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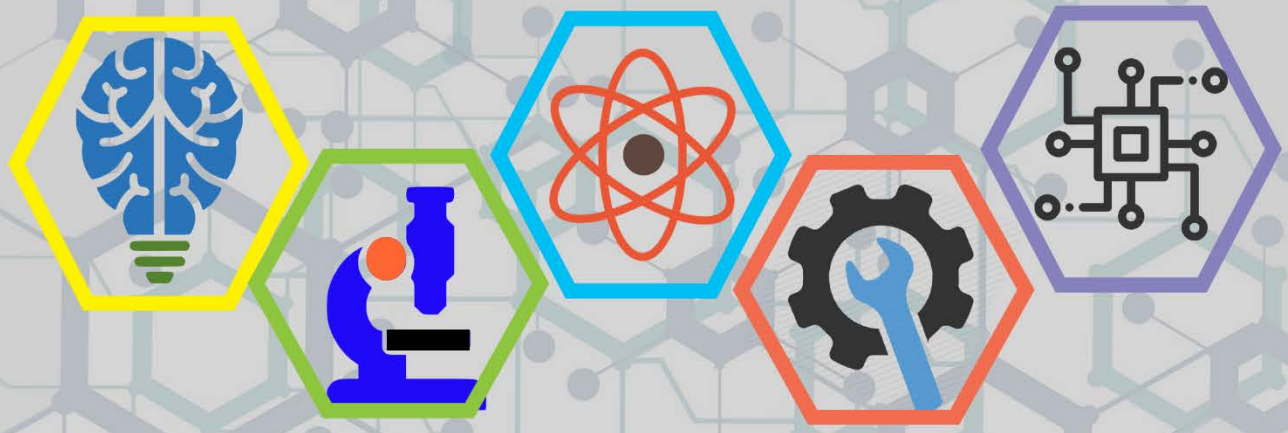

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ESTIMATION OF DEPRESSION DISEASE BY NEURAL FUZZY INFERENCE METHOD

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ABSTRACT: In this study, an ANFIS model that analyzes the data set of depression disease was established and the degree of disease was estimated in this study which was performed for the detection of depression disease by neural fuzzy logic inference method (ANFIS). The data set was prepared according to Beck Depression Test results. The Neuro Fuzzy Designer included in Matlab R2016b was used to process the data set using ANFIS method and generate estimation values. In ANFIS, sugeno method was used and Trimf was selected as the activation function. The learning method is the backpropa method known as the back propagation method. At the end of 50 trainings, the training error value was determined as 0.018197. The training error value resulting from processing a total of 200 disease records is in good condition. The actual values and the estimated values produced by the system were analyzed with SPSS Statistics software and standard deviation and error values were determined. The system is aimed to classify the degree of disease correctly according to the symptoms.

Keywords: ANFIS, Fuzzy Logic, Depression, Disease, Artificial Neural Network

1. INTRODUCTION

Depression, which has a direct or indirect effect on a large part of the society, is a mood disorder with negative emotions such as a reluctance of individuals for a long time, inability to enjoy life, gradually decreasing self-confidence and hopelessness [1]. In severe forms of depression, such as clinical depression, failure to treat may cause significant problems. When left untreated, depression can cause life-threatening problems such as alcohol and drug addiction. By reducing the communication of individuals with their environment, it may cause problems in working life as well as cause greater harm [2]. Clinical depression, called major depression, is a serious disorder that affects the physical and mental state of individuals. It is not possible for people suffering from depression to get out of depression immediately. Clinical depression, such as the use of psychotherapy and the use of antidepressant medications, may persist for months or even years.

Haznedar and Kalınlı carried out a study on the relationship between genetic disorders and thrombophilia disease by using adaptive network based fuzzy logic inference system (ANFIS). In their study, they used Adaptive Network Based Fuzzy Logic Inference System (ANFIS) and compared their results with those of some commonly used classification algorithms. They found that the results obtained with ANFIS were more successful than the results obtained [3]. Arslan and Hazneadar used the Adaptive Network-Based Fuzzy Logic Inference System (ANFIS) to

analyze the prostate cancer microarray gene expression problem. In their study, they compared the classification success of ANFIS model with the classification success of Artificial Neural Networks (ANN) and k-Nearest Neighbor (kNN) and J48 Decision Tree algorithms from traditional methods and as a result they found that ANFIS model was more successful than ANN and traditional algorithms [4]. In his master thesis, Kaya made important studies on the application of fuzzy logic methods for classification in the diagnosis of lung diseases. In this study, we designed a system using ANFIS (Adaptive Network Based Fuzzy Inference System) for the diagnosis of Mesothelioma disease known as membrane cancer. He concluded that the model he created with ANFIS showed a successful and satisfactory prediction performance and that the system was feasible [5]. Gökçe and Sonugür, used ANFIS method to carry the control of the production processes, recording, planning, stock management, the efficiency of natural stone blocks and estimating the production until the emergence of a stone-size raw slab that enters into a natural stone production enterprise as a block. In the study, they developed a system that can support business managers for planning and managing production with a relational database for the enterprise. Using the information in the database, they developed two different models using artificial neural networks and ANFIS, and with these models, they managed to estimate the efficiency and production times of the blocks. According to the efficiency estimation results, they found that sufficient success occurred in the artificial neural network model with the highest error rate of 4.9% [6].

In this study, a total of 200 disease data were used. Disease data set was formed according to Beck depression scale results applied to various patients. The Beck Depression Scale includes questions about physical and mental changes in the individual for at least one week and each question is answered by selecting one of the numbers 0, 1, 2 and 3. The severity of depression is determined by evaluating the sum of the numbers chosen for each question [7]. 150 records in the data set were used as training data. 50 records were used for test and control data. In the developed model, trimf membership function was used. At the end of the training, the error value was determined as 0,018197.

2. NEURAL FUZZY LOGIC INFERENCE SYSTEM (ANFIS)

The basis of ANFIS is Takagi-SugenoKang fuzzy inference system. Jang developed the ANFIS method in 1993 and used this new method to model nonlinear structures, control systems, detect nonlinear components and estimate chaotic time series [8].

In the first layer of the model in Figure 2, the values A_i and B_i are used to define characteristic expressions. The membership function assigns membership degrees to the values Ai and Bi and these values pass to the other layer. In the other layer, the input data is multiplied by each other and transmitted from a node. In the third layer, the activation values are proportional to the total activation values and normalization is performed. After the fourth layer, the Takagi-Sugeno-Kang model is activated. In Takagi-Sugeno-Kang Inference Method, the output variable is defined as a fixed number or variable-dependent function [9-10]. The outputs of the Takagi-Sugeno-Kang method are clear values away from turbidity. Therefore, no further clarification is required. As a result of the last layer, the total output value is obtained from the model.

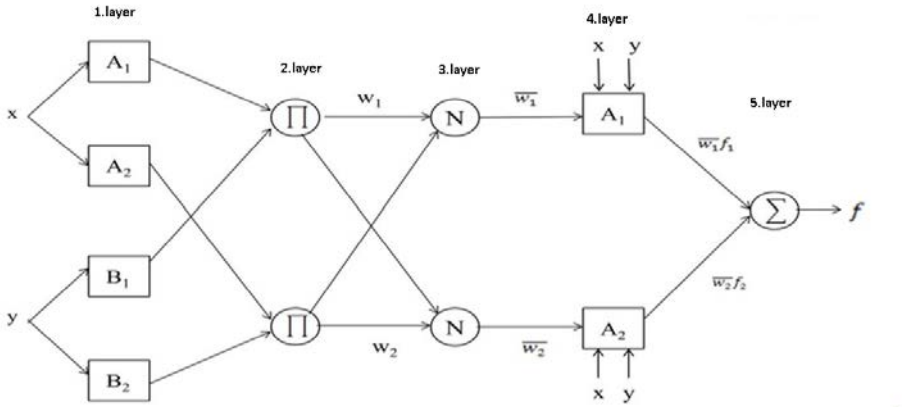

Figure 1. ANFIS Model [5]

To explain the process in mathematical expressions [11];

Set of rules: If, x A_i and y, B_i if $f_i=p_i. x+ q_i. y + r_i$

Layer 1: By selecting a membership function (μ (x)), membership degrees of character variables are determined.
($\mu A_i(x).\mu B_i(y)$)

Layer 2: $w_i= \mu A_i(x).\mu B_i(y)$

Layer 3: $\overline{w_l} = \frac{w_i}{\sum w_i}$

Layer 4: $\overline{w_l}$ = f_i is layer output.

Layer 5: $x_0 = \frac{\sum w_i.f_i}{\sum w_i}$

3. MODEL

3. 1. Beck Depression Inventory

Diagnosis and treatment guidelines recommend the use of screening tests for depression in primary care. Beck Depression Inventory for Primary Care is an internationally recognized scale used for this purpose [12]. Beck depression test aims to find and classify the severity of depression. The questions found in the test are listed Table 5. The degree of depression is grouped according to the scores obtained from the inventory as shown in Table 2.

Table 1. Depression rating scale.

Degree of Depression	Total
Minimal depression	0-9
Mild depression	10-16
Moderate depression	17-29
Severe depression	30-63

Correlation (1) was used to calculate the severity of depression according to the test.

$$Depression\ Severity\ Value = \frac{Test\ Total}{Maximum\ Value}\ x\ 4 \quad (1)$$

3.2. Structure of The Data Set

The data set used in the study was obtained from the study for Beck Depression Inventory [13]. The following table shows some of the data set we used in this study. The data set has three

input sequences containing subtotals from a total of 21 questions in the test and an output sequence containing the severity of depression. The data set contains approximately 1000 records. In this study, 200 of 1000 records were used as training, test and control data.

Table 2. Sample values from the data set used as system input.

1-7 Subtotal	8-14 Subtotal	15-21 Subtotal	Depression Severity
14,00	12,00	4,00	1,90476
13,00	18,00	20,00	3,23810
7,00	12,00	7,00	1,65079
18,00	14,00	11,00	2,73016
11,00	7,00	17,00	2,22222
8,00	15,00	7,00	1,90476
4,00	7,00	11,00	1,39683
15,00	18,00	6,00	2,47619
3,00	7,00	17,00	1,71429

3.3. Model Evolution

In the study, Matlab software was preferred for the formation of data matrices, development of fuzzy logic inference system and analysis in the system. Before the data to be processed in Matlab program was transferred to the workspace, some operations were performed on the data. The data to be used were normalized in Microsoft Excel software, and then training, test and control data groups were created and input variables of the model were created. The data were normalized by linear conversion to [0,1].

For this, the Equation 2 was used [14].

$$X_n = \frac{x_0 - x_{min}}{x_{max} - x_{min}} \quad (2)$$

Training, test and control dataset was formed from data set consisting of approximately 1000 records. Simple random separation method was used to create these clusters. In this method, 150 records in the data set are divided into training sets. A test set of 50 records was defined to test the accuracy of the system, and a control data set of 50 records was also identified to check the system. The square root (RMSE) (Equation 3) of the mean of the error squares was used to evaluate the accuracy of the output generated by the system [15].

$$RMSE = \sqrt{\frac{(p_1 - a_1)^2 + \cdots + (p_n - a_n)^2}{n}} \quad (3)$$

Triangle membership function (trimf) is selected as membership function. Because the minimum error value appears in the trimf function. The fault tolerance value of the system is set to 0. The backpropagation technique was optimized and the training was repeated 50 times. Figure 2 shows the comparison of training results with actual values.

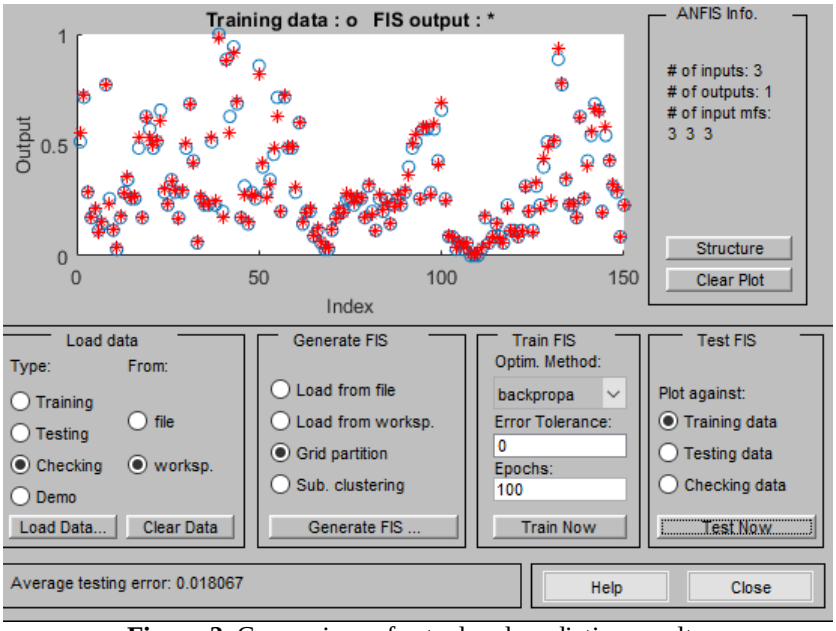

Figure 2. Comparison of actual and prediction results.

Since the accuracy of the developed system is desired to be measured with the test data, the estimation results of the system are compared with the actual values. The values represented by "*' in Figure 3 are the values estimated by the ANFIS system using test data. The values symbolized by "+ are actual values. The actual values and prediction values of the ANFIS system coincide to a great extent. The RMSE value was 0.013701.

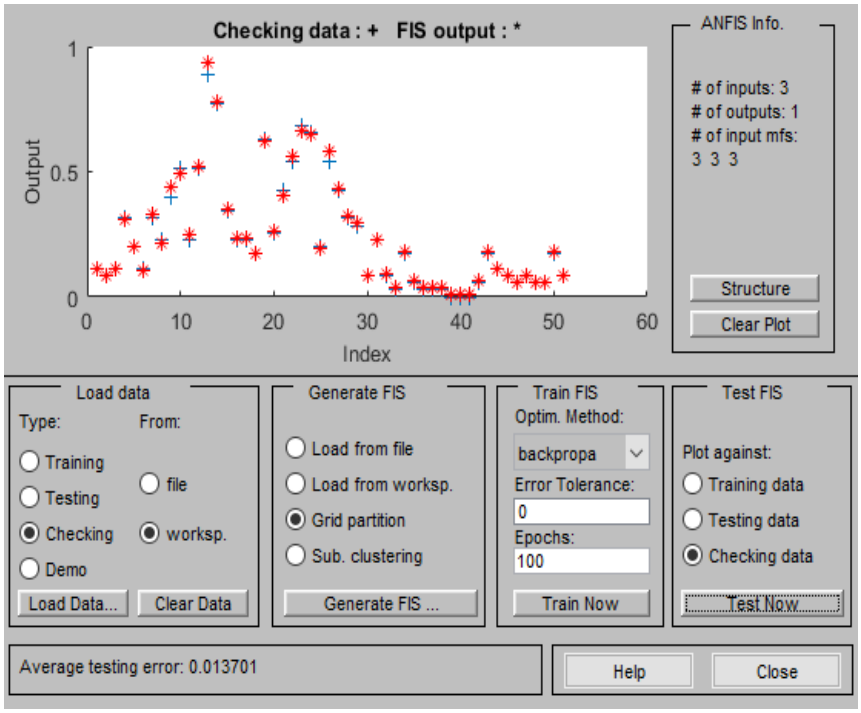

Figure 3. Comparison of the estimated values of the system with the actual values.

The developed ANFIS model has three inputs, one output and 27 rules. The network structure of the developed system is shown in Figure 4.

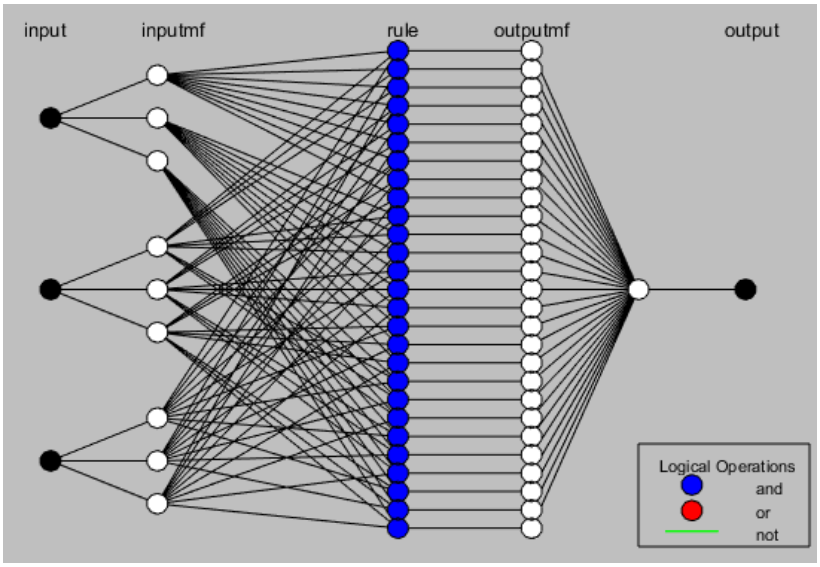

Figure 4. Network structure of the model created.

