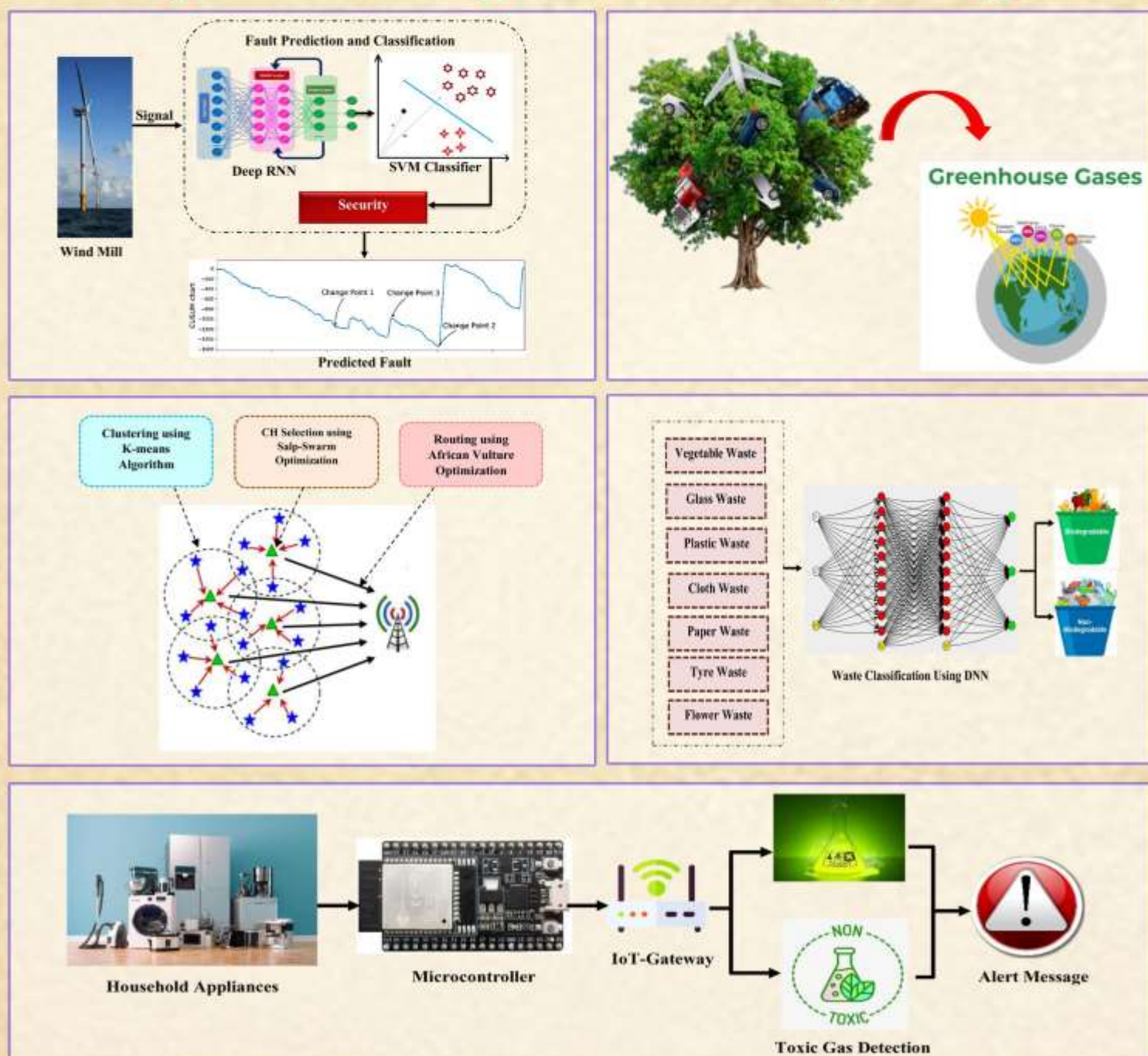


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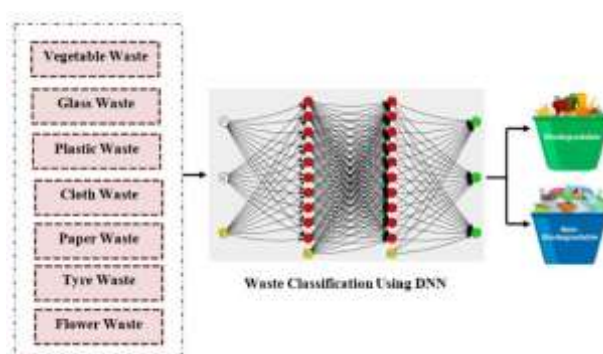


# International Journal of System Design and Computing

## 1. SEVEN CLASS SOLID WASTE MANAGEMENT-HYBRID FEATURES BASED DEEP NEURAL NETWORK

Krishna Bikram Shah, S. Visalakshi, Ranjit Panigrahi

**Abstract** – To keep cities clean, municipal agencies, non-profit organizations, and the private sector all provide solid management as one of their core essential services. Waste management includes the gathering, moving, handling, and getting rid of solid waste as well as monitoring and control. Due to urbanization, India is experiencing a significant environmental problem with solid garbage. The proposed techniques are employed in this work to categories the seven-class solid waste into biodegradable and non- biodegradable waste. Images from the training and testing datasets are used for each input dataset. Feature extraction is the next step, where MeQryEP and PCA (Principal Component Analysis) are employed. It can be mentioned as hybrid features (HF). HF are utilized to extract the texture and shape of the provided images, respectively. The extracted images are then combined. The collected seven class solid waste image is then classified under biodegradable and non-biodegradable garbage using DNN. The experimental results demonstrated that classification accuracy using DNN is 99.16%. Additionally, after a few epoch calculations, deep neural network demonstrated great accuracy, nearly 100%. The proposed seven class solid waste management improves the overall accuracy 9.23%, 0.24%, 37.47%, 3.59% better than PCA+MFCC, PCA+NFNN, PCA+SIFT, PCA+SVM.

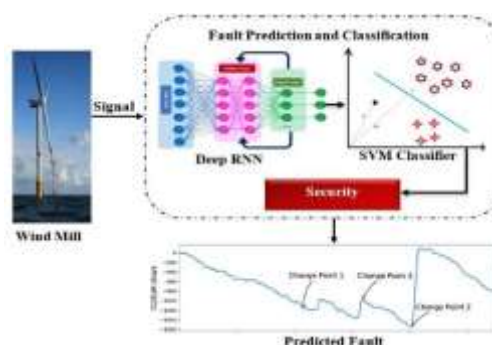


**Keywords** – Waste Management, DNN, Hybrid Features, Biodegradable, Neural Network.

## 2. INTEGRATION OF MONITORING AND SECURITY BASED DEEP LEARNING NETWORK FOR WIND TURBINE SYSTEM

A. Agasthian, Rajendra Pamula, L.A. Kumaraswamidhas

**Abstract** – Wind turbines are the modern-day equivalent of windmills. Simply, it harnesses the wind's energy to create electricity. Although huge wind turbines are the most noticeable, smaller wind turbines for residential use are also available. For example, you may use it to power your caravan or boat. A large plot of land will be necessary. In addition, it endangers the habitat of wildlife, particularly bird species. It uses wind energy to produce energy, making it a renewable energy source. To overcome this issue a novel Integration of Monitoring and Security based Deep Learning Network for wind turbine system technique has been proposed. Denoising Wind Signal to Diagnose Faults in Turbines Using Deep Recurrent Neural Network, the fault can be analysed and classified by using the Optimised Classification Algorithm, Complete Condition Monitoring Elements Integration Model for Wind Turbine System, and Defence Methods for Securing Wind Turbine Records in Cloud-based Cryptography. In terms of accuracy, the proposed fault detection and fault isolation method (CSO-SVM) is 6.5% more accurate than SVM, particle swarm optimisation SVM (PSO-SVM), and K-Nearest Neighbours (KNN).



**Keywords** – Wind turbines system, deep learning, SVM, K-Nearest Neighbors, fault detection.

### 3. REDUCTION IN GREENHOUSE GAS EMISSION BY USING SUSTAINABLE TRANSPORTATION SYSTEMS TO INCREASE THE ENVIRONMENTAL AND ECONOMIC BENEFITS

Dr. R. Sheeja, R. Nishant

**Abstract** – The transportation industry is the major source of air pollution and the cause for an increase in Green House Gases (GHG) emissions globally. 30% of GHG and air pollution generated worldwide is due to the burning of fossil fuels for transportation. Vehicles create smoke which leads to the emission of harmful gasses like nitrous oxide, ozone particulate and many more harmful elements that lead to global warming. Due to the increasing population worldwide, its effects cannot be decreased merely by establishing norms to decrease each individual vehicle's carbon emissions. These effects can be minimized only by building a sustainable transportation system to increase the environmental and economic benefits to a great extent using renewable energy resources such as biofuels, solar energy, and hydrogen. Sustainable transportation reduces carbon emission and increases air quality by replacing the normal modes of transport by eco-friendly ways like walking, cycling, green vehicles, carpooling,

eco-driving, etc., leading the future generation to live in a healthy environment. This paper introduces a novel GHG reduction technology for the global transformation system by providing an accurate measure of GHG gas emission. The technology used in this study increases the environmental benefits by reducing energy consumption, carbon emission, and air pollution. The eco-friendly methods implemented provide a cost-effective method by reducing fuel costs, maintenance costs and repair costs that occur in the normal modes of transport.



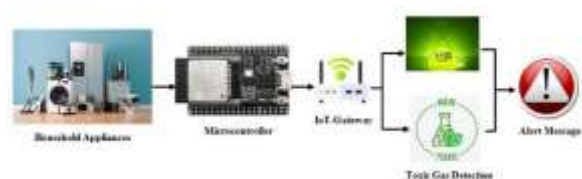
**Keywords** – GHG, Carpooling, Green Vehicles, Transit Rails.

### 4. ESTIMATION OF HOUSEHOLD APPLIANCES AND MONITORIZATION FOR IMPACT REDUCTION USING ELECTRO CHEMICAL SENSOR

M. B. Asha Stebi, A. Jeyam

**Abstract** – Stratospheric ozone depletion occurs when the production/destruction equilibrium shifts away from creation. While transitory ozone depletion can be caused by natural processes, the main culprits are now generally acknowledged to be the chlorine and bromine created by man-made substances like CFCs. Household appliances have a significant influence in the release of harmful gases. Because these appliances are used by everyone on the earth, this leads to the release of large number of gases, resulting in ozone layer depletion. The purpose is to analyse the impact of household appliances using the Product Environment Utilizing the Internet of Things

to lessen the impact of household appliances and Lifecycle Analytics (LCA) footprint engineering (IOT). An electrochemical sensor is utilized here to monitor the hazardous gases emitted by home appliances. When it detects the release of harmful CFC chemicals from household appliances, it sends an alert message to IoT-connected mobile phones and stores the information on the internet. This helps to prevent the depletion of the ozone layer by reducing the emission of CFCs and other harmful gases.



**Keywords**– Electro chemical sensor, IOT, ozone layer, Neural Network, CFC.

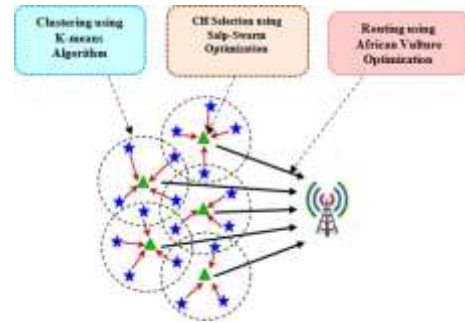
## 5. REDUNDANCY AWARE DYNAMIC ROUTING PROTOCOL USING SALP SWARM OPTIMIZATION ALGORITHM

S. Muthukumar, A. Hevin Rajesh, D. Jenice Prabhu

**Abstract** – Wireless sensor network (WSN) is a collection of specialized transducers linked by a communication system that monitors and records conditions in various locations. The process of determining an appropriate route from the destination node to the Source node. Due to the routing problem, networks last less time and use more energy. In this paper, a novel energy efficient cluster-based data redundancy elimination (EC-DRE) technique has been proposed for improving network lifetime and optimal routing in WSN. The k-means clustering algorithm is used in the proposed EC-DRE technique, and the Salp Swarm Optimization Algorithm is used to choose the Cluster Head (CH). The EC-DRE methodology uses the African vulture optimization method, which takes into account fitness criteria such as distance, network lifetime, energy, and delay when routing data. By using the normalised standard deviation methodology, the suggested method also reduces data redundancy, which was done in two steps, namely Intra Cluster and Inter Cluster. Prior to clustering, intra clustering was carried out. Data redundancy is filtered by Inter

Cluster before the routing process. The presented EC-DRE has been simulated using MATLAB. The proposed framework is compared with existing techniques such as E-ESR, FPTAC, DH, and PSO in terms of network life time, number of clusters, energy consumption, and residual. Experimental results show that the suggested EC-DRE approach extends network lifetime by 48.37%, 42.53%, 33.11%, and 21.42% compared to E-ESR, FPTAC, DH, and PSO Methods.

**Keywords**– Wireless Sensor Network, African Vulture Optimization, clustering, data redundancy elimination, Salp swarm optimization.



# SEVEN CLASS SOLID WASTE MANAGEMENT-HYBRID FEATURES BASED DEEP NEURAL NETWORK

Krishna Bikram Shah<sup>1,\*</sup>, S. Visalakshi<sup>2</sup> and Ranjit Panigrahi<sup>3</sup>

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**Abstract** – To keep cities clean, municipal agencies, non-profit organizations, and the private sector all provide solid management as one of their core essential services. Waste management includes the gathering, moving, handling, and getting rid of solid waste as well as monitoring and control. Due to urbanization, India is experiencing a significant environmental problem with solid waste management. One of cities' largest issues is solid garbage. The proposed techniques are employed in this work to categories the seven-class solid waste into biodegradable and non-biodegradable waste. Images from the training and testing datasets are used for each input dataset. Feature extraction is the next step, where MeQryEP and PCA (Principal Component Analysis) are employed. It can be mentioned as hybrid features (HF). HF are utilized to extract the texture and shape of the provided images, respectively. The extracted images are then combined. The collected seven class solid waste image is then classified under biodegradable and non-biodegradable garbage using DNN. The experimental results demonstrated that classification accuracy using DNN is 99.16%. Additionally, after a few epoch calculations, deep neural network demonstrated great accuracy, nearly 100%. The proposed seven class solid waste management improves the overall accuracy 9.23%, 0.24%, 37.47%, 3.59% better than PCA+MFCC, PCA+NFNN, PCA+SIFT, PCA+SVM.

**Keywords** – Waste Management, DNN, Hybrid Features, Biodegradable, Neural Network.

## 1. INTRODUCTION

Solid wastes are an issue for both the environment and people since they affect both on a direct or indirect basis throughout the whole waste cycle, from the point of production to the point of expulsion [1]. It is classified by bio degradable and non-biodegradable waste. Microbes decompose and breakdown biodegradable trash. Waste that is non-biodegradable cannot be broken down by bacteria. The inappropriate disposal of garbage and the poor management practices are the main causes of land contamination.

In the previous five years, India has created more than twice as much plastic garbage, with an average annual growth rate of 21.8%. In India, 62 million tons of waste are created each year. Even though only 30% of the waste produced by Americans gets recycled, the Environmental Protection Agency claims that 75% of it is recyclable [4]. In 2020, India produced 677 tons of biomedical waste daily, compared to 619 tons in 2019.

The mapping capabilities of QGIS work with predictive analysis methods to produce useful, real-time data for waste management agencies. This feature is not cutting-edge [5]. Another way to categorize waste products is to use Deep Learning and computer vision to enhance the process of finding recyclable items [2]. Another technique to determine a real-time position and gauge the rate at which waste is filling up is to use LoRa and GPS. Both the picture dataset and the image identification are fairly strict [7]. However, it has some drawbacks [9]. The Raspberry Pi 4 is utilized to demonstrate the items' typical accuracy using SSD-ResNet, another automated trash classification method. However, training image accuracy is lacking [6]. The methods used in this paper to classify the wastes using, hybrid feature (HF) extraction and DNN were tweaked to overcome these benefits. To extract the texture, MeQryEP is used. The shape's contour is extracted using PCA. DNN is used to categorize garbage as biodegradable or non-biodegradable.

This study's research is organized as follows. The classification of waste products is summarized in this section under the analysis of the "literature survey". Then, in the section under "Proposed Method," provide specific information on how the suggested method actually operates. The outcomes of the architecture are then examined in the "Experimental results" section. Conclusion and future work are included in the "Conclusion" sections.

| Type Of Wastes                                                                                              | Time Taken To Degenerate | Nature Of Wastes        |
|-------------------------------------------------------------------------------------------------------------|--------------------------|-------------------------|
| <b>Vegetable waste</b><br> | 1 to 2 weeks             | Biodegradable waste     |
| <b>Glass Wastes</b><br>    | 1 million years          | Non Biodegradable waste |
| <b>Plastic Wastes</b><br>  | Several years            | Non Biodegradable waste |
| <b>Cloth Wastes</b><br>   | 2 to 5 months            | Biodegradable waste     |
| <b>Paper Wastes</b><br>  | 10 to 30 days            | Biodegradable waste     |
| <b>Tyre Waste</b><br>    | 50 to 80 years           | Non Biodegradable waste |
| <b>Flower Waste</b><br>  | 3 to 4 days              | Biodegradable waste     |

**Figure 1.** Basic Types of Waste

## 2. LITERATURE SURVEY

Many different approaches to categorizing waste management have been put out over the years, and some of these studies provided a solution to this issue of how-to categories garbage waste. Some of the demonstration systems only provide categorization using image data.

In 2018 Salimi, I., et al. [11] proposed the use of a garbage bin robot for visual-based rubbish detection and classification. The Grey-Level Cooccurrence Matrix (GLCM) and the Histogram of Oriented Gradient (HOG) are combined to produce a set of attributes. Support vector machine, or SVMs, are employed for sorting the characteristics into three classes: trash and non-waste. Here, the term "real robot" is not used.

In 2018 The deep learning model used for the categorization of the Transnet dataset was published by Aral, R.A., et al. [12] The Densenet121, DenseNet169, InceptionResnetV2, Mobile Net, and Exception architectures were used for the Trash net dataset. The neural network model optimizer has been implemented using Adam and Ada delta. The accuracy of the high test was attained by Adam Optimizer. This approach has been tested with modest amounts of data.

In 2018, Gundupalli, S.P., et al. [13] suggested classifying e-waste using methods based on thermal imaging. The categorization of MF and NMF from E-waste by thermal imaging that works in the long wave infrared region is the major objective of this study. The suggested classification model was developed to classify the feature vectors into the broad classes of PCB, metal, and glass.

In 2019 Ruiz, V., et al. [14] saw the publication of the automatic image-based garbage classification. Trash net dataset and deep learning architecture are used in this method to automatically classify different types of garbage. The accuracy model's classification outcome is produced by inception-Resnet. It has some restrictions on how much garbage it can classify.

The waste management data analysis coupled with precision analysis is proposed by Ahmad, S. and Kim, D.H. in 2020 [15]. Timely waste information is used by the efficient planning of waste management. Here, QGIS is used to analyses the precise placement of trash cans and the best route for the garbage truck. This version of QGIS is not an advanced feature.

In 2020 Thokrairak, S., et al. [16] reported the automatic waste classification detection utilizing SSD-Mobile Net. The waste product is categorized using the SSD-Mobile Net. The Raspberry Pi 4 is used to display the product's typical accuracy. The accuracy value of the training images is poor.

Sheng, T.J., et al. [17] focused on waste management using LoRa and the TensorFlow model in 2020. TensorFlow detects and classifying the object once LoRa provides the data. An inbuilt ultrasonic sensor measures the level of waste filling. GPS tracks the bin's location in real time. The image dataset and image identification are both rather rigid.

In 2020 Baras, N., et al. [18] was described the smart-based cloud recycling bin for garbage classification. Smart bins are used to collect measurement data for information systems. To categories the waste from each bin, AI and neural networks are deployed. It has the accuracy necessary to accurately classify the different waste types.

Zeng, M., et al. [19] have suggested utilizing CNN to categorize public garbage in 2020. It is a multi-task classification system that determines the different types of household waste. Using the joint loss function can help to increase accuracy. This method of categorizing the trash has some limitations.

In 2020 Alqahtani, F., [20] published the cuckoo search method for waste management detection. IOT devices track human activity and provide assistance with waste disposal. The cuckoo search neural network is used after that. It analyses the waste's size, composition, and origin [21-25]. The training program me has virtually little backing.

The accuracy value was obtained from these literature reviews using a variety of deep learning and machine learning techniques [26-28]. DNN is utilized in the suggested strategy to categories of seven class solid waste images into biodegradable and non-biodegradable materials [29]. The methods for hybrid feature extraction are MeQryEP and PCA. DNN has great levels of accuracy.

### 3. PROPOSED METHOD

In this section, the proposed seven class solid waste, DNN is used to classify the biodegradable and non-biodegradable wastes. Training and testing images are created from each and every input images. The two categories of feature extraction used in this technique are hybrid extraction. PCA is utilized as the shape extraction, while MeQryEp model is used for texture extraction. After the images have been extracted, the retrieval procedure begins. then the images that were retrieved are categorized using DNN classification, it has classified the images.

