Y. Li, H. Liu, K. Du, F. Zheng, Y. Wu, *et al.*

Improving segmentation accuracy for ears of winter wheat at flowering stage by semantic segmentation

Comput Electron Agric, 176 (2020), p. 105662

[18]R. Barth, J. IJsselmuiden, J. Hemming, E.J. Va n Henten

Synthetic bootstrapping of convolutional neural networks for semantic plant part segmentation Comput Electron Agric, 161 (2019), pp. 291-304

[19] W. Zhao, Y. Fu, X. Wei, H. Wang

An improved image semantic segmentation method based on superpixels and conditional random fields

Appl Sci, 8 (5) (2018), pp. 837-854

[20]R. Barth, J. IJsselmuiden, J. Hemming, E.J.V. Henten

Data synthesis methods for semantic segmentation in agriculture: A Capsicum annuum dataset Comput Electron Agric, 144 (2018), pp. 284-296

[21]J. Wu, Z. Wen, S. Zhao, K. Huang

Video semantic segmentation via feature propagation with holistic attention

Pattern Recognit, 104 (2020), p. 107268, 10.1016/j.patcog.2020.107268

[22]
M. Feng, L. Zhang, X. Lin, S.Z. Gilani, A. Mian

Point Attention Network for Semantic Segmentation of 3D Point Clouds Pattern Recognit, 107 (2020), p. 107446, 10.1016/j.patcog.2020.107446

[23] L. Zeng, J. Feng, L. He

Semantic segmentation of sparse 3D point cloud based on geometrical features for trellis-structured apple orchard. BiosysEng, 196 (2020), pp. 46-55

[24]
Y. Li, Z. Cao, H. Lu, Y. Xiao, Y. Zhu, A.B. Creme rs

In-field cotton detection via region-based semantic image segmentation. Comput Electron Agric, 127 (2016), pp. 475-486

[25]P. Bosilj, E. Aptoula, T. Duckett, G. Cielniak

Transfer learning between crop types for semantic segmentation of crops versus weeds in precision agriculture. J Field Rob, 37 (1) (2020), pp. 7-19

[26]D. Wu, X. Yin, B.o. Jiang, M. Jiang, Z. Li, H. Song

Detection of the respiratory rate of standing cows by combining the Deeplab V3+ semantic segmentation model with the phase-based video magnification algorithm. BiosysEng, 192 (2020), pp. 72-89

[27]M. Villamizar, O. Canévet, J.-M. Odobez
Multi-scale sequential network for semantic text segmentation and localization
Pattern Recognit Lett, 129 (2020), pp. 63-69

[28]A. Abdalla, H. Cen, L. Wan, R. Rashid, H. We ng, W. Zhou, *et al.*

Fine-tuning convolutional neural network with transfer learning for semantic segmentation of ground-level oilseed rape images in a field with high weed pressure. Comput Electron Agric, 167 (2019), p. 105091

[29]L. Xu, Y.e. Li, J. Xu, L. Guo

Two-level attention and score consistency network for plant segmentation. Comput Electron Agric, 170 (2020), p. 105281

[30]Y. Majeed, M. Karkee, Q. Zhang, L. Fu, M.D. Whiting

Determining grapevine cordon shape for automated green shoot thinning using semantic segmentation-based deep learning networks

[31]K.M. Bataineh, M. Naji, M. Saqer
A comparison study between various fuzzy clustering algorithms. Jordan J Mec Ind Eng, 5 (4) (2011), pp. 335-343

[32]N. Dhanachandra, K. Manglem, Y.J. Chanu
Image segmentation using K-means clustering algorithm and subtractive clustering algorithm
Procedia Comput Sci, 54 (2015), pp. 764-771

[33]K.C. Swain, M. Nørremark, R.N. Jørgensen, H. S. Midtiby, O. Green

Weed identification using an automated active shape matching (AASM) technique. BiosysEng, 110 (4) (2011), pp. 450-457

[34]S. Sabzi, Y. Abbaspour-Gilandeh, G. García-Mateos

A fast and accurate expert system for weed identification in potato crops using metaheuristic algorithms. Comp Ind, 98 (2018), pp. 80-89

[35]Adhikary P., Kumar A., Bandyopadhyay S., Mazumdar A. Chilled water pump trouble-shooting by A.I.: A case study 2019 ARPN Journal of Engineering and Applied Sciences volume 14 Article Scopus.

[36]Adhikary P., Kundu S., Mazumdar A. CFD Analysis of Small Hydro Plant Turbines: Case Studies 2021 ARPN Journal of Engineering and Applied Sciences volume 16 Article Scopus

[37]S. Zhang, H. Wang, W. Huang, Z. You
Plant diseased leaf segmentation and recognition by fusion of superpixel, K-means and PHOG Optik, 157 (2018), pp. 866-872

[38]Adhikary P., Roy P. K., Mazumdar A. SELECTION OF SMALL HYDROPOWER PROJECT SITE: A MULTICRITERIA OPTIMIZATION TECHNIQUE APPROACH 2015 ARPN Journal of Engineering and Applied Sciences 10 volume Article Scopus

[39]I.F. Salazar-Reque, S.G. Huamán, G. Kemper, J. Telles, D. Diaz

An algorithm for plant disease visual symptom detection in digital images based on superpixels

Int J Adv Sci Eng Inf Technol, 9 (1) (2019), pp. 194-203

[40]Adhikary P., Roy P. K., Mazumdar A. Turbine Supplier Selection For Small Hydro Project: Application Of Multi-Criteria Optimization Technique 2015 International Journal of Applied Engineering Research volume 10 Article Scopus