The membership functions and rules created for the input values of the developed ANFIS model are shown in Figure 5.

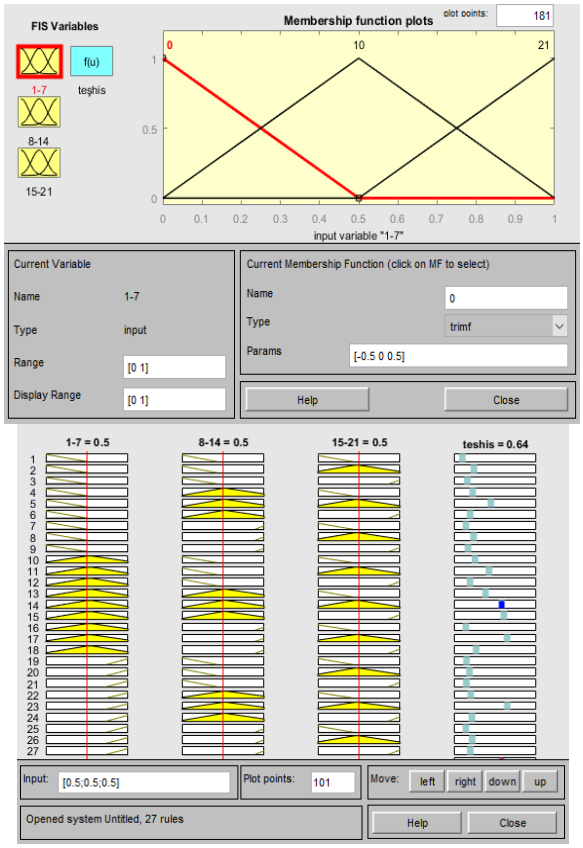

Figure 5. Membership functions of the model and rule table of developed model.

The variation of the error value according to the number of repeated training is shown in Figure 7.

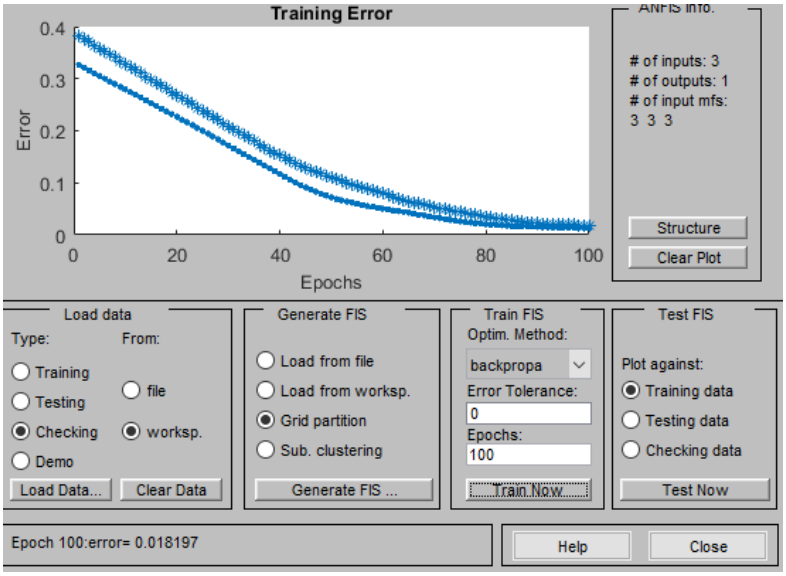

Figure 7. Error change during training.

Figure 8 shows the surface graphs showing the graphical distribution of the system created by the weights and effects of the inputs on each other after training.

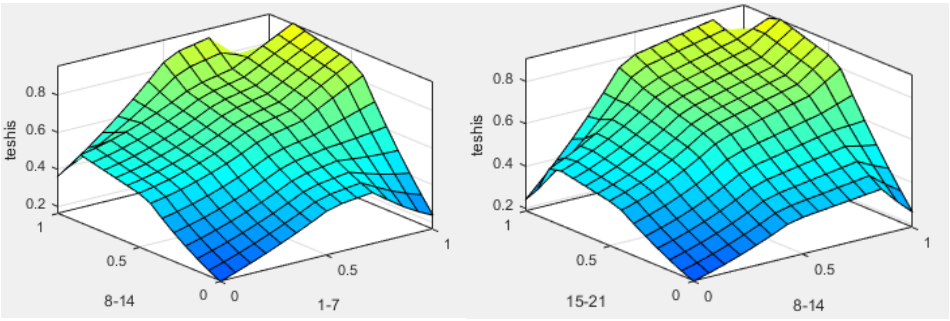

Figure 8. Model surface graphics.

In the Matlab program, the output of the system was created with the evalfish command and the related T test was performed in the SPSS analysis program to determine the similarity ratio between the estimated data and the actual values obtained. The results of the comparison in the SPSS program are shown in Table 3.

Table 3. Comparison of actual results and ANFIS results.

	Average	N	Standard. Deflection	R	p
Actual Results	,3135	150	,22097	,997	,000
ANFIS Results	,3158	150	,21967		

There is a significant similarity between the actual results and the system output ($p < 0.05$). The R value was 0.997 at the end of the test. This value means that the similarity between data is high and positive.

As can be seen from Table 4, the average of the differences is less than 0.05. This means that there is no difference between the output values. The system created according to these values is very successful in the diagnosis and classification of the disease.

Table 4. Comparison of actual results and system output.

	Differences Average	Standard. Deflection
Real Results - ANFIS Results	,00226	,01798

4. CONCLUSIONS

In this study, adaptive network based fuzzy logic inference system (ANFIS) was applied in MATLAB software to diagnose depression. In this study, a data set consisting of a large number of disease data was used. In the data set, 3 separate data series are defined as input variables. The expected result from the system is the accurate diagnosis of the degree of disease based on the data in the input sequences. Of the 1000 data lines in the data set, 150 were allocated as training data, 50 as test data, and 50 as control data. 50 learning were performed in the system.

REFERENCES

[1] Karamustafalioğlu, Yumrukçal, O. H., "Depression And Anxiety Disorders", Şişli Etfal Hospital Medical Bulletin, Volume: 45, Issue: 2, 2011

[2] Uğurlu, T.T., Şengül, C.B., Şengül, C., Psychopharmacology of Addiction, Current Approaches in Psychiatry-2012; 4 (1): 37-50

[3] Haznedar, B., Kalinli, A., "Determination Of The Relationship Between Thrombophilia Disease and Genetic Disorders with Adaptive Network Based Fuzzy Logic Inference System (ANFIS) SA, SAU Fen Bil Der 20. Volume, 1. Issue, p. 13-21, 2016

[4] Arslan, M.T., Haznedar, B., "Classification of Prostate Cancer Gene Expression Profile by ANFIS", International Mediterranean Science and Engineering Congress (IMSEC 2016), October 26-28, 2016, Adana / Turkey

[5] Kaya, H., Sınıf Classification and Application of Fuzzy Logic Methods in Lung Disease Diagnosis", Ankara University, Department of Computer Engineering, M.Sc. Thesis, Ankara

[6] Gökçe, B., Sonugür, G., Verim Productivity Analysis in Natural Stone Production Process Processed by ANFIS and ANN Methods", Afyon Kocatepe University Journal of Science and Engineering, 2016, pp: 174-185, DOI: 10.5578 / fmbd.13951

[7] Bozkurt, N., The Relationship Between Depression And Anxiety Levels and Various Variables Of A Group of University Students, Education and Science 2004, Vol 29, No 133 (32-39)

[8] Yucel, A. (2010), Integrated Neural Fuzzy Logic Approach to Supplier Selection Problem, Istanbul University, Department of Industrial Engineering, PhD Thesis, Istanbul.

[9] Jang, J.-S. R. (1993), F ANFIS: Adaptive-Network-Based Fuzzy Inference System ", IEEE Transactions on Systems, Man and Cybernetics, 23 (3), 665-685.

[10] Şen Z. (2004), Fuzzy Logic Modeling Principles in Engineering, Water Foundation Publications, Istanbul.

[11] Doğan, O., 2016. Kullanım The Use of Adaptive Neural Fuzzy Inference System (ANFIS) for Demand Forecasting and An Application", Dokuz Eylül University Journal of Economics and Administrative Sciences, Volume: 31, No: 1 ss: 257-288

[12] Beck, A. T., Ward, C., Mendelson, M., Mock, J., & Erbaugh, J. (1961). Beck depression inventory (BDI). Arch Gen Psychiatry, 4(6), 561-571.

[13] García-Batista, Z. E., Guerra-Peña, K., Cano-Vindel, A., Herrera-Martínez, S. X., & Medrano, L. A. (2018). Validity and reliability of the Beck Depression Inventory (BDI-II) in general and hospital population of Dominican Republic. PloS one, 13(6), e0199750.

[14] Süzen, A. A. (2019). LSTM Derin Sinir Ağları İle Üniversite Giriş Sınavındaki Matematik Soru Sayılarının Konulara Göre Tahmini. Engineering Sciences , 14 (3) , 112-118 .
http://dx.doi.org/10.12739/NWSA.2019.14.3.1A0436

[15] Süzen, A. A., & Kayaalp, K. (2018). Forecasting Temperature with Deep Learning Methods Samples of Isparta Province, International Academic Research Congress, 531-537.

APPENDIX

Table 5. Beck depression inventory.

1	0. I don't feel sad and distressed.
	1. I feel sad and distressed.
	2. I am always sad and distressed. I can't get away with this.
	3. I am so sad and distressed that I can't stand it anymore.
2	0. I am unhappy and pessimistic about the future.
	1. I am pessimistic about the future.
	2. I have nothing to expect from the future.
	3. I'm desperate about my future and it feels like nothing's going to be right.
3	0. I don't see myself as a failed person.
	1. I feel like I have more failures than most people around me.
	2. When I look back, I see that it is full of failures.
	3. I consider myself a completely unsuccessful person.
4	0. I enjoy many things as much as I used to.
	1. I don't like everything like before.
	2. Nothing gives me full pleasure anymore.
	3. I am bored of everything.
5	0. I don't feel guilty in any way.
	1. I feel guilty from time to time.
	2. I often feel guilty.
	3. I always feel guilty.
6	0. I feel punished.
	1. I feel I can be punished.
	2. Waiting to be punished.
	3. I feel punished
7	0. I am satisfied with myself.
	1. I am not very pleased with myself.
	2. I'm very angry with myself.
	3. I hate myself.
8	0. I don't think I'm worse than others.
	1. I criticize myself for weaknesses or mistakes.
	2. Because of my mistakes I always find myself guilty.
	3. I find myself wrong in every mishap.
9	0. I have no thoughts of killing myself. But I'm not.
	1. From time to time I would consider killing myself.
	2. I would love to kill myself.
	3. I would kill myself if I had the chance.
10	0. I can't cry more than ever.
	1. From time to time comes the cry.
	2. I cry most of the time.
	3. I could cry now, but now I can't.
11	0. Now I'm not more nervous than I have always been.
	1. I get angry or angry more easily than before.
	2. Now I'm always angry.
	3. The things that once made me angry now do not.
12	0. I have not lost my will to talk to others.
	1. I want to talk with others, to less than before.
	2. I have not lost my desire to talk and talk with others.

	3. I do not want to talk to anyone and see anyone.
13	0. I can decide as easily as before.
	1. I can't decide as easily as I used to.
	2. I have much difficulty in making decisions compared to the past.
	3. I can't make any decisions anymore.
14	0. When I look at myself in the mirror, I see no change.
	1. I feel older and ugly.
	2. I feel that my appearance has changed a lot and I'm ugly.
	3. I find myself very ugly.
15	0. I can work as well as I used to.
	1. I need to make an effort to do something.
	2. I have to push myself to do anything.
	3. I can't do anything.
16	0. I can sleep well as usual.
	1. I can't sleep as well as I used to.
	2. I wake up 1-2 hours earlier than usual and cannot sleep again.
	3. I wake up much earlier than usual and can't sleep again.
17	0. I'm not tired more quickly than usual.
	1. I get tired faster than ever.
	2. Everything I do tires me.
	3. I feel too tired to do just about anything.
18	0. My appetite is as usual.
	1. My appetite is not as good as usual.
	2. My appetite decreased.
	3. I have no appetite anymore.
19	0. I haven't lost weight recently.
	1. I lost more than two pounds.
	2. I lost more than four kilos.
	3. I am trying to lose more than six kilos.
20	0. My health does not worry me much.
	1. Pain, Ache, stomach disorders or constipation, such as discomfort, do not worry me.
	2. My health worries me, so it's hard to think about other things.
	3. I am so worried about my health that I can't think of anything else.
21	0. I haven't noticed a change in my interest in sexual issues lately.
	1. I am less interested in sexual issues than before.
	2. I am much less interested in sexual issues now.
	3. I have completely lost interest in sexual issues.

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MICROBIAL FUEL CELL POTENTIAL IN AUGMENTING NIGERIAS' ENERGY MIX

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ABSTRACT: Nigeria generates less than 10000MW of electricity. There is a pressing demand for the increase in power generation for domestic and industrial application. Energy mix is a solution to generate more power. Different technologies harness different energy stored in different element. The microbial fuel cell (MFC) harnesses the energy from organic matter. In this study, three single chamber MFCs and an organic battery was built and organic waste matter used as an energy source to power multiple LED indicator bulbs functioning as road traffic lights. The average power generated by the MFCs and microbial fuel battery (MFB) during the period under investigation was 3.27V and 8.15V daily. Materials selected for the electrodes were cylindrical graphite rods and aluminium plates, while the organic matter used as electrolyte was a mixture of cow dung and water in the ration of 4:1 by weight. Tests and experiments indicated the MFC can be used in a redesigned road traffic light and safety signs to function from power generated from the MFC. Results indicated the use of organic waste matter in the MFC can serve to augment Nigeria's energy mix while simultaneously managing organic waste matter generated and improving the state of the economy.

Keywords: Microbial Fuel Cell, Mediatorless, Organic Matter, Power, Voltage, Current, LED bulbs, Traffic Lights, Energy Mix

1. INTRODUCTION

There is global concern about the negative effects on the environment from the continued use of fossil fuels for power generation; hence identification of renewable energy sources and the development of technology's used in harnessing such energy for power generation is of great importance to scientist and engineers globally [4,8]. Nigeria, a sub-Sahara African country with a population of over 180 million has electric power generation capacity of 10000MW and transmits about 4000MW. It has been identified that economic viability of a nation is dependent on the electric power generated, transmitted and utilised [9].

Electric power can be generated via coal, oil and natural gas; hydro-power, water turbine; nuclear power; solar-wind or water wave turbine; solar thermal generator and solar voltaic generator; however, Nigeria generates power from gas-fired and hydro-electric turbines for bulk generation. The amount of electric power generated from these sources is insufficient to meet domestic, industrial and social demand; hence other energy sources need to be harnessed to improve the power generation in Nigeria [10].

Waste is regarded as unwanted material which is disposed of or cannot be reused after primary use [17]. The amount of waste generated annually in Nigeria exceeds 30 million tonnes and over 50% is organic in nature. Organic matter can be used to generate electricity with the use

of MFC. Though the electric power generated is low, it however finds applications in wastewater treatment, environment sensors for geographical weather monitoring, bioremediation and hydrogen production. Waste generated is improperly managed in Nigeria, with more that 80% not collected for recycling or proper disposal. Failure to properly manage waste generated leads to environmental dilapidation as well as a threat to public health safety [18].

Social energy demand such as energy required for functionality of road traffic lights, road safety signs which helps check road user is often times not available. Due to the current challenges of inability to meet the energy requirement for development and its sustenance such as that required for the powering of road traffic lights and road safety signs, the Federal, State and Local government have resulted to using solar power system to meet this energy demand; however, the solar power system is under threat of theft as a result of the high cost of procurement and the high demand, and the environment as it dependent on the availability of sunlight (insolation). This leads to unchecked road traffic, use of human capital in road traffic control, thereby reducing human productivity. An alternative clean energy source that is cheap readily available and suitable is required to meet the social energy demand. The microbial fuel cell can be utilized in road traffic while simultaneously helping to manage the organic waste generated.