The input images are classified under training and testing data. Then the images are modified in the process of feature extraction. Here feature extraction is classified under two types. One is texture extraction (MeQryEp) and another one is shape extraction (crest line). The details of hybrid extractions are shown below.

#### 3.1. Quinary Encoding on Mesh Pattern (MeQryEp)

MeQryEP has been stated in this study using the concept of local pattern approaches. The local pattern approaches are (LBP, LMeP and LQP). MeQryEP describes the grey scale connection and it employed image quinary sequence characteristics to extract additional spatial structure data. It is one of the robust features when compared to other approaches such as LBP, LTP. The created mesh quinary pattern is then translated into the 04 binary coding pattern using the LQP supplied.

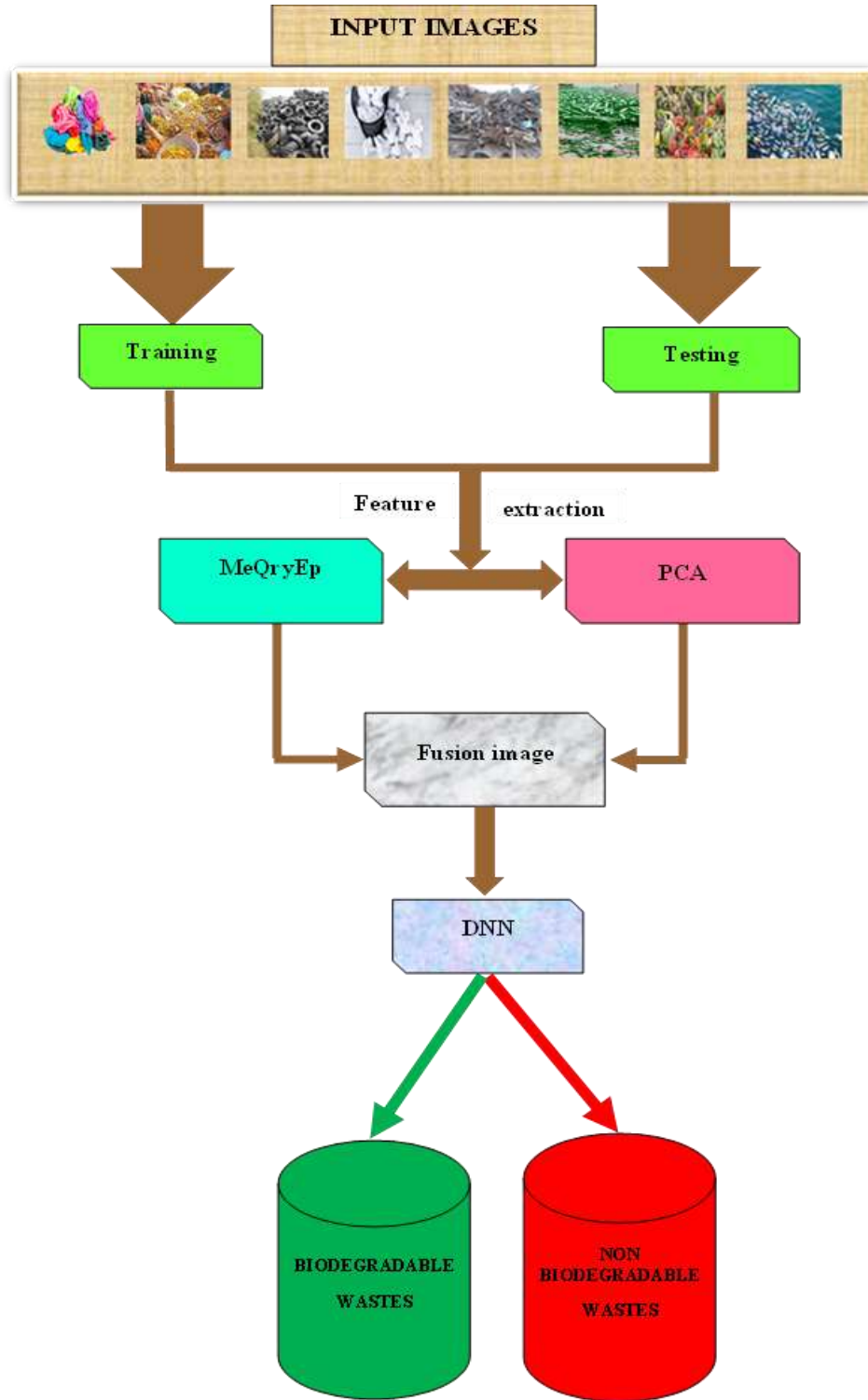
Two higher LQP (for c=1 and 2) are defined as shown in below equations,

$$MQryP_{upper\ 1}(1, i) = \sum_{j=1}^{\binom{s}{2}-1} \vec{f}_2(y, r_1, r_2) \times 2^{i-1}, \quad (1)$$

$$\text{where } \vec{f}_2(y, r_1, r_2) = \begin{cases} 1, & \text{if } (y \geq r_2), \\ 0, & \text{otherwise} \end{cases}$$

$$MQryP_{upper\ 2}(1, 3 + i) = \sum_{j=1}^{\binom{s}{2}-1} \vec{f}_2(y, r_1, r_2) \times 2^{i-1}, \quad (2)$$

$$\text{where } \vec{f}_2(y, r_1, r_2) = \begin{cases} 1, & \text{if } (r_1 \leq y < r_2), \\ 0, & \text{otherwise} \end{cases}$$



**Figure 2.** Block diagram of DNN based image classification

Similarly (for  $c = -1$  and  $-2$ ) are two lower MQryP equation are as follows.

$$MQryP_{lower\ 1}(1, 7 + i) = \sum_{i=1}^{\left(\frac{s}{2}\right)-1} \vec{f}_2(y, r_1, r_2) \times 2^{i-1}, \quad (3)$$

$$\text{where } \vec{f}_2(y, r_1, r_2) = \begin{cases} 1, & \text{if } (r_1 \leq y \leq r_2) \\ 0, & \text{otherwise} \end{cases}$$

$$MQryP_{lower\ 2}(1, 10 + i) = \sum_{i=1}^{\left(\frac{s}{2}\right)-1} \vec{f}_2(y, r_1, r_2) \times 2^{i-1}, \quad (4)$$

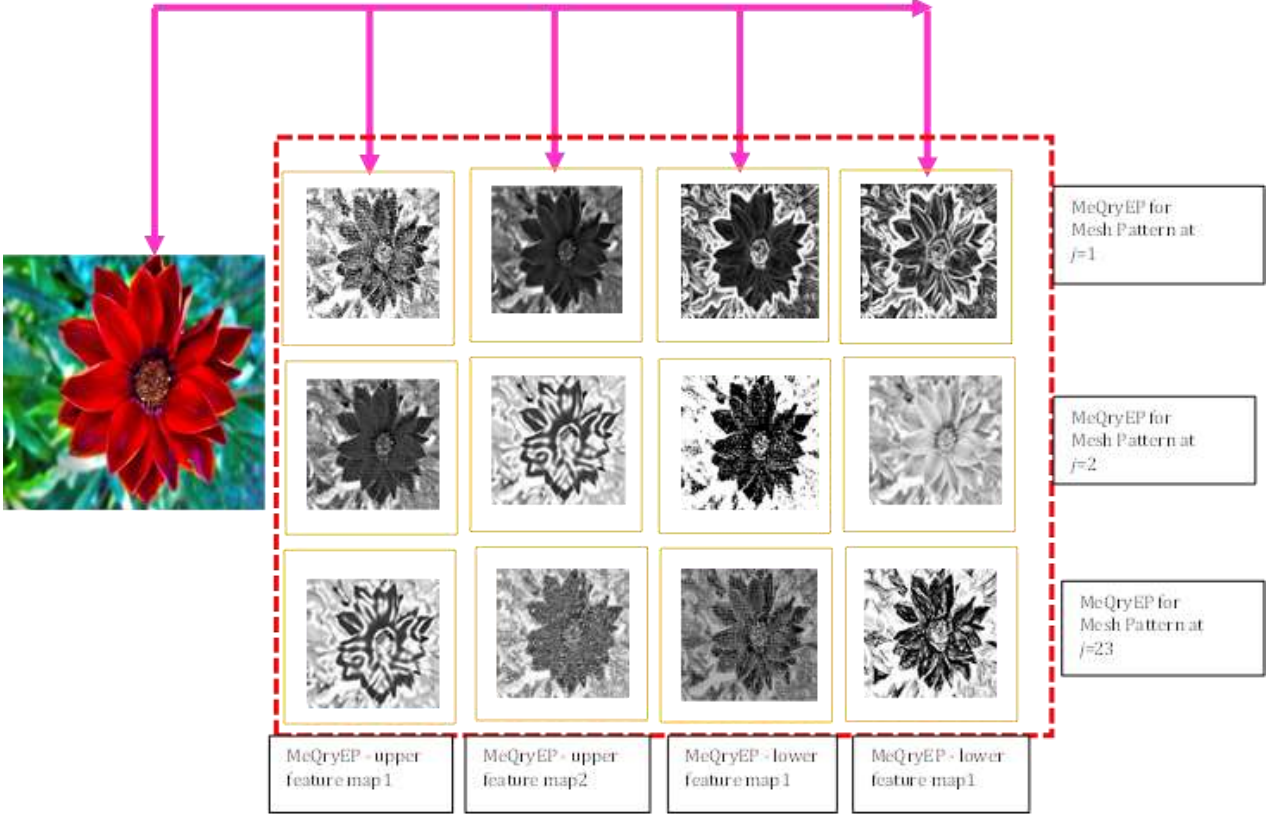
$$\text{where } \vec{f}_2(y, r_1, r_2) = \begin{cases} 1, & \text{if } (y \geq r_2), \\ 0, & \text{otherwise} \end{cases}$$

MeQryEP creates the last histogram vector of features by merging four descriptor histograms from each LQP operator.

$$H_{MeQryEP}(V = \frac{1}{L_1 \times L_2} \sum_{u=1}^{L_1} \sum_{t=1}^{L_2} f_3[MeQryEP(u, t), v]) \quad (5)$$

$$v \in [0, (2^p - 1)]$$

Where an input image's size is represented as  $L_1 \times L_2$



**Figure 3.** Module Architecture of MeQryEP Model

The proposed MeQryEP is distinct from the previously known, current LBP approach. MeQryEP excerpts the grayscale relation for gathered centre pixel with its neighbors with three preset mesh pattern orientations, whereas LBP mines the grayscale relation among a centre pixel and its adjacent pixels.

### 3.2. Principle Component Analysis (PCA)

Karhunen-Loève transform is another name for principal component analysis (PCA). This efficient multivariate analysis technique searches for the projection that most closely approximates the data in the least squares sense. Dimension is automatically decreased when applying the PCA. In order to maximize the variability in the first few axes, the raw data is rotated into an axis as the basis of this method. In the hyperdimensional vector space where there is no relationship between the data, a novel coordinate system must be found in order to do this.

$$A_i = [a_1, a_2, a_3 \dots \dots a_N]_i^S \quad (6)$$

$$g = \frac{1}{G} \sum_{i=1}^G [a_1, a_2, a_3 \dots \dots a_N]_i^S \quad (7)$$

$$C_x = \frac{1}{G} \sum_{i=1}^G (a_i - G) (a_i - G)^S \quad (8)$$

Where,  $A_i$  is a hyperspectral image vector at 'i' that contains information in all N dimensions of a specific pixel.

The original dataset,  $A_i$ , is then transformed into the new coordinate system, Z, using a linear transformation, V. A diagonalized covariance matrix is created from the initial

covariance matrix CX. A generalized eigenvalue problem of the type was the solution.

$$C_x = V D V^S \quad (9)$$

$$\text{Where } D = \text{diag} (\lambda_1, \lambda_2, \lambda_3 \dots \dots \lambda_N)$$

$$V = (v_1, v_2, v_3 \dots \dots v_N) \quad (10)$$

Here D is the diagonal matrix of  $\lambda_1, \lambda_1$  is the eigenvalues  $v_i, v_i$  is the eigen vectors.

Lastly, the PCA technique is calculated as,

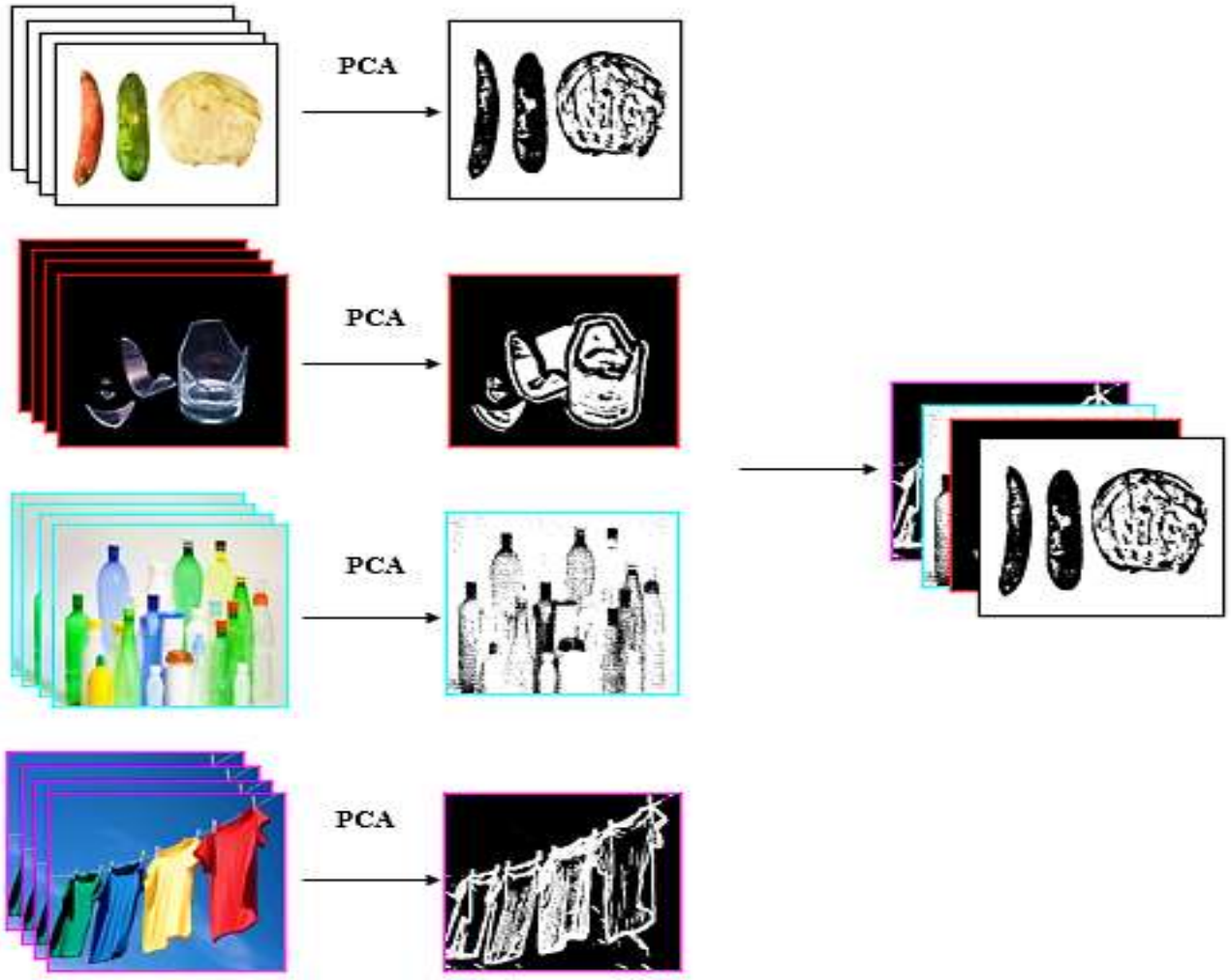
$$Z_i = V^S A_i \quad (11)$$

Where  $i = 1, 2, 3, \dots \dots G$ , The number of components used in this last phase will be carefully examined in our experiments section and will rely on the information extraction task that is desired.

### DNN

In this method DNN is used to classify the waste product under degradable and biodegradable. The feed-forward network model and greedy layer are essentially how the DNN works.

In this approach, there is no looping job involved in the data flow from the input to the resultant layers. The DNN classification model's low chance of missing values is one of its key advantages. During the unsupervised pretraining phase, the DNN concept is implemented with a single layer.



**Figure 4.** Proposed PCA Model

It is a more sophisticated version of the original generation of ANN, which Rosenblatt created based on the 1943 proposal of Culloch and Pitts for a single-threshold logic unit neural network. While MLP's application domains are not as diverse as DNN's, their structures are similar. The restricted Boltzmann machine (RBM) is one strategy that DNN can utilize to determine starting weight values that are close to optimum. Right now, the most common non-linear activation function employed in DNNs is the rectified linear unit (ReLU). It activates significantly more quickly and smoothly than traditional activation functions like the tanh or sigmoid.

#### 4. RESULT AND DISCUSSION

The effectiveness of the categorization strategy is assessed using the following statistical techniques. (1) accuracy (2) precision (3) f1 score

**Accuracy:** To evaluate different models, accuracy is the most often used and best output statistic.

$$accuracy = \frac{TP+TN}{TP+TN+FP+FN} \quad (12)$$

|                   | biodegradable  | Non biodegradable |                                  |
|-------------------|----------------|-------------------|----------------------------------|
| biodegradable     | 98.68%<br>(TP) | 2.32%<br>(FP)     |                                  |
| Non biodegradable | 3.45%<br>(FN)  | 97.55%<br>(TN)    |                                  |
|                   |                |                   | 100<br>80<br>60<br>40<br>20<br>0 |

**Figure 5.** Confusion Matrix of Wastes

**Precision:** It gauges how well the model classifies positive events into the positive category. The precision ratio is the sum of the projected positive values divided by the true positive values.

$$Precision = \frac{TP}{TP+FP} \quad (13)$$

**Recall:** Recall is a metric for how successfully a model can recognize positive occurrences. The sensitivity formula and

the recall formula are therefore equivalent. Recall defines ratio of true positive rates to all true positive rates.

$$Recall = \frac{TP}{TP+FN} \quad (14)$$

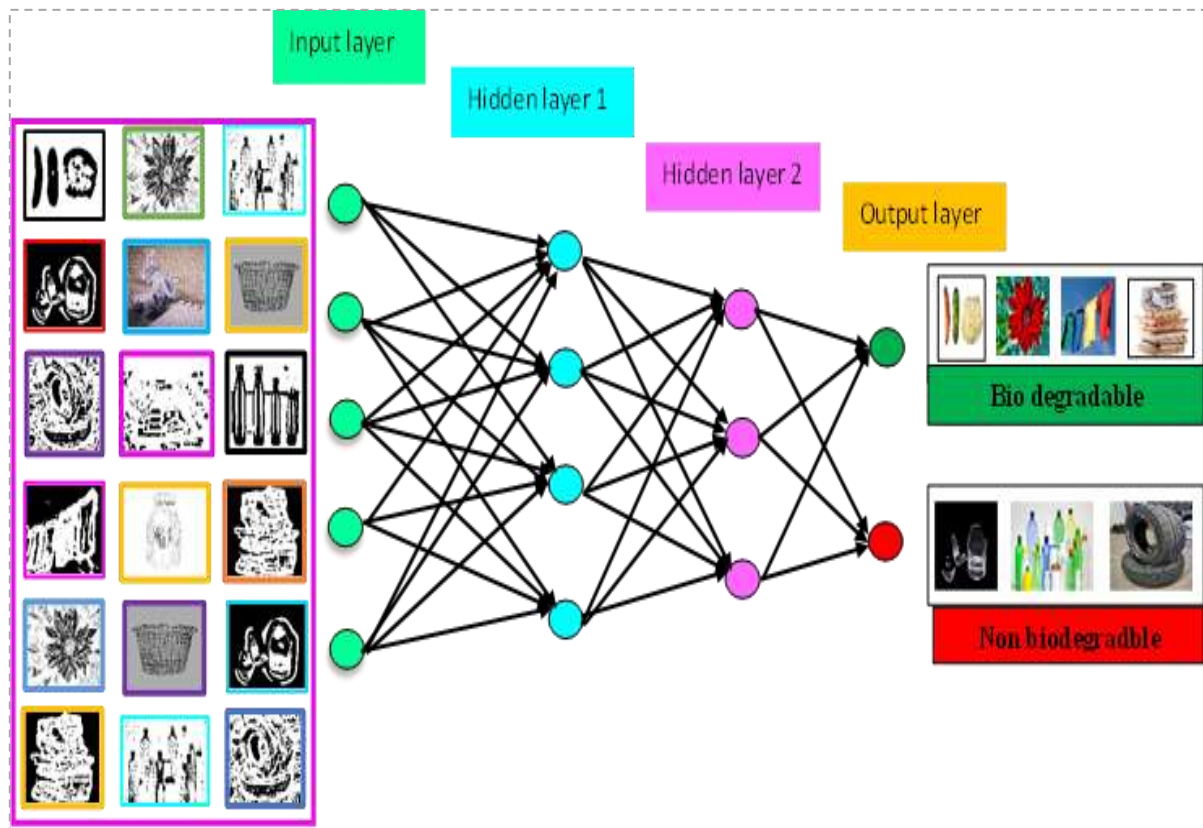


Figure 6. Proposed DNN method

Table 1. Performance of The Proposed DNN Classification Method

| Model                          | Types             | Precision | Recall  | Accuracy |
|--------------------------------|-------------------|-----------|---------|----------|
| DNN based waste classification | biodegradable     | 97.90%    | 96.62 % | 99.16%   |
|                                | Non-biodegradable | 97.87%    | 96.54 % | 99.10%   |
|                                | average           | 97.88%    | 96.58 % | 99.13%   |

Table 1 provides an explanation of the categorization of decomposable and non-decomposable waste with accuracy, precision, recall. From table.1, it is clear to show that the accuracy value is 99.13%, precision value is 96.58% and the recall value is 99.13%. which means DNN classification show more accuracy value.

