Mathematical Statistician and Engineering Applications
ISSN: 2094-0343
2326-9865

Classification of Fruit Diseases Using Hybrid Deep Learning Model

[1]Tella.Sunitha,[2]Dr.M.Suresh,[3]N.Srinu,[4]Dr.K.Navaz,[5]P.Anitha

[1,2,3,4,5]Department of Computer Science and Engineering

[1,2,3,4] QIS College of Engineering and Technology, Ongole

[5]Engineering and Technology Program,GVPCDPGC(A)

[1]tella.sunitha@qiscet.edu.in,[2]csehod@qiscet.edu.in, [3]srinu.nidamanuri@qiscet.edu.in,

[4]navaz.k@qiscet.edu.in,[5]anitha501p@gvpcdpgc.edu.in

Corresponding Author Mail: qispublications@qiscet.edu.in

Article Info
Page Number: 70-80
Publication Issue:
Vol 69 No. 1 (2020)

Abstract: Using the Raspberry Pi board and the Mixture Profound Learning, we examine the paper regarding the standard item grouping and quality maintenance. India has a predominately agro-based economy, with farming serving as the main source of income for the nation's farmers, who are referred to as its foundation. Farmers are known to employ a variety of methods, and because of a lack of training, they are still far from establishing the high level specific farming apparatuses. We are putting forth a low-cost, reliable natural item quality maintenance device that will be useful to farmers and our regular item sellers. In this paper, natural item acknowledgment depiction and arrangement have been finished employing simulated intelligence and embedded

We focused on the natural item acknowledgment by methods such tensor stream classifier and Bunny flood classifier . We arranged the natural item classifier by using Profound Learning thoughts and got the pre-arranged classifier to recognize and sort the natural items with quality. The electronic parts used here are Raspberry Pi. As opposed to raspberry pi, the PC with Linux working system (Ubuntu) can be used. Through picture taking care of and computer based intelligence computations we perceive the kind of results of the dirt quality. A sound insistence is given about the unmistakable evidence of the sort of normal item while dealing with the regular item for packaging. In extra improvement we can encourage a robot which can be used to seclude the unrefined and prepared natural items with the help of ID estimation used in this undertaking.

Article Received: 15 September 2020
Revised: 24 October 2020
Accepted: 26 November
Publication: 30 December 2020

Introduction

Tensor stream is one of the strong man-made intelligence frameworks being used today, and with to the consideration of Tensor Stream Light Small scale in the Arduino Library Boss, anyone may now utilize simulated intelligence [2]. Arduino's venture on natural merchandise requesting has propelled us. To bunch the things, the Tensor Stream Light Small scale library and the Arduino Nano 33 BLE Sense's microcontroller, which contains a colorimeter and a nearness sensor, might be utilized. A little mind organization ought to likewise be running on the genuine board to do this errand. When the item has been adequately close, the embedded RGB sensor — which should be a 1 pixel assortment camera — is utilized to really take a look at the assortment. Albeit this strategy has a couple of disadvantages, it offers a speedy

technique for putting together the items with a limited quantity of assets utilizing an Arduino board [2] with a coordinated colorimeter [2]. Tensorflow stream and Jupyter are utilized to develop the models. The article [26] claims that the determination of sensors and the chance of executing Form Enrollment administrations (PC based knowledge) on the Arduino Nano 33 BLE detecting sheets are its fundamental parts.

Machine Learning:

Tensor stream is one of the solid man-made intelligence structure used man-made intelligence is way to deal with getting the computers to do as per the arranged ventures and computations which on faultlessness might one day anytime at some point lead us progress towards human-level man-made insight [14]. Following sorts of learnings are associated with man-made intelligence 1)Supervised learning design ,2) Unsupervised learning pattern

a) DeepLearning: \sArtificial brain organizations, which are utilized in profound learning, are designed after the construction and capability of the cerebrum. Profound learning, otherwise called managed gaining or gaining from named information and calculations, is a progressive system of nonlinear info changes that might be utilized to produce a measurable model as a result [14].

b) TransferLearning:

