REVIEW: AUTOMATIC APPLE FRUIT CLASSIFICATION USING SOFT COMPUTING MODELS

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Abstract— Agriculture is a major portion of the world economy as it provides food safety. As there are several verities of same fruits in the natural ecosystem, and it can be very difficult to distinguish between them. Botanists and the individuals who think about plants in any case, can recognize the kind of fruits by utilizing the attributes of the fruit and its plant. The manual identification of these fruit verities is a troublesome procedure which can be limited by utilizing computerized strategies for recognizing these different verities of same fruit. In this paper, a new strategy will be developed for identification and recognition of different verities of apple fruits by using soft computing models i.e. ANN, SVM, Fuzzy logic etc.

Keywords—*Apple recognition, apple classification, ANN, SVM, Fuzzy logic.*

I. INTRODUCTION

The fruit industry plays a crucial job in a nation's monetary development. They represent a small amount of the agricultural yield produced by a nation. It forms a part of the food processing industry. Fruits are a major source of energy, vitamins, minerals, fiber and other nutrients. They add to a basic part of our eating routine. Natural products like fruits come in different shapes, colors and sizes. Some of them are exported to other countries, in this manner returning profit to the business industry Fruit sorting and grading are performed before export. This determines the quality of the organic products like fruits which is an essential factor in the food processing industry.

The food industry has broadly utilized machine vision for quality investigation of organic products like fruits, vegetable and processed food [1]. The initial phase in machine vision is image acquisition, followed by image processing and finally, getting the required yield, which could possibly fulfill the necessities of the client or user. Computer vision utilizes the idea of feature detection, a low-level picture processing task. These highlights or features are then extricated resulting in a feature vector which recognizes a fruit, in view of color, shape, texture and intensity based highlights or features. They are then fed to various classifiers to classify them accordingly.

The various applications of fruit recognition and classification are in agricultural and horticultural fields, in robotic fruit harvesting, where robots detect fruits on trees grown in large plantations, which can later be harvested. It also finds application in plantation science and in supermarkets to identify fruits. It can likewise be applied for educational or instructive reason to enhance learning, particularly for little children and down's disorder patients [2]. Fruit industry contributes a noteworthy part in country's development, but there has been a reduction in production of good quality natural products like fruits, because of manual examination, absence of information of fast quality assessment systems. Additionally, rising labor costs, deficiency of talented specialists, and the need to enhance creation forms have all put pressure on makers and processors for the interest of a fast, financial, reliable and nod-destructive investigation technique. In such a situation, computerization can diminish the expenses by promoting production efficiency. Programmed natural product grading and sorting or arranging requires the implementation of computer vision frameworks.

The utilization of Computer Vision Systems in agribusiness has expanded impressively as of late, since it gives significant data about the nature and properties of the produce, diminishes costs, ensures the support of value principles and gives helpful data in real time. PC vision is a novel innovation for acquiring and analyzing a picture of a genuine scene by PCs to control machines or to process it. It incorporates capturing, processing and analyzing pictures to encourage the goal and non-

dangerous evaluation of visual quality attributes in agricultural and food products. The procedures utilized in picture examination incorporate picture acquisition, picture pre-processing and picture interpretation, prompting evaluation and classification of pictures and objects of enthusiasm within images. The overall appearance of fruit object is a mixture of its chromatic traits (color) and its geometric properties (shape, estimate, texture), together with the presence of imperfections that can decrease the outer quality. Subsequently mechanized fruit gradation assumes an imperative job to increase the estimation or value of produces. Automatic fruit classification offers an extra advantage of decreasing abstraction emerging from human experts.