The training accuracy and validation accuracy continuously improved with each epoch, until converging in the latter epochs. each training epoch's accuracy and loss were recorded. It is demonstrated that the train and validation accuracy scores are nearly similar at each epoch.

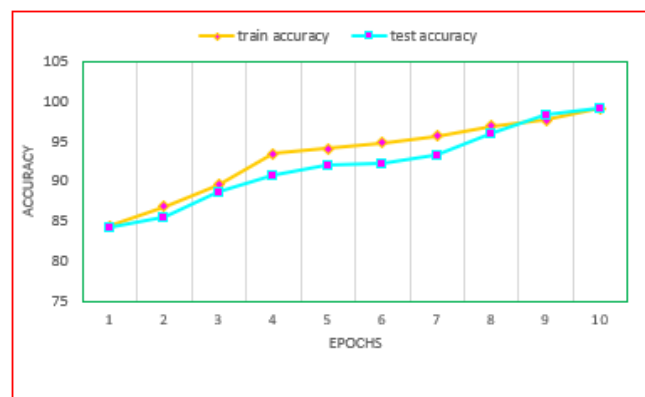
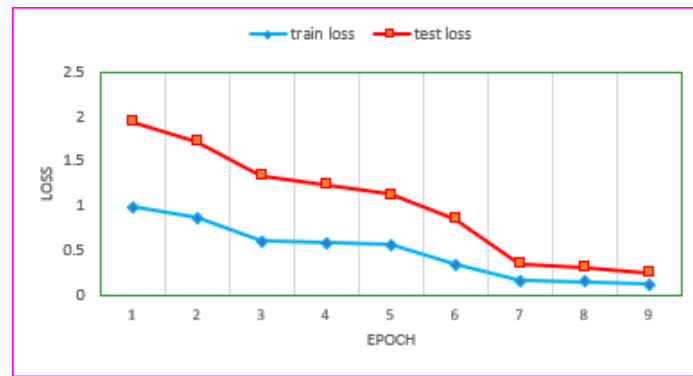


Figure 7. Accuracy Graph



**Figure 8.** Loss Graph

The training loss is slightly higher than the validation loss. With each period, there was a considerable reduction in both the train loss and the validation loss. The accuracy and loss graphs are shown above.

#### 4.1. Performance Analysis

Comparative data for five classifiers are shown in Table 2. The greater accuracy value is produced by DNN on this five-classifier system. DNN clearly has a greater accuracy value than the other classifiers stated above, as evidenced by the comparison.

**Table 2.** Comparison between the traditional and proposed method

| Method            | Accuracy | Recall | Precision |
|-------------------|----------|--------|-----------|
| KNN               | 61.39%   | 58.64% | 60.68%    |
| RF                | 87.89%   | 85.99% | 86.02%    |
| SVM               | 90.82%   | 89.96% | 87.57%    |
| CNN               | 95.54%   | 94.11% | 93.35%    |
| HF DNN (proposed) | 99.16%   | 96.62% | 97.70%    |

The proposed seven class solid waste management improves the overall accuracy 9.23%, 0.24%, 37.47%, 3.59% better than PCA+MFCC, PCA+NFNN, PCA+SIFT, PCA+SVM. The biodegradable and nonbiodegradable wastes are accurately classified by the proposed DNN model with high accuracy

**Table 3.** Comparison Between Existing and Proposed Method

| Author              | Method   | Accuracy |
|---------------------|----------|----------|
| Winursito, A.       | PCA+MFCC | 90%      |
| SINGH, S.           | PCA+NFNN | 98.92%   |
| Pushpaningrum, A.P. | PCA+SIFT | 62%      |
| Musu, W.            | PCA+SVM  | 95.6%    |
| Proposed method     | PCA+DNN  | 99.16%   |

## 5. CONCLUSION

This proposed seven class solid waste management method provides a deep learning technique for the identification of solid waste image datasets for the

classification of waste. Both biodegradable and nonbiodegradable garbage are categorized in the images. The offered methods' initial phases are featuring extraction from the input image dataset and classification. The texture and shape of the input images is extracted using a hybrid feature (HF) extraction tool. The combination of PCA and DNN described in this research can be used to identify the type of wastes. The results are satisfactory, and the proposed DNN performed improved than the majority of the mentioned existing techniques based on accuracy. This DNN proposed method was capable of classifying the biodegradables and nonbiodegradable waste with 99.13% accuracy, 97.88% precision and 96.58% recall. As a result, the improved DNN model produced the highest test accuracy rates. The proposed seven class solid waste management improves the overall accuracy 9.23%, 0.24%, 37.47%, 3.59% better than PCA+MFCC, PCA+NFNN, PCA+SIFT, PCA+SVM.

## CONFLICTS OF INTEREST

No financial or interpersonal conflicts have been reported by the authors that would have affected the study's findings.

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# INTEGRATION OF MONITORING AND SECURITY BASED DEEP LEARNING NETWORK FOR WIND TURBINE SYSTEM

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**Abstract** – Wind turbines are the modern-day equivalent of windmills. Simply, it harnesses the wind's energy to create electricity. Although huge wind turbines are the most noticeable, smaller wind turbines for residential use are also available. For example, you may use it to power your caravan or boat. A large plot of land will be necessary. In addition, it endangers the habitat of wildlife, particularly bird species. It uses wind energy to produce energy, making it a renewable energy source. To overcome this issue a novel Integration of Monitoring and Security based Deep Learning Network for wind turbine system technique has been proposed. Denoising Wind Signal to Diagnose Faults in Turbines Using Deep Recurrent Neural Network, the fault can be analysed and classified by using the Optimised Classification Algorithm, Complete Condition Monitoring Elements Integration Model for Wind Turbine System, and Defence Methods for Securing Wind Turbine Records in Cloud-based Cryptography. In terms of accuracy, the proposed fault detection and fault isolation method (CSO-SVM) is 6.5% more accurate than SVM, particle swarm optimisation SVM (PSO-SVM), and K-Nearest Neighbours (KNN).

**Keywords** – Wind turbines system, deep learning, SVM, K-Nearest Neighbors, fault detection.

## 1. INTRODUCTION

Wind energy is renewable source which is mainly conserved in global and also in India [1]. During earlier decade, wind energy generation had grown quickly and colossal quantities of wind turbines had been passed [2].

On the improvement of wind power, dependability and operational status have become a significant issue that has pulled in much consideration in exploration. Wind energy or wind power portrays the cycle by wind signal is used to produce electricity. Wind turbines change kinetic source of

energy into mechanical energy. A generator, generates electrical energy from mechanical energy. In a wind mill, gearbox is an essential segment and the disappointment rate is low, despite the fact that the support cycle is confounded [3].

The gearbox that connects the shaft and the generator might malfunction, which can potentially lead to wind turbine failures [4]. Since the internal structure of the gearbox is very complicated in nature, the fault diagnosis is difficult which occur due to the variable load condition [5]. The fault in the gear box in turn affects the generator which ultimately results in damage of the whole system. High-frequency vibration test sensors are employed to assess fundamentally important parts, including turbine edges, tips, and machinery [6].

The turbine changes the wind blow into power by the smoothed-out power created by the rotor cutting edges, it run mostly on the helicopter rotor edges or the plain wind method [7]. The rotating blades turn a pole inside the nacelle, which coupled onto the gearbox. It will increase the speed on rotation of generator as per the turning ratio, this process will lead to generate electricity from the mechanical energy [8]. The generated power is transfer to a transformer, which transfer the power from windmill to grid as with corresponding to the rang of transmission line [9]. In the short-sighted view, the working guideline of a wind turbine is only inverse to that of a fan. The major contribution of the work has been followed by

- Denoising Wind Signal to Diagnose Faults in Turbines using Deep Recurrent Neural Network,
- The fault can be analyzed and classified by using the optimized classification algorithm,

- The model integrates all the elements of condition monitoring for wind turbines,
- Defence methods for securing wind turbine records in cloud-based in the cryptography.

The remaining portion of the work has been followed by Section 2 illustrates the Literature Review, Section 3 represents the Proposed methodology, Section depicts the 4 Result and Discussion and finally the conclusion and Future work has been representing in section 5.

## 2. LITERATURE REVIEW

Ehab Bani-Hani et al [9] looks at probably the introduction of a Horizontal Axis Double Rotor Wind Turbines (DRHAWT). Subsequent blade added to standard HAWT subsequent blade restored remaining energy left in the wake of the primary blade; the benefit of the wind turbine was extended through from now on two activities were analyzed; essential approach uses the second blade legitimately after the main blade, where both turn a comparable way, and the subsequent strategy uses the ensuing blade, where blades rotate at opposite direction. This pattern shows the high wind speeds, the effectiveness of two-fold blade wind turbines can proceed with equivalent expanding patterns contrasted and a solitary blade.

Xin Hua et al [10] introduced the breeze turbine was the feathered wind creature such as blades under the working guideline. Three sorts of bionic sharp edges were arranged by bionic wind type and set up subject to the incredible streamlined introduction of seagull wind united as per theory of wind turbine blade structure the bleeding edge segment speculation. Standard blade and streamlined presentations of the bionic front line were evaluated by strategies for numerical proliferation.

In different breeze speeds, the outcome shows edging torque of bionic edge of full-scale will increase airfoil to 10.2%, but bionic sharp edge will not entirely increased by airfoil augments as 14%, and the arrangement improved bleeding-edge augments as 7%. To affirm the precision of numerical amusement results, as it run bionic front line and develop a relating exploratory contraption in a certified assessment. The outcomes of the assessment are unsurprising with the example of numerical entertainment.

Peter, et al [11] investigated the present state of-workmanship for turbine blade design was shown, including speculative most extraordinary efficiency, drive, helpful adequacy, Horizontal axis wind turbine edge structure (HAWT), and blade loads. The review gives an absolute image of the turbine blade structure and express the power of present-day turbines select usage of level rotate blades. The streamlined structure principles for a propelled wind turbine blades were point by point, including sharp blade plan shape/sum, aerofoil assurance, and perfect ambush edges. An organized review of setup stacks on turbine blades was provided, gyroscopic, depicting streamlined, gravitational, outward and the operational conditions. Directly makers were searching for bigger cost proficiency during improved turbine measurement

as opposed to inconsequential increment through upgraded sharp blade adequacy.

Xueru Wang et al [12] built up a wind turbine gearbox temperature model under the run of the mill operating condition using the Gaussian technique, gauge, and evaluation of temperature were moreover depicted. Inside the Bayesian setting, the paper expects to set up a Gaussian strategy, using the most outrageous likelihood improved approach to manage to get the perfect hyper parameters. For tremendous scale backslide endeavors, a novel methodology by Cholesky disintegration to keep up vital good ways from not the well-adjusted system was depicted. Another system using lattice putting away to quicken the retrogressive of structure estimation was planned. Likewise, the improved Gaussian model was helped to envision the gearbox endorsement data, complexity, SVM and BPNN these two methods.

Jinge Chen et al [13] acquainted with relieving the extending burden on up-scaling WT blades to increase its weariness life. Here, the complex bend curve attached with sharp edge was analyzed and used to ease the continuous fluctuation loads in wind shearing. The 5-MW NREL forefront was first then again overhauled of its composite configuration. The fibers on the battle top were diverted a long way from the sharp edge turn to execute the contort bend coupling. In between, the free awake lifting surface method was grasped to process the streamlined weights, which was constrain more reasonable than by largely used BEM procedure. Due to the arrangement model, influence of BTC in the blade streamlined execution was analyzed. Weight help effects on the edges with different battle top fibers focuses were evaluated.

M. Jureczko et al [14] a wind turbine was set up; the aim was to achieve the most power production in the allotted time. According to one perspective, it depends on the turbine blade's condition. The distinction in the condition of the blade was one form of methodologies to change solidness and quality; be that as it may, it may influence the streamlined productivity of the wind turbine. Another methodology to change the mechanical and dynamic properties of wind turbine was altering composite material, and then the blade was made of it. The issue of choosing the perfect condition of the blade and choosing the perfect composite material was a staggering, as the numerical depiction of streamlined weight was confusing and different necessities and goals must be pleased. These thoughts have impelled the makers to took up the issue of multi-criteria perfect arrangement of the WT blades.

It is most common for external wind turbines to fail due to damage to their blades caused by birds striking them, lightning striking them, rain, blade furniture detaching, blade delamination, leading edge corrosion or blade cracks. To overcome these issue a novel has been proposed.

## 3. PORPOSED METHODOLOGY

### 3.1. Fault Detection Model Development utilizing AI

Faults utilizing sensor information can be identified by man-made reasoning procedures, for example, AI and neural

systems. These procedures include the capacity to pick up utilizing preparing information without being unequivocally modified. The prepared calculation can be then used to make expectations from new information gathered from the sensors.

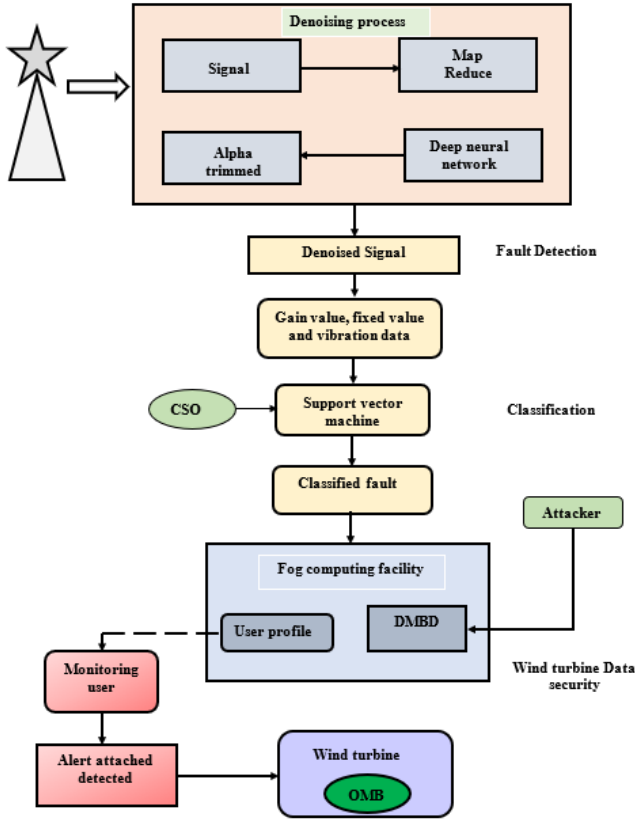


Figure 1. Proposed Methodology

Machine learning errands are for the most part characterized into two classes, contingent upon the idea of the accessibility of information (indicators) and yield (reaction) information accessible to a learning framework. These are:

- **Supervised learning:** The calculation is prepared with model data sources and related wanted yields and the objective is to gain proficiency with a general guideline that maps contributions to yields.
- **Unsupervised learning:** In this situation, marks are not given to the learning calculation, which means it finds a claim to discover structures in the sources of info. Unaided learning is fundamentally utilized for finding concealed examples in the information.

On account of wind turbines, regulated learning is the most proper as noteworthy sensor and comparing fault event information can be utilized as indicators and the reactions can be utilized to prepare fault recognition calculations.

Supervised learning can be ordered into two unique classifications of calculations:

Arrangement: For straight out, reaction esteems, where the information can be isolated into explicit "classes" Relapse: For consistent reaction esteem forecast the fault recognition issue falls under the classification of characterization as the sensor esteems are utilized to foresee all-out reaction, "fault" or "no-fault".

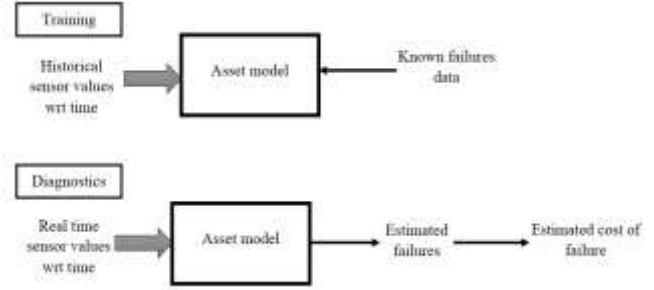


Figure 2. Supervised Learning for fault diagnosis

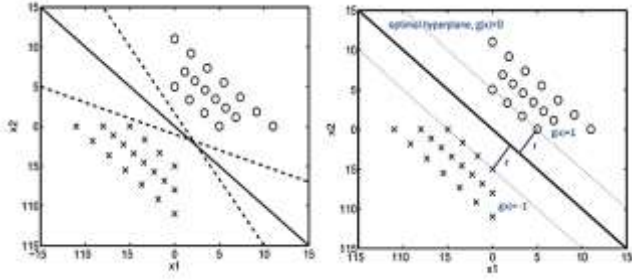
### 3.2. Support Vector Machine (SVM)

SVM is a system for example acknowledgment with this strategy is commonly used in classification issues. This calculation is used to take care of the streamlining issue. The arrangement is finished by discovering the hyper-plane which isolates three capacities: direct capacity, non-straight capacity, and portion work. SVM discovers a detachment hyperplane in the element space with categorizes focuses on the space. The SVM method looks through limits with the greatest edge of detachment from the preparing information plotted into space (named a space part) acquired after a changing role [89]. Edge expansion more often than not diminishes the speculation error (i.e., the expected mistake on a trial dataset free from the set utilized to manufacture the classifier).

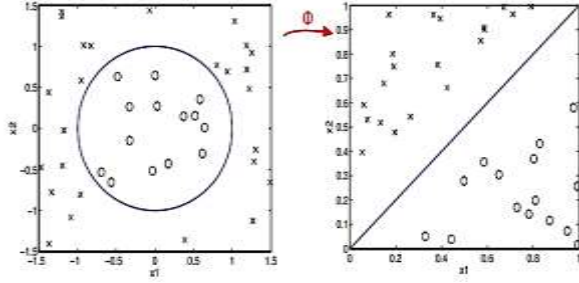
This begins the clarification of the grouping procedure by an arithmetical perspective on the strategy, trailed thru its scientific definition. Right off the bat, the particular instance of no information change is detailed (the case wherein the piece, as clarified in resulting areas, is straight, where the interstellar bit is comparable to the first interstellar) and, at that point, the overall numerical detailing besides the kinds of portions being used. Starting with the perfect instance of a straight divisible dataset, a straightforward geometrical perspective on the thought overdue the SVM, deprived of plotting the information against extra space, is conceivable, just like the idea of the edge.

The three outlines which are strained could be a substantial method for isolating the preparation dataset, however, the ceaseless one has all the earmarks of being an increasingly fitting way.

Scientifically, if we characterize the edge as the separation amid the border and the closest similar streak which marks a case of any of the courses, the limit which is drawn speaks to the border by the greatest edge (see the correct piece of Figure). By and by, there are plenty of issues that meant the information cannot be directly isolated, that is the reason a quest is formed for limits per increasingly compound design.

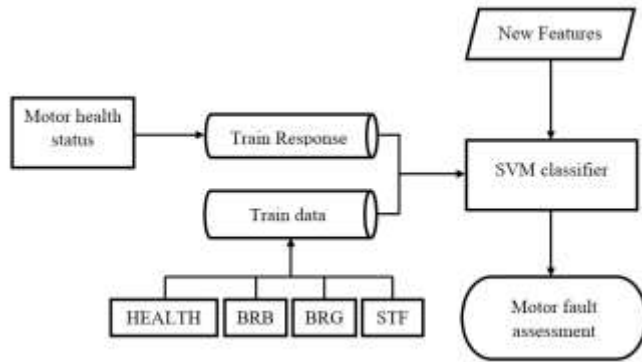


**Figure 3.** The idea of the SVM model



**Figure 4.** Graphical View of the SVM

In the circumstance, on account of SVM, the changing interplanetary of the information is utilized, in which a quest aimed at the hyperplane is achieved, as should be obvious in Figure 4. The tests are performed utilizing misleadingly seeded faults, the SVM classifier might be prepared to utilize a segment of the information [92]. Further, the new information that might be delegated appeared in Fig 5.



**Figure 5.** SVM Classification Scheme

### 3.3. Linear Role

Linear role in SVM is permanently a trustworthy situation and is designated as  $x_i$  and  $y_j$ .