In AI (ML), move learning (TL) is the act of taking the expertise acquired by settling one issue and

applying it to the arrangement of a comparative yet irrelevant test [4]. While attempting to perceive bikes or bikes, the procedures figured out how to recognize cycles may be used. The examining effectiveness of a RL specialist might be impressively further developed utilizing the idea of move realizing, which is utilizing data acquired from one occupation to the obtaining of another. Subsequently In AI, "move learning" alludes to the act of reusing beforehand prepared brain organizations. For example, the Initiation v3 picture acknowledgment model contains two parts: an element extraction segment with a convolutional

The Beginning v3 pre-prepared model distinguishes nonexclusive things with 1000 classes accurately, for example, "blossoms," "Zebra," and "Dishwasher," among others. The model at first gathers conventional qualities from the information photos prior to sorting them in the following stage in view of those credits. The element extraction is reused in move learning, while the grouping is retrained on the first dataset. Since the element extraction a piece of the model needn't bother with to be prepared, we can prepare it quicker and with less PC assets. For this work, we used Google's Commencement picture acknowledgment calculation and prepared it on the organic products informational collection got from Mendeley's [12, 13].

Whenever everything is set up, the model is executed, the Raspberry Pi's current circumstance is laid out, and the pictures are arranged. The model was prepared on a PC involving Ubuntu as the working framework for the Outcomes investigation, and a similar model was applied to the Pi for picture grouping. The capability of ordering a photo has been

explored and looked at on a PC and a raspberry Pi. Improvement through sharing of data One meaning of a pre-prepared model is an organization that has proactively been prepared on a huge picture grouping task and saved from an enormous dataset. Much of the time, a model that has previously been prepared is utilized, or one is moved to another errand through move learning. Utilizing a model prepared on an enormous and shifted dataset to order new photographs.

In this review, we changed a pre-

1. The accompanying methods comprise the ordinary AI work process:
2. The accompanying methods comprise the ordinary AI work process: Information investigation, grasping the information b) input pipeline development (utilizing Keras Picture Information Generator), model
3. c)composition (stacking a pre-prepared base model and stacking the order layers), and d)model preparing and assessment

Literature Survey

There are various techniques that possess been created all through energy for organic product recognizable proof and quality upkeep. As a result of the accessibility of AI systems like

Tensor Stream Light Miniature in the Arduino Library Supervisor, the order of natural product diseases has been fabricated utilizing Arduino and Raspberry Pi and Half and half Profound Figuring out how to make it simple enough for novices to apply Profound Learning

Keeping up with the Consistency of the Determinations to distinguish things, a little brain network is run on the actual board, as nitty gritty in the article Natural product recognizable proof with Arduino and Tensor Stream [3]. This is finished by utilizing the colorimeter and closeness sensor of the Arduino Nano 33 BLE Sense. TinyML is notable for its capacity to perform well on low-controlled gadgets in spite of its minute size, low power utilization, and cheap silicon. It isn't important to utilize a camera since the board's closeness sensor can give a prompt profundity estimation of an item before the board. This manual expresses that the implicit RGB sensor tests the shade of an article when it is close to enough.

In "Organic product distinguishing proof from pictures utilizing profound learning," creators HoreaMuresan et al. give a new, excellent assortment of organic product shots. Various mathematical examination yields for preparing a brain organization to perceive natural products are likewise remembered for the dataset. The examination suggests another photograph assortment with very

much perceived natural products; they name it Organic products 360. The indistinguishable dataset

was utilized in both our article and the refered to one. Madhura introduced a MATLAB-based graphical UI (GUI) for overseeing and ordering organic product quality. With the understanding that the natural products have been arranged, the estimations, level, and weight

are determined utilizing the information given by R. Lodam et al. The objective of this study is to speedily further develop food quality by utilizing the graphical UI (GUI), which shows all information.

Inserted frameworks in light of picture handling are utilized to dissect and control quality, and they give a serious level of evaluating precision, consistency, and quantitative information. To gauge organic product, greyscale pictures were utilized.

