Understanding Blockchain Technology

Edition First

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Preface

Blockchain is an emerging technology that makes it easy to transact securely through the Internet. It utilizes various comprehensive technologies with several technical aspects and can be applied to any discipline. Blockchain is mainly used for asset registration, inventory, and exchange of finance and other materials. Assets can be tangible or intangible. This book, "understanding Blockchain Technology", is a collection of various definitions and illustrations available through the Internet, and rewritten as the most straightforward version for the reader to understand, the technical glitches of the Technology to a certain extent. We hope that this book will be helpful to readers in understanding Blockchain Technology.

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Lidar Based Lane-Change Assistance For Motor Vehicle

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Abstract - The work focuses on developing an algorithm to assist drivers in lane changing using Light Detection and Ranging (LiDAR) and Computer Vision (CV). It is expected to reduce the number of accidents caused by improper lane switching. It proceeds with the help of the dataset taken from Karlsruhe Institute of Technology and Toyota Technological Institute of Chicago (KITTI) vision benchmark suite which consists of both LiDAR and CV samples. By combining the results obtained from CV with the LiDAR data, it is possible to predict the distance between the car and the nearest obstacle. An algorithm is developed to indicate the availability of a free lane with the data obtained.

Keywords: ***LIDAR, Computer Vision, object detection, lane detection and lane change.***

I. INTRODUCTION

According to a report published by Transport Research wing under the Ministry of Road Transport and Highway, Government of India, the country has recorded at least 4,80,652 accidents in 2016, leading to 1,50,785 deaths. The number suggests that at least 413 people die every day in 1317 road accidents. Improper lane change and improper lane usage by a driver topped the list of most common reason behind accident occurrence in Ahmedabad. This problem can be solved using the lane changing algorithm with the help of LiDAR and CV.

LIDAR sensing method is a vastly used technique for Advanced Driver Assistant System (ADAS) and automated driving. This sensing technique provides high ranging accuracy, and the fields of view is wide, with low data processing requirements [1]. It is a combination of GPS, IMU, laser, transmitter, and receiver.

Computer Vision works on enabling computers to see, identify and process images in the same way that human vision does, and then provides an appropriate output. It will interpret what it views and then performs appropriate analysis. It is an interdisciplinary field that draws from signal processing, computer science and several mathematical fields like geometry, algebra and statistics [2]. For example, cars could be fitted with computer vision which helps in identifying and distinguishing objects around it such as vehicles, traffic lights, pedestrians, traffic signs and so on. According to C.Premebida *et al.*

In [3] combining LIDAR data with computer vision has many advantages like processing of data and simpler segmentation. The laser measurements are not sensitive under weather changes and the entire system is more robust.

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This paper is organized as follows: the related works are described in section II. Section III explains the methodology of the project followed by object detection in section IV. Section V elucidates the object tracking and the process of lane detection is discussed in section VI. Section VII describes the Integration of CV with LiDAR data and the detection of free lane along with the pseudo code is completed in section VIII. Results and discussions are provided in section IX and the references are given in section X.

II. RELATED WORK

Lane detection techniques proposed by various researchers uses Adaboost classifier. According to A.Haselhoff et *al* [1] LIDAR and CV is coupled to give only the distance and width of the object. This is done only for the detection of vehicles. This can also be used further for many purposes like lane detection. C.Premebida et *al* [3] has used LIDAR and vision based system. Using this, only the classes were identified but the object of the class was not specified. Usage of mobile LIDAR separately results in increased processing time. Hence the real time working was affected [4] [5]. Abdulhakam.A.M et *al* has faced some difficulty in removing shadows in the process of lane detection [6].

Darknet is an open source software which is the backbone of this work. Using yolo weights it helps to identify vehicles, pedestrians, etc. Linux is preferred over any other OS because it is real time in nature and easy to attain near raw hardware performance. KITTI dataset is trained using yolo weights. It is then tightly coupled with LIDAR data which is used for obtaining the distance between the vehicle and object, this work gives more number of objects and also provides it with an id using SORT [7]. Radar gives the distance of the object by using radar sensor [8].

From these observations, in this work, LIDAR sensor is used. It is an advantage as the speed of light is greater than speed of sound. So speed of receiving data will be improved. In this work, LIDAR and CV are coupled together to acquire the distance and width of the object, detect lanes, vehicles present in the current lane and checks for the availability of free lanes. Since LIDAR and CV are combined, the processing time is reduced and real time working is made easy. Therefore, the detection of objects is more specific as it provides information about both the class and the object. The lane detection is done via many processes including White masking. This masking process helps in overcoming problems like interference of shadows in the lane.

III. METHODOLOGY

Figure 1 describes the preferred method for the detection of a free lane. This method starts with the acquisition of data from the dataset followed by object detection, tracking and lane detection. The output of these processes is combined for the detection of free lane. An algorithm is developed for indication of the same.

The dataset considered in this work is taken from Karlsruhe Institute of Technology and Toyota Technological Institute of Chicago (KITTI) vision benchmark suite which consists of both LiDAR and CV samples. It also has the information about the arrangement of the LIDAR sensor and CV in the vehicle. The raw data can be accessed from http://www.cvlibs.net/datasets/kitti. The raw data set is divided into the categories 'Road', 'City', 'Residential', 'Campus' and 'Person' [9].

LIDAR has a scan angle of 360 degrees which helps in the detection of objects surrounding it. Hence, it can be used in obtaining the information about the object like the object distance and its position. Mobile LIDAR can acquire three-dimensional (3D) dense-points, which enable easier building reconstruction, man-made object extraction, 3D city modelling, street-scene modelling, and visualization than most other methods [5].

There are a few steps of computer vision. The first step is edge detection. This helps the pre-processor to identify areas of the image that possess regions of clearly differing light intensity. The next step is the segmentation. In this level it tries to recognize shapes or regions by distinguishing them from the background. After segmentation is completed the final step is extraction and recognition.

Object detection is necessary to classify the objects in different classes. For example, in class 'vehicle' objects are classified as 'car', 'truck', 'train'. If

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the detected class is 'pedestrian', a warning is provided to reduce the speed of the vehicle.

Object tracking is used for providing an id for the detected object. When an object is detected, the shortest distance of the object from the vehicle is provided. If the shortest distance reaches a threshold value, information such as coordinates of the boundary box and id of the object will be provided. These details will be useful in determining the location of the object and if it is found to be in the current lane, a warning is indicated.

When an obstacle is recognized, lane detection is necessary to check for the position of it and also to identify the presence of a free lane. Canny edge detection method is used to detect the edges followed by Probabilistic Hough Transform which is used to highlight the boundary lines of the lane in the region of interest.

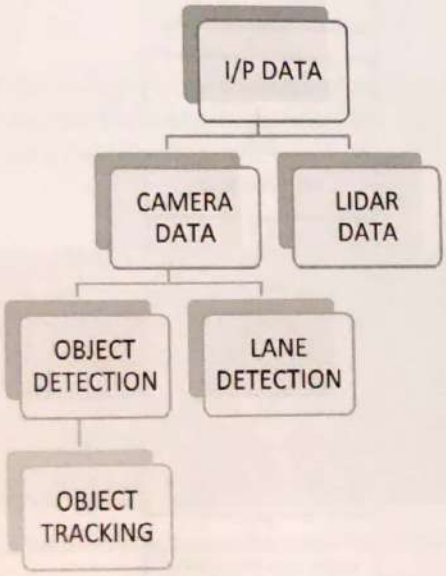


Fig.1. Overview of free lane detection

IV. OBJECT DETECTION

Vehicle detection is the fundamental need for automated driving applications. Object classification is the primary step for object detection. Much software is available for object detections. At first it was experimented with MATLAB but it was less efficient and slow. Hence, it was not preferred. Next in order, nVidia DIGITS was tested. It was inadequate for real-time applications. Finally, Darknet, the open source software [10], was found to be suitable for this purpose.

Using Darknet, LIDAR data was combined with Computer Vision and was also made to run in real time. It supports yolo weights and hence is very useful in object detection purposes. In this work, cars and pedestrians are classified before the detection of the lane. This classification helps in providing a warning if in case there is a need for a lane change.



Fig.2. Output of object detection. The detected object has been classified as a car.

When the computer acquires a video from the camera, it is first segmented into separate frames and is then convoluted for image classification using Convolution Neural Network [7]. The classification is performed using yolo weights and it will be able to classify 9000 objects after the convolution is over.

V. OBJECT TRACKING

Object tracking is the process of locating a moving object or multiple objects over time in a video stream. This is performed by providing a specific id for each object present in the frame which is done with the help of SORT [7] algorithm. This algorithm will track the object for a particular number of frames, 5 in this case. If the object is detected in all the 5 frames an ID will be created for it and is continued to be tracked till it moves out of the vision. If it moves out and does not return back within 3 frames then the ID will be automatically deleted. With this ID, turning of the objects can also be tracked. Tracking is necessary to distinguish between two similar objects. For example, if there are two cars in front of the vehicle, it will be displayed as class: car. To identify the

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car which is at the shortest distance from the vehicle, an ID will be useful. Hence the information about the class and the coordinates of the boundary box will be provided for the object at the shortest distance along with the ID of the object which makes the work simpler.



Fig.3. Output of object tracking. The detected object has been assigned with an ID.

VI. LANE DETECTION

The main objective of this work is to indicate the availability of a free lane. Hence, it is important to check for the availability of a lane. The lane is detected by the following steps shown in figure 5.

i. A white mask is applied for each frame of the video stream. This removes all the shadows and a clear image is obtained. After the masking process is completed each of the frames is then converted from RGB to grayscale.



Fig.4. Output of the image after white mask has been applied.

ii. For the obtained gray image Gaussian blur is applied. This process is performed to reduce unnecessary details and noise in the frame. This will help in detecting the lane edges accurately.

iii. As presence of noise in the system will hinder the accuracy of the edge detection, noise removal is a vital process for efficient edge detection [6]. The Canny edge detection algorithm is known to many as the optimal edge detector [8]. It is used because of its following principles.

- Lower error rate.
- Edge point is localized.
- Each single edge has only one response.

The canny edge detection [13] finds edges by looking for the local maxima of the gradient. It calculates the gradient using the derivative of the Gaussian filter. It uses two thresholds to detect strong and weak edges. If the pixel value is greater than the maximum threshold value, then it is considered as a strong edge. If it lies between the maximum and minimum threshold it is considered to be a weak edge. The weak edges are included in the output only if they are connected to the strong edges. Otherwise it is supressed [11].

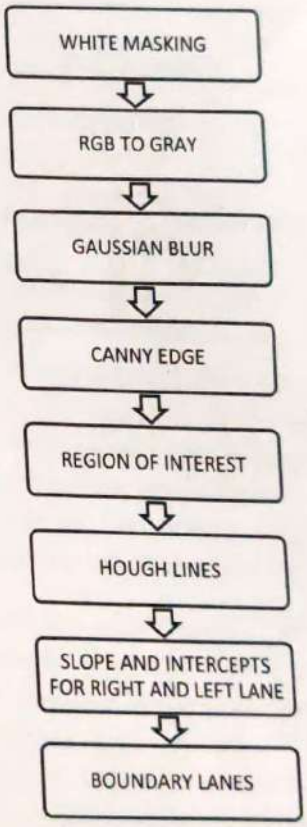


Fig.5. Steps of lane detection

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Fig.6. Output of the image after Gaussian blurring.

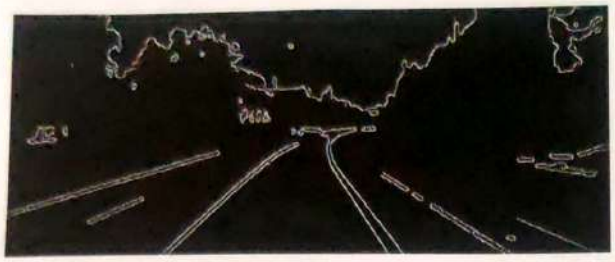


Fig.7. Output of the image after edge detection.

iv. After the completion of edge detection the required region is masked to obtain only the road. The edges of the other obstacles are removed.

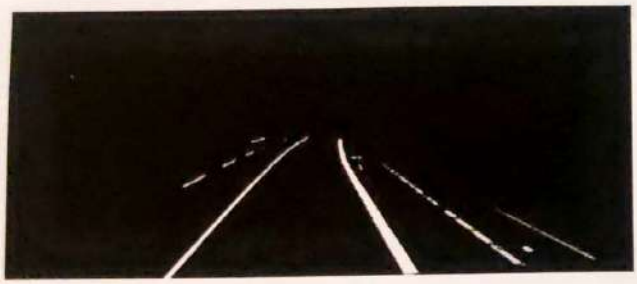


Fig.8. output of the image after the region of interest is taken.

v. Hough transform is a popular technique to detect any shape if that shape can be represented in mathematical form. It has very good fault tolerance and robustness [8]. Probabilistic Hough Transform is an optimization of Hough Transform. It takes only a random subset of points that is sufficient for line detection. If the Hough lines detected are continuous then there should be no lane-change and if not then there is a chance for lane-change.

Probabilistic Hough Transform is applied to the masked region on the original frames.



Fig.9. output of the image after applying Probabilistic Hough Transform

vi. The average of all the lines with negative slope is taken to draw the right lane and those with the positive slope are taken for the left lane. This will help in obtaining the coordinates of the boundary lane lines of the current lane.



Fig.10. output of the image after finding the lane lines.

The coordinates of the boundary box of all the detected objects are checked and only when an object is found within the current lane an indication for lane change is provided.

VII. INTEGRATION OF COMPUTER VISION WITH LIDAR

The distance between the vehicle and the other objects are obtained by combining the LIDAR data and computer vision.

The pixel coordinates of the boundary box in the frame are converted to Cartesian coordinates by equating their slopes. These coordinates are then mapped with the LIDAR point cloud which was used to find the object that is at a shortest distance from the car. If the object is in the same lane as that of the vehicle and when the shortest distance is less than a given threshold value, an indication is provided to change the lane.

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The Lidar sensor captures information at each point in 360 degree and gives a point cloud. In order to reduce the amount of the data being processed and the time complexity of the proposed strategy, we need to segment road surfaces from the entire point clouds [4]. It contains coordinates of points and its distances. It helps in obtaining the distances of objects from the vehicle in this case. It can also be used to check for empty space near the current lane to detect free lanes.