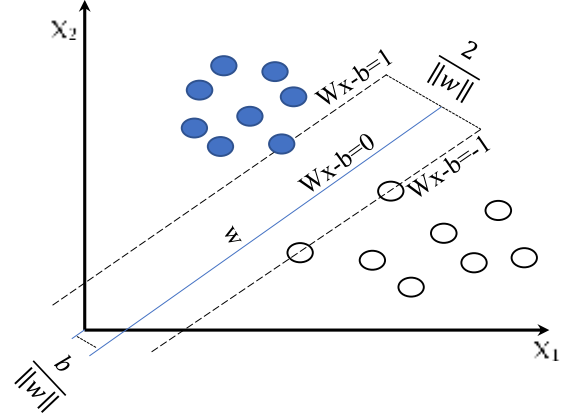
$$r = \frac{y_s(w^T X_s + b)}{\|w\|} = \frac{1}{\|w\|} \quad (1)$$

Intended for every Support direction  $x_s$ , the overhead dissimilarity is an equivalence purpose. In the rouse of rescaling  $w$  and  $b$  by  $\rho/2$  in the equivalence, we acquire that separation amid every  $x_s$  and the hyper-plane is,

$$r = \frac{y_s(w^T X_s + b)}{\|w\|} = \frac{1}{\|w\|} \quad (2)$$

The pointed edge may be articulated over (rescaled)  $w$  and  $b$  as:

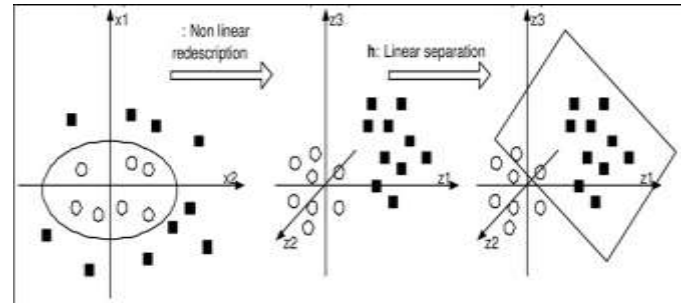
$$\rho = 2r = \frac{2}{\|w\|} \quad (3)$$



**Figure 6.** Linear function classification

### 3.4. Non-Linear Function

This capacity plays a bit trap spot item and it takes care of twofold fault definition. Using the spot result of highlight vectors is done during both the preparation and testing. The straight calculation is contingent just on  $x_i$ , consequently changed calculation based on just  $\phi(x)\phi(x_i)$ .



**Figure 7.** Non-Linear Function using Kernel

### 3.5. Kernel Function

Non-linear issues are handled with the kernel purpose. Whereas in SVM theory, the kernel role is a major area of knowledge for SVM. The RBF kernel job's objectives are as follows:

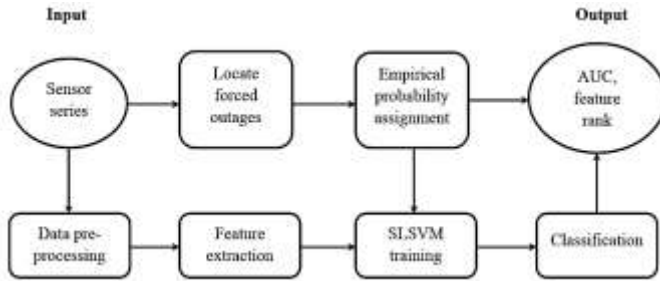
$$K(x, x') = \exp(-\gamma|x - x'|^2) \quad (4)$$

SVM elements choose together its erudition capability also simplification capability. Double main RBF elements associated in SVM are  $C$  and  $\gamma$ .  $C$  gearshifts the symmetry among the complication of the method and the accurate fault. The complaint for parameters  $C$ ,  $\gamma$ .

If C is very huge, the complication is more. If C is very trivial, the complication is little. is a supply element. At the moment, the mainstream of the SVM elements has been verbalized by a smart Procedure.

### 3.5.1. Fault classification

Condition observing methodologies require establishments of explicit hardware and sensors to distinguish issues at explicit pieces of a wind turbine. To order the fault location the framework is developed with copy sensors to estimating the turbine's pitch position and the speed of the rotor and generator. Likewise, these procedures are generally founded on either the compelled explores or re-enacted dataset. Execution checking is another stream of research that spotlights using recorded operational turbine information in a standard time interim. The expenses related to these methods are nearly immaterial since wind turbine execution information is recorded by the Supervisory Control and Data Acquisition. Execution observing methodologies utilizing factual strategies and information mining an elective system of wind turbine condition checking. Issues of cutting edges are of specific concern due to their expense to fix. Two fundamental deficiencies related to turbine cutting edges which adversely influence the presentation of wind turbines are the cutting-edge improbability (i.e., the deviation between the genuine and set pitch edge), and cutting-edge asymmetry (i.e., the deviation of the sharp edge pitch edge). Information mining methodologies using hereditary programming calculation was utilized to screen and anticipate the presence of a sharp edge pitch.



**Figure 8.** General Fault classification process

Figure 8 represents the block diagram of the general fault classification process. Information mining the calculation was worked to anticipate and recognize status designs. wind turbines utilizing status and operational information gathered a presentation checking approach based on wind turbine SCADA alerts was researched the creators in proposed the ceaseless wavelet change based way to deal with upgrade the issue recognition of wind turbine edges considering the Meyer wavelet as the fundamental wavelet. Non-Destructive Testing which is also called as Non-Destructive Evaluation, is utilized to screen the conduct of a breeze turbine sharp edge during a semi-static test-to-disappointment. Acoustic discharge strategy is utilized for checking of a run of the mill wind turbine cutting edge during the exhaustion test. What's more, a procedure based on the infrared warm picture is completed for non-damaging challenging of wind turbine edges the comparable harm stacking methods for full-scale wind turbine cutting edge

which may result in the event of weariness has likewise explored the creators in investigated the piezoceramic based impedance and dynamic detecting strategies for the observing of wind turbine cutting edges. The procedure of highlight determination and shortcoming grouping is led by methods for stratified cross-approval, to show at the point when further preparing isn't bringing about better speculation.

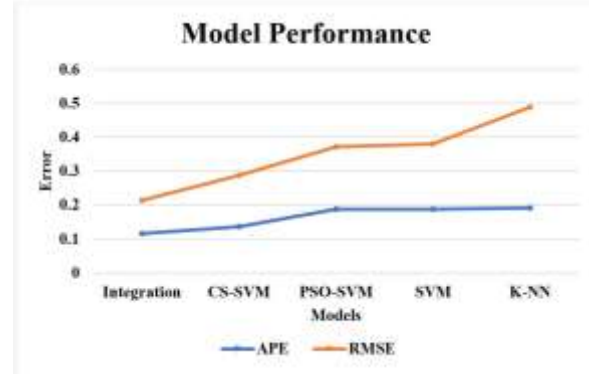
This implies, for every cycle of the approval, one segment of the total arrangement of cases are haphazardly picked to characterize the most critical surface highlights and to prepare the class. Gearbox efficiency fault due to high wind speed.

### 3.5.2. Attacker

DMBD receives information about the attacker. When a flaw is found, its kind and location are identified for easy assistance. Rapid gearbox, generator bearing, and setbacks that occurred in various components are the causes of fault in wind turbines. In a wind farm, wind turbine condition checking is used to reduce maintenance costs and improve accuracy.

## 4. RESULT AND DISCUSSION

The most well-known and advanced tool for wind turbine condition monitoring is the sensor. It inspects the condition of any gearbox faults in wind turbines. A sensor is used to describe the operational status of the wind turbine, such as the level of damage collection.



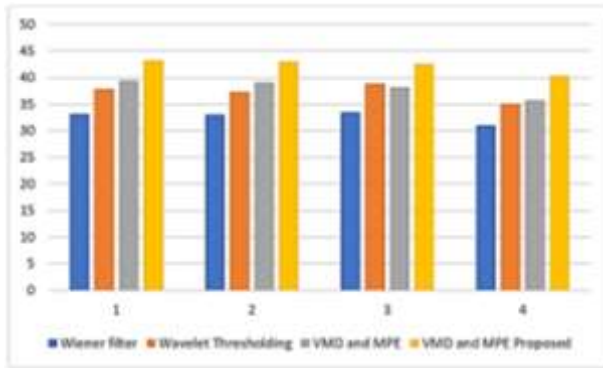
**Figure 9.** Graphical representation of model's performance

Various sorts of motorized flaw happen in a gearbox, for example, harmed riggings and split apparatuses. Utilizing of sensors in gearbox to give adequate alarm to administrators to take support activities, it diminishes the expense.

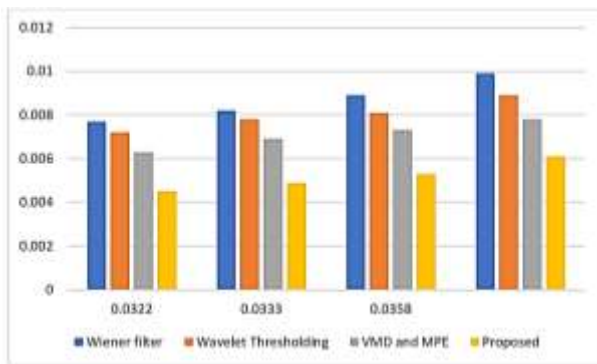
Figure 9 demonstrates that, in comparison to the PSO-SVM, SVM, and K-NN approaches, the integrated model routine uses 0.1145 equivalent APE and 0.2138 comparable RMSE. The APE rates for PSO-SVM, SVM, and K-NN are all 0.1874 and 0.3710, respectively, whereas the APE rates for PSO-SVM are 0.1879 and 0.3800, respectively.

Figure 10 demonstrates Comparison chart of PSNR for Existing and Proposed method. The comparison of PSNR value of the proposed Alpha trimmed mean filter with a deep recurrent neural network strategy is improved by 0.23%, 0.12% and 0.57% of Wiener filter, Wavelet Thresholding and

Variational mode decomposition & multiscale permutation entropy techniques respectively.



**Figure 10.** Comparison chart of PSNR for Existing and Proposed method



**Figure 11.** Comparison chart of MSE for the existing and proposed method

Figure 11 Comparison chart of MSE for the existing and proposed method. The comparison of MSE value of the proposed strategy is reduced by 0.58%, 0.68%, 0.794%, 0.365% of Wiener filter, Wavelet Thresholding, and Variational mode decomposition & multiscale permutation entropy techniques respectively.

## 5. CONCLUSION

In this paper a novel Integration of Monitoring and Security based Deep Learning Network for wind turbine system technique has been proposed. Denoising Wind Signal to Diagnose Faults in Turbines using Deep Recurrent Neural Network, the fault can be analyzed and classified by using the optimized classification algorithm, an integrated model for all condition monitoring components for a wind turbine system, Defence methods for securing wind turbine records in cloud-based in the cryptography. Separated from the outcomes of CS-SVM and PSO-SVM was the CS-SVM model's output. The two systems' anticipated residuals for MAE and RMSE should be counted. As opposed to PSO-SVM, SVM, and K-NN, CS-SVM outputs are more accurate and have a transcendental impact. The CS approach is used to choose the appropriate SVM parameters so that SVM can effectively prevent gear failure. The accuracy of the suggested fault isolation and detection approach (CSO-SVM) is 2.5% and 3.5%,

respectively, which is an increase of 6.5% when compared to SVM, PSO-SVM, and KNN.

## CONFLICTS OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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# REDUCTION IN GREENHOUSE GAS EMISSION BY USING SUSTAINABLE TRANSPORTATION SYSTEMS TO INCREASE THE ENVIRONMENTAL AND ECONOMIC BENEFITS

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**Abstract** – The transportation industry is the major source of air pollution and the cause for an increase in Green House Gases (GHG) emissions globally. 30% of GHG and air pollution generated worldwide is due to the burning of fossil fuels for transportation. Vehicles create smoke which leads to the emission of harmful gasses like nitrous oxide, ozone particulate and many more harmful elements that lead to global warming. Due to the increasing population worldwide, its effects cannot be decreased merely by establishing norms to decrease each individual vehicle's carbon emissions. These effects can be minimized only by building a sustainable transportation system to increase the environmental and economic benefits to a great extent using renewable energy resources such as biofuels, solar energy, and hydrogen. Sustainable transportation reduces carbon emission and increases air quality by replacing the normal modes of transport by eco-friendly ways like walking, cycling, green vehicles, carpooling, eco-driving, etc., leading the future generation to live in a healthy environment. This paper introduces a novel GHG reduction technology for the global transformation system by providing an accurate measure of GHG gas emission. The technology used in this study increases the environmental benefits by reducing energy consumption, carbon emission, and air pollution. The eco-friendly methods implemented provide a cost-effective method by reducing fuel costs, maintenance costs and repair costs that occur in the normal modes of transport.

**Keywords** – GHG, Carpooling, Green Vehicles, Transit Rails.

## 1. INTRODUCTION

Sustainable transport is a transport that is sustained for social, environmental and climatic impacts and also serves economic sustainability. It has a low impact on the environment and it will balance the current and future needs. The sustainable mode of transportation is Walking, Cycling, Car sharing, and green vehicles. It reduces pollution, and

control traffic, and avoid accidents. Nowadays, due to overpopulation, local transport such as cars, bikes, trucks, etc. has been increased. Because of these, many difficulties have been faced with people such as traffic, parking areas, accidents, and will also cause some medical problems and the main problem is greenhouse gas. The greenhouse gas is a gas that emits infrared radiation from the earth due to the combustion of fossil fuels. This may lead to the greenhouse effect which causes global warming. Because of this problem with local transport. So, we prefer to sustainable transport.

At present, each and every person have their own vehicle. Because of overpopulation, the usage of the vehicle is been increased so, many areas are required for parking, Fuel combustion and accidents also occur to avoid such problem car-sharing technique has been introduced it is defined as the car are rented for an hour, day, overnight. Another technique that has been introduced is known as a green vehicle which is a road motor vehicle that reduces the greenhouse effect in the atmosphere. In this electricity is stored in the battery and the stored electricity is used to run the motor and accelerate the vehicle. Instead of petrol and diesel biofuels have been used.



**Figure 1.** walking and cycle

Walking, Cycling and Public transport(bus) is the best way to reduce the usage of private transport. Globally the private vehicle emits 89 pounds of CO<sub>2</sub> per miles but the public bus emits only 14 pounds. To avoid greenhouse gas, we can prefer walking and cycling, as the best way as shown in figure 1. There are many methods that still exist to solve the greenhouse gas effect in rail transport to produce less amount of greenhouse gasses in the air. The engine rail can carry 600 members, for a mile it can carry one gallon of fuel, which is feasible. By comparing the electric train with diesel trains, the diesel train emits more CO<sub>2</sub> than the electric train. So, it is best to prefer electric trains for long-distance. The transit rail that is usually used in urban areas with high passenger capacities and full grade separation from other traffic including engine rail traffic it is been displayed in figure 2, transit vehicle.



**Figure 2.** Transit vehicle

Transportation is the most important part of the environment, between 20% and 25% of energy consumption and carbon dioxide emission takes place. Due to this 97% emission takes place in the burning of fossil fuels. To avoid this emission, sustainable transportation has been used, this will lower the energy consumed in the environment. By using sustainable transport, traffic can be reduced that would develop the economy by which the goods are easily moved from one place to another at the correct time.

Some of the economic benefits of sustainable transport;

- It generates sales
- It is a cost-effective service.
- It is high-valued for land use.
- Productive increased.
- transportation costs are reduced.
- It has economic development.
- Reduce infrastructure costs.
- It creates more jobs.
- It reduces waste, and make the world a more efficient and helping community.

Some of the environmental benefits of sustainable transport;

- Air Quality Improvement

- Reduces greenhouse gas emissions.
- Saves energy.
- Other benefits.
- Minimizes impacts.

### **1.1. Air Quality Improvement**

In urban areas, by introducing sustainable transport, we can reduce traffic and those who live near the high way they can save health risks due to poor quality of air. By avoiding private vehicles and encouraging transit vehicles will not pollute the air. The transits rail will not pollute because of the stored electricity instead of fossil fuels.

### **1.2. Reduces Greenhouse Gas Emission**

Public transportation produces a small amount of greenhouse gas emissions than private vehicles. The transit rail metros, subways produce low greenhouse emission than the Single-Occupancy Vehicles (SOV). The transit can reduce the greenhouse emission by using efficient vehicles, and project construction and service operations are decreased.

### **1.3. Saves energy**

Changing private transport to public transport can save fuel. It can also reduce the need for transportation infrastructure, manufacture of new vehicles, and extraction of more fossil fuels. The study of ICF International states that transit vehicles in the USA can save 947 million gallons of fuel than the single passenger vehicle.

### **1.4. Other benefits**

In addition to environmental benefits, transit serves public purposes such as affordable mobility, congestion relief, and economic development.

### **1.5. Minimizing Impacts**

The transit agencies go above federal requirements, many transit agencies have purchased compressed natural gasses and busses which subsequently reduce air pollution. Even the hybrid electric buses conserve fuel and lower emissions. Several transit agencies are implementing Environmental Management Systems (EMS), which has management issues such as energy conservation, efficient water use, vehicle emission reduction, material recycling, and management of hazardous materials.

The rest of the paper is assigned by the following sections, the II section is related to the literature survey that the different methodologies of the previous paper are compared with the current paper. Section III describes the proposed system of reducing the greenhouse gas with the help of sustainable transport which includes GHG technology, carpooling, green vehicles, transit vehicles, and some of the economic and environmental benefits. Section IV concludes the paper.

## **2. LITERATURE SURVEY**

The main aim of this study is to estimate how sustainable transport is used to reduce greenhouse gas and increase

economic and environmental development. The high-power electron beam is been implanted [1] in this paper. The NH<sub>3</sub> based EB technology is used to change CO<sub>2</sub>, SOX, and NOX into fertilizer and designed to produce high electricity. This used CCS road map for carbon recycles has been used between power and agriculture. It simply states how fuel and carbon are recycled for electricity. during electricity cleaning, the natural carbon cycle has a 10% power loss.

According to this paper [2], the different modes of transportation find the correct view of its sustainable transport and show how urban transportation to developed to form sustainable transport. They have been developed some final statements to developed in Karachi to form sustainable transport. That proves transportation is a danger in Karachi because it is a big problem to solve urban development. The transit rail and another type of transportation is mentioned only in future work and states that how sustainable and urban transport is just used in Karachi

Economic and social development is clearly enhanced in [3]. That says that transportation plays an important role in the quality of cities and has a technology of ICT that gives improving facilities of globalization and localization. In addition, the intelligent infrastructure system will fairer the city and designed sustainable transport and communication for the cities. The household survey says that by walking and cycling a greater number of energies is not been wasted, the car trip for mile use 84% energy and motor trips for a ride using 74% energy. according to this survey they preferred to use sustainable transport for work areas, education and for a long journey and just to developed the environment sources only.

The new method of transportation is been developed to promote sustainable transport [4] in this paper. This is used to minimize energy, carbon dioxide, and traffic efficiency. It states that the uses of an artificial fish swarm algorithm to form a transport structure is an effective model for transport structure. The transportation, consumption of energy, CO<sub>2</sub> is a key factor for sustainable development. This system will make passengers be convenient during traveling and reduce energy consumption and the combustion of fuels only not for the development of economy and environment.

The cost of sustainable transport is been explained in this paper [5] to reduce the usage of the combustion of fuels. Different technology has been used like 'Intelligent Transport Infrastructure' and motorized vehicle technology and 'intelligent transport infrastructure' states that how it reduces key tension of economic growth, mobility, congestion, and environmental sustainability the most important function is electricity and it introduces fuel cell car system for those who avoid public transport. the low carbon vehicle provides a wide range of portion to the environment, and electricity for 'EDU' is applied in different ways. the battery electric vehicle is in practice and it states how the vehicle is charged.

The paper [6] has come across in energy, climate change, and air pollution both in private and public transport. The data-driven approach is formed to adapt to traffic patterns. In this, the main energy consumption vehicle is been formed, which is based on the driving cycles and plays an effective

role in economic development. The important technique is been used in this system are ECO TRIP, which estimates pollution emission, climate change, and fuel consumption by the combustion of engines, and also to estimate the reduction of external cost. In the future, they were ready to orient a technique known as (WLTC) "World-Wide Harmonized Light Vehicles Test Cycle" for deep verification of energy consumption.

According to this paper [7] the process of changing transport transition to the new form and to improve the social, environment, lifestyle, and culture. The Transportation Demand Management Literature' is used for different policies and also sustainable consumption literature is also been used. They integrate all this literature to solve transport problems. It is just about the radical change in transport. In the future, they planned to apply door-to-door steps in public transport. By this method, they disappeared petrol and diesel and this will provide a great opportunity for sustainable transport. And it will reduce the distance between private and public transport but it is not been implemented correctly.

The sustainable transport or urban development [8] is been explained to integrate high density with the mixed land use for the development of public transport and ICET to achieve resource conservation and to improve the quality of life. Combining high density and land use will increase the resource conservation and quality of life and achieve the 80% of share trip by public transportation, 90% share trip by walking and cycling, 90% share trip by MRTS to travel between two cities. The main aim developed in this paper is to give guidelines for land use only.