4.FRUITS DATASET ARRANGEMENT

The photographs were delivered by recording the organic products as they were turned by an engine and afterward eliminating outlines [4] to create the natural product informational collection. By embedding the natural products into the shaft of a low speed (3 rpm) engine and involving a white piece of paper as the foundation, a 20-second video was caught. From that point onward, the natural product picture was Organic products were recorded while being turned by an engine, and afterward the edges were separated to make the pictures for the natural products informational index [4]. The organic products were put in the shaft of a low speed engine (3 rpm), and a white piece of paper was utilized as the foundation to record a short film enduring 20 seconds. A 100x100 pixel organic product picture was then scaled back [8].shrunk to 100x100 pixels [8].

The below figures are some of the example of the defectedfruits

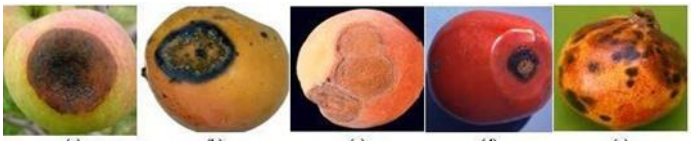


Figure2:*Anthracnosediseasedfruits(a)Apple(b)Mango(c)Orange(d)Tomato(e)Pomegranate*

5. IMPLEMENTATIONANDRESULTANALYSIS

Despite progress in PC vision, picture dealing with, affirmation and movement in PC development, customized regular item gathering is a troublesome task. The fundamental limits that expect critical part while portraying a characteristic item consolidate the man-made intelligence estimation that is being used, nature of pictures in the normal item informational index, regular item's photos' shape and size and natural item's tone. Helper limits that impact the gathering are equivalent characters of normal items like tone, shape, size, etc. In case both fundamental and discretionary limits are not penniless down true to form before all else then it could cause issue during portrayal and may provoke less accuracy and astonishing results.

Many related works have been driven in natural item portrayal using different request computations yet those approaches really need a couple of perspectives. An assessment in normal item portrayal has been done basically by pondering only three regular items with 100% precision. Regardless, considering only three regular item in the model isn't sufficient considering the way that the pre-arranged model may not see the natural item's photos' that

are out of the planning test. Furthermore, proper execution of man-made intelligence estimation should likewise be thought about while performing grouping.

Scope of the Paper:

A. The degree of this paper is just limited to consumable natural items that are open in the regular item educational assortment which is used to set up the system. Hence, when photos of these are given as commitment to the structure, it may not see and may not convey the best result.

B. Objective : The essential targets are to remove features from the natural item's image and To execute the Tensor Stream and man-made intelligence computations for modified regular item portrayal. The major objective of this paper is:

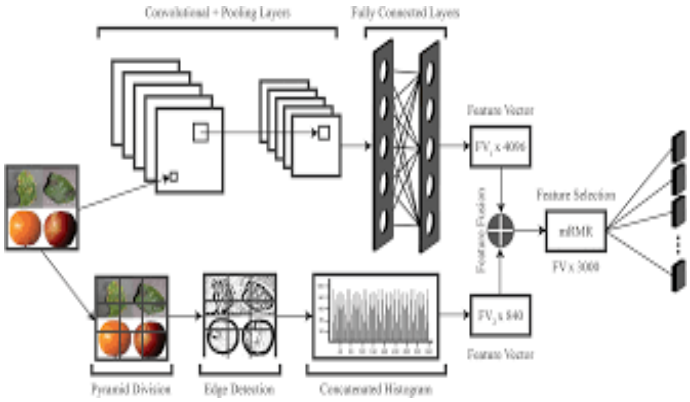
C. • Recognizable proof of Positive or negative Quality regular items successfully.

D. • To perceive the surface disfigurements of regular items considering the use of computer based intelligence and Tensor Stream estimations.

E. • To encourage a web interface stage for testing the assumption for natural item picture.

F. In this section we will look at about the execution and results discussion for the natural item area and request using Raspberry Pi. The undertaking model has been arranged in ahp focus i3 processor based PC having Ubuntu working framework. After the pre-arranged model has been attempted in both PC as well as the Raspberry Pi game plan.