The microbial fuel cell is a device which is used to harness the stored chemical energy in organic matter by converting it directly to electrical energy. There are two types of MFC i.e. mediator and mediatorless MFC [3,19]. Power generated from the MFC is in microwatts but currently finds application in geographical environmental sensors. It can also find application for different social energy demand, for example, in the redesign of road traffic light and safety signs that requires micropower for operation. The MFC has an energy conversion rate of machine or device, hence, there is therefore the need to harness the chemical energy stored in organic waste matter and convert it to electrical energy in the MFC to augment the energy mix for increased power generation while simultaneously efficiently and effectively managing the organic waste generated.

While the current power generated in Nigeria is below the demand, distribution companies resolve to distributing power on an intermittent basis leading to economic stagnation. A stand-alone road traffic or street light powered solely from the electrical energy harnessed from a microbial fuel battery built from waste materials and agricultural waste (cow dung) will reduce the current load on the infrastructure in the power sector as there will be no direct connection with the nation's power grid. This will enable the rerouting of the power utilized for operating road traffic or street light to other production industries and technologies for economic growth and development.

The MFC technology is a maturing industry with positive prospects with regards to economic development. With further development, MFCs have the potential to produce hydrogen for fuel cells, desalinate sea water, and provide sustainable energy sources for remote areas.

2. METHODS

The materials and method applied in the execution of this work is tabulated and explained below.

Three single chamber microbial fuel cells labelled I, II and III respectively were built and connected in series. Scrap aluminium plates were collected from a manufacturing warehouse, cut and folded into multiple rectangular plates which were used as the anode electrode. Cylindrical graphite rods were purchased from a local dealer and were used as the cathode electrode in the each MFC. 8, 6 and 4 electrodes each of aluminium plates were together connected in series respectively thereby increasing the surface area. 8, 6 and 4 graphite rods were also together connected in series with the same motive of increasing the surface area. The ratio of aluminium electrode to graphite electrode used for the three cells was 2:1. The series connections of the various respective aluminium and graphite electrodes were placed in three separate plastic containers and prevented from touching each other with the use of a cut out rubber separator. Cow dung was collected from an abattoir and charged into each MFC. Functionality of the MFCs was tested with an LED indicator bulb. From experimental results, an organic fuel battery was built and used to power a multiple LED indicator bulbs arranged in the form of a road traffic light. The voltage and current output data was measured with a multimeter and the pH level of the organic matter was measured using a pen-type pH meter. The setup was monitored for a period of 28 days.

Table 1. Material used and their function

S/N	Material/Equipment	Function
1	72 polyethylene (PET) bottles	Each PET bottle functioned as one MFC chamber
2	Electrodes (Aluminium plates and cylindrical graphite rods)	The electrode is to establish the presence of a potential difference which the microbes transfer the released electrons to.
3	Organic matter (cow dung + blended fruits)	The organic matter is the source of fuel in the MFC.
4	Flexible copper wires	Connected between both electrodes, its function is to transfer the electrons deposited at the anode electrode through the equipment or machine to be powered and then through to the cathode electrode.
5	LED bulbs	Used to test the functionality of the MFC.
6	Pen-type pH meter	Used to obtain the pH value of the organic matter.
7	Electrical multimeter	Used to obtain voltage and current parameters of the organic matter.

3. EXPERIMENTAL

Mathematical formulae were used to obtain the values of parameters such as power and power density as expressed in (3) and (4) respectively.

Area of aluminium electrodes (A_a) = 2 * l * b (1)

Area of graphite electrode (A_g) = $2\pi r(r + h)$ (2)

Power (P) = voltage (V) * current (I) i.e. P = VI (3)

Power density (Pd) = (Power (W)) / (Total surface area (mm2)) (4)

Volume of containers (V) = length (l) * breadth (b) * height (h) (5)

3.1 Series and Parallel Connection of MFCs

The microbial fuel cell is similar to other electrical cell. The MFC obeys the principles of electricity and therefore may be connected in same way other electrical cells are connected. Figure 1 shows the series connection of the MFCs. Equation 6 and equation 7 shows the mathematical relationship of the total voltage output obtained from the resulting series

connection. Equation 8 shows the mathematical relationship of the total current output ($MFC_{t.current}$) obtained from the resulting series connection.

Figure 2 show the parallel connection of the MFCs. Equation 9 and equation 10 shows the mathematical relationship of the total voltage output obtained from the resulting parallel connection. Equation 11 show the mathematical relationship of the total current output ($MFC_{T.current}$) obtained from the resulting parallel connection.

3.1.1 Series Connection

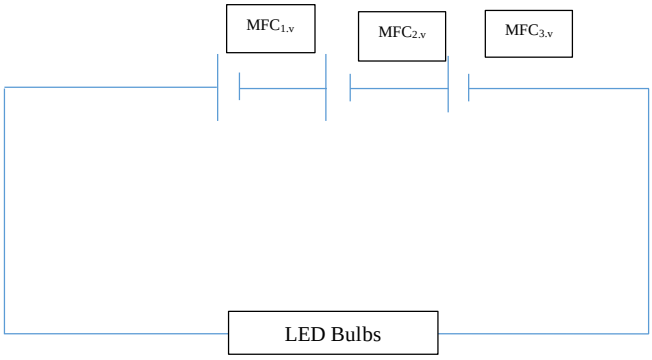

Figure 1. Series connection of the MFCs

Total MFC voltage output ($MFC_{T.volt}$) = $MFC_{1.v} + MFC_{2.v} + MFC_{3.v}$ (6)

Total MFC current output ($MFC_{t.current}$) = $\frac{1}{MFCt.current} = \frac{1}{MFCI1} + \frac{1}{MFCI2} + \frac{1}{MFCI3}$ (7)

Total current output ($MFC_{T.current}$) = $\frac{(MFCI2\ X\ MFCI3)+(MFCI1\ X\ MFCI3)+(MFCI1\ X\ MFCI2)}{(MFCI1\ X\ MFCI2\ X\ MFCI3)}$ (8)

3.1.2 Parallel Connection

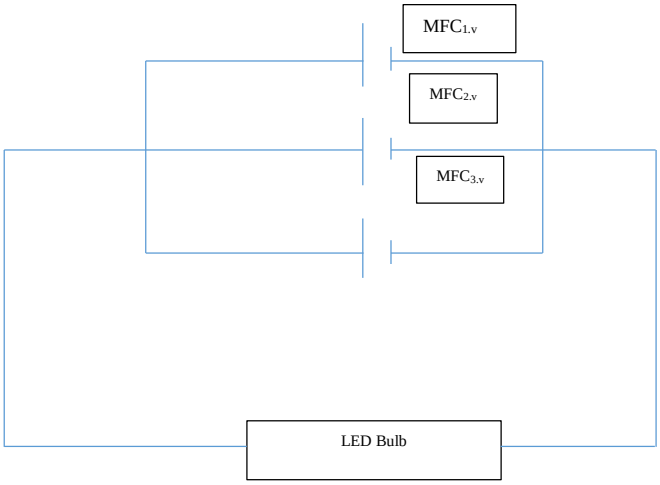

Figure 2. Parallel connection of MFCs

Total voltage output ($MFC_{t.volt}$)

$$\frac{1}{MFCt.volt} = \frac{1}{MFC1.v} + \frac{1}{MFC2.v} + \frac{1}{MFC3.v} \quad (9)$$

$$MFC_{t.volt} = \frac{(MFC2.v\ X\ MFC3.v)+(MFC1.v\ X\ MFC3.v)+(MFC1.v\ X\ MFC2.v)}{(MFC1.v\ X\ MFC2.v\ X\ MFC3.v)} \quad (10)$$

Total current output ($MFC_{T.current}$) = $MFC_{I1} + MFC_{I2} + MFC_{I3}$ (11)

3.2 Microbial Fuel Battery (MFB) Specification

In this research work, the fabricated fuel battery specification was obtained from the data collected. This is presented below. Table 2 show the volume of electrolyte in each MFC of the MFB

Number of stacked MFC = 6

Number of single cells in each microbial fuel battery = 12

3.2.1 Volume Calculation

The plastic container used for each single cell in the MFB was of the same type and dimension. Plastic containers used were a hollow rectangular shape having dimensions of 65mm by 65mm by 130mm.

Volume of single cell container = 65mm * 65mm * 130mm

$$= 549250mm^2$$

Volume of single cell electrolyte (slurry) = 65mm * 65mm * 120mm

$$= 507000mm^2$$

Table 2. Volume of electrolyte in the MFC of the MFB

S/No	Microbial Fuel Cell	Volume of Electrolyte (mm^3)
1	Cell 1	507000
2	Cell 2	507000
3	Cell 3	507000
4	Cell 4	507000
5	Cell 5	507000
6	Cell 6	507000
7	Cell 7	507000
8	Cell 8	507000
9	Cell 9	507000
10	Cell 10	507000
11	Cell 11	507000
12	Cell 12	507000
Total		**6084000**

3.2.2 Electrode Specification

Total area of aluminium electrode (mm^2) = $74496mm^2$

Total area of graphite electrode (mm^2) = $35152.42mm^2$

Ratio of graphite to aluminium electrode = 1 : 2

4. RESULTS

Table 3. Readings from MFC 1.

Sample Description and Parameters	The cathode is graphite and the anode aluminium. The electrolyte is cow dung mixed with water.					
	Average area of graphite electrode				1.91 square cm	
	Total area of graphite electrode				15.26 square cm	
	Average area of aluminium electrode				30.94 square cm	
	Total area of aluminium electrode				247.5 square cm	
	Mass of dung				4kg	
	Mass of water added				1kg	
	Total Mass				5kg	
Day	pH	Volt (V)	Current (mA)	Power (mW)	Power Density (mW/mm^2)	LED Bulb Status
1	5.42	0.73	10.87	7.94	0.106	ON
2	5.57	0.72	10.53	7.58	0.101	ON
3	5.71	0.71	10.46	7.42	0.099	ON
4	5.96	0.65	8.63	5.61	0.075	ON
5	6.03	0.67	6.12	4.1	0.055	ON
6	6.14	0.68	6.2	4.22	0.057	ON
7	6.38	0.65	5.87	3.82	0.051	ON
8	6.41	0.65	4.81	3.13	0.042	ON
9	6.59	0.65	4.39	2.85	0.038	ON
10	6.71	0.6	4.2	2.52	0.034	ON
11	9.39	0.6	7.26	4.36	0.058	ON
12	9.17	0.55	6.38	3.51	0.047	ON
13	8.92	0.54	6.83	3.69	0.049	ON
14	8.83	0.53	6.67	3.54	0.047	ON
15	8.55	0.51	6.11	3.12	0.042	ON
16	8.31	0.5	6.53	3.27	0.043	ON
17	8.16	0.49	5.7	2.79	0.037	ON
18	7.97	0.48	5.4	2.59	0.035	ON
19	7.68	0.41	5.23	2.14	0.029	ON
20	7.42	0.41	5.59	2.29	0.031	ON
21	7.31	0.4	5.43	2.17	0.029	ON
22	7.25	0.39	4.32	1.68	0.023	ON
23	7.18	0.36	4.88	1.76	0.024	ON
24	7.14	0.35	5.21	1.82	0.024	ON
25	7.11	0.32	3.63	1.16	0.016	ON
26	7.09	0.32	3.72	1.19	0.016	ON
27	7.06	0.27	3.93	1.06	0.014	ON
28	7.04	0.26	3.2	0.83	0.011	ON

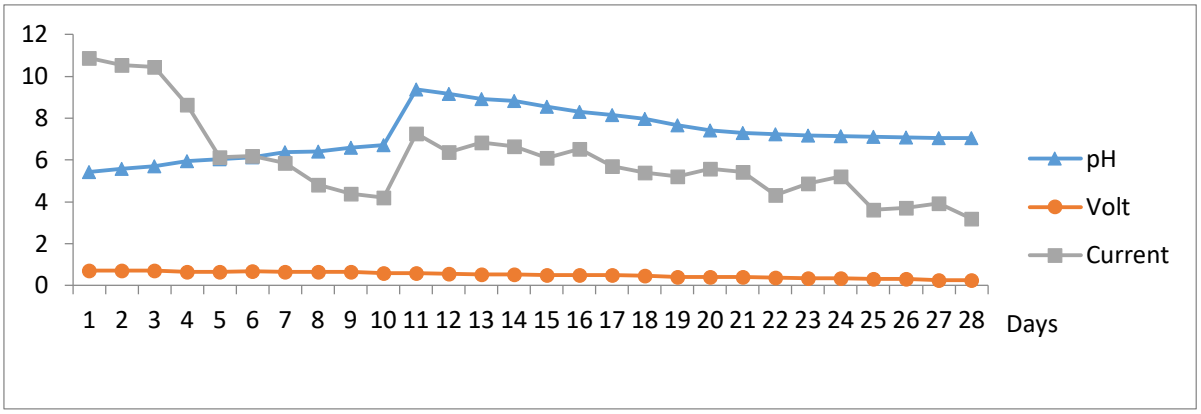

Figure 3. Graph of pH, voltage and current readings from Table 2.

Table 4. Readings from MFC 2.

Sample Description and Parameters	The cathode is graphite and the anode aluminium. The electrolyte is cow dung mixed with water.	
	Average area of graphite electrode	2.29 square cm
	Total area of graphite electrode	13.75 square cm
	Average area of aluminium electrode	32.5 square cm
	Total area of aluminium electrode	195 square cm
	Mass of dung	4kg
	Mass of water added	1kg
	Total Mass	5kg

Day	**pH**	**Volt (V)**	**Current (mA)**	**Power (mW)**	**Power Density (mW/mm^2)**	**LED Bulb Status**
1	5.53	0.7	9.82	6.31	0.110	ON
2	5.61	0.69	8.29	5.72	0.099	ON
3	5.73	0.67	7.02	4.7	0.081	ON
4	5.89	0.67	6.92	4.64	0.080	ON
5	6.01	0.67	5.73	3.84	0.066	ON
6	6.23	0.65	4.82	3.13	0.054	ON
7	6.47	0.65	5.88	3.82	0.066	ON
8	6.65	0.64	5.61	3.59	0.062	ON
9	6.86	0.64	5.83	3.59	0.062	ON
10	9.13	0.63	4.83	3.04	0.052	ON
11	9.47	0.61	8.15	4.97	0.086	ON
12	9.25	0.61	6.56	4.00	0.069	ON
13	9.11	0.6	6.24	3.74	0.064	ON
14	9.03	0.59	5.18	3.06	0.053	ON
15	8.97	0.55	6.84	3.76	0.065	ON
16	8.91	0.53	6.4	3.39	0.058	ON
17	8.63	0.52	5.66	2.94	0.051	ON
18	8.42	0.48	6.2	2.98	0.051	ON
19	8.27	0.48	5.88	2.82	0.049	ON
20	7.94	0.46	5.11	2.35	0.041	ON
21	7.68	0.46	4.8	2.21	0.038	ON
22	7.31	0.41	4.75	1.95	0.034	ON
23	7.23	0.41	5.29	2.17	0.037	ON
24	7.21	0.37	5.63	2.08	0.036	ON
25	7.20	0.36	4.52	1.63	0.028	ON
26	7.19	0.32	4.4	1.41	0.024	ON
27	7.16	0.3	4.57	1.37	0.024	ON
28	7.12	0.3	3.22	0.97	0.018	ON

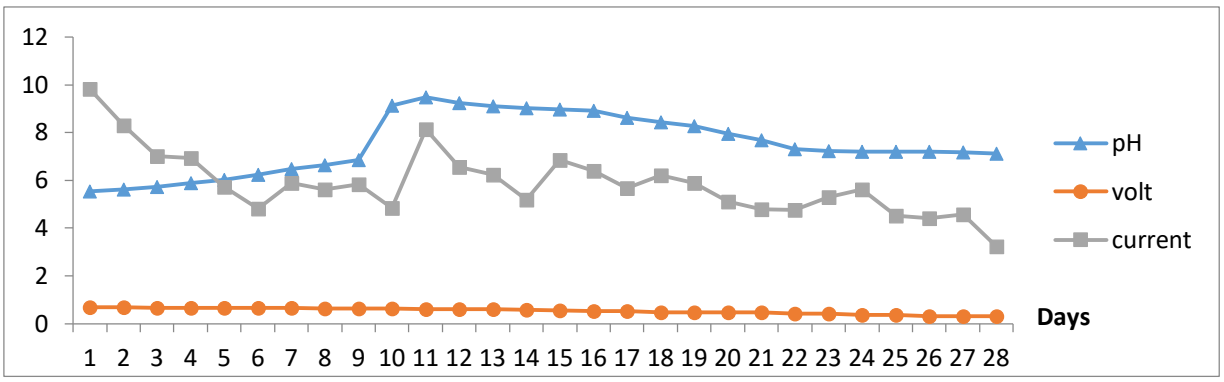

Figure 4. Graph of pH, voltage and current readings from Table 3.