II. REVIEW LITERATURE

Chowdhury et al. (2013) have perceived 10 distinct vegetables utilizing the shading histogram and measurable surface highlights. They have picked up the grouping exactness up to 96.55% utilizing a neural system as a classifier [3]. Danti et al. (2012) grouped 10 sorts of verdant vegetables utilizing BPNN classifier with a triumph rate of 96.40%. They first edited and resized the picture and after that removed the mean and scope of shade and immersion channel of HSV picture to shape the element vector. Suresha et al. (2012) have accomplished 95% arrangement precision over a dataset of containing 8 kinds of various vegetables utilizing surface measures in RGB shading space. They have utilized watershed division to extricate the district of enthusiasm as a pre-preparing and choice tree classifier for preparing and order reason.

Omid et al. (2013) utilized shape, surface and shading highlights to sort tomato natural products as per their circularity, measure, development and imperfections. They accomplished 84.4% precision for deformity location utilizing a probabilistic neural system (PNN) classifier. Shading, surface and shape highlights have been assessed for organic product deformity identification framework, likewise in conjunctions with PNNs [3].

Dubey and Jalal (2012a referred to in Dubey and Jalal 2013) proposed a system for perceiving and characterizing leafy foods vegetables. They thought about pictures of 15 unique kinds of products of the soil gathered from a general store [3] [9]. Their approach was to initially portion the picture to separate the district of intrigue and after that figure picture highlights from that sectioned area which was additionally utilized in preparing and characterization by a multi-class bolster vector machine. They likewise proposed an Improved Sum and Difference Histogram (ISADH) surface component for this sort of issue. From their outcomes, ISADH outflanked the other picture shading and surface highlights.

Haiguang et al. (2012) grouped two sorts of wheat sicknesses dependent on shading, shape and surface highlights to prepare a back proliferation neural system. The subsequent framework accomplished an arrangement precision of over 90%. Arefi et al. (2011) built up a division calculation for the direction of a robot arm to pick the ready tomato utilizing picture preparing procedure. To achieve this point, they arranged a machine vision framework to secure pictures from a tomato plant. Their calculation works in two stages: (1) foundation subtraction in RGB shading space and afterward extricating the ready tomato considering a mix of RGB, HSI, and YIQ shading spaces and (2) limiting the ready tomato utilizing morphological highlights of the picture. They accomplished precision up to 96.36% on 110 tomato pictures [3]. Haidar et al. (2012) introduced a technique for grouping of date natural products consequently dependent on example acknowledgment and PC vision. They extricated suitably made a blend of 15 distinctive visual highlights, and after that, attempted various grouping techniques. Their execution extended somewhere in the range of 89% and 99%.

Cho et al. (2013) utilized hyperspectral fluorescence imaging for recognizing splitting deformities on cherry tomatoes. Omid et al. (2013) utilized shape, surface and shading highlights to sort tomato organic products as per their circularity, estimate, development furthermore, absconds. They accomplished 84.4% precision for imperfection recognition utilizing a probabilistic neural system (PNN) classifier [3]. Danti et al. (2012) grouped 10 sorts of verdant vegetables utilizing BPNN classifier with a triumph rate of 96.40%. They originally trimmed and resized the picture and after that separated the mean and scope of shade and immersion channel of HSV picture to shape the component vector. Suresha et al. (2012) have achieved 95% order exactness over a dataset of containing 8 kinds of various vegetables utilizing surface measures in RGB shading space. They have utilized watershed division to separate the locale of enthusiasm as a pre-handling and choice tree classifier for preparing and grouping reason.

III.SVM

The test set for this evaluation experiment watermark image randomly selected from the internet. Matlab 7.0 software platform is use to perform the experiment. The PC for experim The Support Vector Machine (SVM) was first　proposed by Vapnik and has since pulled in a high level of interest for the AI research about network [4]. A few ongoing investigations have announced that the SVM (bolster vector machines) for the most part are fit for conveying higher execution regarding classification exactness than different information classification algorithms. Sims have been utilized in a wide scope of genuine world issues, for example, content arrangement, manually written digit acknowledgment, tone acknowledgment, picture arrangement and item identification, smaller scale cluster quality expression information examination, information arrangement. It has been demonstrated that Sims is reliably better than other supervised learning strategies. Thus, the client typically needs to conduct broad cross approval all together to make sense of the ideal

parameter setting. This procedure is generally referred to as model choice. One practical issue with model choice is that this process is very tedious. We have explored different avenues regarding various parameters related with the utilization of the SVM algorithm that can affect the outcomes [5]. These parameters include decision of piece works, the standard deviation of the Gaussian portion, relative loads related with slack factors to represent the non-uniform [6] distribution of marked information, and the quantity of training examples.