BlockDiagram



RESULT EVALUATION

This part will cover the execution and results examination for the Raspberry Pi-based natural product identification and arrangement framework. All of the test photographs from the Organic products 360 dataset [19] have had their outcomes analyzed here. The best likelihood of recognition and least likelihood of discovery scores for the picture grouping likelihood score have been determined and recorded. The mathematical discoveries and the main 7 organic product acknowledgment scores are displayed in Table I. We can perceive how the AI framework can perceive the natural product from the probability appraisals. It is easy to

investigate a specific natural product to see whether it has any illness tainting. We have inspected the papaya foods grown from the ground disease here.

Table I: The mathematical discoveries and the main 7 organic product acknowledgment scores are displayed

SL NO	Testing FruitPath	Fruit Name	Fruit Classification Probability inCorei5Processor
1	test-images/21_100.jpg	Banana	banana(sc=0.9131) apple red delicious (sc =0.05031) lemon sc=0.04777)papaya(sc=0.01896) apple golden 3 (sc = 0.002716) bananared(sc= 0.02429) papaya diseasephytophthora(sc= 0.012896)
2	test-images/34_100.jpg	Apple	apple braeburn(sc = 0.857973) apple red yellow (sc= 0.00857) applered1(sc= 0.00624) apple red 2(sc =0.00378) grape pink(sc=0.00438) apple reddelicious(sc=0.00208) mango(sc =0.000779)
3	est-images/132_100.jpg	Mango	mango(sc=0.887582) limes(sc=0.008812) apple red 2(sc =0.00490) applered1(sc=0.00435) apple braeburn (score = 0.00309)applereddelicious (score=0.003322)
4	est-images/PapayaDisease_anthracnose_a48.jpg	Papaya	Papaya disease anthracnose(sc= 0.62189) papaya disease phytophthora (sc= 0.29532) papaya disease ring spot (sc=0.25833) papaya disease powdery mildew(sc= 0.06108) apple red yellow (sc = 0.038951) applered1 (sc= 0.055088)
5	test-images/papayaDisease_b3.jpg	Papaya	Papayadiseaseblackspot (sc = 0.93005) papaya disease ring spot (sc =0.05131) papaya diseasephytophthora(sc= 0.04708) papaya diseasepowderymildew(sc= 0.05179) apple red delicious (sc =0.02354) papaya disease anthracnose(sc= 0.02162) mango(sc =0.00696)
6	test-images/PapayaDisease_black_spot_b17.jpg	Papaya	Papayadiseaseblackspot (sc = 0.534653) papaya disease anthracnose(sc= 0.598052) apple golden 1 (sc = 0.00273) papaya diseasephytophthora(sc= 0.00302) papaya disease ring spot (sc=0.000698) apple golden 2 (sc= 0.00040) banana(sc=0.00034)