According to this paper [9], Climate change is the major problem of greenhouse gas is been formed and some of the technologies have been introduced. It states that climate change is due to the change in transport. The ITS has been used to control traffic, CO<sub>2</sub>, parking, and mobility management is increased. A complex interaction of ITS technologies, mobility, use an appropriate tool to measure the consequences of the environment. It states that energy benefits by providing real-time information, the low carbon fuels are the major impact of the economy and environment. The main problem is the passenger choose private vehicle because it takes a long time for short distances.

The sustainable transport which lowers the energy [10] has two alternatives, one is the storage of electric vehicle in the batteries, and another is a storing of energy in the form of hydrogen. In automatic application is used to displays the gasoline and diesel. This is attained by the electrification in the power train. The future automotive provide limitation for the development of pure batteries. The GM and OPEL were followed by the concept of an extended range of electric vehicles (E-RAIL) and hydrogen fuel cell vehicles. The 500 km of the hydrogen fuel cell vehicle is achieved by 700 bars of CGHZ tanks. This shows the price of the hydrogen fuel high.

In this paper [11] they have controller optimized parameter that controls the input sequence, so the computational burden of the transportation has been reduced. the new model called Dutch a12 is been developed to limit the speed and ramp metering rate. The main technique used

in this paper is to model-based predictive controller parametrized and control the traffics in the modern city. The Model Predictive Control (MPL) [12] technique is used you split the problem for outgoing container hubs. Two features are a destination and due date has been monitoring the cargo volumes overtime. And this paper will give the final destination of operating sustainable transport modalities. The two simulation models such as synchro modal and flexible transport network have been used to make the container hub sustainability.

According to this paper [15], the effective identification method is been introduced to make transportation sustainable and smart. It has been used to identify not only the foot carbon but also the smart way of transportation. To attain the smart transport method, qualitative research should be conducted. It has been introduced many techniques to make the transport sustainable and smart but it could not be completed.

The traditional transport [16] is not been able to approach the economic connection among the city regions and how to measure the steps for sustainable transport to be developed. The Sustainability Urban Mobility Plan (SUMP) called Balaz Modal Plan (BMT) has been introduced to measure the plan for the long term. It has been set inclusion of a new car ownership model or non-based trip generation. Crimean region tourism [15] with sustainable development, conditional factor, and the indicator has been used to monitor the tourism function. And they set some points to reduce the pollution due to the foreigners and, to reduce the tourism less than 4 million, and to increase the payable from Touristed, then the main condition to decrease the air pollution less than 50% was developed in this paper

The method of photogrammetry [16] has been used to count the passengers and to give the flow study and the analysis. The photogrammetry is used to collect the real data of the passengers and to solve the problem of the traffic dynamics. The special algorithms and data processing methods will make ordinary transport into sustainable transport. By using a data transferring method shows how

many passengers are in public vehicles and how many were registered for e-tickets and define that can make the transport into sustainable. A new bicycle transport [17] has been developed to the smart cities and it shows how the usage of the cyclist to be expanded. It conveys the smart bike concepts to monitor the cyclist and the environment to make the electric motor in critical condition. This will also reduce the load of the cyclist and the battery consumption and positively affect the smart city concept. It is used to develop not only economic but also health problems. Though the smart city concept is complex this paper will increase the development of the cities.

### 3. PROPOSED SYSTEM

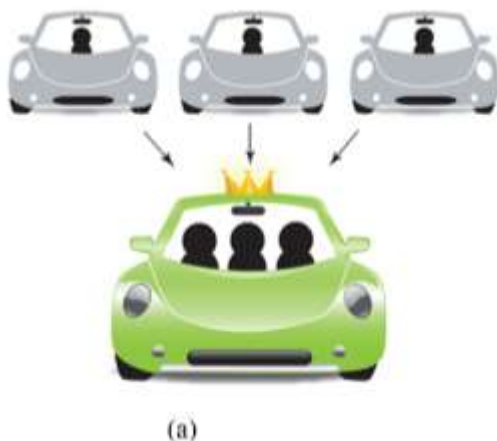
Nowadays people prefer private transport to travel from one place to another. But private transport spoils the atmosphere with greenhouse gas by the combustion of fuels. So, the proposed system defines how sustainable transport will reduce greenhouse gas, traffic, usage of space and how it increases the economic and environmental benefits. Moreover, the detailed explanation of sustainable transport is explained below.

#### 3.1. Novel GHG Reduction Technology

Some of the reduction of technology is (EIO-LCA) Economic Input-Output Life-Cycle Assessment and Principal Component Analysis (PCA). Based On (EIO-LCA) results-focussed manufacture sector are the highest environmental impacts and the economic output with the share of 20% GHG emission. The motor vehicle is the second largest environmental and economic benefits. PCA is the performance evaluation of the transportation system based on its economic benefits.

#### 3.2 The Sustainable Transport

Sustainable transport is a 'green vehicle' and it shows how it has a low impact on the environment. Transportation is the largest cause of air pollution and greenhouse gas emission which will increase the harmful effect on the people.



**Figure 3.** Different methods of Sustainable Transport

The purpose of the transport is – to education, work, goods and service, personal use of friends and family. A single private car needs 2,000 liters of gasoline and emits

4720 kg of carbon dioxide, 186 kg of carbon monoxide, 2.8 kg of volatile organic compounds and 25.6 kg of nitrogen oxides. This will highly emit greenhouse gas. So, we are

proposing a proposed system with sustainable transport that will emit low greenhouse gas. Some of the sustainable transports are walking, cycling, the figure illustrated below displays: (a) cycling and (b) carpooling. Sustainable transport. Sustainable transport like walking will not emit greenhouse gas. avoid car for short distance and prefer walking, it increases heart and lung fitness, and reduce heart disease and stroke, manages hypertension, cholesterol, and diabetes.

### 3.3 Carpooling

To travel a long distance, we can prefer carpooling sharing their journeys with one or more persons. This will avoid the usage of gasoline, traffic, parking areas. The combustion of single-car only takes place so it will reduce greenhouse gas. This will save money so it is useful in the world's economy. The carpooling will enable more people to share their journeys and to reduce stress loneliness. Carpooling services can be found in public websites, social media, smartphone applications, and carpooling agencies. Some of the challenges are faced by carpooling are,

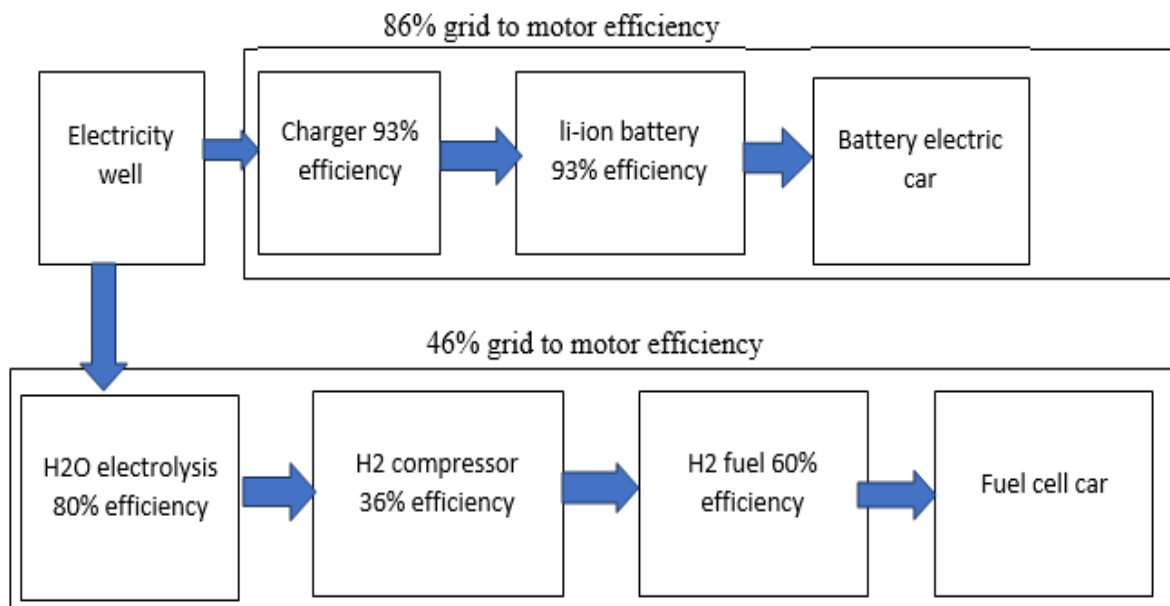
- **Flexibility**-carpool is not flexible in route stops and changing working times. To avoid these 'guaranteed ride home' schemes are used in carpooling agencies.
- **Reliability**-This matches certain trips so the agencies have a scheme that payment is done online if the passengers are not turned up.

- **Riding with strangers**- It is dangerous to drive with strangers so the agencies Benefits of green vehicles will provide trust capital with different schemes.

### 3.4 Green Vehicles

Green vehicles are also known as environmentally friendly vehicles that are road motor vehicles which gives less impact on the environment. In green vehicles, they use electricity instead of diesel or gasoline. Regenerative braking has some energy in the form of electricity which is used to run the motor and accelerate the vehicle. some of the classifications are,

- Electric and fuel cell-powered vehicles.
- Hybrid electric vehicles.
- Compressed air cars, Stirling vehicles, and others.
- Improve conventional cars.
- The electric motor and pedal-powered vehicles
- Environmental –Green vehicles have less impact than a road vehicle.
- Health - Road vehicles produce air pollution and form cardiopulmonary and respiratory diseases and form lung cancer.
- Monitoring– monitoring how much fuel is combusted is not needed.



**Figure 4.** Comparison of motor efficiency electric car and fuel cell car

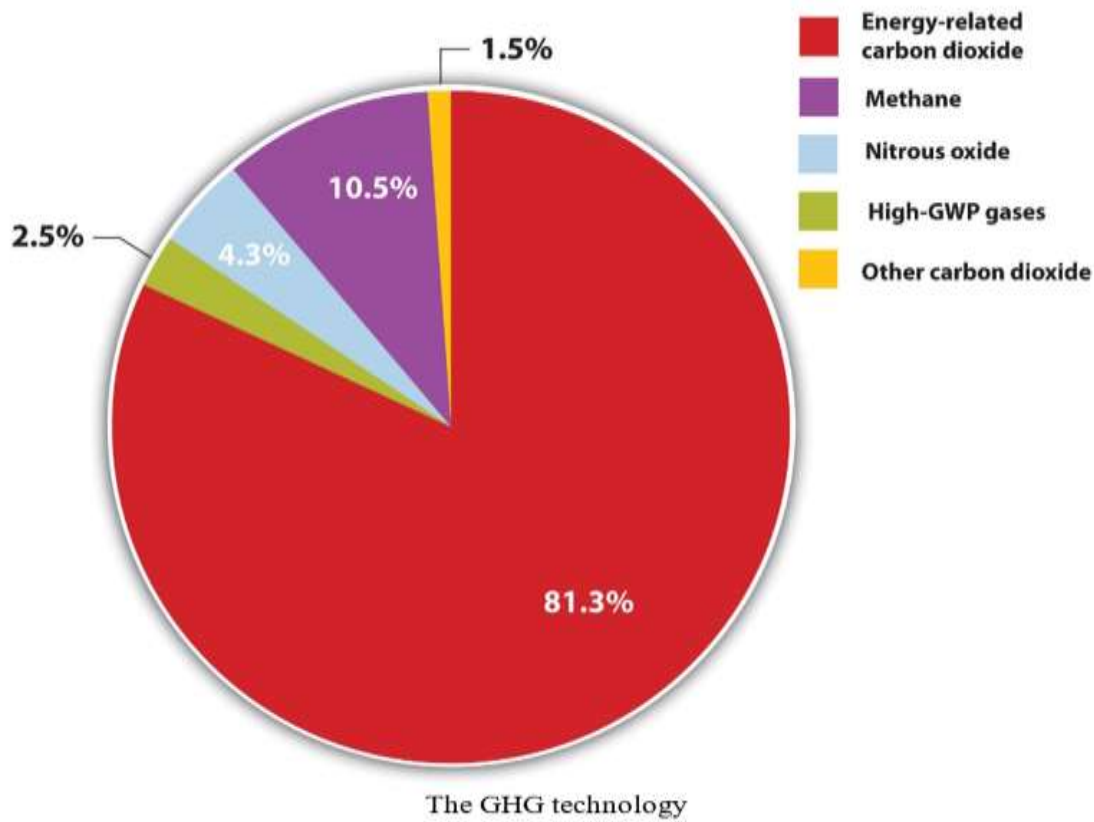
Fig 4. Shows motor efficiency of electric car and fuel cell car. The battery-electric car has 86% of the grid to motor efficiency and fuel cell car has only 43% grid to motor efficiency Transit is operated by a single or group of vehicles that provide public transportation. The transit bus is just public transportation which reduces greenhouse gases. A passenger car can emit 80% pounds of greenhouse gases and transit buses can emit only 14% pounds of greenhouse gases.

For a passenger car, it needs more space for parking, and more traffic, often accidents may occur. To avoid these types of difficulties we can prefer a transit bus, this carries 100 people so there will not be traffic, fewer accidents.

Some of the transit rail systems are subway, tube, metro, elevated, etc. It helps in urban areas to see passenger capacity and its traffic separation. The transit train runs on electricity,

it seems that power lines running above the track such a system is called a catenary system. It has overhead wires which are used to supply electricity to rail that is equipped with a pantograph. More than 5000 passengers can travel through transit per hour. The below graph shows the GHG

methodology and the different parts of the gas emission. 1.5 carbon dioxide and 10.5% methane, 4.3% nitrous oxide, 2.5% high-GWP gases, 81.3% energy related to the carbon dioxide



**Figure 5.** The Graph of GHG Methodology

**Table 1.** Emission of CO<sub>2</sub> from various vehicles

| Modes Of transport | Amount Of CO <sub>2</sub> emission |
|--------------------|------------------------------------|
| Car                | 120.1g per km                      |
| Bike               | 21g per km                         |
| Bus                | 822g per km                        |
| Train              | 100g per km                        |
| Walking&cycling    | Zero                               |

The above table shows that the amount of CO<sub>2</sub> per km is emitted from various vehicles. The red color indicates a high amount of CO<sub>2</sub> emission which causes the greenhouse effect on the environment. The green color indicates that there is no emission of greenhouse gas. This shows that the vehicles without fuel will not pollute the environment abundantly.

### 3.5. Benefits of transit rail

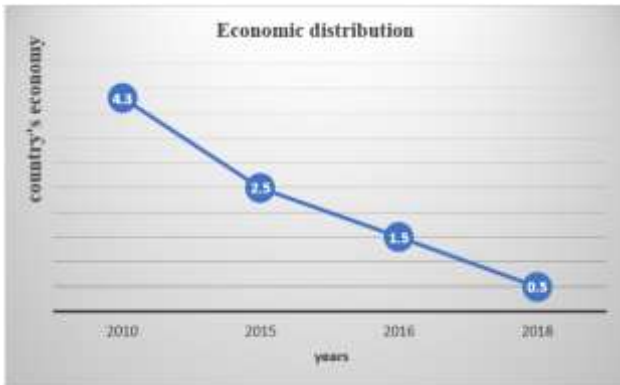
- **Reduced traffic congestion:** This system can take cars off the roads. So, these can reduce traffic from the road and the subway rail will not produce any traffic.
- **Providing affordable transportation:** This system provides the cheapest transport. So, it can improve individual life opportunities.

- **Reduced pollution:** This system runs on electricity rather than fossil fuels. THIS will not pollute the environment as ordinary busses do.
- **Economic development:** The cities which build transit rail require more area. property near the station is increased so the jobless people get jobs and develop the economy.
- **Safety:** It has an excellent safety record. The International Association of public transport conveys that traveling by transit rail is six times faster than traveling by car.
- **Reliability:** - Because rail travels on track only, it operates on adverse weather conditions which the busses and cars cannot.

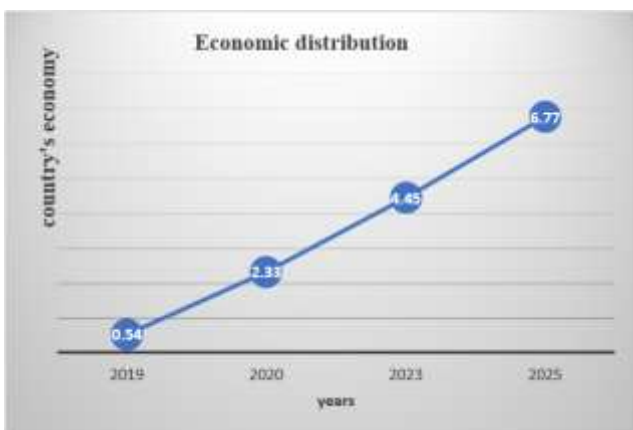
### 3.6. Environmental and Economic Benefits

Nowadays people prefer the private mode of transport but they don't know that it causes damage to our health, economic, environment, etc. To avoid this, sustainable transport is introduced, this will reduce air pollution, greenhouse gas traffics and so on and will increase economic and environmental development. The burning of fossil fuels will emit carbon dioxide and nitrous oxide. Thus, it will provide heat to the atmosphere and this causes greenhouse

gas emission. To avoid the burning of fossil fuels we can prefer transit vehicles, which is public transportation that would increase the country's economy and may not cause any damage to the environment. By designing sustainable transport those who have no jobs and those who are working in another country will get the opportunity to work in their own country. This would increase the country's economy and reduce environmental pollution. By using sustainable transport systems, traffic and accidents will be reduced, this will help the developing country to achieve the goal of a developed country is included.



**Figure 6.** Economic Distribution with The Greenhouse Effect in a Developing Country



**Figure 7.** Predicted Economic Distribution Without the Greenhouse Effect

The above graphs show the economic distribution of a country with and without the greenhouse effect. Figure 6 shows the usage of private and engine vehicles will decrease the economic range of the country. Figure 7 shows that the usage of public and transit vehicles will increase the economic range of the country. Recently FLYGRN is a new technique implemented for those who travel in flight. It is just a flight engine that will quench the CO. When the flight is booked and the payment is paid to the flight services it quenches the CO<sub>2</sub> partially it is done by some solar panel

#### 4. CONCLUSION

Transportation plays a major role in economic and environmental benefits. Nowadays, Due to the population increase, the usage of gasoline and diesel in private transport has been increased. The Private transport systems emit CO, methane, and nitrous oxide, these gases will transmit heat to

the environment and cause a greenhouse effect, which would damage the environment. To avoid this sustainable transport methods have been discussed in this paper. Sustainable transport mainly depends on public transport. Some proposed sustainable transport systems include. Most of the transit vehicle storage sections are batteries instead of a fuel engine. Compared to private transport, sustainable transport would reduce traffic, greenhouse gas, and it will enhance the whole quality of cities in future work, the sustainable mode of transportation is to be implemented in islands and in developing countries. So, this will increase the economic and social welfare by aiming the health benefits.

#### CONFLICTS OF INTEREST

The authors affirm that they are free of any known financial conflicts of interest or close personal ties that might have looked to have affected the research presented in this study.

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# ESTIMATION OF HOUSEHOLD APPLIANCES AND MONITORIZATION FOR IMPACT REDUCTION USING ELECTRO CHEMICAL SENSOR

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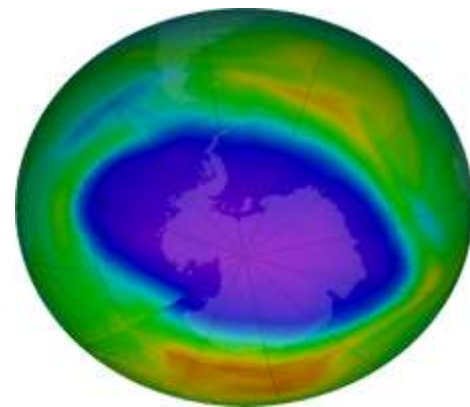
**Abstract** – Stratospheric ozone depletion occurs when the production/destruction equilibrium shifts away from creation. While transitory ozone depletion can be caused by natural processes, the main culprits are now generally acknowledged to be the chlorine and bromine created by man-made substances like CFCs. Household appliances have a significant influence in the release of harmful gases. Because these appliances are used by everyone on the earth, this leads to the release of large number of gases, resulting in ozone layer depletion. The purpose is to analyse the impact of household appliances using the Product Environment Utilizing the Internet of Things to lessen the impact of household appliances and Lifecycle Analytics (LCA) footprint engineering (IOT). An electrochemical sensor is utilized here to monitor the hazardous gases emitted by home appliances. When it detects the release of harmful CFC chemicals from household appliances, it sends an alert message to IoT-connected mobile phones and stores the information on the internet. This helps to prevent the depletion of the ozone layer by reducing the emission of CFCs and other harmful gases.

**Keywords** – Electro chemical sensor, IOT, ozone layer, Neural Network, CFC.

## 1. INTRODUCTION

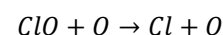
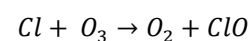
The ozone layer is a natural gas band known as "ozone". It serves as a screen from the sun's harmful Ultraviolet B (UVB) rays and is located between 9.3 and 18.6 miles (15e30 km) above Earth [1]. The ozone layer is important to preserving human health because of the radiation's ability to induce skin cancer and cataracts. It also protects plants, animals and materials from radiation damage.