Table 4 show the maximum voltage obtained was 0.7V with a corresponding maximum current of 9.82mA. The minimum voltage and minimum current obtained were 0.3V and 3.22mA

respectively. The voltage drop was 0.4V during the period under investigation. The average voltage and average current and average power obtained were 0.53V, 5.86mA and 3.22mW respectively. Figure 4 show the curve pattern of pH, voltage and current data obtained from the experiment conducted. The graph shows the current having a fluctuating but decreasing trend. The voltage showed a steady and gradual decrease. The pH showed a steady and gradual increase until a sudden climb followed by a gradual decrease due to the change in the organic decomposition stage.

Table 5. Readings from MFC 3.

Sample Description and Parameters	The cathode is graphite and the anode aluminium. The electrolyte is cow dung mixed with water.	
	Average area of graphite electrode	2.19 square cm
	Total area of graphite electrode	8.77 cm
	Average area of aluminium electrode	29.5 square cm
	Total area of aluminium electrode	118 square cm
	Mass of dung	4kg
	Mass of water added	1kg
	Total Mass	5kg

Day	pH	Volt (V)	Current (mA)	Power (mW)	Power Density (mW/mm^2)	LED Bulb Status
1	5.48	0.69	9.96	6.87	0.190	ON
2	5.66	0.67	9.76	6.54	0.180	ON
3	5.93	0.67	9.53	6.39	0.180	ON
4	6.27	0.67	8.82	5.91	0.160	ON
5	6.41	0.64	7.53	4.82	0.130	ON
6	6.54	0.63	6.63	4.18	0.110	ON
7	6.62	0.62	6.43	3.99	0.110	ON
8	6.73	0.58	5.32	3.09	0.085	ON
9	6.88	0.57	6.01	3.43	0.094	ON
10	8.76	0.57	6.15	3.51	0.096	ON
11	9.31	0.52	8.63	4.49	0.120	ON
12	9.11	0.52	8.15	4.24	0.120	ON
13	8.86	0.51	6.78	3.48	0.096	ON
14	8.77	0.51	6.16	3.14	0.086	ON
15	8.63	0.51	6.05	3.09	0.085	ON
16	8.52	0.5	5.58	2.79	0.077	ON
17	8.44	0.49	6.11	2.99	0.082	ON
18	8.19	0.47	5.23	2.46	0.068	ON
19	7.91	0.47	5.21	2.45	0.067	ON
20	7.83	0.45	5.09	2.29	0.063	ON
21	7.67	0.43	4.93	2.13	0.059	ON
22	7.48	0.42	4.51	1.89	0.052	ON
23	7.39	0.41	4.31	1.77	0.049	ON
24	7.31	0.41	3.88	1.59	0.044	ON
25	7.27	0.41	3.57	1.46	0.040	ON
26	7.22	0.38	3.31	1.26	0.035	ON
27	7.17	0.35	3.26	1.14	0.031	ON
28	7.13	0.34	3.08	1.05	0.029	ON

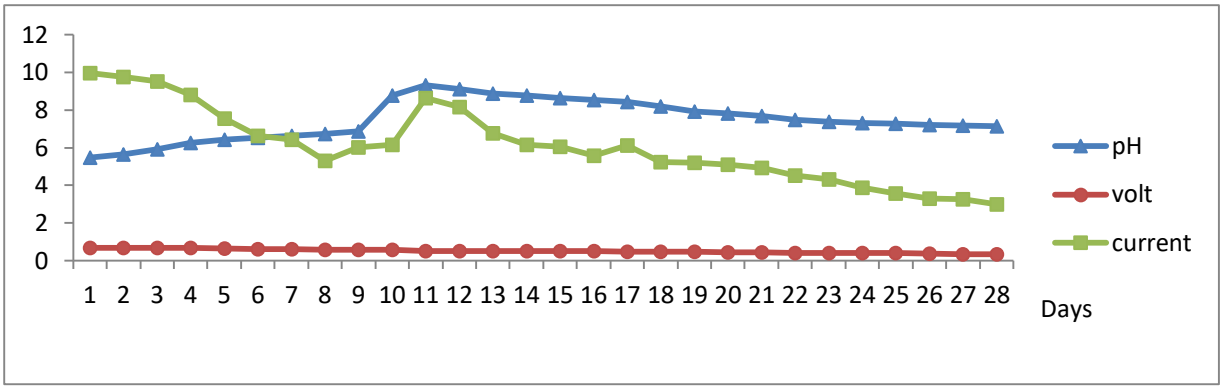

Figure 5. Graph of pH, voltage and current readings from Table 4.

Table 5 show the maximum and minimum voltage obtained were 0.69V and 0.34V respectively. The voltage drop in the cell during the period under investigation was 0.35V. The average voltage, average current and average power obtained was 0.51V, 7.08mA and 3.30mW respectively. Figure 5 shows the curve patterns exhibited by the pH, voltage and current data obtained. The voltage curve pattern shows a gradual and steady decrease. A gradual and steady increase of pH value was observed with a sudden climb followed by a gradual and steady decrease during the period under investigation. The curve pattern exhibited by the current showed a decrease followed by a sudden climb which was then accompanied by a gradual fall. The graph shows one point of intersection between the pH and current curves. The point of intersection occurred at a value of 6.59.

From Table 3, Table 4 and Table 5, the surface area of electrode had an effect on the output of the MFC. The result indicated that the MFC with the largest surface area had the highest voltage drop of 0.47V. This could be as a result of the microbes having more electrode surface area to attach themselves to, thereby transferring more energy.

From Figure 3, Figure 4 and Figure 5 exhibited similar curve patterns indicating that the organic matter undergone through the decomposition process and also the current output is dependent on the stages of these processes.

Table 6. Readings from MFC 1, MFC 2 and MFC 3 connected in series.

Sample Description and Parameters	The cathode is graphite and the anode aluminium. The electrolyte is cow dung mixed with water.	
	Average area of graphite electrode	2.1 square cm
	Total area of graphite electrode	37.78 square cm
	Average area of aluminium electrode	31.14 square cm
	Total area of aluminium electrode	560.5 square cm
	Total Mass of dung	12kg
	Total Mass of water added	3kg

Day	**Volt (V)**	**Current (mA)**	**Power (mW)**	**Power Density (mW/mm^2)**	**LED Bulb Status**
1	2.06	9.71	20.00	0.082	ON
2	2.01	9.59	19.28	0.150	ON
3	1.93	8.46	16.33	0.097	ON
4	1.92	9.98	19.16	0.110	ON
5	1.73	6.45	11.16	0.066	ON
6	1.81	9.85	17.83	0.110	ON
7	1.61	7.89	12.7	0.075	ON
8	1.90	7.95	15.11	0.089	ON
9	1.60	6.12	9.79	0.058	ON
10	1.23	4.98	6.13	0.036	ON

11	0.96	4.00	3.84	0.023	ON
12	0.95	4.24	4.03	0.024	ON
13	1.03	3.42	3.52	0.021	ON
14	0.99	4.63	4.58	0.027	ON
15	0.93	4.43	4.12	0.024	ON
16	1.10	4.41	4.85	0.029	ON
17	0.62	3.60	2.23	0.013	ON
18	0.76	4.80	3.65	0.022	ON
19	0.79	5.01	3.65	0.022	ON
20	0.77	5.33	4.1	0.024	ON
21	0.80	5.14	4.11	0.024	ON
22	0.93	5.23	4.86	0.029	ON
23	0.92	5.12	4.71	0.028	ON
24	0.92	5.53	5.03	0.030	ON
25	0.91	6.16	5.61	0.033	ON
26	0.91	6.70	6.1	0.036	ON
27	0.91	6.40	5.82	0.034	ON
28	0.89	6.50	5.79	0.034	ON

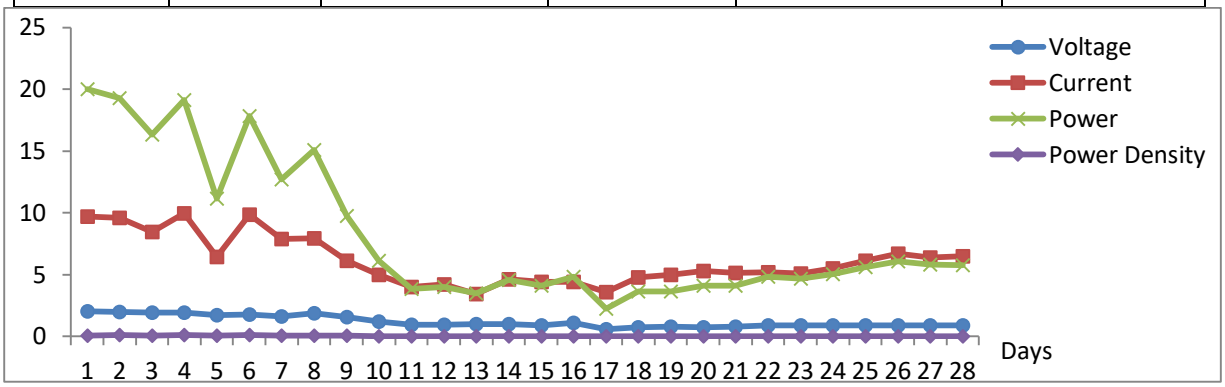

Figure 6. Graph of voltage, current, power and power density of MFCs connected in series

Table 6 shows the maximum voltage obtained was 2.06V. This showed that when MFCs are connected in series, the voltage increased, implying that MFCs obey the principles of electricity. The minimum voltage obtained was 0.89V. The voltage drop over the period under investigation was 1.17V. The average voltage and average current obtained were 1.21V and 6.13mA respectively. Figure 6 shows the different curve patterns obtained for the voltage, current, power and power density respectively. The curve pattern shown by the voltage reveals a gradual and steady decline with little fluctuations which then seemed to flatten out at the latter end of its curve. The power and current curve patterns have similar trend. Various points of intersection can be seen to occur in both the curve pattern of power and current having values between 3.84 and 2.23. Comparing results from Table 3, Table 4, Table 5 and Table 6, it can be seen that the voltages from MFC1, MFC2 and MFC3, gave a total combined output when connected in series considering resistance as would be expected indicating that the organic fuel cell obeys the principle of electricity.

5. DISCUSSION

Results indicate that the MFC can be used in road traffic applications. Road traffic light and indicator signs help maintain safety for road users by checking their speed, awareness and consideration of other road users. The use of MFC in enabling the continuous functionality of these road traffic light and indicator signs will help reduce road accident and the probability of it occurring. Other equipment such as reading lamps, traffic signal wand and flash lights can be designed to function on the power generated from the MFC. This will help reduce the amount of energy required and used in producing chemical cells and batteries for same purpose. The

saved energy can be redirected for other energy requirements. The MFC can also be used to meet some of the energy requirement in tourist events such as "Light Carnivals". This attracts tourists, brings in revenue as well as saves costs in using other energy source to meet same demand.

6. CONCLUSION

The current threats to public health and safety from organic waste matter as well as the economic threat as a result of the insufficient energy supply leads to economic woes. The MFC can be used to manage the organic waste matter making it an attractive energy source in augmenting Nigeria's energy mix while simultaneously helping improve the economy of Nigeria. Cow dung was investigated to examine its potential as a source for generating electrical energy with a single chamber MFC and the result indicated it is a viable resource for power generation. Results indicated that the MFC generated more power when it the organic matter used as the energy source was acidic. The surface area of electrodes also affected the power output of the system. The use of organic waste as an energy resource in the MFC makes organic waste an attractive energy resource which is readily available, hence, stand-alone road traffic lights can be redesigned to operate on the energy output from MFC, thereby making all road traffic lights run on renewable energy from organic source. Moreover, reading lamps, geographical sensors etc. can also be redesign to run on the energy produced from single chamber MFC. The MFC can help attract tourist by using it in "Light Carnivals" as well as in the decoration of trees and flowers in open parks thereby giving the environment an attracting sight. The microbial fuel cell technology is the most efficient and effective means of organic waste treatment while profiting from it.

REFERENCES

[1] Claudine Ellyin (2012). "Small Scale Waste-To-Energy Technologies". International Journal of Engineering Research and Science. Vol. 7, No. 8.

[2] Diji, C.J. (2013). "Electricity Production from Biomass in Nigeria: Options, Prospects and Challenges". International Journal of Engineering and Applied Sciences. ISSN2305-8269, Vol. 3, No. 4, June.

[3] Kun Guo, Daniel J. Hassettb and Tingyue Guc (2012). "Microbial Fuel Cells: Electricity Generation from Organic Wastes by Microbes". ISBN: 978-1845939564, pp 164-189. CAB International, Oxon. United Kingdom.

[4] Ismail Bozkurt (2010). "Energy Resources and Their Effect on Environment". WSEAS Transaction on Environment and Development. Issue 5, Vol. 6. ISSN: 1790.5079.

[5] Mokhtarian N., Rahimnejad M., Najafpour G.D., Wan Ramli Wan Daud, Ghoreyshi A.A.,(2012). "Effect of Different Substrate on Performance of Microbial Fuel Cell". African Journal of Biotechnology Vol. 11(14), pp. 3363-3369, 16 February.

[6] Matteo Daghio, Isabella Gandolfi, Giuseppina Bestetti, Andrea Franzetti, Edoardo Guerrini and Pierangela Cristiani (2015). "Anodic and Cathodic Microbial Communities In Single Chamber Microbial Fuel Cells". New Biotechnology Volume 32, Number 1.

[7] Osueke C.O. and Ezugwu C.A.K. (2011). "Study of Nigeria Energy Resource and Its Consumption". International Journal of Scientific and Engineering Research, Vol. 2, Issue 12. ISSN: 2229-5518.

[8] Dincer I. and Zamfirescu C. (2011). "Sustainable Energy Systems and Applications". Springer Science and Business Media. DOI: 10.1007/978-0-387-95861-3.2.

[9] Ajayi, O.O., and Ajanaku K.O (2010). "Nigeria's Energy Challenge and Power Development: The Way Forward". Energy & Environment · Vol. 20, No. 3.

[10] Osueke C.O. and Ezugwu C.A.K. (2011). "Study of Nigeria Energy Resource and Its Consumption". International Journal of Scientific and Engineering Research, Vol. 2, Issue 12. ISSN: 2229-5518.

[11] You, J. (2016). "Waste and Wastewater Cleanup Using Microbial Fuel Cells". University of the West of England. Available from: http://eprints.uwe.ac.uk/26953.

[12] Sridhar M.K.C., and Hammed T.B. (2014). "Turning Waste to Wealth in Nigeria: An Overview". Journal of Human Ecology, 46(2): 195-203.

[13] Simonyan K.J., and Fasina O., (2013). "Biomass Resources and Bioenergy Potentials In Nigeria". African Journal of Agricultural Research. Vol. 8(40), pp.4975-4989. DOI:10.5897/AJAR2013.6726.

[14] Samuel Mark Maton, Davou Daniel Dabi, Juliet Dingsten Dodo, Ruth Asheazi Nesla (2009). "Environmental Hazards of Continued Solid Waste Generation and Poor Disposal in Municipal Areas in Nigeria". Journal of Geography, Environment and Earth Science International.

[15] International Renewable Energy Agency (2012). Renewable energy technologies: Cost Analysis Series, Volume1: Power Sector, Issue 3/5 Hydropower. 1 (3).

[16] Igbinomwanhia D.I., Obano A.I., Olisa Y.P., Akhator P.E., (2016). "Evaluation of Waste To Energy Potential of Domestic Solid Waste In Benin Metropolis". Journal of Applied Science and Environmental Management. Vol. 20 (4) 1089-1092.

[17] Babayemi, J.O., Dauda, K.T. (2009). "Evaluation of Solid Waste Generation, Categories and Disposal Options in Developing Countries: A Case Study of Nigeria". Journal of Applied Science and Environment Management. Vol. 13(3) 83 – 88. ISSN:1119-8362.