SVMs are set of related supervised learning techniques utilized for characterization and regression [7]. They have a place with a group of generalized linear classification. An uncommon property of SVM is SVM all the while minimize the observational classification mistake and maximize the geometric edge. So SVM called Maximum Margin Classifiers. SVM depends on the Structural risk Minimization (SRM) learning instrument utilized for arrangement and regression [8].

AI is capacity to enable the PC to learn. It utilizes calculation and methods which perform diverse tasks and exercises to give efficient learning. It utilizes nonlinear mapping to change over the unique information into higher measurement. Its goal is to build a capacity which will effectively predict the class to which the new point belongs and the old points. With a fitting nonlinear mapping, two informational collections can generally be divided by hyperplane. Hyperplane isolates the tuples of one class from another and explain decision limit [10]. There are numerous hyper planes that separate the information however just a single will obtain highest division. The principle purpose for highest edge or division in such a case that we utilize a decision limit to arrange, it might finish up closer to one lot of datasets contrasted with others. This was the situation when information is linear but for the most part we determine information is non-linear and data set is indivisible then we use pieces.

The center reason for SVM is to separate the information with decision limit and extends it to non-linear limits utilizing kernel trick. Significant advantage of SVM is flexible methods distinctive Kernel capacities can be indicated for the decision capacity. General kernals are given, but it is likewise possible to indicate custom kernals. SVM becomes prominent when we utilized pixel maps as information; it gives correctness similar to neural systems with detailed features in a handwriting acknowledgment task. Support vector machine is utilized for numerous applications, for example, content arrangement, design acknowledgment, face acknowledgment, handwriting examination yet particularly for classification and relapse applications. Neural Networks are simpler to apply than support vector machine but at some time it gives insufficient outcomes. Indeed, even the perceptron learning calculations (for example gradient descent) are slower than SVM learning. SVM has been observed to be unbeaten when utilized for pattern classification problems. One of the significant test is that of picking a reasonable kernal for given application. Yet, there are numerous standard or default decisions for example,

Gaussian or polynomial kernal however if these demonstrate useless then progressively detailed kernals are required.

As a well-known AI algorithms, SVM is another new generation learning system based on ongoing advances in measurable learning theory [12]. It understands the theory of VC measurement and guideline of basic risk minimum to establish a target work and after that discover a segment hyperplane that can fulfill the class necessity. The essential thought of SVM can be depicted as follows. Ist off all, look through an optimal hyperplane fulfills the request of classification. Besides, utilize a specific calculation to make the edge of the partition close to the optimal hyperplane maximum while guaranteeing the correctness of right classification. By then, the distinguishable information can be arranged into classes satisfactorily. As a type of structural risk minimization based learning algorithms, SVM have better generalization capacities contrasting with other traditional experimental risk [13] minimization based learning algorithms. The diagram of the SVM is depicted below.
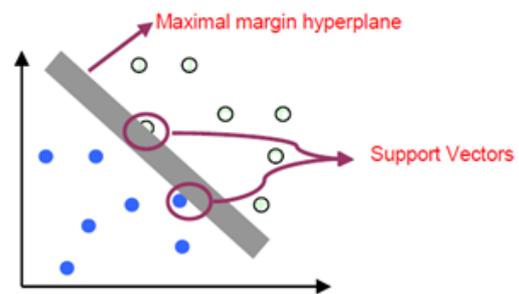