Life on Earth would not be able to develop to this extent without ozone. Oxygen molecules (O<sub>2</sub>), which are made up of two linked oxygen atoms, are what we breathe in. In contrast, ozone (O<sub>3</sub>) is composed of three linked oxygen atoms [3]. Ozone Layer Depletion shown in Figure 1.



**Figure 1.** Ozone Layer Depletion

Earth's upper atmosphere's ozone layer as a result of chemical compounds produced by manufacturing or other human activities that contain chlorine or bromine gas. Ozone [5]. Ultraviolet radiation may break apart CFC molecules in the stratosphere, and the chlorine atom that is liberated can combine with an ozone molecule to produce oxygen and chlorine monoxide molecules. Afterwards, a free oxygen atom can combine with the chlorine monoxide molecule to produce chlorine, initiating the ozone depletion process [6].

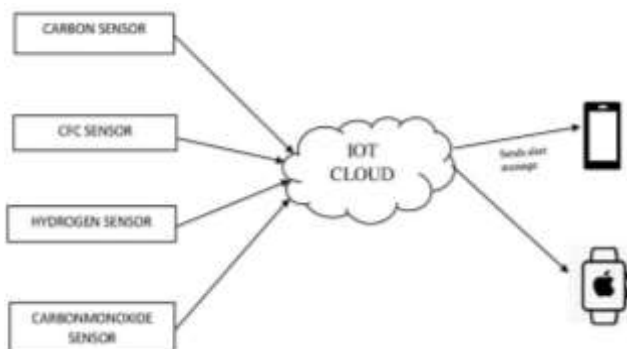


The most important thing is to improve people's willingness to buy energy-efficient equipment in order to minimise household energy usage and carbon emissions. The usage of household appliances is growing quickly, and they are now the main source of emissions and energy consumption in homes [4]. According to global data, by 2020, there is a 37 percent rise in appliances compared to 2013. Due to the rising dependence on energy utilization and

the resources necessary to manufacture and use all of these appliances, they are viewed as one of the most important areas for intervention in order to ensure sustainable production and usage [2].

CFC-11 and CFC-12 are the most common chlorofluorocarbons (CFCs) found in domestic refrigerators, air conditioners and they will be discharged into the environment at some point. Thus, improper disposal of discarded refrigerators will result in ozone depletion and a major contribution to the greenhouse effect from the environmental emissions of these refrigerants.

The goal is to evaluate the effect of household appliances using Product Environment footprint method of LCA and to reduce the impact produced by household appliances using IOT enabled device. Here, an electrochemical sensor is used to monitor the harmful gases that are released from household appliances. When it detects any toxic CFC gases releasing from household appliances, it will generate an alarm message to the mobile that are connected via IOT and keeps the message in the network. IOT network shown in Figure 2.



**Figure 2.** IOT network

The remainder of the document is structured as follows: Examining the literature is covered in Part II. Section 3 outlines the suggested approach. According to Section V and IV, the experimental results are described, the study closes with some suggestions for additional research.

## 2. LITERATURE SURVEY

In 2020, Hischier, R et al [2], have presented a consumer footprint method. Consequently, a device basket's process-based lifetime repository is constructed and analysed, representing the stock of appliances held by European residents. The current study focuses on the impact of popular household appliances in Europe and compares several possibilities for lowering their effect. The life cycle assessment is carried out on fourteen different home appliances that were selected to form a group of sample devices according to the economic worth and extensive use in European households. The Environmental Footprint approach for measuring Consumer Footprint "appliances" is used to examine associated consequences for the baseline year of 2010.

In 2021, Ingemarsdotter, E., et al, [7] examined how IoT-based recirculation techniques affect the environment overall in the context in Sweden, to get insight into when and

how embedding IoT hardware into items to support circular strategies makes environmental sense. A life cycle assessment (LCA) is used to determine whether the current situation will affect a "IoT scenario."

In 2019, Singh, A.K. and Bhargawa, A [8] presented an innovative method for predicting future ozone depleting substance trends (ODSs). The effects of comparable halogen doses on ozone trends were looked at for the years 2018 through 2030. Based on the correlation between the trend in variations of ozone depleting chemicals and the total ozone column, this method was used to evaluate how much of the recent ozone increase may be related to the concentration of ozone depleting chemicals. Using the aforementioned model, they found that the atmospheric concentration of these compounds, which are currently around 3325 parts per trillion (ppt) for chlorine and 14.3 ppt for bromine, will decline to 3217 ppt (3.2%) and 13.1 ppt (8.1%), respectively.

In 2019 Ningombam, S.S., et al [9] have proposed, MLR, or multiple linear regression, is applied. One of the surrogates that is crucial to understanding the dynamics of TOC variation and minimizing dynamic fluctuations is the stratospheric temperature of 100 hPa. After included the lower stratospheric temperature along with other proxies, the MLR model greatly improved, and the projected TOC trend's standard deviation dropped by around 35–43% in 50–65N and by 16–20% in 45–65S. Using the lower stratospheric temperature for each of the phases of depletion (1980–1996) and recovery (1997–2016). Temperatures in the lower-middle stratosphere decrease by -0.09 to -0.02 C annually during the depletion phase. The temperature in the lower stratosphere, on the other hand, is rising throughout the recovery period. The expected warming trends are not statistically significant due to weak signals.

In 2021, Portillo, F, et al, [10] have examined how public network-connected gadgets affect the environment. Two distinct methods of delivering energy to a sensor network are examined in this study. First, they investigate how gadgets linked to the public grid affect the environment. Second, an off-grid arrangement in which the sensor is connected to a PV panel. The outcomes demonstrate that, despite being less advantageous economically, the off-grid alternative offers greater environmental advantages than the grid-connected option. Following a comprehensive investigation of the off-grid scenario, it was discovered that batteries had the worst effects; In response, measures were implemented the battery size, restrict consumption and negative impact were chosen as a result. Breakeven was achieved with a net economic advantage of €0.23 per sensor year after the battery size was reduced in 2018, Sruthi, B. and Sreenivasulu, E., et al [11] have proposed a method to prevent accidents in the workplace and to inspect the contamination control board. Sensors that are connected to the central microcontroller include shot, temperature, and gas sensors. During a breach, sensors are deployed to collect information from the surrounding area. This will be used in the case of a single or many harmful gases leak, resulting in a quick reaction time. An alarm system can be employed by industries to send out a sound signal to surrounding persons. If the amounts of gases and temperature exceeds the avg level above the given

levels, an alarm will be sent out over the internet of the web page and the android app that was made.

Zhu.H et al. [12] suggested in 2020 that deep convolutional neural networks be used as a novel technique for tracking Antarctic ozone depletion. The ozone hole in a meteorological satellite picture was analysed and the appropriate region was extracted using the L\*a\*b colour space. We compile ozone monitoring meteorological satellite photographs and assign each one a unique label. The following labels are then trained onto these images using a deep convolutional neural network (CNN) in order to ascertain the actual extent of the ozone hole region, fresh weather satellite images displaying ozone monitoring over Antarctica may eventually become accessible. Our suggested approach attained a pleasing detection accuracy of 99.23 percent across the globe. In 2012 Benhadid dib S, et al [13] proposed, a halogenated refrigerants in this paper. The purpose of our initiative is to help safeguard the environment. These initiatives also seek to swap out polluting coolants for cleaner ones and lower greenhouse gas emissions. It's simply solar thermal energy-based refrigeration at very low temperatures (below -20°C) [14].

In 2020 de Medeiros., et al [15] proposed, a World Health Organization-recommended An Internet of Things system that tracks the most dangerous pollutants with inexpensive sensors to human health. The proposed method describes the hardware using three sensors: PMSA003, MICS-6814 and MQ-131, fabrication of a device that can detect the levels of the following pollutants: Ozone, Nitrogen Dioxide, Carbon Monoxide, Particulate Matter (PM 2.5 and PM 10), and Ammonia. The gadget comes with an ESP-WROOM-32 microcontroller with WiFi and Bluetooth wireless interfaces, which can transmit data to cloud servers.

### 3. PROPOSED METHOD

The proposed method first assesses the impacts caused by household appliances using Life Cycle Assessment and then proposes a IOT enabled device to monitor the toxic gases generated from the household devices and alert if the level of the gas exceeds.

#### 3.1. Life Cycle Assessment

The entire greenhouse gas emissions from the extraction of raw materials through the conclusion of a product's useful life are shown in its lifetime environmental impact. It is calculated using carbon dioxide equivalents (CO<sub>2</sub>e). For the baseline year 2020, the Product Carbon Footprint "appliances" are estimated using the Environmental Footprint technique.

Appliances in the so-called "baseline scenario" are specified in the first phase of the Product Carbon Footprint method. The goal of this baseline scenario is to analyse the effects of household appliance usage in the world. The product categories were chosen with the aim of analysing the project's benefits with having the key areas in mind. This calculation considers all stages of the life cycle of various consumer electronics products. This baseline scenario for 2020 allows for the identification of environmental hotspots not only across the device's whole lifespan, but also inside

the household appliances under consideration. Life Cycle Assessment shown in Figure 3.

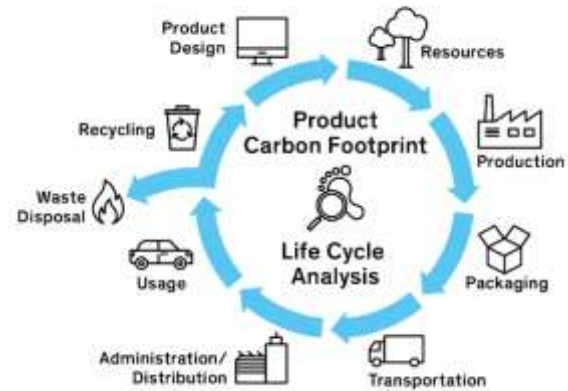


Figure 3. Life Cycle Assessment

Baseline hotspot test results are used as a starting point for selecting viable countermeasures to decrease environmental loads in the second stage. The study investigated Environmental Impact of Various Green Appliances Applied to Home Appliance Systems in 2030, including technological implementation of eco-solutions, changes in consumption patterns, behavioural changes, and a combination of all of these factors. Overall, the goal of this second stage is to identify the potential environmental advantages related with each of the activities under consideration, as well as to identify any potential trade-offs, such as reduced effects in one effect category (example: global warming) while raising effects in other (example: eco toxicity).

All LCA calculations in this investigation were done using a software tool SimaPro8, with data from eco-invent version 3.2 in the background and the Product Environment Footprint (PEF) method in LCIA step, where LCIA stands for life cycle impact assessment.

#### 3.2. Baseline scenario for the year 2020

A quantifiable and quality examination for household appliances consumption was done, as well as an investigation of relevant international trade flows, in order to quantify the baseline scenario of these appliances. Because these gadgets have a longer service time than an annum, simply accounting for visible intake is insufficient to account for the true environmental implications of yearly consumption and usage of such equipment by the ordinary person. For each of the product categories covered, stock information is utilised instead. The stock data for the majority of product categories came from relevant Ecodesign preparatory studies. Refrigerators and room air conditioners (RAC) are assessed in the following way.

#### RAC:

The number of apartments multiplied by the number of apartment units yields the residential RAC units, air conditioning penetration rate, assuming that each home has one unit. This was done by modifying data for the reference year 2020 from the project "ODYSSEE" database.

### 3.2.1. Refrigerators

The number of refrigerants in homes is calculated by multiplying the number of dwellings by the residential sector's refrigerant penetration rate. This was done by modifying data for the reference year 2020 from the project "ODYSSEE" database.

Stock data, mean lifespan, mean utilization, and the fraction of stock covered by sample items of chosen household appliances were collected for the 2020 baseline context. stock coverage data for the baseline year 2020 shown in Table 1.

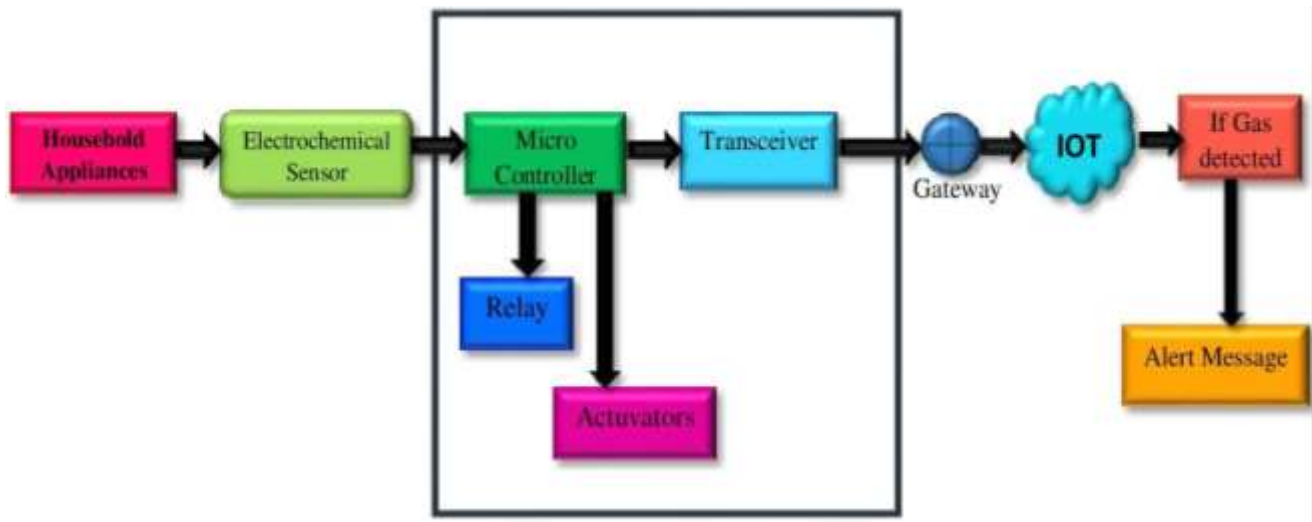
**Table 1.** stock coverage data for the baseline year 2020

| Category of products | Sample representative | Supply 2020 | Lifespan | Periodic Utilization | Share of stock covered |
|----------------------|-----------------------|-------------|----------|----------------------|------------------------|
| Washing machines     | Washing machine       | 395,575,780 | 13.1     | 0.0234               | 100%                   |
| Refrigerators        | refrigerant           | 78,088,790  | 14       | 0.0037               | 100%                   |
| AC                   | RAC                   | 866,289,000 | 15       | 0.0222               | 56%                    |

### 3.3. IOT enabled device method

The proposed method monitors the hazardous gases emitted by household appliances using IoT-enabled devices. IoT is a collection of interconnected networks. The IOT

framework's fundamental infrastructure consists of sensors, actuators, computation servers, and communication networks. Below is a block diagram of the suggested methodology. Figure 4 shows a block diagram for the proposed technique.



**Figure 4.** Block diagram for proposed method

#### 3.3.1. Electrochemical sensors

The Internet of Things is primarily powered by sensors. utilized to gather and send data in real time. IoT success depends on the utilization of sensors, which improves IoT capabilities, performance and hazardous gas detection is done with electrochemical sensors. To be more exact, they monitor the concentration of a certain gas within an external circuit. The utilisation of oxidation or reduction processes is used to accomplish this. As a result of these reactions, positive or negative current passes via the external circuit.

#### 3.3.2. Actuators

A mechanical device called an actuator is used to transform a particular kind of energy into motion. They interpret electrical input from automation systems into actions, modify machines and devices in Internet of Things

systems, and receive electrical input. Various motion patterns, including rotational, oscillatory, and linear motion, can be produced using actuators.

#### 3.3.3. Gateway

The physical hardware or digital platform that connects sensors, IoT modules, and smart devices to the cloud is known as an IoT gateway. IoT devices may connect to the Internet using a gateway by using a wireless access portal.

Total utilisation ( $U_{tot}$ ) by a combination of new ( $A_0$ ) and derivatives. Estimate the current values for the shares  $S_1$ ,  $S_2$ ,  $S_3$ , and  $S_4$  of household appliances.  $A_n$  and  $A_{n+1}$  are linked through the shares  $S_1$ ,  $S_2$ ,  $S_3$ , and  $S_4$ .

$$A_{n+1}(IoT)[\#] = A_n(IoT) - S_1(IoT) - S_2(IoT) - S_3(IoT) - S_4(IoT) \quad (1)$$

$$U_{tot} = U_0(IoT) - A_0(IoT) + U_{1,2,3}(IoT) \cdot \sum_{n=1}^3 A_n(IoT) \quad (2)$$

$$G_{tot}(IoT)[1] = U_0(IoT) \cdot E_0(IoT) \cdot A_0(IoT) + U_{1,2,3}(IoT) \cdot E_{1,2,3}(IoT) \cdot \sum_{n=1}^3 A_n(IoT) \quad (3)$$

$G_{tot}(IoT)$  represents the volume of gas,  $U_{tot}$  represents the total usage of household devices,  $E$  represents the electricity and  $S$  represents the shares. Equation 4 may thus be used to define the Electricity consumption,  $E(t)$ , where  $C$  is a constant and  $E_{min}$  is the minimal Electricity utilization.

$$E(x) = E_{min} + C \cdot X \quad (4)$$

$$E(x = 48) = E_{min} \cdot 1.14 \quad (5)$$

$$E_{min} = E\left(\frac{\Delta x}{2}\right) - C \cdot \frac{\Delta x}{2} = \frac{0.32}{1+0.0029\left[\frac{1}{week}\right] \cdot 4[weeks]} = 0.31631 \quad (6)$$

The above equation is the value of the Electricity consumption when utilising the household appliances at optimal tire time.

$$A \cdot S_{1,IoT} = A \cdot S_{1,current} \cdot S_{2,current} + A_{ws} - A_{wa} \quad (7)$$

$$A_{wa} = A_{ws} \rightarrow S_{1,IoT} = S_{1,current} \cdot S_{2,current} \quad (8)$$

As a result, we can calculate the shares  $S_1$ ,  $S_2$ ,  $S_3$ , and  $S_4$  in the IoT scenario, as shown in Table 2.

This study's framework deals with reducing the impact during the usage phase, changing stock characteristics, and changing user behaviour, respectively.

**Table 2.** shares in IOT scenarios

| Scenarios        | $S_1$ | $S_2$ | $S_3$ | $S_4$ |
|------------------|-------|-------|-------|-------|
| Current scenario | 1     | 0,7   | 0,95  | 0,95  |
| IOT Scenario     | 0,7   | 1     | 1     | 1     |

The scenarios were chosen on different sizes, ranging from improving product efficiency, to improving the energy mix, to accounting for behaviours and consumption patterns impacting the whole appliance stock.

#### 4. RESULTS AND DISCUSSION

The findings of the tested future scenario and the 2020 baseline are shown in the next section, along with an explanation of how each step can potentially reduce its total impact. Table 3. represents the variety of eco-innovation situations.