7	test-images/PapayaDisease_phytophthora_p2.jpg	Papaya	Papaya disease phytophthora(sc= 0.98042) papaya disease anthracnose(sc= 0.07457) papaya disease ring spot (sc =0.02626) papaya disease powdery mildew(sc= 0.00982) applered1(score= 0.00407)applered yellow(sc =0.0056946) limes(sc=0.005618)
8	test-images/PapayaDisease_powdery_mildew_m2.jpg	Papaya	Papaya disease powdery mildew(score= 0.96816) papaya disease ring spot (sc =0.08176) papaya disease anthracnose(sc= 0.03720)papaya disease phytophthora(sc= 0.02889) papayadisease blackspot(sc= 0.00611) apple red yellow (sc = 0.00224)applered1(sc= 0.00217)
9	test-images/PapayaDisease_ring_spot_r33.jpg	Papaya	Papaya disease ring spot (sc =0.981234) papaya disease phytophthora(sc= 0.042587) papaya disease powdery mildew(sc= 0.00741271) papayadisease blackspot(sc= 0.00653) papaya disease anthracnose(sc= 0.001254) applered yellow(score = 0.00221) limes(score =0.00036546)
10	test-images/pomegranate.jpg	Pomegranate	pomegranate (score = 0.97542) applered3(score=0.007452)papayadiseaseblackspot(sc = 0.00423) papaya disease anthracnose(sc= 0.00369) apple red1(sc =0.0012453) applered2(sc= 0.00047)grapefruitpink (sc=0.00023)
11	test-images/Apple_Braeburn/49_100.jpg	Apple	apple brae burn (sc = 0.8542) apple red yellow (sc = 0.02547) applered1(sc= 0.003654) grapepink(sc=0.002548) applered2(sc= 0.002454) applereddelicious(sc=0.003244) mango(sc =0.002479)
12	test-images/Apple_Golden_1/42_100.jpg	Apple	apple golden1 (sc=0.96598)grapefruit white (sc= 0.01243) lemon(sc=0.00124) apple golden3(sc=0.003654) apple golden 2 (sc= 0.002547) papaya(sc=0.0012145) papaya diseaseanthracnose(sc= 0.005806)
13	test-images/Apple_Golden_2/r_44_100.jpg	Apple	apple golden2 (sc=0.93317) apple golden 3 (sc = 0.03457) applegranny smith(sc=0.006325) mango(sc=0.007568) grape white (sc = 0.00654) apple red2 (sc=0.006325)
14	test-images/Apple_Golden_3/r_87_100.jpg	Apple	apple golden 3 (sc = 0.214785) apple golden 2 (sc= 0.06571) limes (sc = 0.02475) papaya (sc = 0.00147) apple golden 1 (sc= 0.00124)
15	test-images/Apple_Granny_Smith/78_100.jpg	Apple	apple granny smith (sc = 0.8547) apple golden 3 (sc = 0.004755) apple red 2 (sc= 0.004578) grape white 2 (sc = 0.001245) mango (sc = 0.00325)
16	test-images/Apple_Red_Delicious/138_100.jpg	Apple	apple red delicious (sc = 0.88102) apple red 1 (sc= 0.003245) grape pink (sc= 0.002354) apple brae burn (sc= 0.00245) apple red 2 (score = 0.000690)
17	test-images/Banana/86_100.jpg	*Banana*	banana (sc= 0.87562) banana red (sc= 0.00245)papaya disease black spot (sc= 0.006475) papaya disease anthracnose (sc = 0.00086) orange (sc = 0.000689)

18	test- images/Dates/95_100.jpg	Dates	dates (sc= 0.8569) banana red (sc = 0.0065234) papaya disease ring spot (sc = 0.00324) banana (sc= 0.0021470) apple red yellow (sc = 0.00087)
19	test- images/Grape_Pink/r_3_100.jpg	Grapefruit	grape pink (sc = 0.9579) apple red yellow (sc = 0.00214) apple red 1 (sc = 0.00066) grape white (sc= 0.00085) pomegranate (sc = 0.00047)
20	test- images/Lemon/r_15_100.jpg	Lemon	lemon (sc = 0.87214) lemon meyer (sc = 0.0087) grapefruit white (sc= 0.00325) apple golden 1 (sc = 0.002457) papaya (sc= 0.000547)
21	test- images/Mango/139_100.jpg	Mango	mango (sc = 0.7854) limes (sc = 0.00542) apple red 2 (sc = 0.003214) apple golden 3 (sc = 0.02358) apple granny smith (sc= 0.00016) apple red 1 (sc= 0.000676)
22	test- images/Orange/r_325_100.jpg	Orange	orange (sc= 0.9958) lemon meyer (sc = 0.075324) grapefruit pink (sc = 0.03258) grapefruit white (sc = 0.02583) lemon (sc= 0.00235)
23	test- images/Papaya/r_9_100.jpg	Papaya	papaya (sc = 0.88856) apple red 1 (sc = 0.00045) banana red (sc = 0.000068) grape white (sc = 0.00006) grape pink (sc= 0.000078)
24	test-images/Pineapple/99_100.jpg	Pineapple	pineapple (sc= 0.89654) pineapple mini (sc = 0.01245) apple red 3 (sc = 0.00145) papaya (sc= 0.00015) limes (sc = 0.00045)
25	test-images/Pomegranate/77_100.jpg	Pomegranate	pomegranate (sc= 0.85476) apple red 3 (score = 0.05324) apple red 1 (sc = 0.006352) apple red 2 (sc = 0.003657)