[18] Njoku N., Lamond J., Everett G., and Manu P., (2015). "An Overview of Municipal Solid Waste Management in Developing and Developed Economies: Analysis of Practices and Contributions to Urban Flooding in Sub-Saharan Africa". University of West England. 2015. (pages 203-204).

[19] Bruce E. Logan and John M. Regan. (2006). "Microbial Challenges and fuel cell applications. Environmental Science and Technology".

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MUSHROOM SPECIES DETECTION USING IMAGE PROCESSING TECHNIQUES

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ABSTRACT: There are many kinds of mushrooms in the world, some of them are edible and some are poisonous. People may want to eat the mushrooms they encounter in nature, as a result of which they may become poisoned or even die. In this research image processing techniques, K-NN and Naive Bayes algorithms were used to classify mushroom species in Selçuk University Campus. As a result of the research, K-NN algorithm achieved 80% and Naive Bayes algorithm achieved 96% accuracy.

Keywords: Image Processing, Mushroom Species, K-NN, Naive Bayes.

1. INTRODUCTION

There are many mushrooms that are edible and poisonous in nature. People may want to eat the mushrooms they see when they come to nature, but they can poison or kill them.

The poisoning applications made to the National Poison Information Center of the Ministry of Health between April 1 and May 13, 2019 increased by 34 percent compared to 2018. Antidote is required for the treatment of poisonings; this situation requires additional costs for the national economy. If people are conscious of mushroom recognition, they will not both poison themselves and cause additional costs for the national economy [1].

This research was carried out by using image processing techniques, K-NN and Naive Bayes algorithms to prevent poisoning from 25 mushroom species in Selçuk University Campus.

Many researches have been done using image processing techniques in plant science. In these researches, mainly color properties were studied. Other research using image processing techniques in plant science are given below.

Neuman et al. [2] developed an image processing method to evaluate the color of grains and other objects in digital images in their study. According to RGB color characteristics of different wheat classes were examined, and differences were observed.

Neuman et al. [3] examined wheat colors by differentiation according to RGB properties in

order to distinguish grains depending on the class and types of wheat. As a result, the differences between different wheat classes were successfully revealed.
Göknur Dursun [4] determined wheat, barley, corn, chickpeas, lentils, beans, kidney beans and soybean, such as some grain products projected by image processing techniques the work done. Thanks to this research, the projection areas of small grain products have been determined precisely.

Njoroge et al. [5] stated that fruit can be classified according to internal and external characteristics of fruit in automatic fruit sorting systems. They stated that CCD cameras are used to determine the external (color, size and shape, etc.) properties of fruits, and X-ray rays are used to measure internal properties such as sugar content and acidity content.

Feng and Qixin [6] classified Crystal Fuji apples according to their color characteristics in their study. The color ratios of the fruits were calculated by HSI color space and the system worked 90% accuracy.

Chamelat et al. [7] used image processing techniques to identify grape fruit. They have extracted color attributes from RGB and HSV. They trained a support vector machine with these attributes and tested the developed algorithm on images taken under different conditions. The system worked 99% accuracy.

Lino et al. [8] used image processing techniques to classify lemon and tomato quality. The quality is determined according to shape, size, mass, hardness and stains. ImageJ program was used to determine the properties.

Tonguç and Yakut [9] have done apple sorting with image processing techniques. In this research, apples were classified according to their color and size characteristics. The system works at an improved level.

Omid et al. [10] conducted a study on the citrus volume and mass estimation using image processing technique. Lemon, lime, orange and mandarin were used as citrus varieties. Two cameras were used to take pictures of fruits in upright position. Image processing was performed in 3 steps: background segmentation, image enhancement and calibration. The results showed that the size of the citrus fruit had no effect on the accuracy of the calculated volume.

Al-Mallahi et al. [11] used image processing techniques to separate potatoes and clods. This research was tested between 380 contact tubers and 112 contact tubers and soil clods. The results show that 99% of the contacts were successfully exposed. The reason for the failure is that there are no sharp corners between the tubers and clods.

Liming and Yanchao[12] studied strawberry classification according to shape, size and color characteristics. As a result of the research, strawberry size detection error is not more than 5%, color classification accuracy is 88.8% and shape classification accuracy is above 90%. 1 strawberry is classified under an average of 3 seconds.

Aggelopoulou et al. [13] used image processing method by looking at the density of flowers found in apple trees to determine the harvest yield. In their research, they took color images from the trees at the time of flowering and measured the yields of the trees at the end of the

harvest. They revealed white flowers in the tree by thresholding. In their research, they were able to determine the harvest yield of 53 trees with an error of 18%.
Gastélum-Barrios et al. [14] conducted research using image processing techniques to improve tomato quality. In determining the quality of tomatoes, basic properties such as color, ripening rate, hardness, shape, size and content of minerals were examined.

Balestani et al. [15] used image processing techniques to classify cherries by size, maturity, and defect. They took 250 images with CCD camera. According to the RGB color properties were examined. As a result, the accuracy in size classification was 96%, the accuracy in maturity classification was 92%, and the accuracy in classification according to the failure status was 90%.

Sofu et al. [16] using the image processing method to determine the color, size and stains on apples and to classify stains, have studied various apples. In their study on a total of 201 apple images, they determined the accuracy of classification in color estimates as 99% and the accuracy in classification by apple species as 95.52%. The study classified 7 of the 10 stained apples as stained.

Font et al. [17] have initiated a study to avoid problems such as the simultaneous harvesting of nectarine of six varieties and the daily average of 500 tons of harvested at the same time in Aitona (South Lleida). During the nectarine packaging process, nectarines are classified according to their histogram properties. For this purpose, a small data set was prepared which kept histogram properties of each nectarine and a comparison was made between these nectarines.

Bhange and Hingoliwala [18] conducted a study using image processing to detect diseases on pomegranate. In this study, they aimed to provide a web-based service to the farmers for the definition of pomegranate disease by loading the image of pomegranate into the system. The system has a dataset with pomegranate images. When users enter their own pictures, they are compared with the pictures in the system. The system works 82% accuracy.

This research consists of 6 chapters. In the second chapter materials and methods, in the third chapter application, in the fourth chapter results and recommendations were explained.

2. MATERIAL AND METHOD

2.1. Material

In this research, images of mushroom species grown naturally in Selçuk University Campus were collected by faculty members and students of Selçuk University Faculty of Science Biology Department. A total of 25 mushroom species were studied and 8 of them were edible and 17 of them were poisonous mushrooms. Figure 1, has showed the two mushroom species on the Campus of Selçuk University. Species of mushrooms are showed in Table 1.

Table 1. Species of mushrooms.

Names of Mushrooms	Species
1-Agaricus altipes	Edible
2-Agaricus bitorquis	Edible
3-Agaricus bresadolanus	Poisonous
4-Agaricus campestris	Edible
5-Agrocybe arvalis	Poisonous
6-Agrocybe paludosa	Poisonous
7-Bjerkandera adusta	Poisonous
8-Coprinellus disseminatus	Poisonous
9-Coprinopsis episcopalis	Poisonous
10-Coprinopsis marcescibilis	Poisonous
11-Coprinus comatus	Edible
12-Hygrocybe conica	Poisonous
13-Inocybe nitidiuscula	Poisonous
14-inocybe splendens	Poisonous
15-Protostropharia semiglobata	Poisonous
16-Psathyrella candoleana	Poisonous
17-Psathyrella corrugis	Poisonous
18-Psathyrella hirta	Poisonous
19-Psathyrella prona	Poisonous
20-Psathyrella senex	Poisonous
21-Suillus bovinus	Edible
22-Suillus collinitus	Edible
23-Suillus flavidus	Edible
24-Suillus luteus	Edible
25-Tricholoma orirubens	Poisonous

Figure 1. Two mushroom species in Selçuk University Campus.

2.2. METHOD

2.2.1. K-NN(K NEAREST NEIGHBOR) ALGORITHM

This algorithm is one of the most common used algorithms. While the classification is made, the distance of each record in the database with the other records is calculated. However, only k piece of the other records is considered for one record. k piece recording is the closest distance to the calculated point compared to other records. k value is pre-selected in the algorithm [19,20].

The working principles of the algorithm are summarized in the following steps.
Step 1: Determine an appropriate distance measurement space (Euclid distance measurement is the most used).
Step 2: Identify k piece point closest to each other.
Step 3: Determine the most common class of the specified group.

Step 4: Assign this group the name of the specified class [21].

Euclid distance measurement was used in this research. Euclid distance measurement is calculated according to Eq. (1). x and y are coordinates of points [22].

$$d(x,y) = \sqrt{\sum_{i=1}^{n}(x_i - y_i)^2} \quad (1)$$

2.2.2. Naive bayes algorithm

The Bayesian classification technique is a method that calculates the likelihood of a new data entering any of the existing classes by using existing, already classified data.
Developed algorithms and classification techniques based on Bayesian rule are called with this name [21].
Bayes' theorem is given in Eq. (2).

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)} \quad (2)$$

P (A | B) = Probability of event A when event B occurs.
P (A) = Probability of event A.
P (B | A) = Probability of event B when event A occurs.
P (B) = Probability of event B [21].

2.2.3. Emgucv

EmguCV is an Open CV wrapper library that can be used in .Net languages. OpenCV (Open Source Computer Vision) is an open source image processing library.

2.2.4 Thresholding

Thresholding is the process of separating objects from the background and is the simplest segmentation method. It is used for different purposes such as reducing noise on the image or identifying objects. (i, j) is pixel value and T is the threshold value,
If (i, j) > T, (i, j) is point of the object,
If (i, j) <=T, (i, j) is point of the background.

2.2.5. Dilation and erosion

A binary image is a description of the image in black and white. Dilation is a morphological process used to magnify or highlight objects in binary images, erosion used to minify objects in binary images. Principle of dilation and erosion has showed in Figure 2.

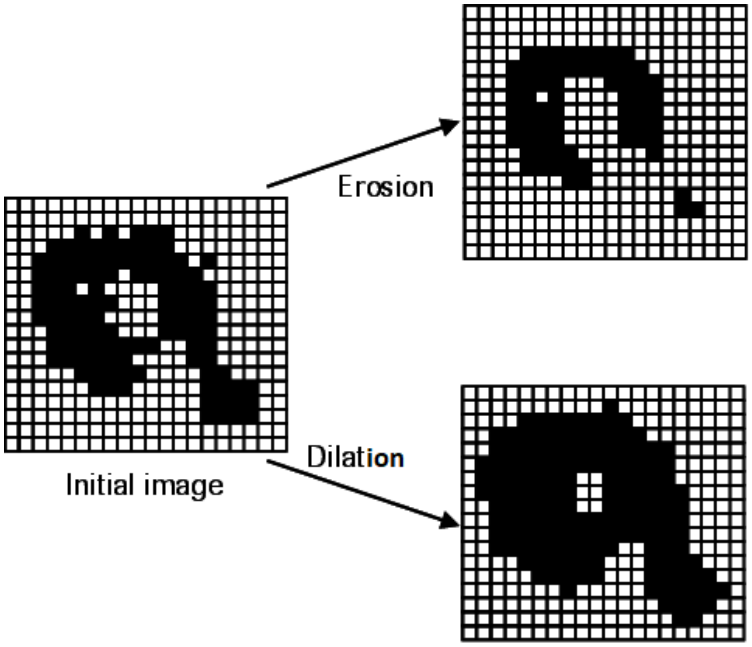

Figure 2. Principle of dilation and erosion [23].

3. APPLICATION

The research was carried out using Microsoft Visual Studio 2012 software. Opening window of program is given in Figure 3. There are 3 buttons on the opening window of program. After opening the picture, two buttons that are inactive will be opened. Figure 4 is the screen after opening the picture.

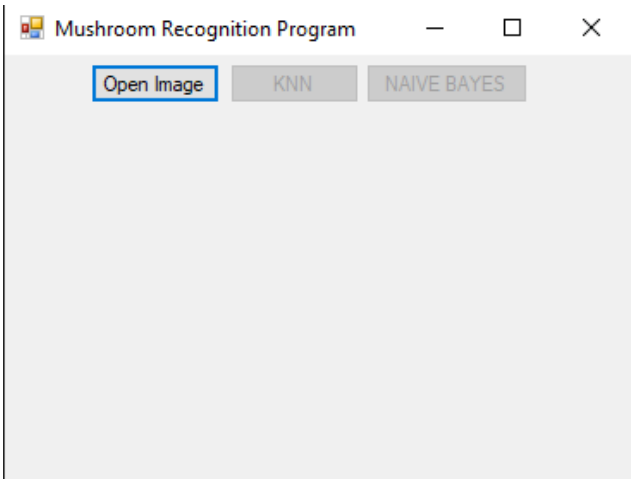

Figure 3. Opening window of program.

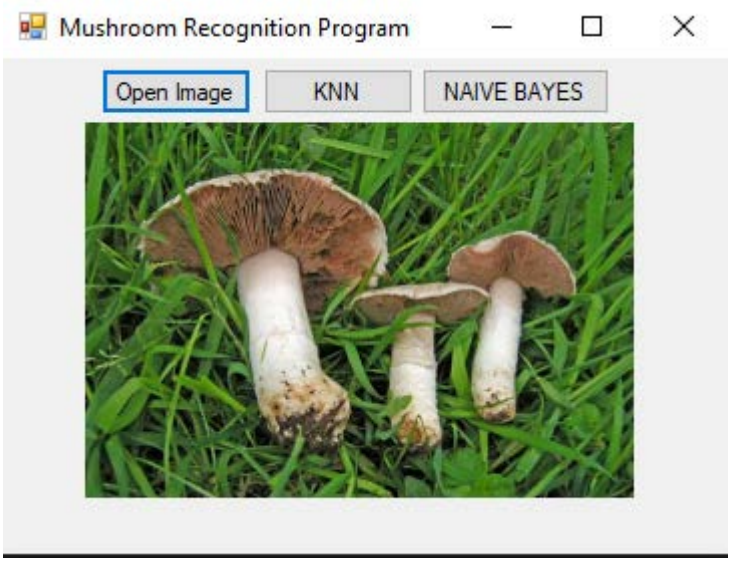

Figure 4. Opening the picture.

Mushroom pictures were reduced to 300 * 300 size for effective working of program. RGB values and the ratio of mushrooms were selected for feature extraction in this research.
To find the ratio, the width of the cap of the mushroom is divided by the height of the mushroom. The RGB values and ratio of mushrooms were studied with the help of Emgucv Library. Thresholding, dilation and erosion were used for feature extraction. Thresholding, dilation and erosion were performed before RGB values and ratio were found. Figure 5 is the screen erosion and Figure 6 is dilation applied picture. Thresholding applied picture is given in Figure 7.

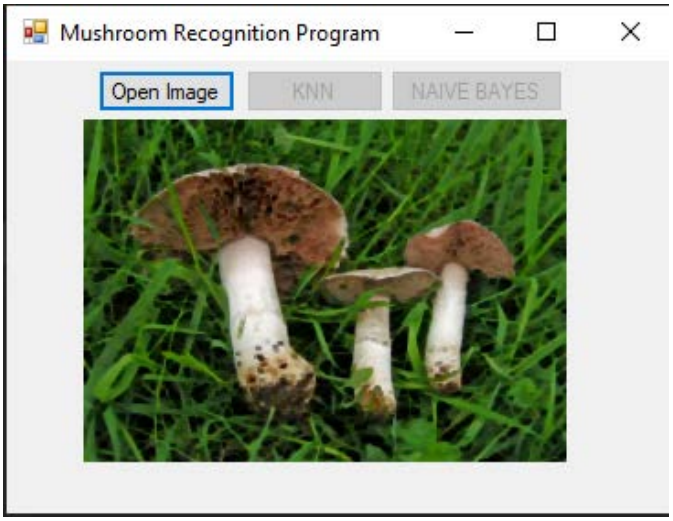

Figure 5. Erosion applied picture.

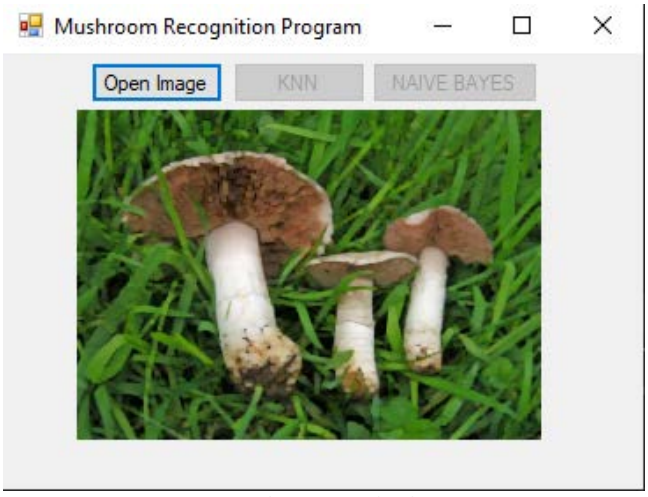

Figure 6. Dilation applied picture.