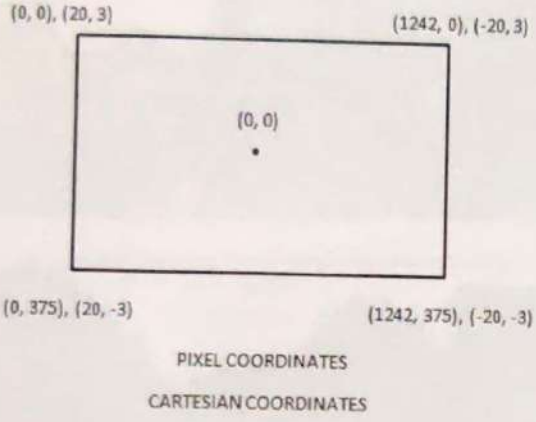


Fig.11.Pixel and Cartesian coordinates for the image

$$XC = \frac{40}{1242} XP - 20$$

$$YC = \frac{-13}{375} YP + 10$$

- Camera: x = right, y = down, z = forward
- Velodyne: x = forward, y = left, z = up.



Fig.12. output of the computer vision

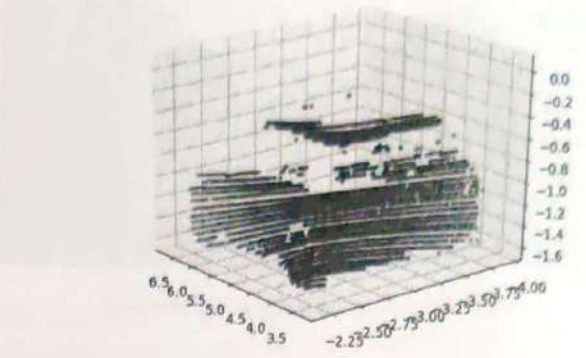


Fig.13. output of the LIDAR point cloud for the detected image

VIII. FREE LANE DETECTION

After the caution from the ADAS system regarding the front vehicle getting closer, availability of free lanes are tested. By using LIDAR sensor, a threshold value is set to check for the presence of free lane around the car. If the region within the threshold radius is an empty space in the LIDAR point cloud then the lane is detected to be free. Else an indication will be given saying that the lane is not free.



Fig.14. Indications showing right lane is free and left lane is not free



Fig.15. Indications showing right lane is not free in the front and left lane is free

IX. RESULTS AND DISCUSSION:

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The proposed algorithm helps in finding the free lane in case of a single way multi-lane system. It detects vehicles both in front as well as in rear. This work can be improved by detecting even the curved lane lines. It can also be extended for overtaking vehicle with the use of same camera and sensor. This can also be implemented in autonomous cars for lane change purposes.



Fig.16. Indications in an image showing right lane is not free and left lane is free.

```
Cam frame predicted in 0.056769 seconds.
right lane is not free
left lane is free
{'right': 827, 'bottom': 230, 'top': 110, 'class': 'bus', 'prob': 0.667312741279
602, 'left': 667}
```

Fig.17. Indications in the terminal

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Leaf Recognition and Disease Detection using Content based Image Retrieval

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Abstract *The agricultural domain in past few decades has seen a decrease in its productivity. The main cause for this was found to be an increase in plant diseases. Having diseases in plants is quite common, but due to improper care there have been serious effects on plants.But we cannot keep inspecting each and every plant present in thousands. Hence, in this work an approach is developed which provides faster and more accurate results of the detected plant leaves and its corresponding diseases. The proposed work approach uses various image processing techniques for recognising the plant leaf type and detecting disease. The system uses two different classification methods namely, Support Vector Machine (SVM) and K-Nearest Neighbours (KNN) and their performances are compared.*

Keywords-Image Processing, K-means clustering, Support Vector Machine, K-Nearest Neighbours

1 INTRODUCTION

In the past few decades agricultural domain has faced lot of struggles to support its rapidly increasing population around the globe. The world has been facing quantityof food, crops and fibre. Despite, the Indian Agriculture accounting for as much as a quarter of its economy and 60% of the labour force employed in agriculture, it is considered inefficient and incapable of solving the food production problems [1-5]. The main reason behind this is the increasing plant diseases. Having diseases in plants is unavoidable but, we must be in a position to combat them. There are many situations are present, where the losses are disastrous caused by postharvest diseases. These pathogens create several serious health hazards for the consumers because of their toxin production. To overcome this issue farmers spend piles of money on disease management, more often without proper technical support, which results in very poor disease control and also leads to catastrophic losses. But we cannot keep inspecting each and every plant present in thousands, so we have developed a simple approach which helps recognise the plant leaf and detects its corresponding disease. The work covers five plant varieties i.e. Apple, Grapes, Tomato, Potato and corn, which is more prominently present across India.The main reason for choosing these crops is that thesewere the most affected plant varieties during the last two years. We have collected leaf images containing both healthy leaves and diseased leaves of their corresponding variety are collected for creating a dataset.

II. RELATED WORKS

In [6] proposed a two step approach on shape based image retrieval using centroid counter distance curve (ccD) and eccentricity which is scale, translation and rotation invariant. In the first step the images which are not similar from the input query image will be filtered using eccentricity which reduces the search space. The search space is further reduced using centroid distance curve which is neither scale invariant nor rotation invariant. This work can achieve a good performance with a much reduced computational complexity.

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The [8] of plant leaf species. This work first classifies if the given input image is a leaf using a binary classifier andthen the image is segmented to obtain a binary image. In the segmentation process the stem of the leaf is first removed. Curvature based features are extracted and then the leaf is identified using Nearest neighbours.

The [7] proposed a content based image retrieval technique using shape, colour and texture features. The purpose wasto identify the plant leaf species for the medical industry, cosmetic industry and botanical gardening.HSV colour space is used to extract the features of the leaf. The texture of a plant leaf has many veins or parallel lines in different direction or colour. So the proposed method uses Log-Gabor method for texture feature extraction.

The [8] put forth an image processing technique for the disease detection of leaf. The image is resized and then converted into HSI color space and the noise is removed. The image is segmented using K-means clustering and then the features are extracted.The classification of the disease is done using SVM(Support Vector machine).

In [9] proposed a shape based image retrieval method with a two step algorithm, where the database is reduced into few geometric features and contour features and similarity matching between the geometric and contour descriptors is done respectively. The colour image is converted into binary image. The shape features are extracted using geometric and contour descriptors. Two step image retrieval process is used where the top candidates of the geometric descriptors are retrieved and the candidates are scores based on contour descriptors.

III CONTENT BASED IMAGE RETRIEVAL

Content Based Image Retrieval (CBIR) is the methodology that is in trend in the Image Processing domain. CBIR is a technique for searching and retrieving images from large database when a user gives a query image, by using its visual features.
CBIR involves three type of feature extraction process, based on its Colour features, Texture features and Shape features of the images in the database. The image given by user is also processed through CBIR model. Then, the features are compared to achieve the target images through the search engine. Schemes using conventional practice of CBIR have some limitations:

- Speed of the system is slow
- It was difficult to identify negative examples
- Accuracy of the result is very poor

All these limitations were improved in the later versions of CBIR scheme development.
The proposed work mainly deals with Shape based Image Retrieval. The perception and visual understanding of a human depends largely on the shape features of the objects around them. There are several shape descriptors that has been developed. They are broadly of two main categories: one based on region properties and the other based on contour. The Contour descriptors mainly use the boundary data but not the shape data. So they cannot be used to describe the shape as complete information is not available. The Region based descriptors uses both boundary data as well as internal data. So they are capable of identifying specific shapes[10].

The CBIR process flow can be widely segmented into three parts: Feature extraction segment, Input query segment and Retrieval segment. The feature extraction part keeps record of all the features of the images in the database in a row-column format. The features of the input query image are also obtained in the similar way the images in the database were obtained. Then in the retrieval segment the features of the query image is compared with the features in the database. The similarity measurements are computed and the most relevant images are obtained. The process flow for CBIR model is shown in Fig1.

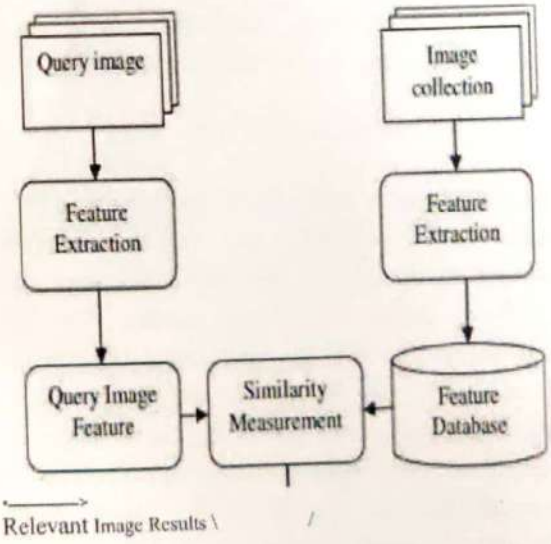


Fig1: Process flow for CBIR model

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IV PROCESS APPROACH

Images are the informational sources in biological domain. The detection of plant leaves and its diseases automatically is the solution to many problems in the agricultural field which helps in reducing the observation time of the crops in large fields. The proposed system is a simple software solution for the above problem. Adataset containing the leaf images of five plants containing variations in their properties is created as the first step in the process [12]. This work deals with two parts of process flow. The first one dealing with leaf recognition and the second one dealing with disease detection. Both the parts have similar process flow but have difference in their pre-processing and feature extraction steps.

Considering the first part of the system i.e. Leaf recognition, deals with recognising the group or to the plant variety it belongs. It involves many image processing techniques like pre-processing, feature extraction, creating training set and testing set of the leaf images and finally classification [13].

The second part of the system i.e. disease detection deals with the detection of the leaf diseases of the query leaf image. It also incorporates the following steps: pre-processing of the diseased leaf, image segmentation, feature extraction of the ROI (Region of Interest) chosen by the user i.e. diseased region, creating training set and testing set of the diseased leaf images and classifying the diseased parts into their respective diseases.

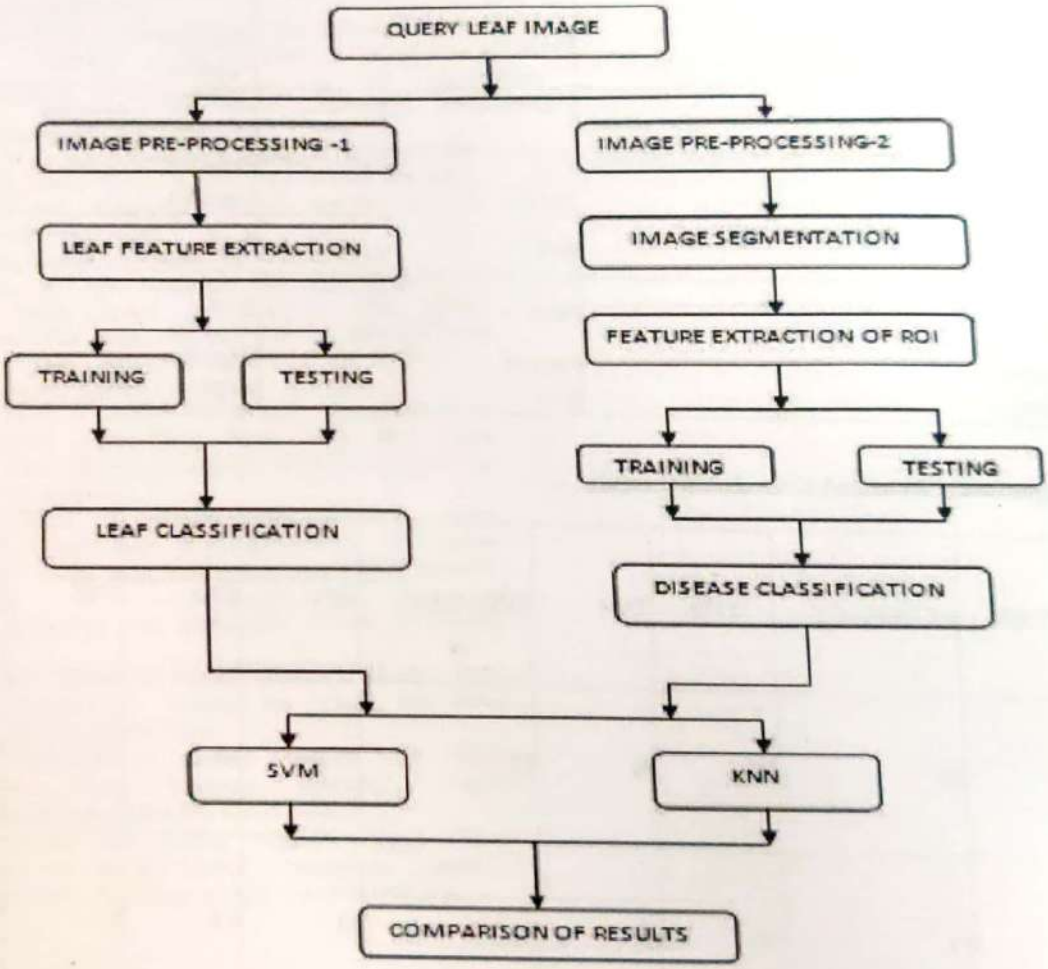


Fig 2: Block diagram of proposed work

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V RESULTS

A systematic approach is designed and developed to recognize the leaf and detect the disease using the two classifiers. The proposed method works well for classification leaf type as well as classification for disease. The parameters mentioned in the equations [13] were derived from the result of the classifier and used for performance comparison of SVM and KNN.

The performance of the classifiers KNN and SVM are compared by computing various performance analysis parameters as listed below:

Table 2: Confusion matrix of KNN

Confusion Matrix of KNN	Predicted values	
	Predicted positive (Diseased)	Predicted Negative (Healthy)
Condition Positive (Diseases)	True Positive tp=27	False Negative fn=3
Condition Negative (healthy)	False Positive fp=4	True Negative tn=26

Table 3: Comparison of SVM and KNN classifier results

PARAMETERS	ACCURACY	TPR	TNR	PRECISION	NPV	FPR	FNR	FDR	FOR
KNN(%)	88	90	86	87	89	12	10	12	10.3
SVM(%)	91	93	90	90.3	93	9.6	6	9.6	6

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VI CONCLUSIONS

The proposed work was developed successfully for the identification of leaf and detection of diseases. This work illustrates a faster and more accurate way of identifying, detecting and classifying leaf and its diseases. A comparison study of disease classification between SVM and KNN is carried out. Here, SVM has produced a relatively higher accuracy and precision than KNN.

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Natural Convection of Sodium Alginate and Copper Nanofluid inside Parallel Plates with Uncertain Parametric Behavior

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Abstract

This chapter includes the natural convection of a non-Newtonian fluid Sodium Alginate contaminated with Copper nanoparticle between a parallel plates. The same is considered with imprecisely defined parameters and investigated. The imprecisely defined parameters are taken as intervals and the said problem is studied by using Interval Homotopy Perturbation Method (IHPM). A novel percentage parametric technique is introduced to handle imprecise parameters with Homotopy Perturbation Method (HPM) and desired uncertain solution is obtained.