Fig. 1.   An illustration of SVM

IV. FUZZY LOGIC AND ITS APPLICATIONS

Fuzzy logic is a multi-valued logic acquired from fuzzy set theory manages the human reasoning that ranges from 'practically sure' to 'all around impossible'[14]. Conversely to classical propositional logic (true/false), the membership value of fuzzy logic factors are not just 0 also, 1 however it would be able to extend somewhere in the range of 0 and 1. While utilizing linguistic variables these degrees might be overseen by specific functions, as examined below. For instance, give a 100 ml a chance to glass contain 40 ml of water. At that point we may think about two ideas: Empty and Full. Fuzzy set explains the importance of both the ideas. At that point one may explain the glass as being 0.6 vacant and 0.4 full [15]. As the idea of vacantness would be abstract and in this way would depend on the observer or designer [16].

A.   Fuzzy Logic in Bioinformatics –

Bioinformatics combines the multi-disciplinary region, for example, software engineering, science, physical and chemical standards, planning of tools used for the examination and demonstrating of huge biological informational collections, chronic diseases management, learning of atomic computing and cloning etc. The field of bioinformatics is escalating for innovative work of new innovation. Presently fuzzy inference advancements are more than once applied in bioinformatics. For instance, increment the suppleness of protein themes and find out about the qualification among polynucleotide, using the fuzzy versatile resonance theory for the examination of test expression information, applying the dynamic programming algorithm for the arrangement of the groupings dependent on fuzzy recast, fuzzy k-closest neighbors algorithm used to distinguish the proteins sub-cell areas from their dipeptide piece, applying fuzzy c-means and partitioning strategy for trademark group relationship estimations of qualities, investigation of quality appearance information, useful and familial connections between amino acids with the assistance of fuzzy alignment technique, fuzzy classification rules produced by neural system design for the investigation of issues among qualities and decode of a hereditary set-up to process micro-array pictures, utilization of fuzzy vector filtering structure in the classification of amino acid arrangements in to various super families and so forth.

B.   Fuzzy Logic and Anesthetics–

The anesthetic specialists deal with the consciousness also, unconsciousness, pain and its ease, development of muscles and relaxation during specified time run. In the activity theater anesthetized tolerant is a piece of a 'criticism circuit' (Figure 2) for the time of a task. At the time of observing the consistency of the patients, on the off chance that any change happens in pulse and respiratory rate at that point manage the ventilation [18] and adjust the medication measurements. In this procedure anesthetist will assume the job of leader and controller, who will make his own choice to perform best. In a progression of ventilated patients Schaublin and colleagues tried a fuzzy logic program that checked CO2 and end tidal CO2 and modified ventilator recurrence and tidal volume to keep end-tidal CO2 at a wanted dimension. The execution of system was not less well than the anesthetist regular practice under comparative conditions. Fuzzy logic have been connected to quantify the pulse, tidal volume, breathing recurrence and oxygen immersion , to set up the necessity for pressure support ventilation in escalated care.
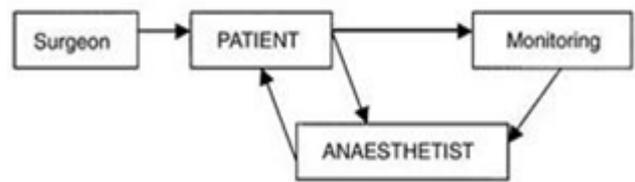

Fig. 2.   Watermark embedding algorithm Block Diagram

C.   Fuzzy Logic in Medicine–

In the area of medicine fuzzy logic play an basic job a few models in which fuzzy logic have been executed are as per the following: Detection of diabetic [19] retinopathy in the early hours and investigate diabetic neuropathy, to choose the reasonable lithium dose, cerebrum tissue volume have been determined from magnetic resonance imaging (MRI) and to investigate useful MRI information. To distinguish breast cancer, prostate disease, or lung malignant growth, to help the conclusion of tumors in central nervous systems (astrocytic tumors), to recognize kind skin slices from threatening melanomas, to imagine nerve strands in the human cerebrum, to show the quantitative estimation of medication use, to think about the sound-related P50 segment in schizophrenia, to learn fuzzy epidemics, to define choices in nursing.