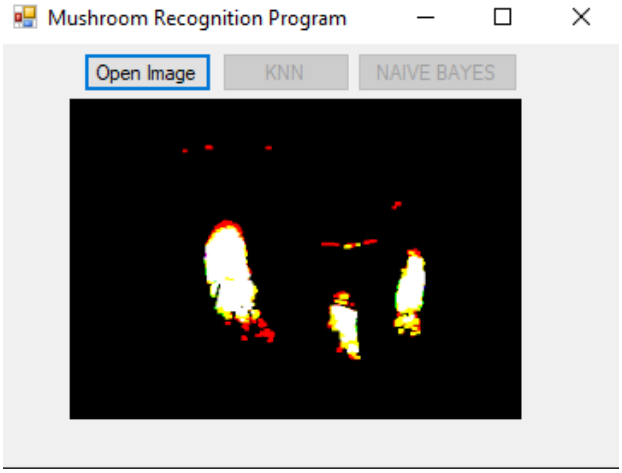

Figure 7. Thresholding applied picture.

There are 3 listboxes, 4 labels and 4 textboxes in the background of program. 255 of the RGB values are counted and these numbers are written on the labels.

Found RGB values and ratio of mushrooms has showed in Figure 8. Values of R, G, B and ratio of mushrooms is given in Table 2.

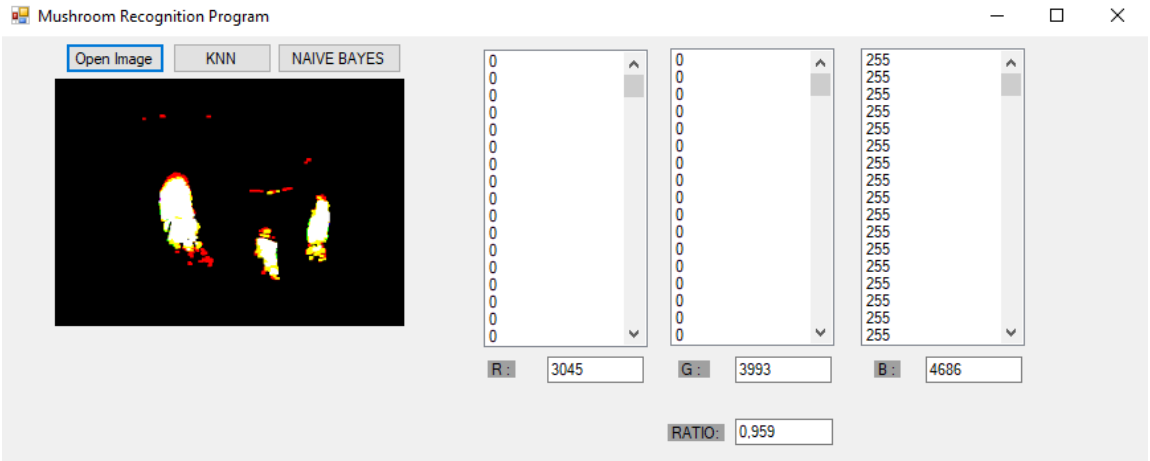

Figure 8. Found RGB value and ratio of mushrooms.

Table 2. Values of R, G, B and ratio of mushrooms.

Names of Mushrooms	R	G	B	Ratio of mushrooms
1-Agaricus altıpes	3045	3993	4686	0,959
2-Agaricus bitorquis	5588	6634	6714	1,242
3-Agaricus bresadolanus	2221	4188	7040	1,112
4-Agaricus campestris	3083	2646	2657	0,966
5-Agrocybe arvalis	483	1488	2200	0,996
6-Agrocybe paludosa	3984	7003	7453	1,707
7-Bjerkandera adusta	2102	1711	3189	1,004
8-Coprinellus disseminatus	950	2784	4415	1,348
9-Coprinopsis episcopalis	1000	1023	1269	1,351
10-Coprinopsis marcescibilis	112	376	201	0.993
11-Coprinus comatus	3418	3762	3971	0,76
12-Hygrocybe conica	0	40	9367	1,324
13-Inocybe nitidiuscula	0	1517	14963	0,993
14-Inocybe splendens	1787	1782	6846	1,093
15-Protostropharia semiglobata	1436	5573	4694	0,925
16- Psathyrella candoleana	1202	748	1418	1,014
17- Psathyrella corrugis	301	1273	1815	0,93
18- Psathyrella hirta	298	1286	5949	0,843
19- Psathyrella prona	4813	9060	11983	0,84
20- Psathyrella senex	71	2996	6322	0,993
21- Suillus bovinus	495	3254	16629	0,89
22- Suillus colinitus	4387	3725	2654	0,993
23- Suillus flavidus	585	5658	7994	0,795
24- Suillus luteus	482	749	1539	0,913
25- Tricholoma orirubens	2513	2405	1848	1,004

RGB values and ratio of mushroom images were coded to improve the performance of K-NN and Naive Bayes algorithm. Coding of ranges for RGB values were presented in Table 3. Coding of ranges for ratio of mushrooms were presented in Table 4.

Table 3. Coded of number ranges for RGB values.

Ranges	Coding
0-1000	1
1001-2000	2
2001-3000	3
3001-4000	4
4001-5000	5
5001-6000	6
6001-7000	7
7001-8000	8
9001-10000	10
11001-12000	12
14001-15000	15
16001-17000	17

Table 4. Coded of number ranges for ratio of mushrooms.

Ranges	Coding
0.000-1.000	1
1.001-2.000	2

Values after coding is given in Table 5.

Table 5. Values after coded.

Names of Mushrooms	R	G	B	Ratio of mushrooms
1-Agaricus altıpes	4	4	5	1
2-Agaricus bitorquis	6	7	7	2
3-Agaricus bresadolanus	3	5	8	2
4-Agaricus campestris	4	3	3	1
5-Agrocybe arvalis	1	2	3	1
6-Agrocybe paludosa	4	8	8	2
7-Bjerkandera adusta	3	2	4	2
8-Coprinellus disseminatus	1	3	5	2
9-Coprinopsis episcopalis	1	2	2	2
10-Coprinopsis marcescibilis	1	1	1	1
11-Coprinus comatus	4	4	4	1
12-Hygrocybe conica	1	1	10	2
13-Inocybe nitidiuscula	1	2	15	1
14-Inocybe splendens	2	2	7	2
15-Protostropharia semiglobata	2	6	5	1
16- Psathyrella candoleana	2	1	2	2
17- Psathyrella corrugis	1	2	2	1
18- Psathyrella hirta	1	2	6	1
19- Psathyrella prona	5	10	12	1
20- Psathyrella senex	1	3	7	1
21- Suillus bovinus	1	4	17	1
22- Suillus colinitus	5	4	3	1
23- Suillus flavidus	1	6	8	1
24- Suillus luteus	1	1	2	1
25- Tricholoma orirubens	3	3	2	2

k value was selected 3 for K-NN algorithm. Result of K-NN algorithm was presented in Figure 9. Result of Naive Bayes algorithm was presented in Figure 10.

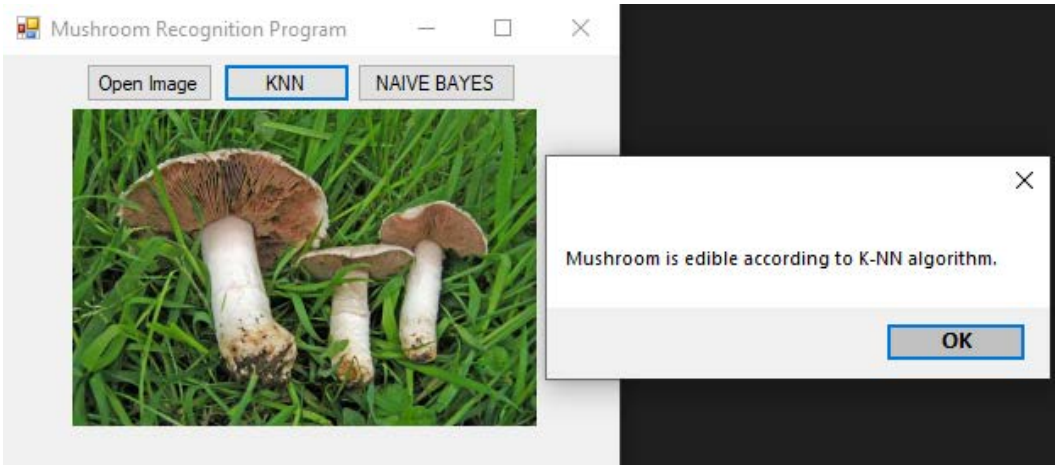

Figure 9. Result of K-NN algorithm.

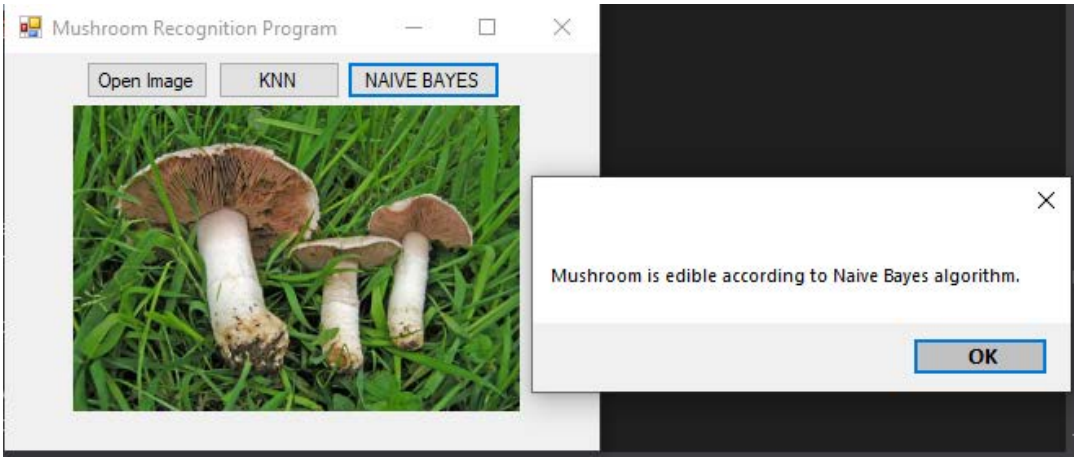

Figure 10. Result of Naive Bayes algorithm.

4. RESULTS AND RECOMMENDATIONS

In this study, K-NN and Naive Bayes Algorithm were used to determine mushroom species with image processing. The K-NN algorithm incorrectly classifies 5 of 25 mushroom species images and achieves 80% accuracy. Naive Bayes algorithm misclassifies one image and achieves 96% accuracy. Result of K-NN and Naive Bayes algorithms are presented in Table 6.

Table 6. Results of K-NN and Naive Bayes algorithms.

Names of Mushrooms	K-NN Algorithm	Naive Bayes Algorithm	Edibility
1-Agaricus altipes	Edible	Edible	Edible
2-Agaricus bitorquis	Poisonous	Edible	Edible
3-Agaricus bresadolanus	Poisonous	Poisonous	Poisonous
4-Agaricus campestris	Edible	Edible	Edible
5-Agrocybe arvalis	Poisonous	Poisonous	Poisonous
6-Agrocybe paludosa	Poisonous	Poisonous	Poisonous
7-Bjerkandera adusta	Poisonous	Poisonous	Poisonous
8-Coprinellusdisseminatus	Poisonous	Poisonous	Poisonous
9-Coprinopsis episcopalis	Poisonous	Poisonous	Poisonous
10-Coprinopsis marcescibilis	Poisonous	Poisonous	Poisonous
11-Coprinus comatus	Edible	Edible	Edible
12-Hygrocybe conica	Poisonous	Poisonous	Poisonous
13-Inocybe nitidiuscula	Poisonous	Poisonous	Poisonous
14-Inocybe splendens	Poisonous	Poisonous	Poisonous
15-Protostropharia semiglobata	Edible	Poisonous	Poisonous
16-Psathyrella candoleana	Poisonous	Poisonous	Poisonous
17-Psathyrella corrugis	Poisonous	Poisonous	Poisonous
18-Psathyrella hirta	Poisonous	Poisonous	Poisonous
19-Psathyrella prona	Poisonous	Poisonous	Poisonous
20-Psathyrella senex	Poisonous	Poisonous	Poisonous
21-Suillus bovinus	Poisonous	Edible	Edible
22-Suillus collinitus	Edible	Edible	Edible
23-Suillus flavidus	Poisonous	Edible	Edible
24-Suillus luteus	Poisonous	Poisonous	Edible
25-Tricholoma orirubens	Poisonous	Poisonous	Poisonous

Edible mushroom species are less than poisonous mushroom species in this research. The low accuracy of K-NN algorithm compared to Naive Bayes algorithm may be due to lack of mushroom species. Mushroom images can be reproduced.

The importance of this research is to classify mushroom species in Selcuk University Campus for the first time by using image processing techniques, K-NN and Naive Bayes algorithm. An application about Selçuk University Campus's mushroom classification can be made on the mobile system in the future.

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REFERENCES

[1] SAGLIK, from <https://www.saglik.gov.tr/TR,55310/mantar-zehirlenmeleri-uzerine-yapilan-basin-aciklamasi-14052019.html/>, last accessed july 21, 2019.

[2] Neuman M.R, Sapirstein H.D, Shwedyk E, Bushuk W., (1989 a). Wheat grain colour analysis by digital image processing I.methodology. Journal of Cereal Science, 10(3), 175-182. DOI:10.1016/S0733-5210(89)80046-3.

[3] Neuman M.R., Sapirstein H.D., Shwedyk E. and Bushuk W., (1989 b). Wheat grain colour analysis by digital image processing II.wheat class discrimination. Journal of Cereal Science, 10(3), 183-188. DOI:10.1016/S0733-5210(89)80047-5.

[4] Göknur-Dursun, İ., 2001. Bazı Taneli Ürünlerin İzdüşüm Alanlarının Görüntü İşlemeyle Belirlenmesi. Tarım Bilimleri Dergisi, 7(3), 102- 107. DOI: 10.1501/Tarimbil_0000000661.

[5] Njoroge, J.B., Ninomiya, K., Kondo, N., Toita, H., 2002. Automated Fruit Grading System Using Image Processing. SICE 2002, Proceedings of the 41st SICE Annual Conference, 1346-1351. DOI:10.1109/SICE.2002.1195388.

[6] Feng, G., Qixin, C., 2004. Study on Color Image Processing Based Intelligent Fruit Sorting System. Proceedings of the 5th World Congress on Intelligent Control and Automation, 6, 4802-4805. DOI: 10.1109/WCICA.2004.1343622.

[7] Chamelat, R., Rosso, E., Choksuriwong, A., Rosenberger, C., Laurent, H., Bro, P., 2006. Grape detection by image processing. ECON 2006 - 32nd Annual Conference on IEEE Industrial Electronics, 7-10 November. DOI: 10.1109/IECON.2006.347704.

[8] Lino, A.C.L. ,Sanches, J., Dal Fabbro, I.M., 2008. Image Processing Techniques For Lemons and Tomatoes Classification. Bragantia, Campinas, v.67, n.3, p.785-789. DOI:10.1590/S0006-87052008000300029

[9] Tonguç, G., Yakut, A.K., 2009. Fruit Grading Using Digital Image Processing Techniques. Tarım Makinaları Bilimi Dergisi, 5(1), 93–101.

[10] Omid , M., Khojastehnazhand, M., Tabatabaeefar, A., 2010. Estimating Volume And Mass Of Citrus FruitsBy Image Processing Technique. Journal of Food Engineering,100, 315–321. DOI: 10.1016/j.jfoodeng.2010.04.015.

[11] Al-Mallahi,A., Kataoka,T., Okamoto,H., Shibata,Y., 2010. An image processing algorithm for detecting in-line potato tubers without singulation. Computers and Electronics in Agriculture, 70, 239–244. DOI: 10.1016/j.compag.2009.11.001.

[12] Liming, X., Yanchao Z., 2010. Automated strawberry grading system based on image processing. Computers and Electronics in Agriculture, 71S, S32–S39. DOI: 10.1016/j.compag.2009.09.013.