**Table 3.** Eco innovation scenario

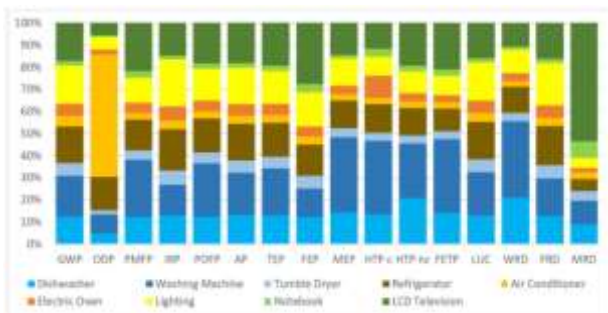
| Interventional area                                          | Interventions that could be used                          | Evaluated case                                                                | Assumption                                                                                                                                                                                                                                                                                   |
|--------------------------------------------------------------|-----------------------------------------------------------|-------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Effects of usage phase on reduction                          | Energy preparation with fewer bad effects                 | Increased use of renewable energy sources                                     | Based on the statistics, a renewable energy mix of 42.9 percent is estimated.                                                                                                                                                                                                                |
|                                                              | Devices that are more energy efficient are used.          | Improved washing machine efficiency                                           | scenarios that, while accounting for differences in detergent amounts, produce the optimum balance between life cycle costs and energy savings, is utilized. This scenario does not necessitate any modifications to the BOM. There is no consideration for an increase in machine capacity. |
|                                                              |                                                           | Improved Refrigerator efficiency                                              | The VHK, 2016 best available technology (BAT) scenario is utilized, which includes all material implications for the device's whole life cycle.                                                                                                                                              |
| Ozone-depleting substances are being reduced.                | Less emission                                             | Reduction of refrigerant leaks when air conditioners are used                 | A 1% annual emission limit applies to HFC                                                                                                                                                                                                                                                    |
|                                                              | Reduce pollutants                                         | Replacement of present coolers                                                | R600a was employed as a chemical with 0 ODP and low GWP in a 1:1 replacement rather than R134a (used in the baseline scenario).                                                                                                                                                              |
| Stock characteristics have changed.<br>User Behavior Changes | New technology is introduced.<br>Reusability is improved. | Increase of remanufacturing<br>Increase of the recycling rate ring and reuse. | Reused devices have a life expectancy of 1/3 that of new equipment, with maintenance costs increasing by a factor of two to account for device preparation for the second life.                                                                                                              |

#### Table 4. System boundaries

| Stages of the Life Cycle that are covered | Activities/processes that were included                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Manufacturing components                  | <ul style="list-style-type: none"> <li>• Manufacturing of primary products</li> <li>• The refinement of raw materials</li> <li>• Components are transported to the production, where they are manufactured.</li> <li>• Working on putting together</li> </ul>                                                                                                                                                                            |
| Manufacturing of product Packaging        | <ul style="list-style-type: none"> <li>• Produce the packaging</li> <li>• Packaging is transported to the plant.</li> <li>• Packaging for disposal at the end</li> </ul>                                                                                                                                                                                                                                                                 |
| Phases of service and retail use          | <ul style="list-style-type: none"> <li>• Packaging for final disposal.</li> <li>• Transport packed goods from the producer to the retailer or distributor.</li> <li>• Phase of application</li> <li>• Product transportation from the retail/service centre to the final customer</li> <li>• Energy and water consumption from detergent use, possibly salt use, and product use</li> <li>• If there is any waste management,</li> </ul> |
| Upgradation                               | <ul style="list-style-type: none"> <li>• Production of components that will be replaced</li> <li>• Sorting materials and components</li> <li>• Recycling is a good idea.</li> <li>• Energy recovery and incineration</li> </ul>                                                                                                                                                                                                          |

**Table 5.** Result for household appliances

| Impact category                | Unit                            | Baseline result |
|--------------------------------|---------------------------------|-----------------|
| Global warming                 | kgCO <sub>2</sub> equivalent    | $3.48E + 02$    |
| Depletion of ozone             | kgCFC-11 equivalent             | $8.85E - 05$    |
| Fine dust                      | kgPM <sub>25</sub> equivalent   | $1.04E - 05$    |
| Ionizable emission             | KBq U <sup>235</sup> equivalent | $1.27E + 02$    |
| Photochemical ozone generation | kg NMVOC equivalent             | $8.95E - 01$    |
| Terrestrial eutrophication     | Moloc N equivalent              | $3.01E + 00$    |
| Freshwater eutrophication      | kgP equivalent                  | $3.70E - 01$    |
| Marine eutrophication          | kg N equivalent                 | $4.42E - 01$    |
| cancer effects, Human toxicity | CTUh                            | $2.17E - 07$    |
| Acidification                  | moloc H <sup>+</sup> equivalent | $2.10E + 00$    |
| Freshwater ecotoxicity         | CTUe                            | $7.06E + 03$    |



**Figure 5.** Environmental impacts using household appliances

Table 4 represents the baseline scenario of the household appliances system boundaries were defined.

Table 5 represents the results using the Product Environmental Footprint technique for household appliances throughout the world in 2020.

Fig 5 shows the graphical representation that describes the contribution study of the environmental consequences of yearly usage of household appliances by an avg person in 2020 by kind of appliance (i.e baseline scenario).

Table 6 represents the patterning of relevant objects included in the household appliances, key facts and assumptions were evaluated.

**Table 6.** Evaluation of key facts and assumptions

|                                 | Dishwasher<br>13ps | Washing<br>Machine | Combined<br>Refrigerator<br>Freezer | Compact<br>fluorescent<br>lamp | Medium<br>for halogen<br>lamps |
|---------------------------------|--------------------|--------------------|-------------------------------------|--------------------------------|--------------------------------|
| <b>i)Product Structure</b>      |                    |                    |                                     |                                |                                |
| Net weight<br>(In kg)           | 47.8               | 66.7               | 69.6                                | 0.06                           | 0.02                           |
| Plastic                         | 22.7%              | 17.%               | 34.0%                               | 23.0%                          | -                              |
| Glass                           | -                  | 2.8%               | 10.0%                               | 45.3%                          | 86.1%                          |
| Metal                           | 57.3%              | 48.9%              | 54.1%                               | 3.7%                           | 6.6%                           |
| Electronic                      | 2.9%               | 0.3%               | 0.5%                                | 24.8%                          | 0.8%                           |
| Other Material                  | 17.1%              | 30.3%              | 0.8%                                | 3.2%                           | 6.5%                           |
| Cooler                          | -                  | -                  | 0.1%                                | -                              | -                              |
| <b>ii) Packaging Structure</b>  |                    |                    |                                     |                                |                                |
| Net Weight<br>(In kg)           | 1.33               | 2.92               | 4.65                                | 0.06                           | 0.06                           |
| Cardboard and paper             | 30.5%              | 78.1%              | 63.29%                              | 90.0%                          | 90.0%                          |
| Plastic                         | 69.5%              | 21.6%              | 36.71%                              | 10.0%                          | 10.0%                          |
| <b>iii) Use Characteristics</b> |                    |                    |                                     |                                |                                |
| Energy(kWh/a)                   | 398                | 140.4              | 290                                 | 5.6                            | 16.4                           |
| Water(L/a)                      | 5'180              | 11'000             | -                                   | -                              | -                              |
| Lifetime(a)                     | 12.5               | 12.5               | 15                                  | 12                             | 3.3                            |

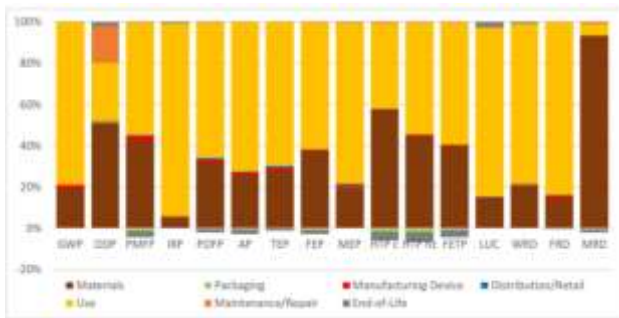
**Figure 6.** Environmental impacts

Figure 6 shows the graphical representation that describes the contribution study of environmental implications of the yearly usage of such products by an avg number of users in 2020, broken down into lifetime stages (i.e baseline scenario).

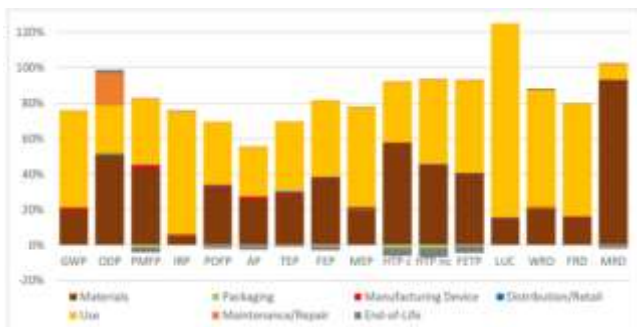
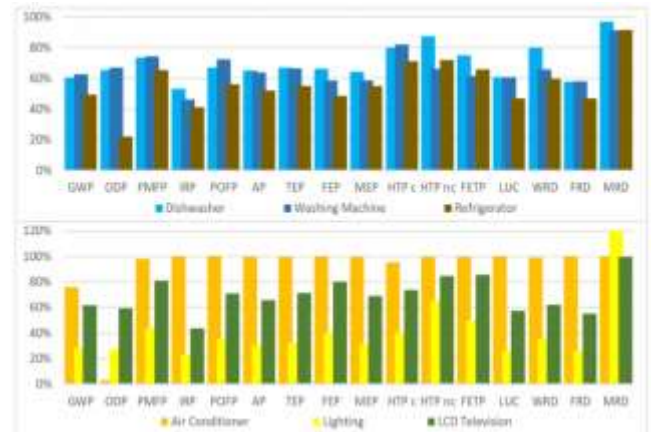
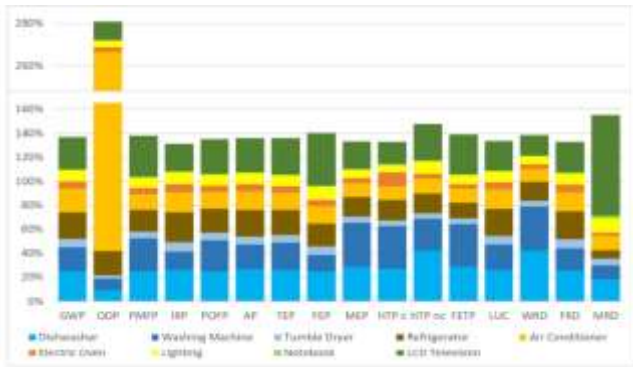
**Figure 7.** Changes in the power mix have an impact on the avg person's annual usage of household appliances in 2030.

Fig 7 represents the changes in the power mix have an impact on the avg person's annual usage of household appliances in 2030.

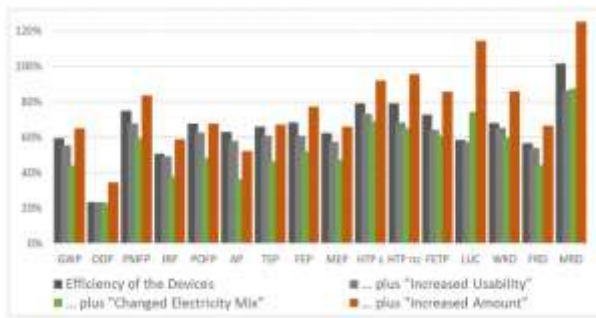
**Figure 8.** The avg person's annual use of main household equipment in 2030

The avg person's annual use of necessary consumer electronics in 2030 is depicted in the chart below, which has the potential to be reduced due to their greater efficiency. In contrast to the relevant category's 2020 baseline scenario, the resulting consequences for the here modelled, most efficient gadgets are indicated. The avg person's annual use of main household equipment in 2030 shown in Figure 8.



**Figure 9.** yearly use of household appliances in 2030

Fig 9 represents the impacts of an avg person's yearly use of household appliances in 2030, taking into consideration the rising number of devices per family.



**Figure 10.** calculation of yearly household appliance consumption in 2030

Fig 10 shows the graphical representation, when all eco-innovation scenarios are combined, and calculated the overall (reduction) potential for yearly household appliance consumption by an avg person in 2030. The ensuing implications are shown in a step-by-step format (details in the text) in contrast to the 2020 baseline scenario.

## 5. CONCLUSION

With the product environment Footprint, a method that enables for the first time a full assessment of the environmental consequences associated with a product, ordinary people's consumption habits. Compared to all other lifecycle phases taken into consideration, the 2020 Base Scenario calculation findings indicate that the usage phase is highly significant in terms of energy use. In the use phase, the two most significant elements influencing the impact of an avg person's annual use of a household appliance in 2030 are energy efficiency of the device and customer behavior, or the intensity of use, given the increasing number of devices per household. When all environmental innovation possibilities are combined, the overall (reducing) potential for an avg European citizen's yearly consumption of home appliances by 2030. In relation to the 2020 baseline scenario, the impact is shown sequentially (details in the text). According to the findings of this study, when evaluating the environmental sustainability of appliances, several scales should be used. The predicted increase in product efficiency (micro scale) should be weighed against the expected improvement in energy mix (meso scale), taking into consideration socioeconomic factors and consumption

patterns that influence the entire appliance stock. The proposed method monitors CFC gases with electrochemical sensors and sends alerts through an alert message. The computed findings for the baseline scenario in 2020 demonstrate that the usage phase is crucial in terms of energy consumption when compared to the other life cycle phases taken into consideration. It has a significant impact on CFC emissions. The scenario is based on the fundamental issue identified in the baseline study, namely, that the usage phase is the most significant lifecycle stage among practically all effect categories; this will be taken into account in the future.

## CONFLICTS OF INTEREST

The authors confirm that they have no known financial or interpersonal conflicts that would have appeared to have an impact on the research presented in the present paper.

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# REDUNDANCY AWARE DYNAMIC ROUTING PROTOCOL USING SALP SWARM OPTIMIZATION ALGORITHM

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**Abstract** –Wireless sensor network (WSN) is a collection of specialized transducers linked by a communication system that monitors and records conditions in various locations. The process of determining an appropriate route from the destination node to the Source node. Due to the routing problem, networks last less time and use more energy. In this paper, a novel energy efficient cluster-based data redundancy elimination (EC-DRE) technique has been proposed for improving network lifetime and optimal routing in WSN. The k-means clustering algorithm is used in the proposed EC-DRE technique, and the Salp Swarm Optimization Algorithm is used to choose the Cluster Head (CH). The EC-DRE methodology uses the African vulture optimization method, which takes into account fitness criteria such as distance, network lifetime, energy, and delay when routing data. By using the normalised standard deviation methodology, the suggested method also reduces data redundancy, which was done in two steps, namely Intra Cluster and Inter Cluster. Prior to clustering, intra clustering was carried out. Data redundancy is filtered by Inter Cluster before the routing process. The presented EC-DRE has been simulated using MATLAB. The proposed framework is compared with existing techniques such as E-ESR, FPTAC, DH, and PSO in terms of network life time, number of clusters, energy consumption, and residual. Experimental results shows that the suggested EC-DRE approach extends network lifetime by 48.37%, 42.53%, 33.11%, and 21.42% compared to E-ESR, FPTAC, DH, and PSO Methods.

**Keywords** – Wireless Sensor Network, African Vulture Optimization, clustering, data redundancy elimination, Salp swarm optimization.

## 1. INTRODUCTION

WSN is made up of multiple sensor nodes that wirelessly connect in order to gather data and detect critical events in physical and environmental conditions. [1]. Sensor nodes in a WSN collect data on different environmental characteristics and deliver it to one or more sinks through hop-by-hop communication. When the sink receives the information, it analyzes it and provides it to the user. [2]. Sensor devices with such qualities have a wide range of appealing applications.

WSNs have several uses, including as smart homes, surveillance, and industrial diagnostics [3]. His WSNs in several study domains are thoroughly examined. WSNs have shown to be the most effective option in distant places that have yet to be explored owing to their dangerous nature and inaccessibility [4]. Sensor nodes in WSNs, on the other hand, have limited battery resources, memory size range, and computational capability. As a result, the lifespan of WSNs is an important factor to consider when deploying such networks [5-8].

Clustering is a popular WSN topology management approach for extending network lifespan [9]. Utilizing a predetermined set of criteria, including quality of service (QoS), network load balancing assistance, and resource usage optimization, clustering technology unites nodes into units known as clusters [10-13]. When the CH node of one cluster speaks with the CH node of another cluster, this is known as intercluster communication. [14, 15]

Routing is a vital action in WSNs that must be done carefully [16]. The process of selecting pathways for traffic inside a network or across or among many networks is known as routing. Here, a novel is discussed. energy efficient cluster-based data redundancy elimination (EC-DRE) technique has been proposed for improving network lifetime and optimal routing. The major contributions of the suggested EC-DRE technique are given as follows.

- The proposed EC-DRE method uses the k-means clustering algorithm to perform clustering and the Salp Swarm Optimization Algorithm to select Cluster Head (CH).
- The Salp Swarm optimization technique takes into account delay, energy, network lifetime, and distance while choosing the CH.
- The African vulture optimization method, which is used by the EC-DRE approach, considers fitness parameters including distance, network lifetime, energy, and delay while routing data.

- The proposed method also eliminates data redundancy, which has been performed in two stages, namely Intra Cluster and Inter Cluster via normalized standard deviation technique. Intra Clustering has been performed before clustering. Inter Cluster filters data redundancy before routing process.

The remainder of the paper is structured as follows. In Section 2, the literature review is covered. Section 3 provides a description of the suggested system. Section 4 presents the findings and discussion. Conclusions and future improvements are discussed in Section 5.

## 2. LITERATURE REVIEW

WSN is a network type that is composed of huge nodes that gathered data from sensing fields and transmit it to a BS. The SN attached are mobile and dynamic discusses several clustering-based routing protocols that have been performed in this area due to the importance of clustering-based routing protocols in WSNs.

In 2020, Sankar et al [17] suggested the Energy Efficient Cluster-based Routing technique be used to improve the existence of the network throughout its lifetime. This experimental result showed that 5–10% of the network life was increased and 10–20% of end-to-end latency decreased by this technique. In this experiment decreases the node-to-sink delays and improves network life time by this proposed SOA

In 2019, PavaniM and Trinatha [18] suggested an energy-efficient technique for safe routing in WSN networks, called the secure cluster-based routing protocol (SCBRP). It combines an enhanced Firefly method with adaptive particle swarm optimization (PSO). Use a variety of sensor node characteristics, such as residual energy (RE), intra- and inter-cluster distance, and base station distance. The better CH is chosen in every cycle to maintain an equilibrium in the energy consumption of the sensor nodes.

In 2021, Shoo, B.M., et al [19] developed a PSO and Genetic Algorithm (GA) for CH selection and to optimise the sink mobility in order to achieve the optimal network enforcement of the cutting-edge algorithms at different levels of enforcement metrics. It introduces one of the key issues with WSN, namely the effective use of sensor nodes' energy. In comparison to the PSOECMS, PSO-UFC, PSOECMS, GADA-LEACH, PSOB GABEEC, H and PSOB GABEEC, DCH-GA protocols, GAPSO-H enhances bandwidth by 24.3%, 13.5%, 56.6%, 63%, 39.6%, and 78.6%, respectively.

In 2021, Al-Otaibi S et al [20] presented a hybridization of the met heuristic cluster-based clustering approach (HMBCR), which incorporates both clustering and brain storm optimization using Levy distribution (BSO-LD), which includes they are Network load, Distance to the base station, in addition to the hotspot case in WSN, address the use of the met heuristic-unequal clustering method.

In 2019, Sharma, D.K [21] proposed a context-aware routing protocol named means clustering-based routing protocol for opportunistic networks (kROp) that provides a variety of network features that provide a VNF produced

dynamically for making routing decisions. Similarly, we want to use several clustering methods on opponets and evaluate their efficacy against kROp.

In 2022, Muthukumar, S. and Rajesh et al [22] proposed the OC-TAS-IM approach (Optimal Clustering-Turbid Ant Swarm-Improved Myopia) to boost energy effectiveness. It is very difficult to understand the experiment creating clusters and choosing CHs for the clustering process are involved. By lowering the cost of internal transmission, clustering results in energy conservation. The contest is carried out by OC-TAS-IM, as shown by experimental. Also, it changes the optimal value for the correlation between grid length and electricity usage.

In 2021, Moussa N et al [23] presented an enhanced Ant Colony Optimization (ACO) algorithm and Unequal Clustering (ECRP-UCA) cluster-based routing system. Using a batch-based clustering technique, the network can run for a lot of cycles without spending more money on configuration. The suggested routing system has undergone rigorous testing and has been compared to analogous protocols currently in use. The suggested ECRP-UCA beats conventional approaches in a variety of intriguing criteria, according to the simulation findings.

In 2021, Yarinezhad Rand Sabaei M et al [24] proposed a routing technique that distributes the transmission load of the receiver among one the large scale IoT network was supported by the Wireless Sensor Network (WSN), which causes the network to have an effective and efficient performance of the proposed clustering and routing algorithm rather than another similar algorithm. 1.2-approximation used by the clustering algorithm.

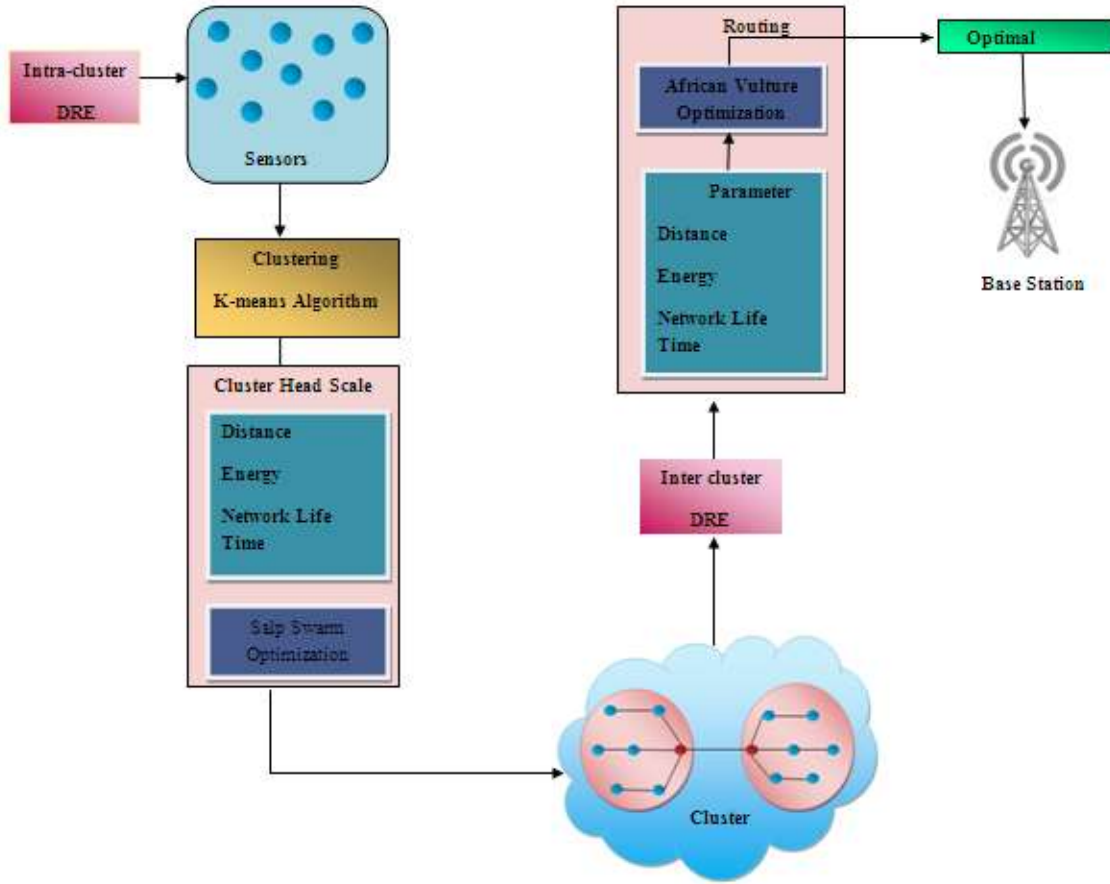
In 2022, Ramteke, R., Singh, S. R [25] presented a particle swarm optimization (GMP SO) based on genetic variation. Natural routing systems that resemble the behavior of social species serve as a great motivator. The effectiveness of GMP SO is contrasted with that of already-in-use techniques like FJPSO, NWPSO, and PSO-based. The dead node rate per round of PSO based on NWPSO and FJPSO is successfully decreased by 31.98%, 46.44%, and 51.12% using GMP SO.