CONCLUSION

Move learning has been handily used for the development of the paper utilizing man-made intelligence and Mixture profound learning strategies. A Google Initiation model that has previously been prepared was utilized to prepare an informational index of organic products that were taken from a current, confirmed information assortment. Python was utilized for the preparation and examination of the discoveries. The open source Tensor Stream structure seems, by all accounts, to be great for creating AI calculations and techniques. The constructed TinyAL library permits the proposed venture to be created involving Arduino as well.We have involved Crossover Profound Learning and the raspberry Pi as a move up to

identify organic products using the sensors worked inside the Arduino Nano 33 BLE detecting model. The quantitative Outcomes

REFERENCES

1. S.Bargoti,J.Underwood, Deep fruit detection inorchards, IEEE International ConferenceonRoboticsandAutomation(ICRA),pp.3626-3633,2017 https://blog.arduino.cc/2019/11/07/fruit-identification-using-arduino-and-tensorflow/export.arxiv.org
2. Fruits360Dataseton GitHub.https://github.com/Horea94/Fruit-Images-Dataset.
3. R. Barth, J. Ijsselmuiden, J. Hemming, E. Van Henten,Data synthesis methods for semantic segmentation in agriculture: A Cap sicumannuum dataset, Computersand, Electronicsin Agriculture, 144,pp.284-296, 2018
4. KrithikaJayasankar,KarthikaB,JeyashreeT,DeepalakshmiR,KarthikaG,―FRUITFRESHNESSDETECTION USING RASPBERRY PI‖,International Journal of Pure and Applied Mathematics. Volume-119No.152018,1685-1691ISSN:1314-3395(on-line version)
5. H. Cheng, L. Damerow, Y. Sun, M. Blanke,EarlyYieldPredictionUsingImageAnalysisofAppleFruitandTreeCanopyFeatureswithNeuralNetworks,JournalofImaging,Vol.3(1),2017.
6. Fruits360 Dataset on Kaggle. https://www.kaggle.com/moltean/fruis
7. HoreaMuresan,MihaiOltean,‖Fruitrecognitionfromimagesusingdeeplearning‖,ACTAUNIV. SAPIENTIAE,INFORMATICA,10,1(2018)26–42
8. D.Clevert, T.Unterthiner, S.Hochreiter, Fastand Acurate Deep Network Learning by Exponential Linear Units(ELUs)CoRRabs/1511.07289,2015
9. K. Kapach, E. Barnea, R. Mairon, Y. Edan, O. Ben-Shahar,Computervisionforfruitharvestingrobotsstateoftheartandchallengesahead,JournalofImaging,Vol.3(1),pp.4-34,2017.
10. M.Liang,X.Hu,Recurrent Convolutional Neural Network for Object Recognition, IEEE Conference onComputerVisionandPatternRecognition(CVPR)Boston,pp.3367-3375,2015.
11. S.Puttemans, Y.Vanbrabant, L.Tits,T.Goedem, Automated visual fruit detection for harvest estimationand robotic harvesting, Sixth International Conferenceon Image Processing Theory, Tools and Applications,2016
12. M,Rahnemoon far, C.Sheppard, Deepcount:fruitcounting based on deep simulated learning, Sensors,17(4),p.905-,2017.
13. S.Ren,K.He ,R.Girshick, J.Sun,Fasterr-cnn:Towards real-time object detection with region proposalnetworks, In Advances in neural information processingsystems,pp.91-99,2015.
14. I.Sa,Z.Ge,F.Dayoub ,B.Upcroft, T.Perez&C.McCool, Deep- Fruits: A Fruit Detection System UsingDeep Neural Networks, Sensors (Basel, Switzerland),Vol.16(8),pp.1222-,2016.
15. J. Schmidhuber, Deep learning in neural networks: An overview, Neural Networksvol.61,pp.85-117,2015
16. H. Mureşan and M. Oltean, “Fruit recognition from images using deep learning,” Acta