V. ANN

Artificial Neural Networks are moderately unprocessed electronic models which is dependent on the neural structure of brain [20]. The mind fundamentally learns from experience. It is common confirmation that a few issues that are past the extent of current PCs are to be sure feasible by little energy effective bundles. This better approach to manage processing in like manner gives an increasingly corruption at the time of system over-burden than its dynamically standard accomplices. These naturally propelled techniques for computing are believed to be the following real progression in the processing business [21]. Indeed, even straightforward animal minds are fit for capacities that are at present not possible for PCs. PCs do repetition things well, such as keeping records or performing complex math. Presently, advances in biological research ensure a fundamental understanding of the typical thinking segment. This exploration demonstrates that brains store data as examples. This method of securing information as precedents, utilizing those models, and a short time later dealing with issues wraps another area in computing. This field, as referenced already, does not utilize standard programming but instead incorporates the creation of significantly parallel systems and the readiness of those systems to deal with detailed issues.

For the most part neural system was utilized to refer as framework or circuit of natural neurons , anyway present day utilization of the term much of the time refer [22] to ANN. ANN is numerical model , a data preparing worldview for example motivated by the way biological nervous system, for example, brain data system[17]. All the ANN neurons working as one to take care of unique or difficult issues. ANN is designed for taking care of artificial intelligence issues without making a model of genuine biological system. ANN is utilized for speech acknowledgment, picture investigation and versatile control so on. All of the above applications are done through a learning procedure, such as learning in biological system, which includes the change between neurons through synaptic association. Same occur in the ANN.
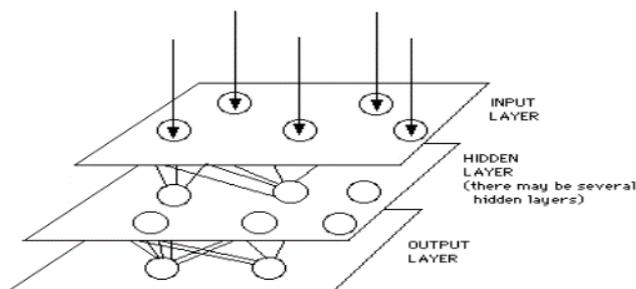

Fig. 3. A Simple Neural Network Diagram

Artificial Neurons are the fundamental unit of Artificial Neural Network which replicates the four essential capacity of biological neuron [11]. It is a numerical capacity which is imagined as a natural neuron model. The accompanying figure demonstrates the essential artificial neuron.
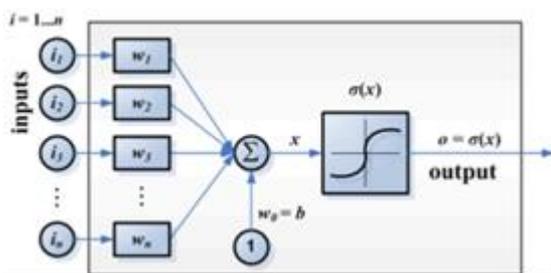

Fig. 4. Basic Artificial Neuron

In the above figure, different data sources are appeared by the scientific image, i (n).By connecting weights w (n) every inputs are multiplied. For the most part, this items are basically summed and sustained to the exchange capacity to produce the output results.

VI. CONCLUSION

On the basis of survey conducted, it has been deduced that soft computing models have shown a remarkable performance in fruit classification. While different number of promising technologies exist for the automatic apple fruit classification. This automatic apple fruit classification utilizing soft computing models will fill in as the pilot project that will be additionally extended out on a bigger scale. This has been utilized to distinguish between different types of apples by which farmers can sell different varieties of apples at their deserving quality price according to the qualities of apple classified using soft computing models.