Keywords: Uncertainty, Interval, Homotopy Perturbation Method (HPM), Interval Homotopy Perturbation Method (IHPM), Percentage parametric technique, Convection

Nomenclature

C_p	specific heat capacity
k_f	thermal conductivity of the fluid
k_s	thermal conductivity of the nanoparticles
k_{nf}	thermal conductivity of the nanofluid
μ_f	dynamic viscosity of the fluid
μ_{nf}	effective dynamic viscosity of the nanofluid
ρ_f	density of the fluid
ρ_s	density of the nanoparticles
ρ_{nf}	effective density of the nanofluid
$(\rho C_p)_f$	thermal capacitance of the fluid
$(\rho C_p)_s$	thermal capacitance of the nanoparticles

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$(\rho C_p)_{nf}$	heat capacitance of the nanofluid
$\emptyset$	nanoparticle volume fraction
θ	temperature
v	volume

1. Introduction

Natural convection heat transfer is a common phenomenon which comes into play in various physical and engineering application problems viz. heat exchangers, petroleum reservoirs, nuclear waste management, geothermal systems and chemical catalytic reactors [1-4]. In view of these, many researchers reported number of articles based on the flow of fluids. In particular, Newtonian and non-Newtonian fluid flow through two infinite parallel vertical plates. Bruce and Na [5] investigated the natural convection of non-Newtonian fluids between vertical flat plates. Ziabakhsh and Domairry [6] studied laminar natural convection problems. Whereas, Pawar et al. [7] studied an experiment on isothermal steady state and non-isothermal unsteady state conditions in helical coils for and Newtonian fluid (water, glycerol-water mixture) and non-Newtonian fluid (dilute aqueous polymer solutions of sodium carboxy methyl cellulose (SCMC), sodium alginate (SA) mixture). Tang et al. [8] investigated the nature of the flow of deionized water and the PAM solution for a range of Reynolds numbers as well as the non-Newtonian fluid flow in microchannel. Further, in this broad area, Xu and Liao [10] studied the unsteady magneto-hydrodynamic viscous flows of non-Newtonian fluids caused by an impulsively stretching plate by means of homotopy analysis method to investigate the effect of integral power-law index of these non-Newtonian fluids on the velocity. In another experimental work Hojjat et al. [11] prepared three different types of nanofluids by dispersing Al2O3, TiO2 and CuO nanoparticles in a 0.5wt% of carboxymethyl cellulose (CMC) aqueous solution. They measured thermal conductivity of the base fluid and nanofluids with various nanoparticle loadings at different temperatures. Their results show that the thermal conductivity of nanofluids is higher than the one of the base fluid and the increase in the thermal conductivity varies exponentially with the nanoparticle concentration [11]. There are some simple and accurate approximation techniques for solving differential equations called the Weighted Residuals Methods (WRMs). Collocation, Galerkin and Least Square are examples of the WRMs. Stern and Rasmussen [12] used collocation method for solving a third order linear differential equation. Vaferi et al. [13] have studied the feasibility of applying of Orthogonal Collocation method to solve diffusivity equation in the radial transient flow system.

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Hendi and Albugami [14] used Collocation and Galerkin methods for solving Fredholm–Volterra integral equation. Then, Aziz and Bouaziz [15] used least square method for a predicting the performance of a longitudinal fin. They found that least squares method is simple compared with other analytical methods. Shaoqin and Huoyuan [16] developed and analyzed least-squares approximations for the incompressible magneto-hydrodynamic equations. The concept of Differential Transformation Method (DTM) was first introduced by Zhou [17] in 1986 and it was used to solve both linear and nonlinear initial value problems in electric circuit analysis. This method can be applied directly for linear and nonlinear differential equation without requiring linearization, discretization, or perturbation and this is the main benefit of this method. Ghafoori et al. [18] used the DTM for solving then on linear oscillation equation. Other analytical studies in this field can be found in [19–21].

In the above literature, the wide range of application as well as the importance is noticed. As such, various researchers employed many methods and it is found that HPM is simple to use. Besides this, the presence of uncertainties makes the problem complicated and become more realistic. Hence, the said problem is investigated with the presence of uncertainties. The uncertainties occur due to impreciseness, vagueness and lack of information about the involved parameters, constants, coefficients and experimental values. In this regards, many researchers used various techniques to handle these uncertainties effectively. Few of the research works are discussed here for the understanding of involved challenge to handle and need.

Qiu et al. [22] used an interval approach in reliability theory and obtained an interval probability of system failure. The combination of reliability theory and interval analysis is then applied to solve two example problems of truss systems. Whereas, Blackwell and Beck [23] considered thermal properties and temperature measurements as uncertainties to analyze linear inverse heat conduction problem to estimate heat flux from interior temperatures. In detail, Chakraverty and Nayak [24] studied interval uncertainties and redefined interval arithmetic through a transformation that converts intervals into crisp form by symbolic parameterization. Then interval arithmetic has extended for fuzzy numbers and the fuzzy finite element method is developed. Then the same has used to solve a heat conduction problem. Besides, Nayak and Chakraverty [25] taken modified Fuzzy Finite Element Method (FFEM) where they changed α- cut interval fuzzy numbers into crisp form and investigate the sensitiveness of involved uncertain parameters for conjugate heat transfer in a square plate. Further, Nayak et al. [26] studied the distribution of temperatures in a conduction-convection system under uncertain

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environments. With modification in the representation of intervals, Wang and Qiu [27] introduced an Interval Parameter Perturbation Method (IPPM) and a sensitivity-based interval analysis method (SIAM). Then the same have used to estimate temperatures for a steady-state heat convection-diffusion problem with uncertainties in material properties, external loads, and boundary conditions. Li et al. [28] presented several numerical algorithms to solve the convection-diffusion equation with random diffusivity and periodic boundary conditions. In this respect it is observed that there is an essence of alternate tool to handle interval uncertainties with the percentage of error occurred. Hence, a novel technique of percentage parametric approach is proposed to compute intervals. Further, this technique is used to study the natural convection of a non-Newtonian fluid Sodium Alginate contaminated with Copper nanoparticle between a parallel plates with uncertainties.

2. Natural convection of nanofluid inside parallel plates

A schematic diagram of a non-Newtonian fluid flows between the two vertical plates are shown in Fig. 1. The problem consists of two vertical plates which are separated by a distance $2b$. In between the two vertical parallel plates a non-Newtonian fluid flows with natural convection. Constant temperatures T_2 and T_1 are maintained at the plate walls at $x = b$ and $x = -b$ respectively, where $T_1 > T_2$. This difference in temperature causes the fluid near the wall at $x = b$ to fall and the fluid near the wall at $x = -b$ to rise. The fluid is a non-Newtonian Sodium Alginate (SA) based nanofluid containing Cu and Ag nanoparticles. It is assumed that the base fluid and the nanoparticles are in thermal equilibrium and no slip occurs between them. The thermos physical properties of the nanofluid are given in Table 1.

The effective density, the effective dynamic viscosity, the heat capacitance and the thermal conductivity of the nanofluid are given as [1, 2].

$$\rho_{nf} = \rho_f(1-\emptyset) + \rho_s\emptyset \tag{1}$$

$$\mu_{nf} = \frac{\mu_f}{(1-\emptyset)^{2.5}} \tag{2}$$

$$(\rho C_p)_{nf} = (\rho C_p)_f(1-\emptyset) + (\rho C_p)_s\emptyset \tag{3}$$

$$\frac{k_{nf}}{k_f} = \frac{k_s + 2k_f + 2\emptyset(k_s - k_f)}{k_s + 2k_f - \emptyset(k_s - k_f)} \tag{4}$$

where $\emptyset$ denotes the nanoparticle volume fraction.

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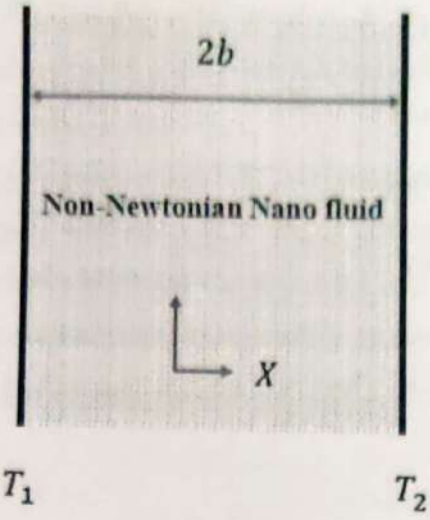


Fig.1 Diagrammatic representation of a non-Newtonian nanofluid flow between two vertical flat plates

Table 1. Physical properties of non-Newtonian fluid and Nano particles

Material	Density (kg/m^3)	$C_p(J/kgK)$	Thermal conductivity, W/mK
Copper (Cu)	8933	385	401
Silver (Ag)	10500	235	429
Sodium Alginate (SA)	989	4175	0.6376

Here C_p denotes specific heat.

Define similarity variables as like

$$V = \frac{v}{V_0}, \eta = \frac{x}{b} and\ \theta = \frac{T-T_m}{T_1-T_2} \tag{5}$$

Using these assumptions and the Nano fluid model, the Navier-Stokes and energy equations are reduced to the coupled differential equations as

$$\frac{d^2V}{d\eta^2} + 6\delta(1-\emptyset)^{2.5}\left(\frac{dV}{d\eta}\right)^2\frac{d^2V}{d\eta^2} + \theta = 0 \tag{6}$$

$$\frac{d^2\theta}{d\eta^2} + EcPr\left(\frac{(1-\emptyset)^{2.5}}{A_1}\right)\left(\frac{dV}{d\eta^2}\right)^2 + 2\delta EcPr\left(\frac{1}{A_1}\right)\left(\frac{dV}{d\eta}\right)^4 \tag{7}$$

where, Pr and Ec stands for Prandtl and Eckert number respectively, δ for dimensionless non-Newtonian viscosity, A_1 for ratio of thermal conductivity of nanofluid and that of real fluid and they have the forms:

$$Ec = \frac{\rho_f {V_0}^2}{(\rho C_p)_f(\theta_1-\theta_2)}, Pr = \frac{\mu_f(\rho C_p)_f}{\rho_f K_f}, \delta = \frac{6\beta_3 {V_0}^2}{\mu_f b^2} \tag{8}$$

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$$A_1 = \frac{k_{nf}}{k_f} = \frac{k_s + 2k_f + 2\emptyset(k_s - k_f)}{k_s + 2k_f - \emptyset(k_s - k_f)} \tag{9}$$

The boundary conditions are taken as

$$V(\eta) = \begin{cases} 0, & \eta = 1 \\ 0, & \eta = -1 \end{cases} \tag{10}$$

$$\theta(\eta) = \begin{cases} -0.5, & \eta = 1 \\ 0.5, & \eta = -1 \end{cases} \tag{11}$$

It can be mention that, if a small change in the value of nano particle volume fraction it affect the velocity and temperature profile. Now we are handling such a problem in uncertain environment by interval analysis.

3. Interval Homotopy Perturbation Method (IHPM)

Here, the concept of interval analysis is hybridised with the Homotopy Perturbation Method (HPM) to develop IHPM. The involved uncertainties are computed through the interval computation technique. To understand the same, first the interval arithmetic is discussed and the HPM is included.

An interval A can be defined as [29]

$$A = [a_1, a_2] = \{t | a_1 \leq t \leq a_2, a_1, a_2 \in \mathcal{R}\}, \tag{12}$$

where a_1 and a_2 are the left and right endpoints of the interval A.

Two intervals are said to be equal if the left endpoints and right endpoints for both the intervals are the same. For example, if we take two intervals viz. $A = [a_1, a_2]$ and $B = [b_1, b_2]$ then they are said to be equal if $a_1 = b_1$ and $a_2 = b_2$.

The width of an interval A is defined by $w = a_2 - a_1$. Whereas, the midpoint of A is $m = \frac{a_1 + a_2}{2}$.

To compute interval uncertainties, the traditional interval arithmetic operations are defined as

$$[a_1, a_2] + [b_1, b_2] = [a_1 + b_1, a_2 + b_2]; \tag{13}$$

$$[a_1, a_2] - [b_1, b_2] = [a_1 - b_2, a_2 - b_1]; \tag{14}$$

$$[a_1, a_2].[b_1, b_2] = [\min(a_1b_1, a_1b_2, a_2b_1, a_2b_2), \max(a_1b_1, a_1b_2, a_2b_1, a_2b_2)]; \tag{15}$$

$$\frac{[a_1, a_2]}{[b_1, b_2]} = \left[\min\left(\frac{a_1}{b_1}, \frac{a_1}{b_2}, \frac{a_2}{b_1}, \frac{a_2}{b_2}\right), \max\left(\frac{a_1}{b_1}, \frac{a_1}{b_2}, \frac{a_2}{b_1}, \frac{a_2}{b_2}\right)\right], \text{ where } b_1, b_2 \neq 0. \tag{16}$$

Alternatively, an interval $A = [a_1, a_2]$ can be written as the following crisp form [30, 31] by using a parameter $\alpha, 0 \leq \alpha \leq 1$.

$$A = f(\alpha) = a_1 + \alpha(a_2 - a_1) \tag{17}$$

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Substituting, $\alpha = 0$ and $\alpha = 1$, one may get the lower and upper bounds of the interval A respectively. The expression Eq. (17) converts the interval into a single variable function which is used here to compute the interval uncertainties.

Further, the need of handling percentage error and interval uncertainties motivate to propose alternate technique to compute intervals effectively. In this regards, in the following a percentage parametric technique is discussed here.

For the interval $[a, b]$, the midpoint is defined as $m = \frac{a+b}{2}$ and Δ is the percentage of error. The width of the interval is $w = b - a$. Then, there exist a number

$$x = a + \frac{\beta}{\Delta} w, \tag{18}$$

where $\beta \epsilon [0, \Delta]$.

If Δ is consider to be 5% error of $m = 10$ then the interval is $[9.5, 10.5]$, where $\beta \epsilon [0, 0.5]$.

The interval $x = [a, b]$ can be transformed into the following crisp form

$$f(\beta) = a + \frac{\beta}{\Delta} w, \tag{19}$$

where β is a parameter lies in the closed interval $[0, 0.5]$.

So, Eq. (19) can be written as $f(\beta) = \frac{-1}{\Delta}(\Delta^2 - m\Delta - \beta w) = \left(9.5 + \frac{\beta}{.5}(b - a)\right)$.

The basic idea of HPM can be understood from the below mentioned differential equation.

Let us consider the differential equation

$$A(u) - f(r) = 0, r \in \Omega \tag{20}$$

with the boundary condition

$$B\left(u, \frac{dV}{d\eta}\right) = 0, r \in \Gamma \tag{21}$$

where A is a differential operator, B is the boundary operator, $f(r)$ is a known analytical function and Γ is the boundary of the domain Ω.