Universitatis Sapientiae Informatica, vol. 10, no. 1, pp. 26–42, 2018.
17. K. P. Ferentinos, “Deep learning models for plant disease detection and diagnosis,” Computers and Electronics in Agriculture, vol. 145, pp. 311–318, 2018.
18. M. Abadi, P. Barham, J. Chen, Z. Chen, A. Davis et al., “Tensorflow: A system for large-scale machine learning,” in 12th {USENIX} Sym. on Operating Systems Design and Implementation, pp. 265–283, 2016.
19. S. Sakib, Z. Ashrafi, M. Siddique and A. Bakr, “Implementation of fruits recognition classifier using convolutional neural network algorithm for observation of accuracies for various hidden layers. arXiv preprint arXiv:1904.00783, 2019.
20. L. Rajasekar and D. Sharmila, “Performance analysis of soft computing techniques for the automatic classification of fruits dataset,” Soft Computing, vol. 23, no. 8, pp. 2773–2788, 2019.
21. Y. Duan, F. Liu, L. Jiao, P. Zhao and L. Zhang, “SAR Image segmentation based on convolutional-wavelet neural network and markov random field,” Pattern Recognition, vol. 64, pp. 255–267, 2017.
22. B. Liu, Y. Zhang, D. He and Y. Li, “Identification of apple leaf diseases based on deep convolutional neural networks,” Symmetry, vol. 10, no. 1, pp. 11, 2018.
23. S. Sladojevic, M. Arsenovic, A. Anderla, D. Culibrk and D. Stefanovic, “Deep neural networks based recognition of plant diseases by leaf image classification,” Computational Intelligence and Neuroscience, vol. 2016, 2016.
24. T. Akram, M. Sharif and T. Saba, “Fruits diseases classification: Exploiting a hierarchical framework for deep features fusion and selection,” Multimedia Tools and Applications, pp. 1–21, 2020.
25. P Ramprakash, M Sakthivadivel, N Krishnaraj, J Ramprasath. ”Host-based Intrusion Detection System using Sequence of System Calls” International Journal of Engineering and Management Research, Vandana Publications, Volume 4, Issue 2, 241-247, 2014
26. N Krishnaraj, S Smys.”A multihoming ACO-MDV routing for maximum power efficiency in an IoT environment” Wireless Personal Communications 109 (1), 243-256, 2019.
27. N Krishnaraj, R Bhuvanesh Kumar, D Rajeshwar, T Sanjay Kumar, Implementation of energy aware modified distance vector routing protocol for energy efficiency in wireless sensor networks, 2020 International Conference on Inventive Computation Technologies (ICICT),201-204
28. Ibrahim, S. Jafar Ali, and M. Thangamani. "Enhanced singular value decomposition for prediction of drugs and diseases with hepatocellular carcinoma based on multi-source bat algorithm based random walk." Measurement 141 (2019): 176-183. https://doi.org/10.1016/j.measurement.2019.02.056
29. Ibrahim, Jafar Ali S., S. Rajasekar, Varsha, M. Karunakaran, K. Kasirajan, Kalyan NS Chakravarthy, V. Kumar, and K. J. Kaur. "Recent advances in performance and effect of Zr doping with ZnO thin film sensor in ammonia vapour sensing." GLOBAL NEST JOURNAL 23, no. 4 (2021): 526-531. https://doi.org/10.30955/gnj.004020 , https://journal.gnest.org/publication/gnest_04020
30. N.S. Kalyan Chakravarthy, B. Karthikeyan, K. Alhaf Malik, D.Bujji Babbu,. K. Nithya

S.Jafar Ali Ibrahim , Survey of Cooperative Routing Algorithms in Wireless Sensor Networks, Journal of Annals of the Romanian Society for Cell Biology ,5316-5320, 2021

31. Rajmohan, G, Chinnappan, CV, John William, AD, Chandrakrishan Balakrishnan, S, Anand Muthu, B, Manogaran, G. Revamping land coverage analysis using aerial satellite image mapping. Trans Emerging Tel Tech. 2021; 32:e3927. https://doi.org/10.1002/ett.3927
32. Vignesh, C.C., Sivaparthipan, C.B., Daniel, J.A. et al. Adjacent Node based Energetic Association Factor Routing Protocol in Wireless Sensor Networks. Wireless Pers Commun 119, 3255–3270 (2021). https://doi.org/10.1007/s11277-021-08397-0.
33. C Chandru Vignesh, S Karthik, Predicting the position of adjacent nodes with QoS in mobile ad hoc networks, Journal of Multimedia Tools and Applications, Springer US,Vol 79, 8445-8457,2020