This automatic apple fruit classification is done by using three different soft computing techniques like SVM for defect detection, ANN, and fuzzy logic through which nondestructive assessment of fruit classification is achieved. Correctness of these techniques are significantly high and can be implemented in actual practice quite easily.

VII. REFERENCE

[1] Suchitra A. Khoje, Dr. S. K. Bodhe, Dr. Alpana Adsul, "Automated Skin Defect Identification System for Fruit Grading Based on Discrete Curvelet Transform", International Journal of Engineering and Technology (IJET), Vol 5 No 4 Aug-Sep 2013.

[2] Woo Chaw Seng and Seyed Hadi Mirisaee, "A New Method for Fruits Recognition System", MNCC Transactions on ICT, Vol. 1, No. 1, June 2009.

[3] Misigo Ronald and Miriti Evans, "Classification of Selected Apple Fruit Varieties Using Naive Bayes" Misigo Ronald et al / Indian Journal of Computer Science and Engineering (IJCSE), ISSN: 0976-5166 Vol. 7 No. 1 Feb-Mar 2016.

[4] JieyueHe , Hae-JinHu , RobertHarrison , Phang C.Tai and YiPan, "Transmembrane segments prediction and understanding using support vector machine and decision tree", Expert Systems with Applications, Volume 30, Issue 1, January 2006, Pages 64-72. Retrieved from https://www.sciencedirect.com/science/article/pii/S09574 17405002411

[5] Ramon Gouveia Rodrigues , Celso Camilo-Junior , and Thierson Couto , "A Taxonomy for Sentiment Analysis Field", International Journal of Web Information Systems 14(2):00-00 · May 2018,DOI:10.1108/IJWIS-07-2017-0048,. Retrieved from https://www.researchgate.net/publication/324902836_A_ Taxonomy_for_Sentiment_Analysis_Field.

[6] Jaskirat Singh and Sachin Sapatnekar ," Statistical timing analysis with correlated non-gaussian parameters using independent component analysis" San Francisco, CA,USA—July24-28,2006, ISBN:1-59593-381-6 DOI: 10.1145/1146909.1146953. Retrieved from https://dl.acm.org/citation.cfm?doid=1146909.1146953.

[7] A.Suárez Sánchez , P.J.García Nieto , P.Riesgo Fernández, J.J.del Coz Díaz and F.J.Iglesias-Rodríguez , "Application of an SVM-based regression model to the air quality study at local scale in the Avilés urban area (Spain)", Mathematical and Computer Modelling, Volume 54, Issues 5–6, September 2011, Pages 1453-

1466. Retrieved from https://www.sciencedirect.com/science/article/pii/S08957 17711002196.

[8] Kabiru O. Akande, Taoreed Owolabi, Ssennoga Twaha and Sunday Olusanya Olatunji, "Performance Comparison of SVM and ANN in Predicting Compressive Strength of Concrete", September 2014 DOI:10.9790/0661-16518894. Retrieved from https://www.researchgate.net/publication/265682979_Perf ormance_Comparison_of_SVM_and_ANN_in_Predicting _Compressive_Strength_of_Concrete.

[9] Dubey, S. R. (2012). Automatic Recognition of Fruits and Vegetables and Detection of Fruit Diseases. Master's theses, GLA University Mathura, India

[10] Putri W. Novianti, Victor L. Jong, Kit C. B. Roes and Marinus J. C. Eijkemans, 'Factors affecting the accuracy of a class prediction model in gene expression data'' , BMC Bioinformatics. 2015; 16: 199. Published online 2015 Jun 21. doi: 10.1186/s12859-015-0610-4

[11] Mehmet Saltan and Hüseyin Sezgin , "Hybrid neural network and finite element modeling of sub-base layer material properties in flexible pavements", Materials & Design Volume 28, Issue 5, 2007, Pages 1725-1730. Retrieved from https://www.sciencedirect.com/science/article/pii/S02613 0690600077X.