The operator A can be classified into two parts viz. linear (L) and non-linear (N). Then the Eq. (20) can be written as

$$L(u) + N(u) - f(r) = 0, \quad r \in \Omega \tag{22}$$

One may construct a homotopy $v(r, q): \Omega \times [0,1] \rightarrow R$ satisfying

$$H(v, q) = (1 - q)[L(v) - L(u_0)] + q[A(v) - f(r)] = 0 \tag{23}$$

where q is an embedding parameter lies between 0 and 1, u_0 is an initial approximation satisfying boundary condition Eq. (21).

From Eq. (23), we observe that when $q = 0, L(v) = L(u_0)$ and for $q = 1, A(v) - f(r) = 0$

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In other words, when q converges to 1, we get the solution of Eq. (20). As q is a small parameter, the solution of Eq. (23) can be expressed as in terms of power series in q

$$v = v_0 + qv_1 + q^2v_2 + q^3v_3 + \cdots \tag{24}$$

By setting $q = 1$, we get the solution of Eq. (20) is

$$v = \lim_{q\to 1}(v_0 + qv_1 + q^2v_2 + q^3v_3 + \cdots) \tag{25}$$

In this chapter, we have hybridized the concept of interval uncertainties with the usual HPM to get IHPM. Following sections, the nanofluid heat transfer problem is stated and the same is solved by using IHPM.

4. Solution of Natural Convection of Sodium Alginate and Copper Nanofluid inside Parallel Plates using percentage parametric HPM

Considering the percentage parametric technique the coupled differential Eqs. (6) and (7) in interval form ca be written as

$$\left(9.5+\frac{\beta}{.5}\left(\overline{v''}-\underline{v''}\right)\right)+6\delta\left(1-\left(9.5+\frac{\beta}{.5}\left(\overline{\emptyset}-\underline{\emptyset}\right)\right)\right)^{2.5}\left(9.5+\frac{\beta}{.5}\left(\overline{v'}-\underline{v'}\right)\right)^2$$
$$\left(9.5+\tfrac{\beta}{.5}\left(\overline{v''}-\underline{v''}\right)\right)+\left(9.5+\tfrac{\beta}{.5}\left(\overline{\theta}-\underline{\theta}\right)\right)=0, \tag{26}$$

$$\left(9.5+\frac{\beta}{.5}\left(\overline{\theta''}-\underline{\theta''}\right)\right)+Ec.\Pr\left(\frac{\left(1-\left(9.5+\frac{\beta}{.5}\left(\overline{\emptyset}-\underline{\emptyset}\right)\right)\right)^{2.5}}{\left(9.5+\frac{\beta}{.5}\left(\overline{A_1}-\underline{A_1}\right)\right)}\right)\left(9.5+\frac{\beta}{.5}\left(\overline{v'}-\underline{v'}\right)\right)^2+$$
$$2\delta Ec.Pr\frac{1}{\left(9.5+\frac{\beta}{.5}\left(\overline{A_1}-\underline{A_1}\right)\right)}\left(9.5+\frac{\beta}{.5}\left(\overline{v'}-\underline{v'}\right)\right)^4=0. \tag{27}$$

For simplicity, we may write

$$9.5+\frac{\beta}{.5}\left(\overline{v''}-\underline{v''}\right)=f_v''(\eta,\beta)$$

$$9.5+\frac{\beta}{.5}\left(\overline{\emptyset}-\underline{\emptyset}\right)=\emptyset(\beta)$$

$$9.5+\frac{\beta}{.5}\left(\overline{\theta}-\underline{\theta}\right)=f_\theta(\eta,\beta)$$

Then the Eqs. (26) and (27) becomes

$$f_v''(\eta,\beta)+6\delta(1-\emptyset(\beta))^{2.5}(f_v'(\eta,\beta))^2f_v''(\eta,\beta)+f_\theta(\eta,\beta)=0 \tag{28}$$

$$f_\theta''(\eta,\beta)+Ec.\Pr\left(\frac{(1-\emptyset(\beta))^{-2.5}}{A_1(\beta)}\right)f_v'(\eta,\beta)+2\delta Ec.Pr.\left(\frac{1}{A_1(\beta)}\right)(f_v'(\eta,\beta))^4=0 \tag{29}$$

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Similarly, the boundary conditions can be expressed as

$$f_v(\eta,\beta) = \begin{cases} 0, & \eta = 1 \\ 0, & \eta = -1 \end{cases} \tag{30}$$

$$f_\theta(\eta,\beta) = \begin{cases} -0.5, & \eta = 1 \\ 0.5, & \eta = -1 \end{cases} \tag{31}$$

Now we apply HPM to solve Eqs. (28) and (29). Homotopy for Eqs. (28) and (29) is constructed as

$$H_1(q,\eta) = (1-q)[f_v''(\eta,\beta) + f_\theta(\eta,\beta)] + q[f_v''(\eta,\beta) + 6\delta(1-\emptyset(\beta))^{2.5}(f_v'(\eta,\beta))^2 f_v''(\eta,\beta) + f_\theta(\eta,\beta)] = 0 \tag{32}$$

$$H_2(q,\eta) = (1-q)[f_\theta''(\eta,\beta)] + q\left[f_\theta''(\eta,\beta) + Ec.\Pr\left(\frac{(1-\emptyset(\beta))^{-2.5}}{A_1(\beta)}\right)(f_v'(\eta,\beta))^2 + 2\delta Ec.Pr.\left(\frac{1}{A_1(\beta)}\right)(f_v'(\eta,\beta))^4\right] = 0 \tag{33}$$

According to the percentage parametric technique and HPM,

$$f_v(\eta,\beta) = f_{v_0}(\eta,\beta) + q f_{v_1}(\eta,\beta) + q^2 f_{v_2}(\eta,\beta) + q^3 f_{v_3}(\eta,\beta) + \cdots \tag{34}$$

and

$$f_\theta(\eta,\beta) = f_{\theta_0}(\eta,\beta) + q f_{\theta_1}(\eta,\beta) + q^2 f_{\theta_2}(\eta,\beta) + q^3 f_{\theta_3}(\eta,\beta) + \cdots \tag{35}$$

are the assumed series solution of Eqs. (24) and (25).

The aim is to find the unknown functions $f_{v_0}(\eta,\beta)$, $f_{v_1}(\eta,\beta)$, $f_{v_2}(\eta,\beta)$, $f_{v_3}(\eta,\beta)$ and so on for velocity profile and $f_{\theta_0}(\eta,\beta)$, $f_{\theta_1}(\eta,\beta)$, $f_{\theta_2}(\eta,\beta)$, $f_{\theta_3}(\eta,\beta)$ and so on for temperature profile. As assuming solution $f_v(\eta,\beta)$ and $f_\theta(\eta,\beta)$ should satisfy the differential equations by substituting Eqs. (26) and (27) in Eqs. (24) and (25) and collecting the various power of q we get

$$\begin{aligned} &[f_{v_0}''(\eta,\beta) + f_{\theta_0}(\eta,\beta)]q^0 \\ &+ \left[f_{v_1}''(\eta,\beta) + 6\delta(1-\emptyset(\beta))^{2.5}\left(f_{v_0}'(\eta,\beta)\right)^2 f_{v_0}''(\eta,\beta) + f_{\theta_1}(\eta,\beta)\right]q^1 \\ &+ \left[f_{v_2}''(\eta,\beta) + 6\delta(1-\emptyset(\beta))^{2.5}\left(f_{v_1}'(\eta,\beta)\right)^2 f_{v_1}''(\eta,\beta) + f_{\theta_2}(\eta,\beta)\right]q^2 + \ \ldots = 0 \end{aligned} \tag{36}$$

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$$\left[f''_{\theta_0}(\eta,\beta)\right]q^0 + \left[f''_{\theta_1}(\eta,\beta) + Ec.\Pr\left(\frac{\left(1-\phi(\beta)\right)^{-2.5}}{A_1(\beta)}\right)\left(f'_{v_0}(\eta,\beta)\right)^2 + 2\delta Ec.Pr.\left(\frac{1}{A_1(\beta)}\right)\left(f'_{v_0}(\eta,\beta)\right)^4\right]q^1 + \left[f''_{\theta_2}(\eta,\beta) + Ec.\Pr\left(\frac{\left(1-\phi(\beta)\right)^{-2.5}}{A_1(\beta)}\right)\left(f'_{v_1}(\eta,\beta)\right)^2 + 2\delta Ec.Pr.\left(\frac{1}{A_1(\beta)}\right)\left(f'_{v_1}(\eta,\beta)\right)^4\right]q^2 + \cdots = 0 \quad (37)$$

Equating the coefficients of various power of q from Eqs. (36) and (37) to zero separately an also by using boundary conditions we get the functions $f_{v_0}(\eta,\beta), f_{v_1}(\eta,\beta), f_{v_2}(\eta,\beta), f_{v_3}(\eta,\beta)$ and so on for velocity profile and $f_{\theta_0}(\eta,\beta)$, $f_{\theta_1}(\eta,\beta)$, $f_{\theta_2}(\eta,\beta)$, $f_{\theta_3}(\eta,\beta)$ and so on for temperature profile.

First equating the coefficient of q^0 in Eq. (37) to zero, we get

$$f''_{\theta_0}(\eta,\beta) = 0 \quad (38)$$

with the boundary conditions

$$f_{\theta_0}(\eta,\beta) = \begin{cases} -0.5, & \eta = 1 \\ 0.5, & \eta = -1 \end{cases} \quad (39)$$

From Eq. (38) and (39) we have

$$f_{\theta_0}(\eta,\beta) = \frac{-\eta}{2} \quad (40)$$

Next equate the coefficient of q^0 in Eq. (36) to zero, we obtain

$$f''_{v_0}(\eta,\beta) + f_{\theta_0}(\eta,\beta) = 0 \quad (41)$$

with boundary conditions

$$f_{v_0}(\eta,\beta) = \begin{cases} 0, & \eta = 1 \\ 0, & \eta = -1 \end{cases} \quad (42)$$

From Eq. (41) and (42) we get

$$f_{v_0}(\eta,\beta) = \frac{\eta^3}{12} - \frac{\eta}{12} \quad (43)$$

First equating the coefficient of q^1 in Eq. (37) to zero, we have

$$f''_{\theta_1}(\eta,\beta) + Ec.\Pr\left(\frac{\left(1-\phi(\beta)\right)^{-2.5}}{A_1(\beta)}\right)\left(f'_{v_0}(\eta,\beta)\right)^2 + 2\delta Ec.Pr.\left(\frac{1}{A_1(\beta)}\right)\left(f'_{v_0}(\eta,\beta)\right)^4 = 0 \quad (44)$$

with boundary conditions

$$f_{\theta_1}(\eta,\beta) = \begin{cases} 0, & \eta = 1 \\ 0, & \eta = -1 \end{cases} \quad (45)$$

From Eqs. (44) and (45) we get

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$$f_{\theta_1} = \frac{-Ec.Pr}{12}\left(\frac{\left(1-\emptyset(\beta)\right)^{-2.5}}{A_1(\beta)}\right)\left[\frac{\eta^6}{40}-\frac{\eta^4}{24}+\frac{\eta^2}{24}-\frac{1}{40}\right] - \frac{2\delta Ec.Pr}{12^2}\left(\frac{1}{A_1(\beta)}\right)\left[\frac{\eta^{10}}{160}-\frac{3\eta^8}{224}+\frac{\eta^6}{80}-\frac{\eta^4}{144}+\frac{\eta^2}{288}-\frac{19}{10080}\right] \quad (46)$$

First equating the coefficient of q^1 in Eq. (46) to zero

$$f''_{v_1}(\eta,\beta) + 6\delta\left(1-\emptyset(\beta)\right)^{2.5}\left(f'_{v_0}(\eta,\beta)\right)^2 f''_{v_0}(\eta,\beta) + f_{\theta_1}(\eta,\beta) = 0 \quad (47)$$

With boundary conditions

$$f_{v_1}(\eta,\beta) = \begin{cases} 0, & \eta = 1 \\ 0, & \eta = -1 \end{cases} \quad (48)$$

From Eqs. (46) and (47) we get

$$f_{v_1} = \frac{-6\delta\left(1-\emptyset(\beta)\right)^{2.5}}{12}\left[\frac{\eta^7}{112}-\frac{\eta^5}{80}+\frac{\eta^3}{144}-\frac{17\eta}{5040}\right] - \frac{Ec.Pr.}{12}\left(\frac{\left(1-\emptyset(\beta)\right)^{-2.5}}{A_1(\beta)}\right)\left[\frac{\eta^8}{2240}-\frac{\eta^6}{1612800}+\frac{\eta^4}{288}-\frac{\eta^2}{80}+\frac{67}{6720}\right] - \frac{2\delta Ec.Pr}{12^3}\left(\frac{1}{A_1(\beta)}\right)\left[\frac{\eta^{12}}{1760}-\frac{3\eta^{10}}{1680}+\frac{3\eta^8}{1120}-\frac{\eta^6}{360}+\frac{\eta^4}{288}-\frac{19\eta^2}{1680}+\frac{203}{22179}\right] \quad (49)$$

By continuing the same process for different powers of q from Eqs. (36) and (37) we get $f_{\theta_2}(\eta,\beta), f_{v_2}(\eta,\beta), f_{\theta_3}(\eta,\beta), f_{v_3}(\eta,\beta)$ and so on.

According to this method the approximate solution for velocity and temperature profiles are given by



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$$f_v(\eta,\beta)=\frac{\eta^3}{12}-\frac{\eta}{12}-\frac{6\delta\left(1-\emptyset(\beta)\right)^{2.5}}{12}\left[\frac{\eta^7}{112}-\frac{\eta^5}{80}+\frac{\eta^3}{144}-\frac{17\eta}{5040}\right]$$
$$-\frac{Ec.Pr.}{12}\left(\frac{\left(1-\emptyset(\beta)\right)^{-2.5}}{A_1(\beta)}\right)\left[\frac{\eta^8}{2240}-\frac{\eta^6}{1612800}+\frac{\eta^4}{288}-\frac{\eta^2}{80}+\frac{67}{6720}\right]$$
$$-\frac{2\delta Ec.Pr}{12^3}\left(\frac{1}{A_1(\beta)}\right)\left[\frac{\eta^{12}}{1760}-\frac{3\eta^{10}}{1680}+\frac{3\eta^8}{1120}-\frac{\eta^6}{360}+\frac{\eta^4}{288}-\frac{19\eta^2}{1680}+\frac{203}{22179}\right] \quad (50)$$

and

$$f_\theta(\eta,\beta)=\frac{-\eta}{2}-\frac{Ec.Pr}{12}\left(\frac{\left(1-\emptyset(\beta)\right)^{-2.5}}{A_1(\beta)}\right)\left[\frac{\eta^6}{40}-\frac{\eta^4}{24}+\frac{\eta^2}{24}-\frac{1}{40}\right]$$
$$-\frac{2\delta Ec.Pr}{12^2}\left(\frac{1}{A_1(\beta)}\right)\left[\frac{\eta^{10}}{160}-\frac{3\eta^8}{224}+\frac{\eta^6}{80}-\frac{\eta^4}{144}+\frac{\eta^2}{288}-\frac{19}{10080}\right] \quad (51)$$

respectively.