[13] Aggelopoulou, A.D., Bochtis, D., Fountas, S., Swain, K.C., Gemtos, T.A., Nanos, G.D., 2011. Yield prediction in apple orchards based on image processing. Precision Agriculture, 12(3), 448-456. DOI: 10.1007/s11119-010-9187-0.

[14] Gastélum-Barrios, A., Bórquez-López, R. A., Rico-García, E., Toledano-Ayala, M., Soto-Zarazúa, G. M. , 2011. Tomato quality evaluation with image processing: A review. African Journal of Agricultural Research Vol. 6(14), pp. 3333-3339. DOI: 10.5897/AJAR11.108.

[15] Balestani, A.M., Moghaddam, P. A., Motlaq, A.M., Dolaty, H., 2012. Sorting and Grading of Cherries on the Basis of Ripeness, Size and Defects by Using Image Processing Techniques. International Journal of Agriculture and Crop Sciences, 4-16,1144-1149. ISSN:2227-670X.

[16] Sofu, M.M., Er, O., Kayacan, M.C., B. Cetişli, 2013. Elmaların Görüntü İşleme Yöntemi ile Sınıflandırılması ve Leke Tespiti. Gıda Teknolojileri Elektronik Dergisi, 8 (1), 12- 25. e-ISSN:1306-7648.

[17] Font, D., Tresanchez, M., Pallejà, T., Teixidó, M., Martinez, D., Moreno, J., Palacín , J., 2014. An image processing method for in-line nectarine variety verification based on the comparison of skin feature histogram vectors. Computers and Electronics in Agriculture, 102, 112–119. DOI: 10.1016/j.compag.2014.01.013

[18] Bhange, M., Hingoliwala, H.A., 2015. Smart Farming: Pomegranate Disease Detection Using Image Processing. Procedia Computer Science, 58, 280 – 288. DOI: 10.1016/j.procs.2015.08.022.

[19] Beyer, K., Goldstein, J., Ramakrishnan, R., Shaft U., 1998. When Is “Nearest Neighbor” Meaningful?. ICDT’99, LNCS 1540, 217-235.

[20] Khan, M., Ding, Q., Perrizo, W., 2002. K-Nearest Neighbor Classification on Spatial Data Streams Using P-Trees. PAKDD 2002, 6th Pacific-Asia Conference, 517-518. DOI: 10.1007/3-540-47887-6

[21] Silahtaroğlu, G., (2016). Veri Madenciliği. Papatya Bilim, pages 118-119, 97-98.

[22] Özkan, Y., (2016). Veri Madenciliği Yöntemleri. Papatya Bilim, 143.

[23] Gendrin, C., (2008). Chemical imaging and chemometrics for the analysis of pharmaceutical solid dosage forms. Engineering Sciences, Universit´e Louis Pasteur – Strasbourg I.

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DESIGN AND DEVELOPMENT OF A GRASS GRINDING MACHINE

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ABSTRACT: The search for energy alternatives involving locally available and renewable resources is one of the main concerns of governments, scientists and business people worldwide. This paper focuses on the design and fabrication of a grass grinding machine to facilitate grass grinding as an aid to sustainable energy from biomass in Nigeria. The work further focuses on grinding of elephant grass for generation of energy due to its availability and alternative means of energy generation to fuelwood. The elephants grass was Oven heated to 250^{o}C, to ensure dryness, the materials for the fabricated machine was sourced locally. They include a 1hp motor, a medium carbon steel Shaft, a SPA rubber melt, a mild Steel bearing, a 255mm by 255mm mild Steel hopper at the top and 125mm by 125mm at the bottom with a thickness of 2mm, a mild steel casing, a mild steel mesh of 4mm and cast iron pulleys. The dried grass is fed into the hopper and the tilted shaft within the casing carries out the grinding and sends it to the mesh which then sieves the ground particle into the receiver for collection. Dried Grass of mass 510.1kg was fed into the hopper and in three minutes the grass was pulverized to a fine particle of mass 43kg. The ground elephant grass can further be converted into pellets and briquettes, which can be used as heating fuel to provide an alternative to wood, biogas etc.

Keywords: Energy Alternatives, Grass Grinding Machine, Generation of Energy.

1. INTRODUCTION

One of the most challenging tasks facing Nigeria just like other developing countries is finding a means of expanding her energy services especially to the rural households, and at the same time addressing the health and environmental consequences of over-dependence on fire-wood for cooking. Irrespective of Nigeria's position as the sixth largest oil producing country, she suffers enormous energy crisis and still employs the use of biomass in the form of wood to meet her energy demands for local use.

Energy no doubt is important to the well-being of humans and to a country's economic development. It is an important input in achieving sustainable development including reduction of poverty. Energy is important to meet our basic needs such as cooking and boiling water. The most common form of energy widely used in Nigeria is biomass in form of wood [1-2].

Biomass is any organic matter that is renewable over time. It is simply a stored energy, and most often refers to plants or plant based materials such as grasses, sugarcane, wood, and wood

chippings etc, which are specifically called lignocellulosic biomass. Wood remains the most common source of biomass in Nigeria to date [1].

The overdependence of most Nigerians on wood biomass in meeting their energy demands for heating and cooking purposes has increased the demand for wood through time. With this increase in demand for wood, wood collection has placed a considerable pressure on the forest and consequently this has resulted in deforestation and other environmental consequences.

Deforestation poses a significant threat to lives on Earth due to the fact that burning of wood releases CO_2, a greenhouse gas which facilitates global warming. Hence the need for a more available, affordable, and environmental friendly alternative source of energy for cooking in Nigeria. In this regards grass pulverization and briquetting can be employed as a suitable and a more reliable alternative for wood in accordance with the Nigeria national energy policy: To de-emphasize and discourage the use of wood as fuel [3].

This paper is therefore part of an ongoing work on grass grinding as an aid to sustainable energy from biomass in Nigeria. However this work focuses on the grinding of elephant grass for generation of energy due to its availability and alternative means of energy generation to fuelwood.

2. LITERATURE REVIEW

Survey shows that authors across the globe have developed machines for grinding, cutting and crushing of biomass or solid waste materials/agro residues in Asia, America and Europe, [4-5].

Anand, (2016) [6] showed in the past that manually operated machine has been developed for fodder cutting. The Machine design was baesd on a human powered flywheel or a bicycle drive with speed variation mechanism. Hence, the effort for the process was extensive and unsafe. To overcome these obstacles we have designed a grass grinding mechanism which is safer and effort reducing with minimum power consumption.

Khurmi, (2016)[7] developed a Chaff Cutting Machine which is hay or straw cutting machine that is used for uniform chopping of fodder for livestock to agro industries. In this paper, design and development of grass grinding Machine is presented. The machine is developed gradually from basic machines into commercial standard machine that can be electrically driven to achieve effective grinding of elephant grass. The grass grinding machine is modified for its compactness and to avoid blockage of grass.

Grass is a biomass material readily available in the savannah areas of Nigeria (Guinea forest savannah, made up of plains of tall grasses, Sudan savannah which is the most common across the country with similar but shorter grasses and the Sahel savannah made up of patches of grasses and sand [8].

Generally in Nigeria, grasses are cut and mostly used for feeding live stocks. Often times it is considered a waste regardless of its abundance in the country. Presently, with the advancement in technology, perennial grasses such as elephant grass can be pulverized and pressed into pellets and briquettes and used as a heating fuel to replace or complement fuels made from wood fibers [8].

Energy studies indicate that significant gains in energy return and reduction in carbon emissions can be achieved by using grasses as biomass fuel [9].

Basically, for grasses to be pelletized or turned into briquettes it must undergo a very vital process which is the "grinding process''. To grind simply means to reduce a material to fine particle, in other words grinding means to crush, pulverize or to reduce to powder by friction [10]. Thus a grass grinding machine utilizes the force of friction in reducing grasses to powder.

Grasses more technically known as graminoids are monocotyledonous, usually herbaceous plants with narrow leaves growing from the base. They include the '' true grasses'' of the family poaceae as well as the sedges (cyperaceae) and the rushes (Juncaceae) [10].

3. METHODOLOGY

The conceptual design considerations are based on its mode of operation, material selection, belt size, shaft diameter, throughput capacity, dynamic load on bearing, power of the electric motor required to turn the shaft for effective grinding using the disc plate, diameter of the screw shaft, the dynamic load on the bearing transmitted by the screw shaft, power of the electric motor required to compact pulverized feedstock as well as extrude the resultant briquette from the die, and the size of the machine.

The conceptual diagram of grass grinding machine is as shown in figure 1. The grass is fed through the hopper and to the crushing chamber for material size reduction. The crusher is made of disc plate driven by a direct coupled drive electric motor carrying a shaft and bearings. The screw press is driven with a direct coupled drive to the electric motor which is linked to a shaft by means of pulleys. The smooth grinded grass is moved and extruded with aid of a die.
The design parameter calculations for the grinding components include: length of belt, diameter of shaft, the power required to overcome the inertia of the shaft and the screw, and the energy required for grinding.

The length of the V-belt (L) was determined using Eq. (1) as given by Khumi, (2005).

$$L = \frac{\pi}{2}\left(D_1 + D_2\right) + 2C + \frac{1}{4C}\left(D_1 - D_2\right)^2 \quad (1)$$

Where
d_1= diameter of motor pulley, d_2 = diameter of shaft pulley, C = center distance between the two pulleys.

The shaft is designed on the basis of strength, rigidity and stiffness. Khumi, (2005) shows that the shaft diameter can be deduced from;

$$\mathbf{d^3} = \frac{\mathbf{16}}{\mathbf{\pi S_s}}\sqrt{(\mathbf{K_b M_b})^2 + (\mathbf{K_t M_t})^2} \quad (2)$$

Where, M_t = Torsnional moment (Nm)

S_s = Shear stress

M_t = torsnional moment, Nm

M_b = bending moment, Nm

K_t = combined shock and fatigue factor applied torsnional moment

k_b =, combined shock and fatigue factor applied bending moment

Power requirement: This is given by:

$$Power(P) = \frac{2\pi NT}{60} \quad (3)$$

Where N = speed of rotation and T = torque

$$Torque = \frac{WL}{2} \quad (4)$$

Thus, L =Length of shaft, W = Load.

This concept was adopted after other concepts were evaluated against certain chosen criteria. The criteria for selection were based on the functional requirements of the system, ease of fabrication and the objectives of the grinding machine. In the above concept the shaft housing is tilted at an angle similar to that so that the grasses can slide down during grinding with the help of gravity but relatively less complex and less costly. Energy equation utilized for grinding is given as:

$$E = K_R \left(\frac{1}{d_2} - \frac{1}{d_1}\right) \quad (5)$$

From Rittinger's law of grinding,

E ($J.kg^{-1}$) = the energy required per mass of feed (W/(kg/s)),

K_R = Rittinger's constant,

d_1 (m) = the average initial size of pieces,

d_2 (m) = the average size of ground particles.

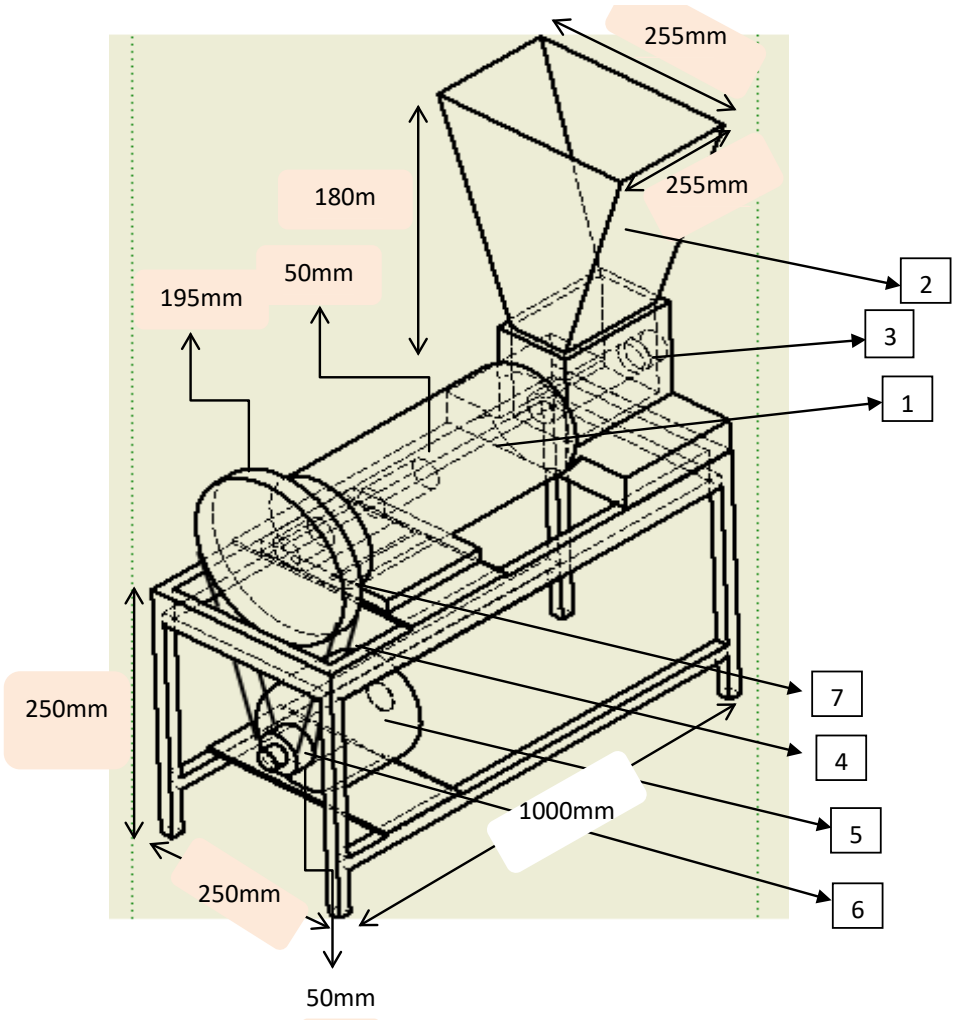

Figure 1. Isometric View of Conceptual diagram of grass grinding machine.

Table 1. Key.

Item No	Description
1	Shaft
2	Hopper
3	Sieve
4	Belt
5	Motor
6	Small Pulley
7	Big Pulley

Hopper Design: The hopper is considered as squared frustum made of mild steel as shown in Figure 2.

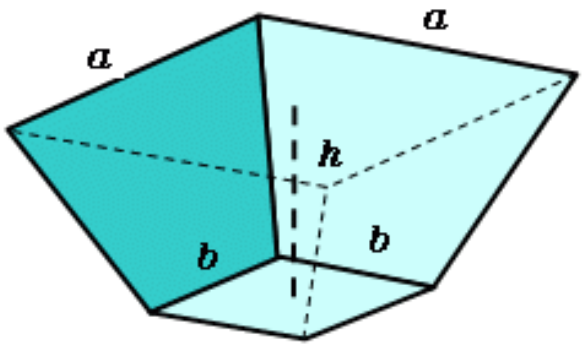

Figure 2. Hopper Design.

The volume of the hopper is given by equation (6),

$$V = \frac{h}{3}[A_1 + A_2 + \sqrt{A_1 A_2}] \quad (6)$$

Where, h = height of the hopper, A_1 = area of the upper base, A_2 = area of the lower base, a = length of the upper base and b = length of the lower base.

4. RESULTS AND DISCUSSION

The grass grinding machine was designed and fabricated as shown in the figure 3 for material crushing of elephant grass used for energy generation. The machine parameters and specifications obtained from the design considerations and theoretical formulations are as provided in Table 2.

Table 2. Machine Parameters and Specifications

S/No	Design Parameter	Specification
1	Volume of hopper	$33.51 \times 10^{12} mm^3$
2	Length of belt	1240mm
3	Power of the electric motor	1hp
4	Diameter of screw shaft	50mm

Figure 3. Fabricated Grass Grinding Machine.

The following results were obtained from dried elephant grass at oven temperature of 250^{o}C.
Mass of sack = 16.4g
Total Mass = Mass of sack + Mass of Dried Grass.

Table 3. Mass of dried elephant grass at 250^{o}C at different time interval.

	Sample A	**Sample B**	**Sample C**
Initial Total Mass (g)	526.5	526	527
Total Mass after 1 hour (g)	436.9	462.8	431.8
Total Mass after 2 hours (g)	406.7	428.3	413.8
Total Mass after 3 hour (g)	406.7	427.99	413

510.1kg of the dried elephant grass was fed into the hopper for 2 minutes to pulverize to fine particles of 43kg. The pulverized product was sieved using a sieve size of 4mm to test for fineness of particles. The pulverized particles and the sieved particles obtained are as shown in Figure 4 and 5 respectively.