[12] Pretesh B Patel and Tshilidzi Marwala , "Caller behaviour classification using computational intelligence methods", International Journal of Neural Systems 20(1):87-93 · February-2010, DOI:10.1142/S0129065710002255, Retrieved from https://www.researchgate.net/publication/41549307_Calle r_behaviour_classification_using_computational_intellige nce_methods.

[13] Arindam Chaudhuri and KajalDe, "Fuzzy Support Vector Machine for bankruptcy prediction" Applied Soft Computing Volume 11, Issue 2, March 2011, Pages 2472-2486 https://doi.org/10.1016/j.asoc.2010.10.003, Retrieved from https://www.sciencedirect.com/science/article/pii/S15684 9461000253X.

[14] George J. Klir and Bo Yuan , "FUZZY SETS AND FUZZY LOGIC Theory and Applications" Library of Congress CataCoging-in-ruhlication Data Klir, Georga J., 1932—fuzzy SeU and fuzzy logic: theory and applications / George J. Mir, Bo YlatFr. czn.. ISBN 043-W1171-5 1. Retrieved from https://epdf.tips/fuzzy-sets-and-fuzzy-logic-theory-and-applicationse17786be32fb053e0aef318a4dd1cb4561301.h tml

[15] Babu Appat, "Fuzzy logic" ICT Enabled Training fortified with the age old Indian Instructional Principles, Published on Jan 5, 2012. Retrieved from https://www.slideshare.net/appat/fuzzy-logic-10819010.

[16] Miguel Cavique and António Gonçalves-Coelho, "REPEATABILITY IN DESIGN SCIENCE" Proceedings of ICAD2011 The Sixth International Conference on Axiomatic Design Daejeon – March 30-31, 2011, ICAD-2011-05, Retrieved from http://www.axiomaticdesign.com/technology/icad/icad20 11/ICAD-2011-Paper5-Cavique-and-Gonçalves-Coelho.pdf

[17] Md. Tanjil Sarker, Sanjida Noor And Dr. Uzzal Kumar Acharjee, "Basic Application and Study of Artificial Neural Networks", International Journal of Multidisciplinary Research Hub Volume 4, Issue 4, April 2017, ISSN: 2394-3122.

[18] Weschler, T, "Cervical Mucus and Your Fertility" (2002), New York, NY: HarperCollins Publishers Inc. Retrieved from https://americanpregnancy.org/getting-pregnant/cervical-mucus/.

[19] Ashish Patel, Shailendra K Gupta, Qamar Rehman, and M. K. Verma, "Application of Fuzzy Logic in Biomedical Informatics", Journal of Emerging Trends in Computing and Information Sciences , Vol. 4, No. 1 Jan 2013 , ISSN 2079-8407.

[20] Hadi Matar, Mahmoud Al-Zu'bi and Dr. Nihad Dib, "Artificial Neural Networks and Their Applications to Microwave Problems", Jordan university of science and technology. Retrieved from http://www.just.edu.jo/~nihad/files/mat/591/ANN-project.pdf

[21] Ray Y.Zhong , XunXu , EberhardKlotz and Stephen T.Newman, "Intelligent Manufacturing in the Context of Industry 4.0: A Review", Volume 3, Issue 5, October 2017, Pages 616-630. Retrieved from https://www.sciencedirect.com/science/article/pii/S20958 09917307130.

[22] Sakshi Tripath, "A Review on Prevention and Eradication of Poliomyelitis", Research & Review: Journal of Pharmaceutics and Nanotechnology, September 16, 2016, e-ISSN: 2347-7857 p-ISSN: 2347-7849. Retrieved from http://www.rroij.com/open-access/a-review-on-prevention-and-eradication-of-poliomyelitis-.php?aid=79687.

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