5. Concluding remarks

This chapter describes a novel percentage parametric approach to handle involved uncertain values of the problem. The main advantage of this method is that the percentage of error in uncertainties are initially considered and computed by using parametric transformation. The percentage of error gives a liberty to choose the level of uncertainties that is tolerance of error in uncertain parameters. Also, this technique can convert the intervals to single variable function which reduces the computation effort. Using the same, generalized series solution is obtained for the velocity and temperature profiles in natural convection of a non-Newtonian fluid Sodium Alginate contaminated with Copper nanoparticle between a parallel plates.

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FEATURE FUSION IN MULTIMODAL EMOTION RECOGNITION SYSTEM FOR ENHANCEMENT OF HUMAN-MACHINE INTERACTION

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Abstract. Emotion Recognition (ER) systems is very much important for interpersonal relationship. Emotions are developed by some physiological changes. The straightforward of this effort is to discover the competence of language and facemask elements to deliver the feeling exact information for enhancing the Human-Machine interaction. The techniques and systems used in emotion detection may vary depending on the features inspected. Since both these features complement each other, combining them results in higher performance in terms of accuracy of 94.734%. The proposed system was tested on ENTERFACE'05 database and real time video. For Video, Speeded Up Robust Features (SURF) and Gabor features are used.

Keywords- : Emotion recognition; Support Vector Machine (SVM); prosodic features; SURF and Gabor Features; Extraction of energy contour; Extraction of pitch contour

1. INTRODUCTION

Emotion theory is related with organization of some aspect of human behavior or performance [1]. It enables us to make predictions about the behavior or performance. Components of emotion include (i) Cognition (ii) Physiological (iii) Expressive (iv) Motivation and (v) Feeling. Recently, emotion recognition in human - computer interaction studies (HCI) is one of the topics that researchers are most interested in. To have a human like interaction, machines should be trained in such a way that it can identify the faces and recognize the emotions. During the training process of a machine the main challenge comes during the natural interface with the user. ER is very important because the meaning of the message can be altered by the emotions. Emotions are transparently identified from the face, body gestures, sound, and intensity of the voice. Hence, researchers have started to shift their studies toward spontaneous facial expression by fusing the speech expressions [2-4]. The fusion of features is performed either at the decision level or before classification. Multimodal approaches by combining the mode of interactions results in enhancing the understanding level and results in an efficient ER system in terms of better performance and robustness.

The summary of this work is prearranged as follows. Section II deals a review of related works and methodology used in this work. The proposed work is also presented in this Section for facial ER system, Speech ER system and multimodal system.: Section III deals the Results and discussions, and final section concludes the paper.

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2 MATERIAL AND METHOD

2.1 Related Works

Emotional expression is one of the basic expressions of the human. It motivates an action by adding a meaning and richness to the human experience. Basic emotional theory states that almost all ER system works on the universal emotions. However, in majority of real-life situations the system fails as it is different from the acted emotions. Existing studies about ER systems from video are discussed in this section which includes following dimensions (i) facial system, (ii) acoustic system and (iii) combined facial and speech system.

2.1.1 Facial ER system

Few other works using facial ER system employed methods such as optical flow technique[4] [5], [6][7], appearance model [8] and local parameterized models [9]. OF is also used by Rosenblum [10] [11] [12] to measure the facial region with Radial Basis Function (RBF) network as a classifier. Otsuka and Ohya [11] [13][14] used the OF to calculate the 2D Fourier transform coefficients which is applied to Hidden Markov Model (HMM) to classify the expressions [17].

2.1.2 Multimodal ER system

Extensive research was performed based on ER by using either facial or speech features in the past, now the researchers have moved towards fusion of audio and visual data for an efficient ER system.

Decision level fusion [23] separatelymeansevery unimodal structure and combines the result at the end. For predicting the emotions effectively two unimodal systems are shared at the better dimension using facial, acoustic, facial, features. Few other studies were made on emotion recognition using facial features [24-25], speech features [26-29] and with combining both features [30-33]. Based on the above studies, it is observed that design of a multimodal system has significant advantages in enhancing human machine interaction. With this motivation, fusion of features (facial and speech) is attempted in this work to enhance the human-machine interaction. The proposed system in this study with the fusion of facial and spectral features is providing better results in terms of accuracy. The details are elaborated in the next sections.

2.2 Methodology

In this work, a multimodal scheme for programmed ER is proposed. Figure. 1 depicts the whole process of machine learning emotion recognition used in this study. The stages include (i) Obtaining emotional face and speech database (ii) Feature selection and extraction (iii) Classification. Initially, two unimodal systems are developed by exploring the facial and speech features. The description of these features is elaborated in the following sections. Datasets used is ENTERFACE'05 database. In addition, the developed system was tested with real time video data.



Figure. 1 Machine learning approach for emotion recognition system

2.2.1 Feature Extraction

2.2.1.1 Prosodic Features

One of the significant features of the speech is the energy contour. It is used to differentiate the unvoiced region and voiced region of the speech. Vowel sound mainly serves high energy contour. Since speech signal is stationary in nature, it has to be segmented by multiplying with a window function. Most preferred window for segmenting is hamming window because it gives the higher weight to middle samples. After segmentation, squaring is done which yields the energy signal. These energy values are plotted against the time domain to get the energy contour. Fundamental frequency of the speech signal is referred as pitch. Pitch contour mainly refers to a curve that track the pitch in a given speech signal. It includes variety of sounds utilizing multiple of pitches and also relate to the frequency function at one point to a later point. Resonance frequency of human vocal tract is referred to as formant.

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2.2.1.2 Spectral Features

Spectral features are mainly used to capture the information based on movement of articulate, shape and size of vocal tract. In the proposed work, MFCC features are used to extract the emotional information. They are the coefficients of Mel Frequency Cepstrum which is derived from power spectrum. In this work for each audio file 13 coefficients are derived. After taking the mean and variance of these coefficients it is fed into the feature extraction part.

2.2.1.3 Gabor Features

Properties of image are mainly defined by the features extracted out of it, which is then used for the identification of the image in next phase. Gabor filters are used in this work to extract the features with 5 scales and 8 orientations [34, 35].

Gabor wavelet is defined as

$$\Psi(Z) = \frac{P_{a,b}^2}{\sigma^2} \exp[-\frac{P_{a,b}^2 Z^2}{2\sigma^2}] [\exp(iP_{a,b}Z) - \exp(-\frac{\sigma^2}{2})] \quad (1)$$

Here $z = (x, y)$ which is the input image, a denotes the orientation and b denotes the scale of the Gabor filter. $P_{a,b} = P_b e^{\phi_b}$ Where $P_b = {}^{p_{max}}/_{f^b}$ and $\phi_b = \Pi$ b/8. p_{max} gives the maximum frequency and the spacing factor is termed by f.

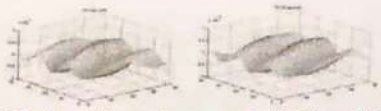


Figure 2. Real and imaginary part of Gabor Wavelet

Gabor filter mainly has two parts: the real part and imaginary part. The real part is transformed to get the magnitude feature and the phase feature is derived from the imaginary part. For every image there are 40 Gabor features. Computation of Gabor wavelet features is more complex and also the redundancy is high due to the convolution of Gabor wavelet with facial images. Statistical parameters are computed such as mean, standard deviation over feature vectors to reduce the problem of computational complexity. The real and imaginary part of Gabor wavelet used is shown in Figure 2.

2.2.1.4 SURF Features

The SURF detector is based on Gaussian derivative filters which is used to locate the features. By convoluting the basis image with the factor of the Hessian (DoH) matrix (Equation 2). The metric obtained by this method is further divided by the Gaussian's variance, σ^2, to normalize its response:

$$DoH(x, y, \sigma) = \frac{G_{xx}(x, y, \sigma).G_{yy}(x, y, \sigma) - G_{xy}(x, y, \sigma)^2}{\sigma^2} \quad (1)$$

$$\text{where } G_{ij}(x, y, \sigma) = \frac{\partial N(0,\sigma)^2}{\partial i.\partial j} . \text{image(x, y)} \quad (2)$$

By blurring the image the Gaussian filters are removing the noisy data, hence many feature detection schemes rely on Gaussian filter. SURF beats the existing techniques in terms of fast performance, robustness, repeatability, and distinctiveness. The algorithm mainly has two parts (i) Detector and (ii) Descriptor. Key point in the input image is located by the detector whereas feature extraction and the construction of the feature vector are performed by descriptor. For detecting the key points it is necessary to construct the scale space which is commonly a pyramid scale space. For describing the features of key points SURF uses the response of Haar wavelets. These wavelets are preferred because of its robustness and less computation time. In order to extract the descriptor, first step is to construct a square region which is centered at the key point. This region is then split into smaller sub-region, and every sub-region response of Haar wavelet is computed. To obtain the first entries of the feature set, wavelet responses are summed up, and for the intensity changes absolute values of the responses are calculated. The results of the SURF features extracted for the ENTERFACE'05 database is shown in Figure 3.

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Figure.3 Extracted SURF features

For classification SVM is used in this work which is a classification prediction that use theory space of a direct roles in a extraordinary dimensional feature vector [36]. Using SVM, it is possible to map linearly non-separable features into linearly separable filters[37]. In this work, RBF kernel and polynomial kernels were used and the results are compared. The next section elaborates proposed methods for ER system using facial features, acoustic features, and combined features.

2.3 Description of proposed multimodal system

2.3.1 Facial Emotion Recognition System

The projected work for the facial feeling recognition is depicted in Figure 4. Three key points in the facial ER systems are detecting the face, extracting feature and the classification. The response given to the detection stage in the shape of an image, so that the video input data is converted into frames.

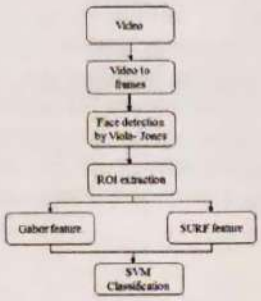


Figure 4. Proposed system for Emotion Recognition using facial features

Then, this algorithm [38] is used over every framework to get the region of interest. The output of the face recognition and the ROI detection is shown in Figure 5.



Figure 5 Face recognition and ROI detection [23]

In the next stage, Algebraic features cruel and standard deviation were calculated for respectively responses of the Gabor filter. Next SURF features are extracted from the entire face. To lessen the dimensionality dilemma, mean of the features were calculated which caused in the feature vector length of 64. Classification was carried out using SVM with four different emotions: anger, disgust, fear and happiness.

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2.3.2 Speech ER system

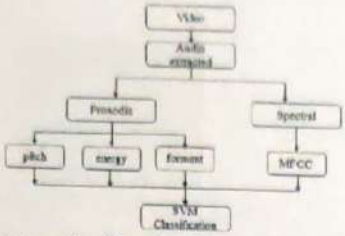


Figure .6. Proposed system for Emotion Recognition using speech features

The proposed system for emotion recognition using speech is depicted in Figure 6. Recognition of emotion from speech, spectral and prosodic features is employed. Studying the spectral behavior, MFCC is explored while pitch, energy and formants are utilized to find the prosodic information which is shown in Figure 7.

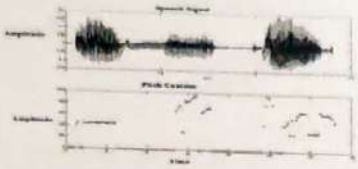


Figure 7. Extraction of Pitch Contour

2.3.4 Extraction of energy contour

Next feature extracted is the energy contour, and the steps for extraction are described in Figure 8. The dissimilar steps in discovery the frequency are given below (i) Pre-emphasize of input speech signal and normalization to 1 and -1 amplitude (ii) Segmentate of voice signal by getting after applying hamming window (iii) Removal of DC values using Butterworth high pass filter (iv) Computation of the logarithm of the spectrum for the visibility of all the values. Based the proposed systems for emotion recognition using facial and speech features, a multimodal system can be designed as shown in Figure 10.

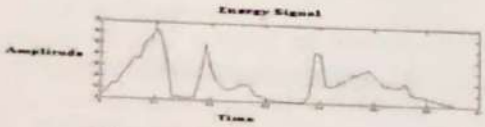


Figure 8. Energy Signal [23]

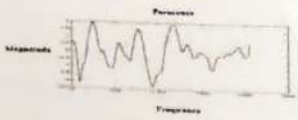


Figure 9. Formant Frequency [23]

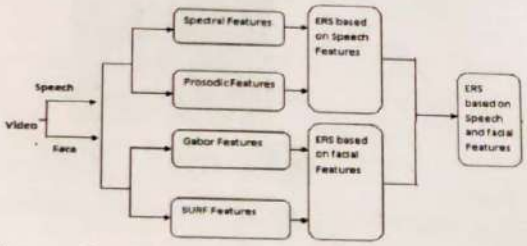


Figure.10 Proposed multi modal Emotion Recognition System (ERS)

3. RESULTS AND DISCUSSIONS

Initially face ER system was developed and two features are extracted namely Gabor and SURF. The method of extraction of these features is explained in section II. As an initial step Gabor features are stemmed from left eye, right eye and mouth and fed to the classifiers. The accuracy obtained for Gabor features by polynomial kernel is 68.42% and RBF kernel is 47.36%. As a second step, the Face system is made by SURF features. It gives accuracy as 63.15% for polynomial kernel and 47.36% for RBF kernel.

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As a third step, SURF and the Gabor features are combined which gives improved accuracy as 66.66% using RBF kernel and 90.47% using polynomial kernel. It was observed from the results that polynomial kernel outperforms well for the classification using combined features (Table. 1). Next stage after face ER system, speech ER system was developed. The MFCC features of the speech signal is extracted which yields a system with an accuracy of 63.15 % for polynomial kernel. For speech system, classification using RBF kernel is giving better results using prosodic features whereas polynomial kernel gives better results for spectral features [42]. Fusion of these features increases the overall performance of the system in terms of accuracy using polynomial kernel upto 84.21%. Table. 1 gives the accuracy of different systems and its comparison by using different kernels. From the Table 2, it was observed that the data set of DEAB is giving the highest accuracy of 94.73% compared with unimodal face and speech ER systems. The details of fusion of data considered are elaborated in Figure 11.