Table 4. Mass of ground product of grass and time taken to grind.

Mass of dried Grass (kg)	**Sieve size (mm)**	**Mass of grinded grass Before Sieve (kg)**	**Mass of grinded grass after Sieve (kg)**	**Time Taken to Grind the Grass**
510.1	4	62	43	5mins 2secs
445.5	4	58	35	4mins 25sec
402.6	4	55	30	3mins 38secs
308.6	4	48	35	2mins 40secs
270.6	4	45	30	2mins

Figure 4. Sample of an Oven Dried Grass

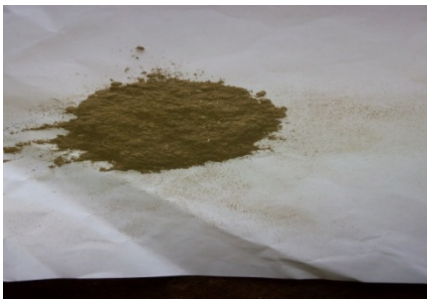

Figure 5. Pulverized Product of Grass

5. CONCLUSION

It can be inferred from the test, result and analysis that the grass grinding machine was effective in not just its ability to grind the elephant grass but also a large variety of grass samples it can grind. The machine is portable by virtue of its size and eases of operation and was fabricated from locally sourced materials making it very affordable for homes and for commercial uses thereby increasing the availability of energy to Nigerians. The pulverized product of grass from the machine will be effectively utilized in the production of briquettes and pellets and used as biofuel to complement fuels made from wood fiber alongside, reducing deforestation and its effects.

The design and fabrication of this machine lays a unique foundation for sustainable energy generation from biomass and hence further research for Nigerians.
Therefore we recommend

- Government to encourage and fund the local production of the machine to further enhance the use of grasses as a viable substitute for wood.
- Cheaper and better production processes for the fabrication of the machine to be researched.
- Government to provide a means of utilizing the end products from the machine such as pellet and briquette stove.

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REFERENCES

[1] United Nations Development Project (2012).Africa Gender and Energy.

[2] World Health Organization (2006) http://www.who.int/heli/risks/indoorair/indoorair/en/).

[3] Iloeje, O. C. (2002). Renewable Energy Development in Nigeria: Proceedings of a National Workshop on "Energising Rural Transformation in Nigeria: Scaling up Electricity Access and Renewable Energy Market Development". Federal Ministry of Power and Steel, Abuja, Nigeria. March 19-20, 2001. pp180. ICEED.

[4] Kishinmoto,S.(1969), "Briquetting of sawdust and other waste materials," proc. Inst. Briquetting and Agglomeration, Sunc. Valley, Idaho, Aug.27th-29th.pp43.

[5] ASTM (1951). Standard for Coal and Coke, pp: 46-51.

[6] Anand K. T. (2016), "Design and Modal Formulation of power Operated Chaff Cutter", International Journal on Emerging Technologies (IJET), vol. 4, p.p. 0975-8364.

[7] Khurmi, R. S. & Gupta, J. K.(2005), "Machine Design". Eurasia Publishing House (PVT) Ltd., RAM Nagar, New Delhi.

[8] Roger, M. R.; Mario, T. F. and Edwin C. A. (2007). Fibre Morphology in Fast Growth Gmelina Arborea Plantations. Madera Bosques, Vol. 13. No. 2. pp 3-13.

[9] Colley, Z.; Fasina, O. O.; Bransby, D. and Lee, Y. Y. (2006). Moisture Effect on the Physical Characteristics of Switchgrass Pellets. Transaction of ASABE. Vol. 49. No. 2. pp 1845-1851.

[10] Earle, R. L. and Earle, M. D. (2004). Size Reduction. Web Edition ed. Unit Operations in Food Processing. The New Zealand Instiute of Food Science and Technology (Inc.).

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FUZZY CONTROL OF CIRCUIT BREAKERS IN POWER TRANSFORMER CENTERS

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ABSTRACT: Transformer outages resulting from malfunctions by automatic maneuvers should be reflected to the system as soon as possible. Disruptions resulting from interruptions and losses should be minimized. In this study, Fuzzy Logic Control of Cutters in Transformer Centers has been provided. Since the energy parameters of the controlled electricity distribution line has been able to monitored continuously, energy consumption has been controlled. The fault conditions of all the elements in the substation are immediately determined and immediate intervention is possible. Human errors have been minimized by the control of breakers in the substation with fuzzy logic.

Keywords: Power Transformers, Transformer Breakers, Fuzzy Logic, Fuzzy Control.

1. INTRODUCTION

The advancement of technology, the more common power quality problems are becoming more important. The short or long-term changes in the power supply voltage result in huge financial losses for the industrialists who want to continuously increase their production [1, 2]. For the industrialist, power quality is an important issue in terms of continuous operation of the process and in order not to damage the devices. The harmonics in the transformer centers go up to a level that will deactivate sensitive devices or cause them to malfunction. For industrial users, it is important to minimize these risks and losses caused by risks and to keep energy consumption at the optimum level. Such events should be repeated frequently and the power quality improved. The biggest benefit to the consumer is the electricity distribution system under control and monitored; the most efficient and efficient use of existing energy is to eliminate risks in terms of life and property security [3, 4]. In all electrical facilities where electric energy is produced, transmitted, distributed and consumed, the distribution and transmission system is controlled and the energy parameters are monitored and the system is monitored. By means of this study, the automatic maneuvers and the interruption of the breakers in the substation with fuzzy logic have been reflected to the system as soon as possible.

2. CIRCUIT BREAKERS IN TRANSFORMER CENTERS

Circuit breakers are an absolutely essential part of any electrical system. Used in conjunction with proper grounding, they can safeguard against electrocution. Circuit breakers also protect appliances, wiring and property against fire hazards and other damage resulting from abnormal

current flow, short circuiting, overloading, and heat build-up. Circuit breakers in transformer centers is shown in Figure 1.

Figure 1. Circuit breakers in transformer centers.

There are many types of circuit breaker designs and they can be classified on the basis of voltage (high, medium and low) or other characteristics like their arc quenching media and operating mechanism. The winding short-circuit protection relays are used for large power alternators and transformers. An isolation fault is used to prevent short circuits between the phase windings of the alternators or the short circuits between their windings of a phase. In the case of a winding or winding short circuit failure in a winding, the relay is energized since the vector is zero. The relay opens the breaker. The winding short-circuit protection relay is used to protect the system against short circuits between the short-windings formed between the phase windings of large power transformers and alternators or the short-circuits between a phase's own windings. When there is no winding short circuit fault, the vector sum of the voltages is zero in the secondary connected coils in the wattmetric relay, there is no voltage. When the winding short circuit occurs, this balance is disturbed and the position of the contacts is changed by pulling the pallet. In the case of short circuit faults that occur in the energy transmission lines forming the interconnected network, the protection relay distance relay which detects and disables the defective part is the relay. A short circuit protection relay is used in large power transformers to avoid short circuits between the phase windings of transformers or the windings of a phase due to an isolation fault. The star connected and neutral point of the alternators and transformers is the relay phase earth leakage protection relay which is used to protect the power transformer in a phase-earth fault that occurs in the circuit fed by the secondary winding which is grounded. The transformer is used to protect the line against the short circuit of the feeder-ground and to protect the transformer output hat against the short circuit of the earth. In large power transformers, phase earth leakage protection relay is used in order to protect the system during phase-earth leakage between phase windings and earth.

3. FUZZY LOGIC CONCEPT

Fuzzy logic is based on fuzzy set and sub set. In a classical approach, an entity is a member of the coop or is not. When expressed mathematically, "1" is the value when the element is a member of the conglomerate, and "0" when the element is not a member of the conglomerate. Fuzzy logic is the extension of classical cluster representation. Each entity in the fuzzy entity set has a membership level. Contrary to classical clusters, the membership grades of fuzzy clusters can change in infinite number of intervals (0,1). These are a whole bunch of grades of membership that are continuous and unbroken. Binary variables such as cold-warm, fast-slow, light-dark in sharp clusters are likened to the real world by being softened by flexible qualifiers such as a little cold, a little warm, a little darkness in the fuzzy logic. Once fuzzy variables are defined and membership functions are assigned to them. There are some rules that are used in defining fuzzy clusters. In principle, the number of fuzzy sets assigned to each variable is usually a single number. This provides the presence of a centre point to prevent numerical oscillation between adjacent values. Second, the number of fuzzy sets is usually between 3 and 9. To describe causal relations, we must be able to distinguish one subset from the other by the use of linguistic variables. The greater the number of sub-clusters, the more difficult it becomes. It is easy to distinguish between short, medium and long variable values. But with a lot of data, this situation becomes more difficult. The linguistic descriptions of the subclasses can be interpreted. At the same time, each fuzzy set must sum up the compound sets. This overlay provides a continuous control area for the fuzzy controller. Once the blur sets have been defined and assigned their membership functions, the rules must be written for each combination of the control variable. These rules will relate input variables to output variables using ‘If-Then’ expressions in decision-making. The condition ‘If’ is a prelude to the result of each rule. In general, each rule is shown in ‘If’ (prefix) ‘Then’ (result) style.

4. TRANSFORMER CIRCUIT BREAKERS CONTROL BY FUZZY LOGIC

Fuzzy system for circuit breakers control is given in Figure 2.

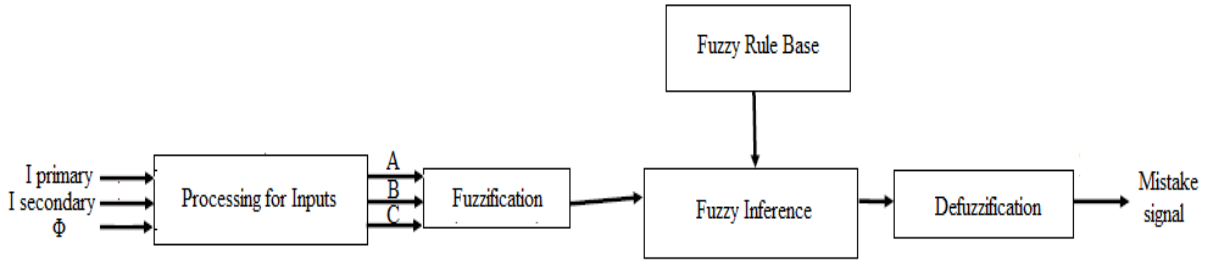

Figure 2. Fuzzy system for circuit breakers control**.**

The Fuzzy Control System is designed to monitor transformer fault information, to see the location of the breaker and the reason for opening the breaker opened under various fault conditions. Abbreviations and explanations of fuzzy expressions is given in Table 1.

Table 1. Abbreviations and explanations of fuzzy expressions.

Fuzzy parametre	Fuzzy Abbreviation	Fuzzy variable	Fuzzy Abbreviation
Over Voltage	OV	Short	S
Over Current	OC	Very short	VS
Voltage Imbalance	VI	Very long	VL
Current Imbalance	CI	Long	L
Temperature	T	Normal	N
Over Voltage Medium	OVM	Medium	M
Over Current Low	OCL	Low	l
Temperature High	TH	High	H

Fuzzy logic rule table is given in Table 2.

Table 2. Fuzzy logic rule table.

OV	OC	T	VI	CI	OVL	Output
OVl	OCI	Tl	X	X	X	VL
OVl	OCI	TM	X	X	X	VL
OVl	OCM	TH	X	X	X	N
OVl	OCH	TI	X	X	X	L
OVM	OCH	TH	X	X	X	VS
OVH	OCI	TI	X	X	X	L
OVl	OCM	X	X	X	X	L
OVl	X	TI	X	X	X	VL
X	OCI	TI	X	X	X	VL
OVl	X	X	X	X	X	L
X	OCM	X	X	X	X	N
X	X	X	VII	CII	OVI	VL
X	X	X	VII	CII	OVM	VL
X	X	X	VII	CII	OVH	L
X	X	X	VII	CIM	OVI	VL
X	X	X	VII	CIM	OVM	L
X	X	X	VII	CIM	OVH	N
X	X	X	VII	CIH	OVI	L
X	X	X	VIM	CIM	X	N
X	X	X	VII	X	OVI	VL
X	X	X	X	CII	OVI	VL
X	X	X	VII	X	X	L

Instantaneous values of current, instantaneous values of voltage, overcurrent information, earth leakage information, current transformer ratios, voltage transformer ratios, active power information, reactive power information, power factor, the value of the fault current that opens the system, when the system is turned on due to malfunction, and oscillographic diagrams of fault currents that open the system must be known. In the system monitored from the computer in the center, the remote control of the circuit breaker is also made from the same center. With the MC20 R reclosing microprocessor relay, the open circuit breaker is closed again to energize the line after the time set to the system with the breaker opened at the center. In order to decrease the rule base, two different results are produced by dividing 6 different input values and the smaller of the produced results is used as the final result. Created software in Matlab Program is given in Figure 3.

>> If OV is OVI and OC is OCI and T is TI then Output is VL else
>> If OV is OVI and OC is OCI and T is TM then Output is VL else
>> If OV is OVI and OC is OCM and T is TH then Output is N else
>> If OV is OVI and OC is OCH and T is TI then Output is L else
>> If OV is OVM and OC is OCH and T is TH then Output is VS else
>> If OV is OVH and OC is OCI and T is TI then Output is L else
>> If OV is OVI and OC is OCM then Output is L else
>> If OV is OVI and T is TI then Output is VL else
>> If OC is OCI and T is TI then Output is VL else
>> If OV is OVI then Output is L else
>> If OC is OCM then Output is N else
>> If VI is VII and CI is CII and OVL is OVI then Output is VL else
>> If VI is VII and CI is CII and OVL is OVM then Output is VL else
>> If VI is VII and CI is CII and OVL is OVH then Output is L else
>> If VI is VII and CI is CIM and OVL is OVI then Output is VL else
>> If VI is VII and CI is CIM and OVL is OVM then Output is L else
>> If VI is VII and CI is CIM and OVL is OVH then Output is N else
>> If VI is VII and CI is CIH and OVL is OVI then Output is L else
>> If VI is VIM and CI is CIM then Output is N else
>> If VI is VII and OVL is OVI then Output is VL else
>> If CI is CII and OVL is OVI then Output is VL else
>> If VI is VII then Output is L

Figure 3. Created software in Matlab Program.

This system is designed to protect the substations against faults, and has designed a fuzzy control system which will cut the energy in case of over voltage, over current, temperature, voltage imbalance, current unbalance and low voltage. As with most protection relays, if the system detects an error, it waits for a certain period of time and the power is cut off if the error is not corrected. The time to wait to de-energize the substation is critical. This needs to be determined by experts. In this study, waiting time for many different combinations is produced as turbidity. Due to the rule base created by the experts, the waiting period according to the error type and degree is calculated flexibly. Thus, the waiting time can be adjusted optimally according to the type and condition of the fault. In addition, the results of the simulation and the results of the experimental study show the reliability of the system. The classic system is 3 seconds with constant standstill, regardless of fault difference. The more flexible stop time is between 0 seconds and 4.5 seconds compared to the error type which is performed. The software is developed to adapt the system according to the parameters in the transformer central system.

6. CONCLUSIONS

By controlling the breakers in the substation with fuzzy logic, automatic maneuvers and interruptions resulting from the fault are reflected to the system as soon as possible. In this way, disruptions and losses resulting from the interruption are minimized. Since energy parameters of the controlled electricity distribution line can be monitored continuously, energy consumption is controlled. As the fault conditions of all the equipment in the system can be monitored from the system immediately, the intervention was interrupted without losing time. Fuzzy logic control system created by the human error, as well as a very small number of personnel was kept under control.

REFERENCES

[1] Martin H. B. Joost S., Richard A., Jhon, E., (1996), Condition monitoring of high voltage circuit breakers, Afrıcon, IEEE Afrıcon 4th, vol. 2, pp. 880-885.
[2] ANSI / IEEE, A Guide to Describe the Occurrence and Mitigation of Switching Transients Induced by Transformer and Switching Device Interaction. C57.142.
[3] Runde, M., Ottesen, G. E., Skyberg, B., Ohlen, M., (1996), Vibration analysis for diagnostic testing of circuit-breakers, IEEE Trans. Power Delivery, vol. 11, no. 4, pp. 1816-1823.
[4] IEEE Guide for the Selection of Monitoring for Circuit Breakers, IEEE standard C37.10.1-2000.