These methods outperform those previously developed but they have some drawbacks such as Minimum storage and are link limited devices. To overcome these drawbacks, an Energy efficient Cluster based Data Redundancy elimination also known as data de-duplication, (EC-DRE) technique has been proposed, which increase the energy efficiency and network lifetime and eliminates the redundant data.

## 3. PROPOSED SYSTEM

This section described briefly in EC-DRE Frame work technique The Slap Swarm optimization and K-Means Clustering approach selects the CH by considering parameters such as delay, energy, network lifetime, and distance. The EC-DRE approach uses the African vulture optimization method, which considers fitness parameters including distance, network lifetime, energy, and delay when routing data. By using the normalised standard deviation methodology, the proposed method also reduces data

redundancy, which two phases, namely Intra cluster - DRE and Inter cluster - DRE



**Figure 1.** Block representation of the suggested EC-DRE framework

### 3.1 K-Means Clustering algorithm via Clustering

K-means clustering is a popular data clustering approach for unsupervised learning problems. The k-means clustering technique is used in the suggested EC-DRE approach to conduct clustering. This approach reduces the objective function based on the squared error function in an effort to locate the best cluster centroid (SEF). The K-Means technique enhances cluster formation and decreases the average distance between each cluster node. To balance network load, it is more beneficial to disperse nodes around the cluster. Building clusters of various WSN apps may be done extremely effectively using this method. The following is a definition of the K-Means algorithm's goal function:

$$K = \sum_{x=1}^m \sum_{y=1}^l dis(a_x, a_z)^2 \quad x = 1, 2, \dots, m, y = 1, 2, \dots, l \quad (1)$$

Where  $dis(a_x, a_z)^2$  is the Euclidean distance used to calculate the separation between node  $a_{ji}$

Phase1: Find L centroid locations in the space that the data collection represents, where L is the given number.

Phase 2: The cluster with the closest centroid distance should be given to each data point.

Phase 3: Recalculate the position of the L centroid once all of the data points have been clustered.

Phase 4: Reiterate Phases 2 and 3 up till the center of mass's location does not considerably shift.

### 3.2 Cluster head selection via Salp Swarm Optimization (SSO)

The network lifespan is optimized by this method. It works with surrounding nodes to replace the damaged node if it is unable to transmit data due to damage. By replacing nodes, the cluster head SSO version discussed in this work enhances the performance of the prior SSO. It is challenging to find biological research of thrap and its habitat. The challenge of confining salp reefs in a constrained space led to the development of the salp reef strategy. The so-called salp chains, which swarm in deep-water regions, provide for more mobility when looking for food, gives a mathematical representation for the equation SSO (2).

$$T_y^x = \begin{cases} ET_y + q_1[(VC_y - NC_y)q_2 + NC_y]q_3 \geq 0 \\ ET_y - q_1[(VC_y - NC_y)q_2 + VC_y]q_3 < 0 \end{cases} \quad (2)$$

$$q_1 = 2f^{-\left(\frac{4m}{M}\right)^2} \quad (3)$$

The number L denotes the present round, and M is the higher number of rounds, where q 1 is a significant coefficient of SSA.

### 3.3. Routing via African Vulture Optimization Algorithm (AVOA)

AVOA represents the foraging and navigational habits of African vultures. The Americas are place of residence to vultures, while Europe, Asia, and Africa are home to old-world vultures. Australia and Antarctica are devoid of vultures. Most vultures lack normal feathers and are bald. according to this algorithm, which divides all starting populations according to their suitability. In each iteration, a different population type either moves or removes one of the top two vultures. The required requirements and points for the standard AVOA are listed below.

#### Step 1: Choosing the Ideal Best Node

Here Best Vulture represents BN; Using Eq 3 the best node is selected. After every capability repetition, the population is recalculated

$$Q(x) = \begin{cases} BN_1 xebx = k_1 \\ BN_2 xebx = k_1 \end{cases} \quad (4)$$

Prior to the search process, two parameters with values between 0 and 1 must be evaluated: K1 and K2. The two parameters added together equal 1.

#### Step 2: A Large Force of Vultures Is Starving

When vultures are starving or have less energy to fly great distances, they become violent against one another based on mathematics (Eq (5)).

$$F_0 = (2 * q \text{ and } 1 + 1) * c * \left(1 - \frac{\text{iterations}}{\text{maxiterations}}\right) + s \quad (5)$$

F denotes the vultures are full vultures are full, iteration indicates how many repetitions are happening now, max iterations indicate how many repetitions there have been in total, and c represents a random number between -1 and 1.

#### Step 3: Exploration of Best Node

$$D_o(x+1) = \begin{cases} eqn (7) \text{ if } p_o \geq q \text{ and } p_{o1} \\ eqn (9) \text{ if } p_o < q \text{ and } p_{o1} \end{cases} \quad (6)$$

$$D_o(i+1) = Z(x) - P(x) * E_o \quad (7)$$

$$D_o(x+1) = Z(x) - E_o + q \text{ and } 2 * ((upper - lower)) * q \text{ and } 3 + lower \quad (8)$$

Where, the position vulture for the following repetition is denoted by  $D_o(x+1)$  and the node's saturation rate,  $E_o$ , is determined using Eq (6).

#### Step 4: Phase One for Exploitations

When the value  $|E_o|$  is in the centre of (1) and (2), The AVOA moves into the initial phase of the usage stage (0.5)

$$p_o(i+1) = \begin{cases} eqn (11) \text{ if } P_2 \geq q \text{ and } P_{o2} \\ eqn (12) \text{ if } P_2 < q \text{ and } P_{o2} \end{cases} \quad (10)$$

$$P_o(i+1) = P(i) * (F + q \text{ and } 4) - p(s) \quad (11)$$

$$p(t) = z(i) - D_o(x) \quad (12)$$

$$D_o(x+1) = z(x) - (N_1 + N_2) \quad (13)$$

$$N_1 = \begin{cases} z(x) * ((q \text{ and } 5 + d_o(x) / 2\pi) * \cos(p_o(i))) \\ z(x) * ((q \text{ and } 6 + d_o(x) / 2\pi) * \sin(p_o(i))) \end{cases} \quad (14)$$

Where qand4 is a value selected at random from 0 to 1.

#### 3.4. Exploitation: Phase Two for Exploitation

In the utilisation stage, the AVOA moves into the second stage. Where  $|d_o|$  less than or equal to  $0.5|d_o|$

$$D_o(x+1) = \begin{cases} eqn (16) \text{ if } p_o \geq q \text{ and } p_{o3} \\ eqn (17) \text{ if } p_o < q \text{ and } p_{o3} \end{cases} \quad (15)$$

$$D_o(x+1) = \frac{Bt_1 + Bt_2}{2} \quad (16)$$

$$\begin{cases} BT1 = BN1(x) - \frac{(BN1(x) * (D_o(x)))}{(BN1(x) - (D_o(x)))} * E_o \\ Bt2 = BN2(x) - \frac{(BN2(x) * (D_o(x)))}{(BN2(x) - (D_o(x)))} * E_o \end{cases} \quad (17)$$

$$D_o(I+1) = C(i) - |p(s)| * E_o * Levy(dis) \quad (18)$$

The current iteration's primary vultures for the first and second groups are BN1 I and BN2 I. The outcomes of BT1 and BT2 are different. Dis (t) symbolizes the distance between the vulture and one of the two groups' top vultures. Using Eq., Levy (dis) was the mean Levy Flight (LF) (19).

$$Levy(dis) = \frac{0.01 * r2 * \sigma}{|r1|^{\frac{1}{\beta}}} \quad (19)$$

$$\Sigma = \left( \frac{(1+\beta) * \sin\left(\frac{\pi\beta}{2}\right)}{(1+\beta^2) * \beta * 2^{\left(\frac{\beta-1}{2}\right)}} \right) \wedge \frac{1}{\beta} \quad (20)$$

Q1 and q2 are fixed and default values, and is a random number between (0) and (1). (1.5). Figure 5 depicts the algorithmic flowchart of the suggested algorithm navigation algorithm in an undiscovered area. The steps in the AVOA for mobile robot navigation are described below in this context.

1. Build the position of the robot, the objective, and the obstacles.

2. If the sensor does not identify any obstacles in the detecting region, it is presumed that the robot would go directly to the destination place. If not, the suggested algorithm gets to work moving the robot to the desired location.

3. Once the robot has arrived at its destination, the programme will determine the distance and time required. If not, the algorithm will seek for the target because the software has determined that it is dynamic.

4. Using Eq. 5, the robot's optimal trajectory may be determined. The robot must dodge all barriers and continue stages 2 through 4 until it reaches the destination.

## 4. RESULTS AND DISCUSSION

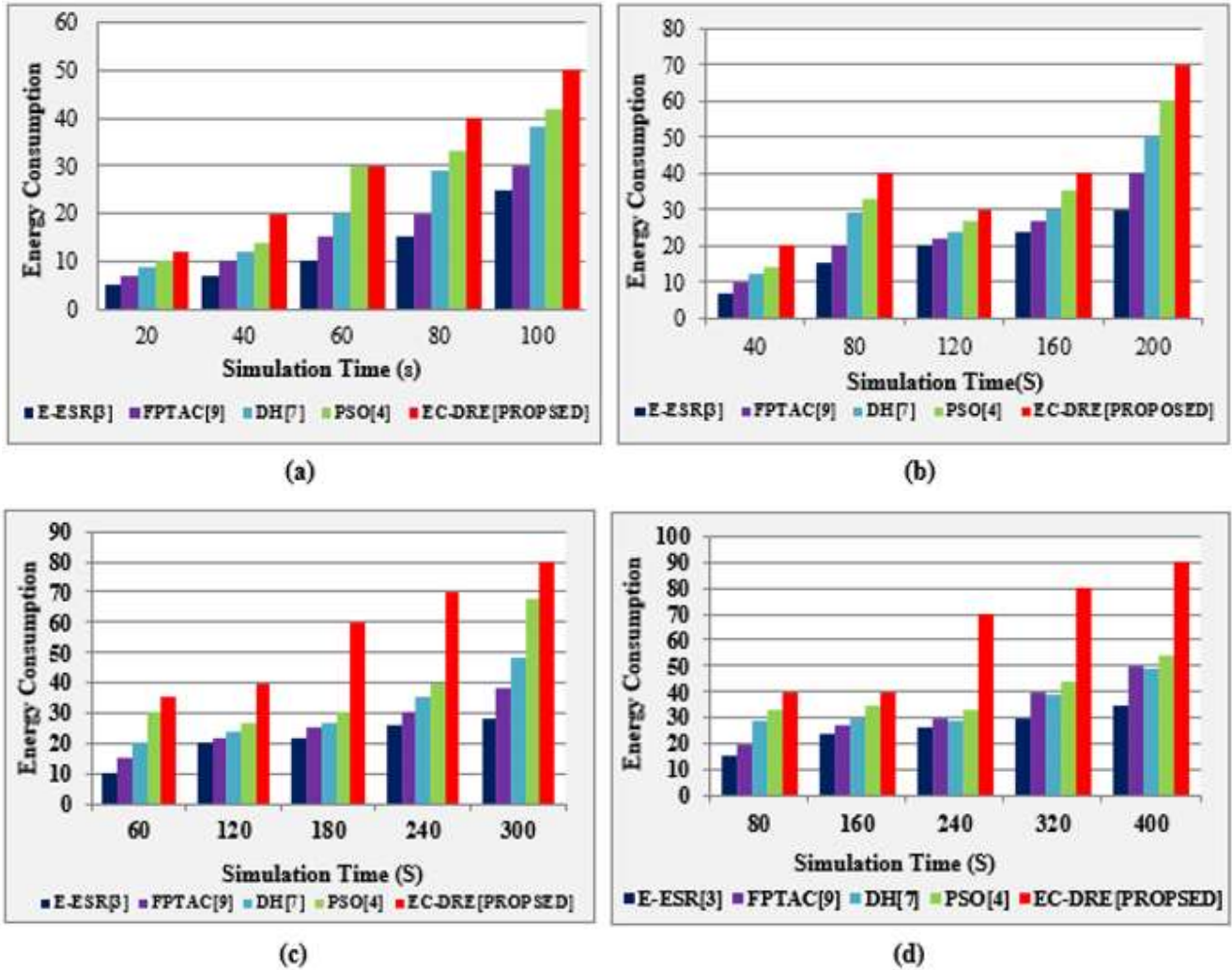
A comparison of the suggested EC- DRE Performance with E-ESR, FPTAC, DH, and PSO is made. Regarding Energy Consumption, Network Lifetime, Cluster Count, and Remaining Energy MATLAB is used to run the simulation.

The network consists of one sink and 100 sensors. The 100m x 100m network's sensor nodes are strewn about at random. Performance indicators like energy consumption, latency, and packet reception rate are used to assess the effectiveness of the proposed EC-DRE. Table 1 displays the parameters and simulation.

The figure 2 shows the Energy Consumption for the proposed EC-DRE with existing system such as E-ESR, FPTAC, DH and PSO. From Fig. 3, it has been discovered that the suggested strategy offers a longer network lifetime. In the Simulation time comes under 100, 200, 300, and 400.

**Table 1.** Simulations and Parameter

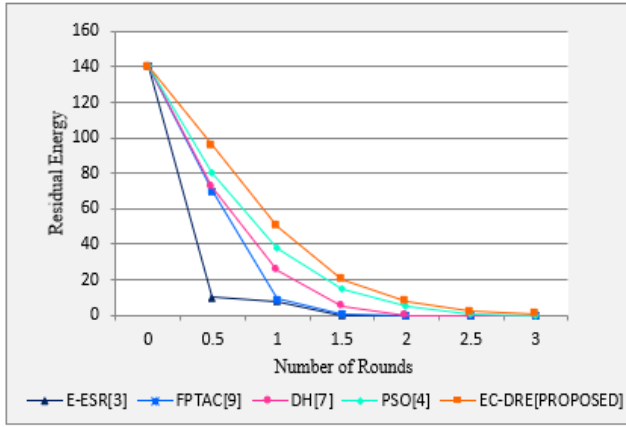
| Simulations     | Parameters |
|-----------------|------------|
| Nodes           | 100        |
| Location of BS  | (50m, 50m) |
| Initial Energy  | 50 J       |
| Simulation area | 100m X100m |
| Packet Size     | 4000 bits  |
| Number of CH    | 10         |
| Simulation Time | 400s       |



**Figure 2.** An analysis of energy use

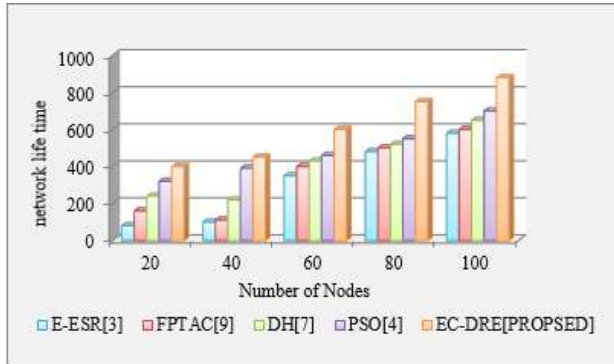
**Table 2.** Residual Energy Comparison

| Number of rounds | Residual Energy |           |        |         |                   |
|------------------|-----------------|-----------|--------|---------|-------------------|
|                  | E-ESR [3]       | FPTAC [9] | DH [7] | PSO [4] | EC-DRE [proposed] |
| 0                | 140             | 140       | 140    | 140     | 140               |
| 0.5              | 10              | 70        | 72     | 80      | 96                |
| 1                | 8               | 9         | 25     | 38      | 50                |
| 1.5              | 0               | 1         | 5      | 15      | 20                |
| 2                | 0               | 0         | 0      | 5       | 8                 |
| 2.5              | 0               | 0         | 0      | 1       | 2                 |
| 3                | 0               | 0         | 0      | 0       | 1                 |

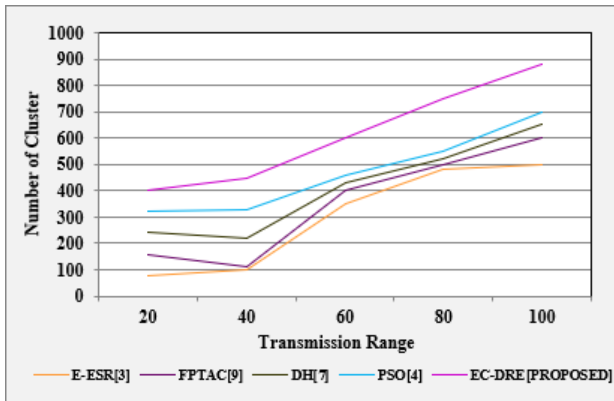


**Figure 3.** Comparison of Residual Energy

Each network node's remaining energy is inversely correlated with the number of rounds. It is clear from the graph that the suggested work has more residual energy than the current work does. This results in the establishment of clusters that have evenly dispersed energy and balanced loads among the Cluster Leaders. Consequently, the proposed work has a higher residual energy level than the current works.



**Figure 4.** Increasing network time

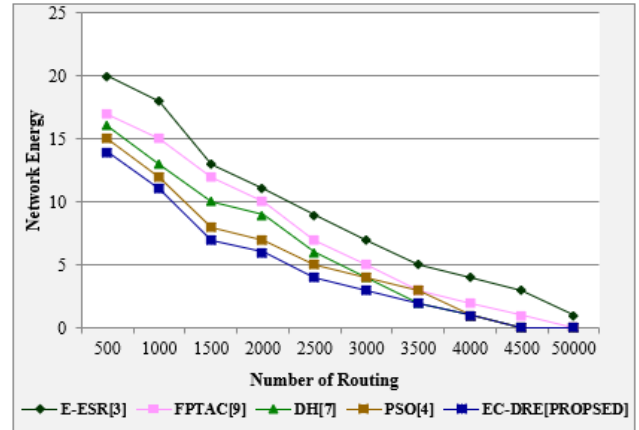


**Figure 5.** Comparison of Cluster and Transmission Range

Figure 5 displays the number of Clusters proposed by EC-DRE as well as the current node count estimation techniques. The numbers 20, 40, 60, 80, and 100 were used. The suggested strategy selects the optimum cluster with wide coverage areas, extending the network's lifespan.

EC-DRE technique outperforms E-ESR [3], FPTAC [9], DH [7], and PSO [4] in terms of accuracy. The EC-DRE approach is an acceptable formulation of a fitness function

that is generated for both the Network Energy and routing process, increasing the network's lifetime.



**Figure 6.** Network Energy and Routing

## 5. CONCLUSION

In this paper novel EC-DRE method which follows the best cluster heads were chosen based on each node's residual centrality, distance, density, and energy. The suggested EC-DRE method utilized the k-means clustering algorithm, and the Salp Swarm Optimization Algorithm is employed to select the CH. The African vulture optimization approach that is used by the EC-DRE methodology considers fitness factors such distance, network lifetime, energy, and delay while routing data. To reduce the data redundancy by applying the normalized standard deviation methodology Inter Cluster are used which are prior to the routing process and Intra clusters are prior to clustering these two methods are implemented in the suggested system. The number of clusters, residual energy, network time, and energy consumption of the proposed framework are compared to those of known techniques as E-ESR, FPTAC, DH, and PSO. In comparison to E-ESR, FPTAC, DH, and PSO Methods, experimental results illustrates that the suggested EC-DRE method increase network lifetime by 48.37%, 42.53%, 33.11%, and 21.42%, respectively. In the future can be improved by applying a new trust mechanism to enable effective secure routing.

## CONFLICTS OF INTEREST

No financial or interpersonal conflicts have been reported by the authors that would have affected the study's findings.

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