Table 1 Comparison of two kernels

Features	Efficiency by RBF kernel	Efficiency by Polynomial
Prosodic features	89.47%	78.94%
Spectral features	47.36%	63.15%
Prosodic + Spectral features	73.68%	84.21%
SURF features	47.36%	63.15%
Gabor features	47.36%	68.42%
SURF + Gabor features	66.66%	90.47%
Face system + speech system	89.47%	94.73%

Table 2. Accuracy results for multimodal system with various fusion combinations

Training Data	Testing Data	Face system	Speech system	Multimodal system
ABCD	E	84.21%	73.63%	89.47%
BCDE	A	78.94%	73.63%	84.21%
CDEA	B	78.94%	78.94%	89.47%
DEAB	C	90.47%	84.21%	94.73%
EABC	D	84.21%	78.94%	90.47%

Table 3 shows the confusion matrix of face system. The overall performance for this system is 90.47%. Anger, fear and happiness are correctly classified whereas the disgust is often confused with anger. Although, disgust is correctly classified by 90.42% however, almost 9.523% misclassification is happening for this emotion.

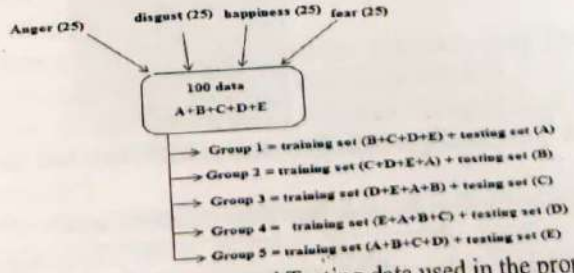


Figure 11. Combinations of Training and Testing data used in the proposed system

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Table 3 confusion matrix for face ER system

	Anger	Disgust	Fear	happiness
Anger	100%	0	0	0
Disgust	0	100%	0	0
Fear	0	0	100%	0
Happiness	5.263%	0	0	94.736%

Table 4. Confusion matrix for speech ER system

	Anger	Disgust	Fear	happiness
Anger	100%	0	0	0
Disgust	9.523%	90.47%	0	0
Fear	0	0	100%	0
Happiness	0	0	0	100%

Table. 4 shows the confusion matrix of speech system. The overall performance for this system is 84.21%. Anger, fear and disgust [43] are correctly classified whereas the happiness is often confused. Happiness is correctly classified by 84.21% but it is misclassified with anger and disgust by 10.52% and 5.26% respectively.

Table 5. Confusion matrix for multimodal ER system

	Anger	Disgust	Fear	happiness
Anger	100%	0	0	0
Disgust	0	100%	0	0
Fear	0	0	100%	0
Happiness	10.52%	5.26%	0	84.21%

Table 5 shows the confusion matrix of proposed system. The general performing for this system is 94.736%. Anger, fear and disgust are correctly classified whereas the happiness is often confused. Happiness is correctly classified by 94.736% but it is misclassified with anger by 5.623%. The three systems are then tested for real time video data set collected (Figure. 12). The two emotions happiness and anger are considered and classified by using SVM classifier. It is possible to obtain 80% accuracy using the proposed multimodal system. To increase the quality of the system, number of training data is to be increased which is the future scope of the work. The result of the real time data classification is given in Table 6. The given system is associated with the currentmethods and the results are given in Table 7.



Figure.12 Detection of ROI from real time Video

Table 6. Real time emotion classification

Speech	Accuracy
Speech system	55.55%
Face system	77.7%
Multimodal System	80%

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Table.7 Comparison with existing method

Previous Studies	Maximum Accuracy Obtained	Proposed Method	Accuracy
Face System by Gabor Features	85.71%	Face System by Gabor + SURF Features	90.47%
Speech System by Spectral Features	80.32%	Speech System by Spectral and Prosodic Features	84.21%
Multimodal system by Morphological and Spectral Features	93.62%	Multimodal System	94.73%

4 CONCLUSIONS

A multimodal framework on ER system is proposed in this work.Then a combined system was developed, and results reveal that there is a marginal improvement in the performance with 94.73%. It was observed that polynomial kernel outperforms well in the classification stage of all the proposed systems. The proposed system was tested on real time video and it is possible to obtain the accuracy of 80% which can be enhanced the quality and number of training data. Feature level fusion is employed in this work and it can be extended to physiological signals with real life scenario instead of staged performance. Gestures hear beat and skin conductivity analysis may also give a better system [39]. Using advanced machine learning techniques and using deep convolutional networks it will be possible to overcome the limitations mentioned in the proposed work [40, 41].

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Renewable Energy with IoT and Biomedical Applications

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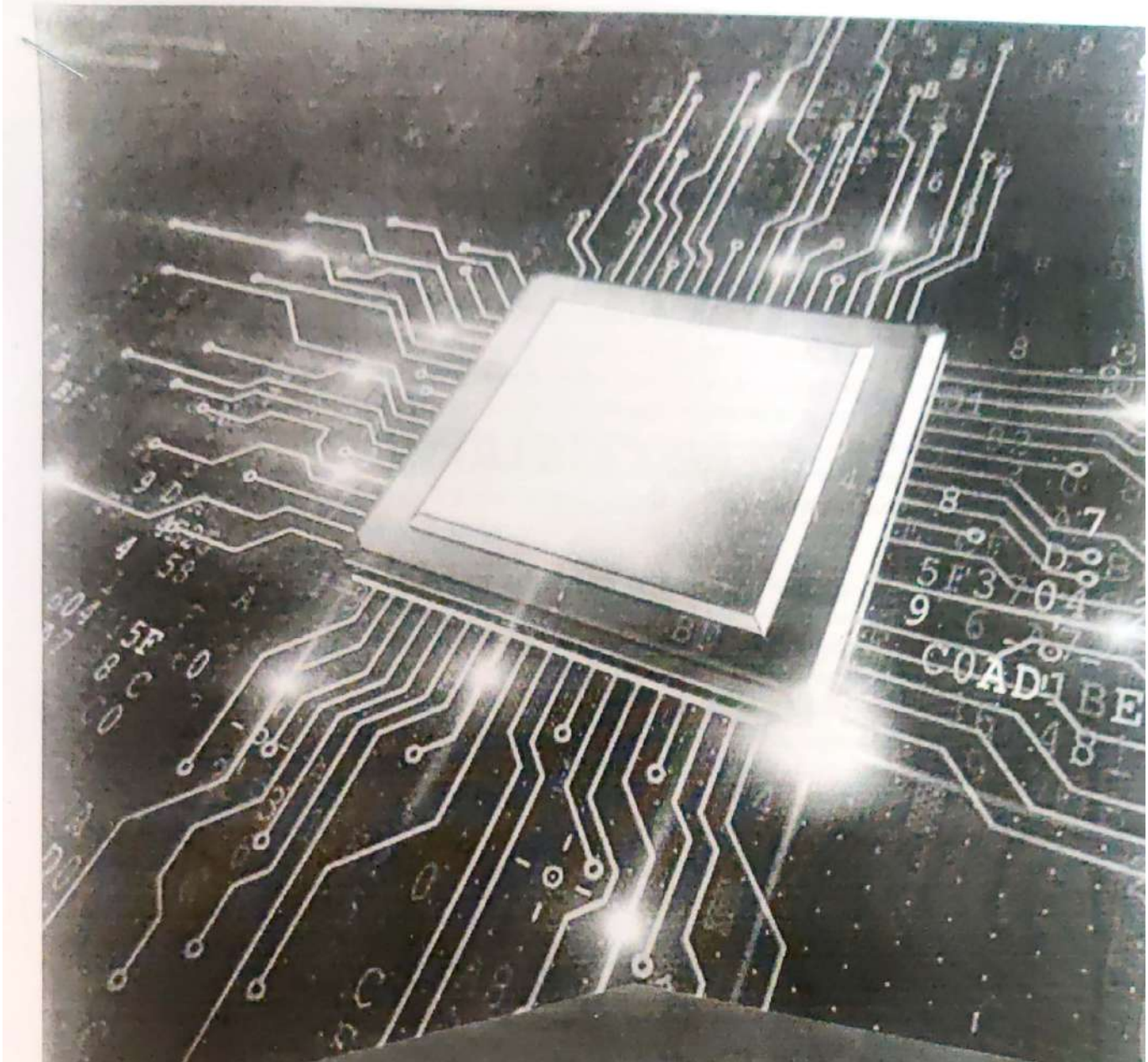
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FIRST EDITION

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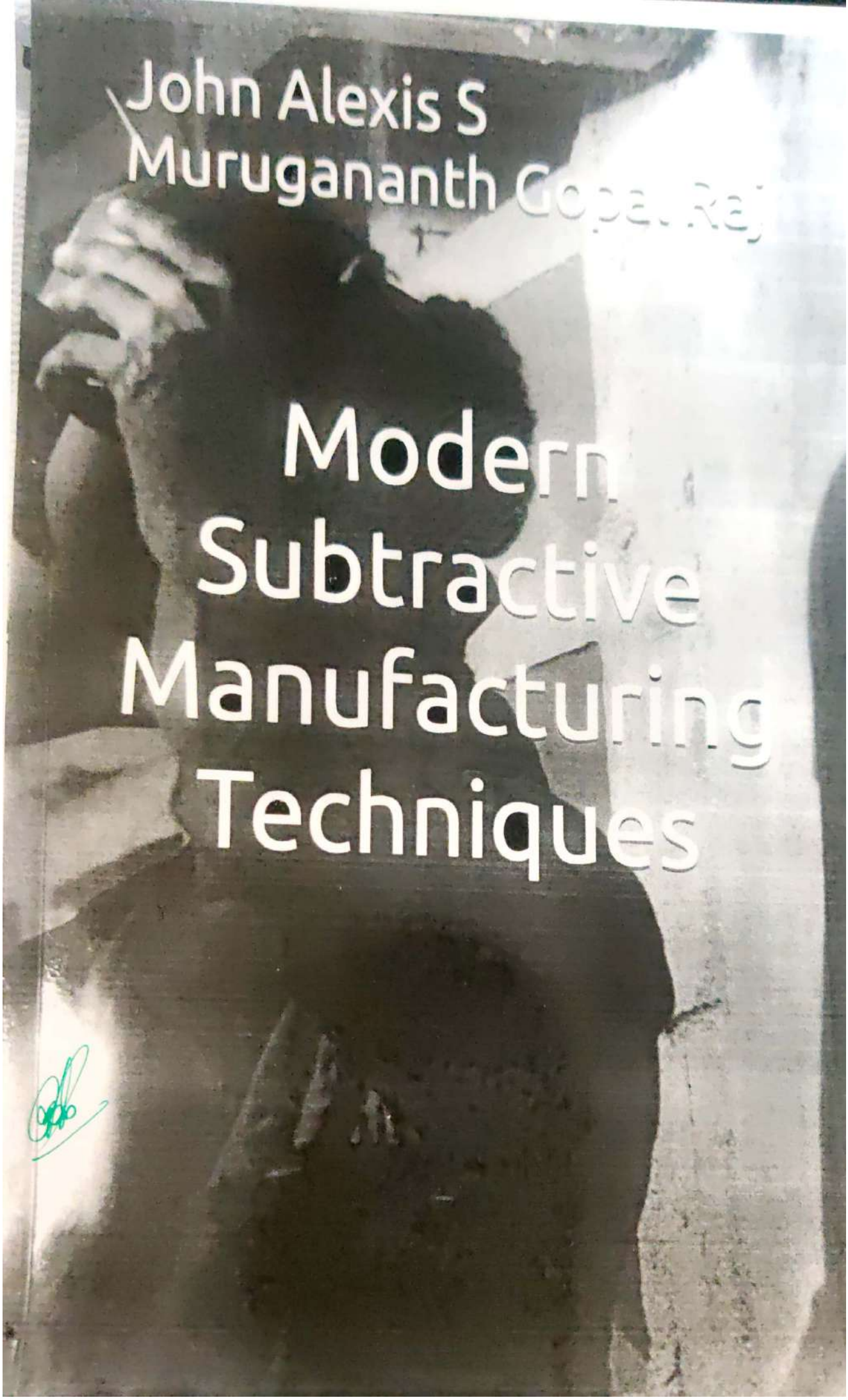


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MODERN SUBTRACTIVE MANUFACTURING TECHNIQUES

By

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Department of Electrical and Electronics Engineering

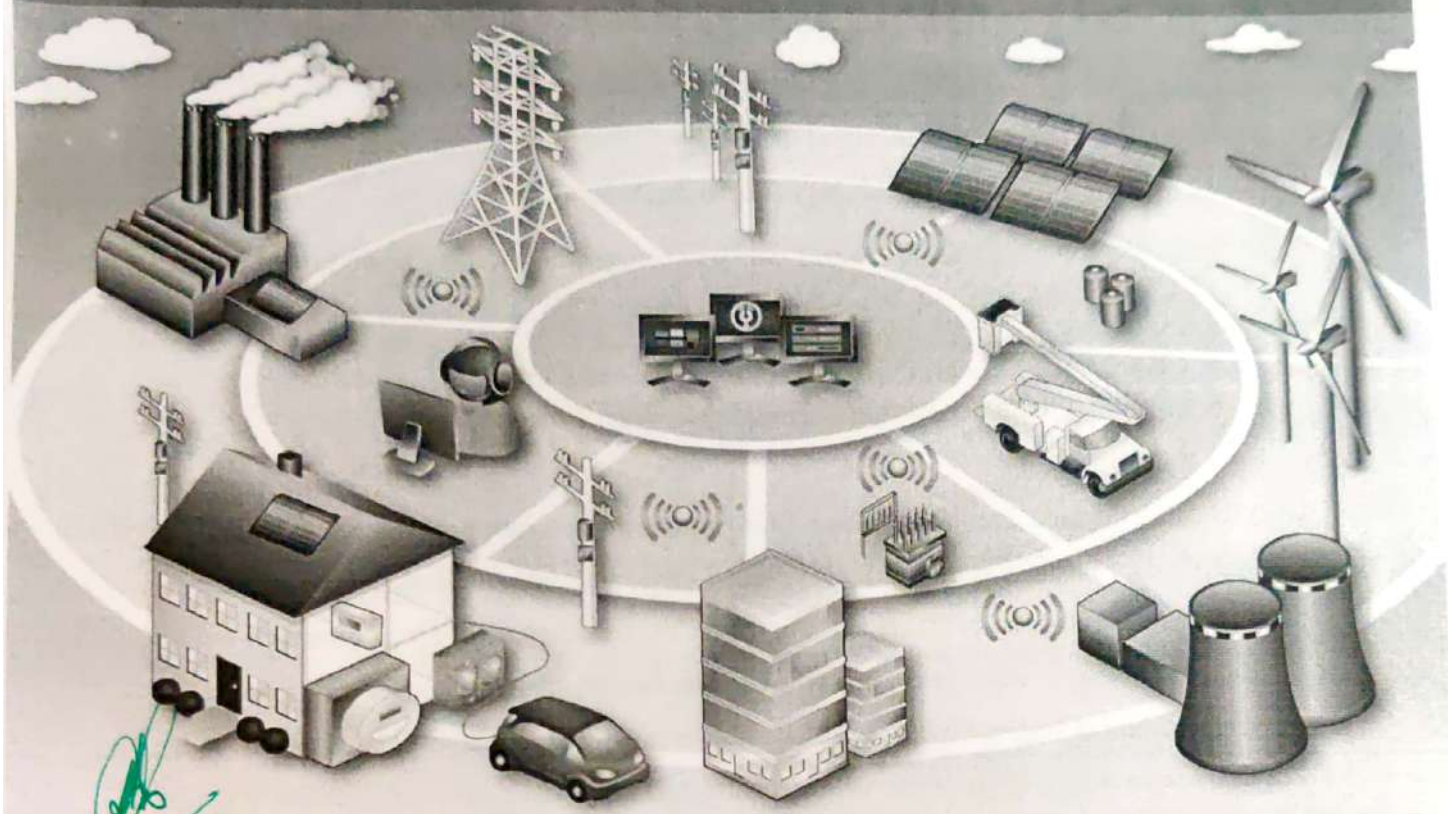
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Emerging Technologies in Engineering Research



Chapter 7: Smart Electrical Grids

Dr. Murugananth Gopal Raj
Dr. S. Arul Kumar
Dr. G. Irusapparajan
Dr. K. Karthikeyan

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SMART ELECTRICAL GRIDS

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Abstract: Smart grids are a developed grid systems which oversees power request in a manageable, dependable and financial way, based on cutting edge infrastructure and tuned to encourage the incorporation of all included. In the realm of the Smart Grid, customers and service organizations the same have instruments to oversee, screen and react to energy issues. The progression of power from utility to buyer turns into a two-way discussion. Smart grids will give greater power to fulfill rising need, increment dependability and nature of intensity supplies, increment energy productivity, can incorporate carbon free fuel sources into power networks.

Keywords: Smart Grid, Modeling, Security Challenges and Features.

I. INTRODUCTION

A Smart Grid (SG), likewise named smart electrical/power grids, intelligent grids, intelligrids, future grids, intergrids, or intragrids, are an improvement of the twentieth century power grid. The customary force grid is commonly utilized for conveying power as of a couple of focal generator toward an enormous amount of clients otherwise consumers. Interestingly, the Smart Grid utilizes two path streams of power as well as data for making a robotized also appropriated progressed energy conveyance networks.

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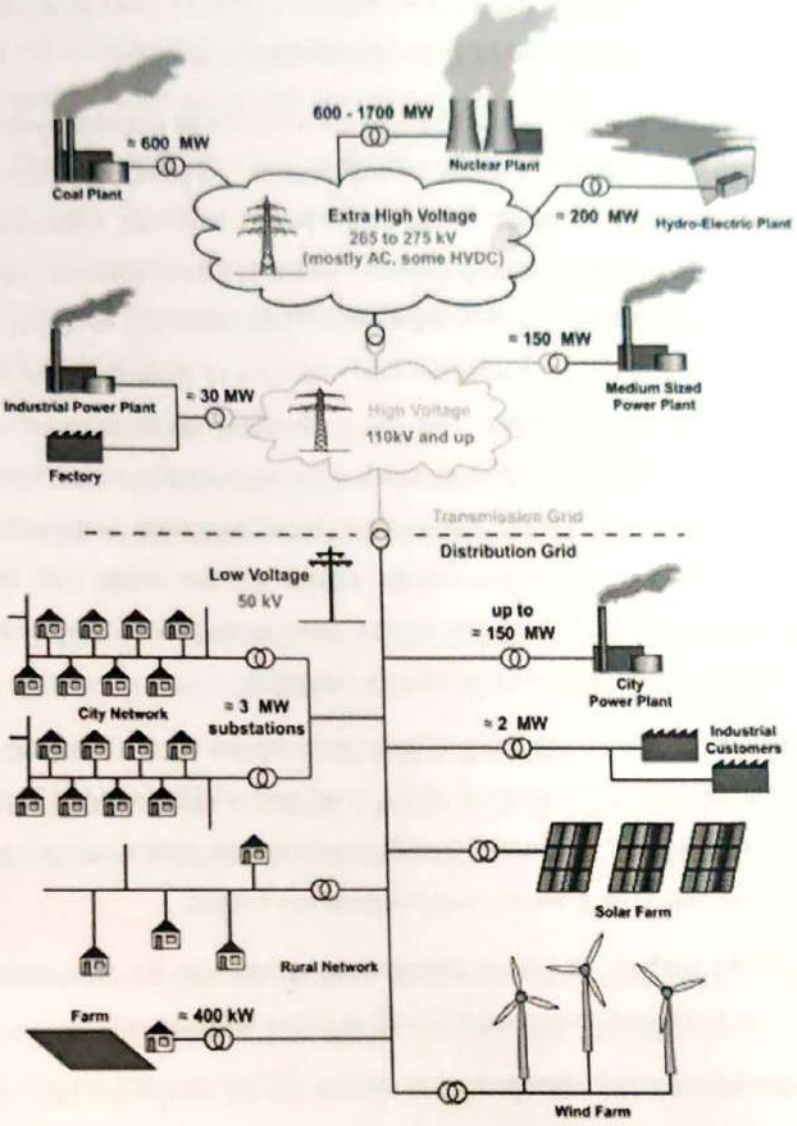


Figure.1: Smart Electrical Grid System

With the help of existing year's information innovations, the smart grids are equipped to convey power into additional effective manners as well as react toward wide extending condition as well as occasion. Broadly articulated, the smart grid can receive occurrences which happens anyplace within the grids, for example, control period, broadcast, circulation, and consumption, furthermore receive the linking procedures. For instance, when an average voltage transformer

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disenchantment occurrence takes place into the dispersion grid, the smart grid might naturally alter the force streams also recuperate the force transportation administration.

To a greater extent explicitly, the smart grid is observed like an electrical system which utilizes information, two-way, digital secured communication progress, furthermore computable approaching into an integrated manner across control period, broadcast, substation, dispersions as well as consumption for accomplishing a system which has been spotless, protected, secured, dependable, stronger, effective, as well as sustainable. These portrayals cover the entire collection of the energy system as of the age toward the final intentions of consumption of the power [1]. A perfect smart grid has been a dream. This has a liberated reconciliation of correlative part, subsystem, capacity, as well as administration below the unavoidable power of profoundly astute management as well as power systems. Known the tremendous outlook of the smart grid research, various scientists might communicate various visions of the smart grid due to different concentrations also viewpoint. Taking into account these organizations, herein, let's study three significant systems into smart grid as of an expert's viewpoint:

Smart Infrastructure System: The smart infrastructure systems are the energy, information, also communication infrastructure fundamental of the smart grid which upholds 1) improved control period, transportation, as well as consumption; 2) developed information assessing, observing, as well as management; and 3) progressed communication innovations.

Smart Management System: The smart management systems are the subsystems within smart grid which provides developed management as well as power management.

Smart Protection System: The smart protection systems are the subsystems into smart grid which provides developed grid firm standard examination, disenchantment protection, furthermore safety as well as secured protection management.

II. SMART GRID MODELLING

A wide range of ideas have been utilized to demonstrate keen force grids. They are commonly concentrated inside the structure of complex systems. In an ongoing meeting to generate new

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ideas, the force grid was considered inside the setting of ideal control, environment, human perception, smooth elements, data hypothesis, microphysics of mists, and numerous others. Here is a choice of the sorts of investigations that have showed up as of late.

Bio-Systems: Power grid is identified with difficult natural system into numerous different settings. During some investigation, power grid was contrasted with the dolphin's informal community [2]. Such animals smooth out or strengthen communication if there should arise an occurrence of a bizarre circumstance. The intercommunication which empowers themselves for enduring is profoundly intricate.

Random Fuse Networks: Into permeation hypothesis, irregular circuit network is contemplated. The existing thickness may be excessively lower into certain regions, also excessively solid in others. The examination can hence be utilized to streamline possible issues in the network. For example, rapid PC examination can foresee blown circuits and right for them, or investigate designs that may prompt a force blackout [3]. It is hard for people to foresee the drawn out examples into difficult network, thus circuit otherwise diode's network is utilized.

Smart Grid Communication Network: Simulator is utilized for recreating/copying network's communication impacts. These ordinarily include creating a laboratory by the SG gadgets, application and so forth through the virtualized networks been given with the network's test system [4].

Neural Networks: Neural network (NN) is believed to have control grid administration too. Electrical force system is arranged into various manners: non straight, active, distinct, otherwise arbitrary. Fake Neural Network (ANN) endeavors toward settle the majority troublesome of such issues, the non direct issues.

III. SECURITY CHALLENGES

A smart grid is an enormous scope system which extends since a force age workplace toward each particular force overwhelming gadgets, such as, house apparatus, personal computer, as well as telephones. Such huge scope character enlarged the possible results of far off activity of

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intensity management as well as appropriate system. By energy being a superior quality, assuring safety beside robbery, misuse, as well as malevolent work outs within a smart grid has been a major issue.

The complexities of assuring network protection within a smart grid have been different in character due to the mixed variety of the components as well as the configurations through which smart grids have been conveyed. Transmitting a smart grid with no firm as well as industrious safety measure permits developed digital attacks remains undetected, that can inevitably bargain the entire system [5]. Lacking safety measure could likewise bargain the strength of the grids through presenting this to, for instance, effectiveness extortion, thrashing of private client data as well as power-utilization information [6].

The digital protection goals are arranged to accompany 3 classes [7].

Honesty: Protecting against the unapproved alteration or annihilation of data. Unapproved data access opens the entryway for misusing of data, prompting mismanagement otherwise misuse of intensity.

Secrecy: Protecting safety as well as restricted information by approved constraints on data access and divulgence.

Accessibility: Ensuring convenient and solid admittance toward information also administration. It's been undermined through disturbance of admittance for information which subverts the force transference.

Accessibility as well as honesty has been the major significant safety destinations in the SG as of the viewpoint of system firm feature. In any case, because of the systems collaborations through customers, the importance of classifications are additionally developing into these two-manner data communication system which interrelates the entire system together with meter, gatherers, communications network, also efficacy server ranch [5].

Smart grid security component ought to be upheld at a few levels together with physical as well as intelligent layer [5]. Truly, SG system as well as part should be made sure about as of hurt,

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treating, burglary, defacing, and damage. Instances of physical layer's safety incorporate establishment of barrier, visual reconnaissance, as well as ready systems. Safety within the sensible layers manages ensuring the advanced information. Into [5], a point by point conversation on sensible layer's safety instruments is introduced; a couple of this is featured underneath.

- **Encryption:** information encoding within SG, as of meters toward service focus, has been a valuable apparatus for forestalling sneaking around, subsequently shielding the classification of data. Solid however dynamic calculation is utilized; nonetheless, the entire SG gadgets, such as, meter, gatherer, processor, as well as switch, is authorized by encrypting usage ability.
- **Authentication:** This has the method toward validating such as a customer otherwise substances are, for sure, equivalent to been assured. SG application should consist of solid verification abilities, for recognizing as well as discharge unauthorized association among its fragments, for instance, meter and the service interface.
- **Application Security Controls:** Smart meter application ought to be planned as well as coded properly so that cybercriminals can't get to a meter to mount support flood attacks otherwise for installing an attack. Data authorization has been a scenario of methods which is been utilized.
- **Security Patches:** It could shield an application from known dangers; consequently, codes ought to be remained by the most recent safety patch.
- **Malware Removal:** Use of anti-virus as well as anti-spyware programming all with the smart grid application could assist with distinguishing as well as eliminating malwares as of the system.

Assuring digitalized protection into SG requires nonstop monitoring with the goal where several possible assaults are recognized within occasion furthermore appropriate shifts are done quickly. In addition, verifying several SG boundaries could assist distinguishing some dubious otherwise strange actions. Moreover, comprising fast rebuilding arrangements are also significant.

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IV. SMART GRID FEATURES

SG signifies the complete set-up of flow as well as projected responses toward the complexities of control flexibly. In view of the differing scope of variables, it has various competing systematic classifications furthermore no indulgence to complete definitions. All things considered, one potential order is given here.

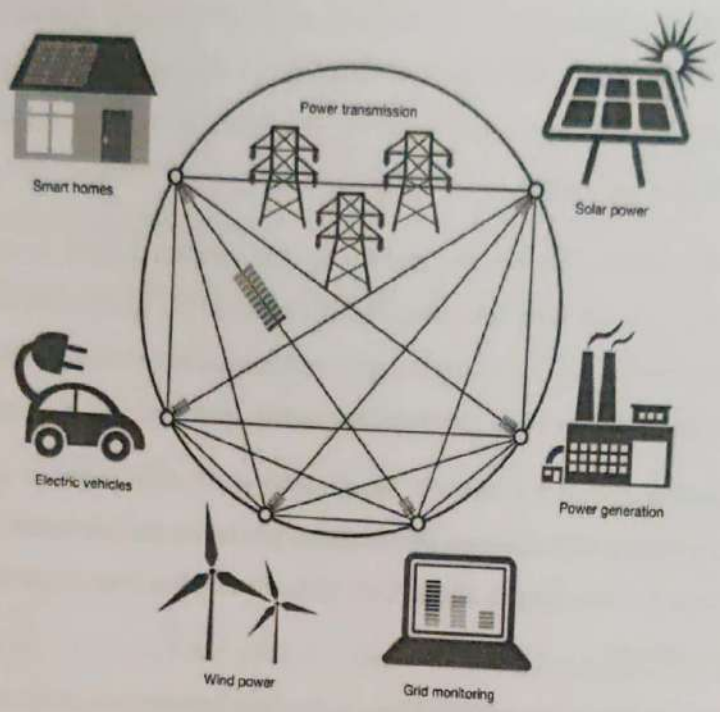


Figure.2: Features of Smart Electrical Grid

Reliability: SG utilizes improvements, such as, state assessment [8], which improves flaw recognition as well as permits its own improving of the network exclusive of the intercession of specialists. It guarantees additional firm gracefully of authority, as well as reduced limitation toward catastrophic events otherwise assaults. Albeit various courses have been promoted like an element of the SG, the older grids additionally emphasized several lessons. Starting electric wires within the grid had been manufactured using spiral models, afterward accessibility had been guaranteed through numerous lessons, proposed like a network configuration. In any case, it did

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several other issues: when the existing streams otherwise associated impact upon the network beat the restrictions of a particular network element, this can fizz, furthermore the existing is moved toward further network elements, so that during the long-term might flop as well, causing a domino impacts. Observe power shutdown. A method toward forestall which load sheds through engineered power outages otherwise voltage decreases.

Adaptability in Network Topology: Next-age broadcast as well as conveyance infrastructure is healthier organized for dealing with possible bi-directional energy stream, considering disseminated age, such as, as of photovoltaic board upon construction rooftop, yet as well charge to/from the battery of electrical vehicles, wind-turbine, siphoned hydro-electrical force, the utilization of power devices, as well as several basis. Exemplary grid has been proposed on behalf of single direction streams of power, however as it was with the aim of a neighborhood sub network produces additional force compared to its disbursing, the converse streams could increase comfort as well as firm feature concerns. A SG intends toward deal with such circumstances [9].

Effectiveness: Numerous commitments to in general development of the productivity of power infrastructures have been foreseen as of the organization of SG innovation, specifically together with request area administration, for instance killing forced air systems in transient spike into power value, decreasing the voltages while conceivable upon circulation line by Voltage/VAR Optimization (VVO), wiping away truck-shifts of meter peruse, furthermore lessening truck-shifts through improved collapse management using data as of Advanced Metering Infrastructure systems. The common impacts are less repetition within broadcast as well as appropriation line, also further notable use of generator, urging low power cost.

Manageability: The improved flexibility of the smart grid certifies further significant infiltration of profoundly factors sustainable power source, such as, sun oriented force as well as wind power, yet exclusive of the extension of energy accumulation. Existing network infrastructure isn't worked to consider many disseminated input concentrates, also normally despite of whether several inputs are allowed on the nearby (scattering) levels, the broadcast-level infrastructure could not oblige this. Rapid changes during disseminated age, such as, due to overcastting otherwise windy

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climates, present noteworthy complexities toward control engineer and they should warranty firm force level by fluctuating the yields of the additional manageable generator, as, gas-turbine also hydro-electric generator. Smart grid innovations have important criteria to several of inexhaustible powers upon the grids consequently. It's been likewise upholding vehicle-to-grid.

Market- empowering: The SG considers organized communications among providers (its power cost) also buyers (its readiness to-compensate), as well as allows equally the providers plus the purchasers should further adaptable along with complex during its functional procedures. Just the basic burdens should address the pinnacle energy costs, and purchasers will have the option for further vital into while it uses power. Generator through more prominent adaptability would have the option for selling power deliberately to greatest benefit, while unbendable generators, for example, foundation-load steam-turbine as well as wind-turbine would get a changing levy dependent fair and square of interest and the status of different generators right now working. The general impacts are a sign which grants power productivity as well as power utilization which has been delicate toward the instant-shifting constraints of the flexibly. On the homegrown levels, apparatuses through levels of power stockpiling otherwise warm gathering, (for example, fridges, heat bank, as well as warmth siphons) are all around put toward 'plays' the advertise as well as aim to limit power rate through adjusting request toward the cheaper power uphold times. It's an expansion of the dual levy power estimating referenced previously.

V. CONCLUSION

Herein, numerous aspects of the smart electrical grid are conversed so as to incorporate modeling, safety challenges as well as features of novel grid element. The SG has a huge, interconnect systems through numerous novel as well as rising parts also application, that needs a careful examination upon the interoperable concerns too. Plainly, various specialized difficulties as well as concerns related to successful as well as safe communications also data handling have to be settled prior to understanding the idea of a smart power grids.

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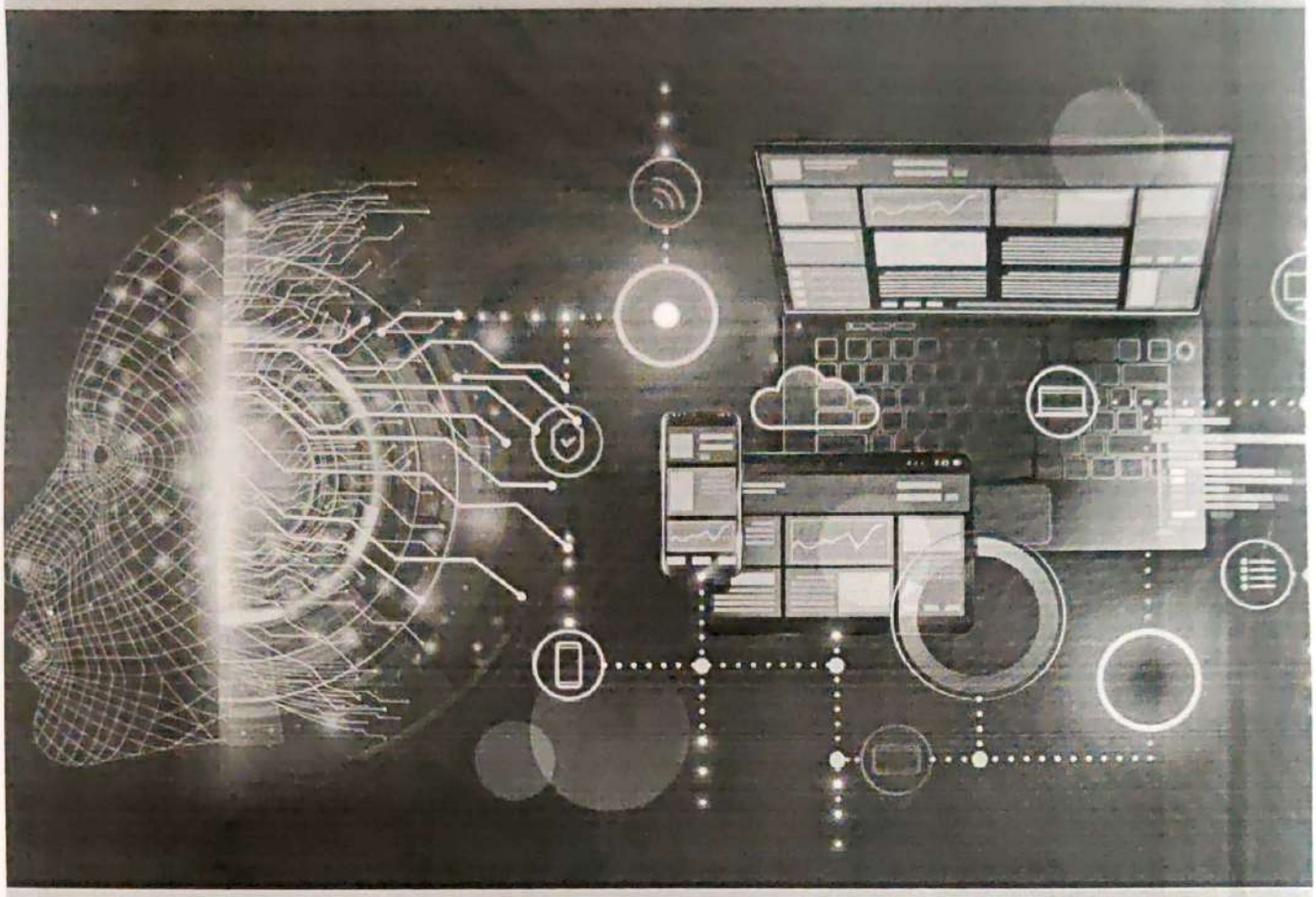
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Emerging Technologies in Engineering Research



Chapter 11: Deep Learning

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R. Kanimozhi
Dr. A. Anushya
Dr. Amanpreet Kaur

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DEEP LEARNING

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Abstract: A Deep Learning has been a category of machine learning (ML) that accomplishes strongly preferable on amorphous information. Deep learning strategies have been outflanking existing ML procedures. This empowers computation model for gaining includes continuously as of information by different stages. The prominence of deep learning enhanced since the measure of information accessible expanded just as the headway of equipment that gives incredible PCs. This chapter involves the development of deep learning, different ways to deal with deep learning, designs of deep learning, strategies, and applications.

Keywords: Deep Learning, Machine Learning, Artificial Intelligence and Neural Networks.

I. INTRODUCTION

Deep learning as well recognized like deep structured learning; it has been important for a more extensive group of ML techniques dependent upon artificial neural networks (ANN) with portrayal learnings. Learnings are administered, semi-administered otherwise unsubstantiated [1-3]. Deep learning has been a class of ML calculations which uses numerous coats toward reasonably separate more elevated level highlights as of the rudimentary data. For example, during

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image preparing, junior layer might identify boundaries, whereas higher layer might differentiate the concepts related toward a humanoid, e.g., numbers otherwise letters otherwise face [4].

Mainly present-day deep learning model depend upon ANNs, obviously, Convolutional Neural Networks (CNN)s, while it could similarly integrate propositional calculations otherwise inactive factors collected layer wise into deep propagative model, e.g., the hub within deep conviction networks also deep Boltzmann machine [5].

During deep learning, every level figures out the way to alter their data to a marginally additional active also complex representation. During a image acknowledgment applications, the rudimentary data is a network of pixel; the primary reliable layers might digest the pixel also encrypt boundaries; the subsequent layers might build also encrypt courses of action beyond boundaries; the 3rd layers might encrypt a nose as well as eyes; and the 4th layers might notice such as the image have a face. Critically, a deep learning cycle could understand that highpoints toward preferably allocate whichever levels all alone.

The word "deep" within "deep learning" refers towards the amount of layer whereby the data has been altered. Especially, deep learning framework has a generous credit assignment path (CAP) perspicacity. The credit assignment path has been the shackle of variations as of contribution towards yield. Covers portray perhaps fundamental association among info as well as yield. Aimed at a feedforward neural network, the perceptiveness of the credit assignment path has been a network also the amount of covered layer as well as one (since the yield layers are furthermore defined). Towards repetitive neural network, where a sign might engender by a layer above once, the credit assignment path profundity has been conceivably boundless [2]. Not one all-around endless supply of profundity partitions narrow learnings as of deep learning, though furthermost scientists agree such as deep learning comprises credit assignment path profundity higher compared to two. Credit assignment path of profundity two is established to be a widespread approximator since this could replicate somewhat capacity. Past that, further layers do not augment towards the capacity approximator capacity of the network. Deep models (CAP > 2)

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could separate preferred highpoints on narrow model also hence, further layer helps during learning the highlights effectively.

II. EVOLUTION & HISTORY

Deep learning has been a subcategory of machine learning, which utilizes calculations. An infant that can't talk in the absolute starting point inside a couple of eons, this gains as of the individuals everywhere. Now originates the function of the neural network that has like networks within the cerebrum [6].

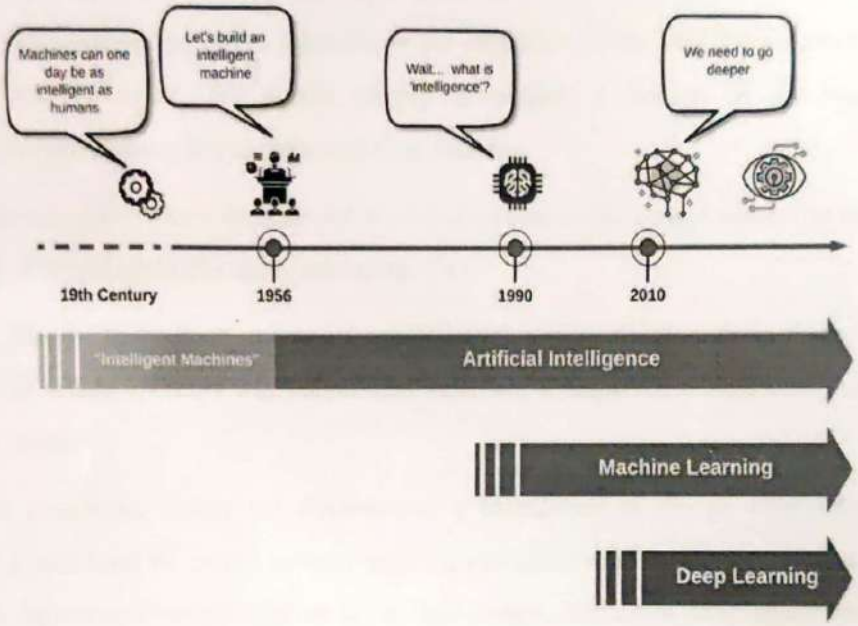


Figure.1: Deep Learning – A History

The term deep learning had been initially utilized whereas discussing ANNs by Igor Aizenberg also partners within otherwise round 2000. Deep learning has been a subcategory which utilizes different levels towards continuously separate more significant level highlights from the crude information. for instance, picture handling higher the layer expanded the idea of distinguishing proofs are applicable towards humanoid-like faces else letters bring down the layer this may recognize the boundaries as it were.

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Artificial Intelligence (AI) is a subcategory of Machine learning (ML) also it holds additional subsets and it is Deep learning (DL). DL assumes a part within ML through the neurons existing into our cerebrums. Such neuron is sorted out as layers. Various layer performs various types of changes on its information sources. An immense assortment of neural network task incorporates discourse acknowledgment, informal communication, and so forth DL had been created towards further explicit levels through the inclusion of AI as well as ML [6].

History:

This is the furthermost significant advancement into the realm of AI at the present time. Be that as it may, rather than attempting to get a handle on the subtleties of the field which could stretch this article excessively a lot. We should simply investigate a portion of the significant improvements throughout the entire existence of deep learning.

Regardless of the reality where the study of the humanoid mind has a huge number of eons old. The initial move to neural networks occurred during 1943.

In 1943: Once Warren McCulloch, a neurophysiologist, also a youthful mathematician, Walter Pitts, composed an article upon the way neuron may function. It displayed a basic neural network through electric circuit.

In 1958: Frank Rosenblatt makes the discernment, a calculation of design acknowledgment dependent upon a dual-layer PC neural network utilizing straightforward expansion also deduction. The observation figures a subjective entirety of the data sources, deducts a limit, also permits one of two potential qualities available as the outcome.

In 1980: Kunihiko Fukushima suggested the Neocognitron that has been progressive, multifaceted ANN. This is utilized in penmanship acknowledgment also further example acknowledgment issues.

In the 1980s-1990s: Deep Learning had been acquainted with the ML network through Rina Dechter during 1986. Yann LeCun's designed the machines which can peruse manually written numbers. These creations cut down underneath the more extensive biosphere's radar. Whereas the

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calculation functioned also this involved preparing for 3 days. Now, once the subsequent Artificial Intelligence winter started, that additionally affected examination of neural networks also Deep Learning. Different excessively idealistic people had overstated the "quick" capability of Artificial Intelligence, breaking desires, and enraging financial specialists. Fortunately, a few people kept on chipping away at Artificial Intelligence also Deep Learning, besides several critical developments had been completed. During 1995, Dana Cortes as well as Vladimir Vapnik built up the help vector machines.

Sepp Hochreiter also Jürgen Schmidhuber distribute an achievement article upon "Long Short-Term Memory" (LSTM). This is a kind of Recurrent Neural Network engineering which would proceed towards change DL for a long time to arise.

In 2006: Geoffrey Hinton, Ruslan Salakhutdinov, Osindero, also the inside and out distributed the article. A quick learning calculation of deep conviction nets where it loaded various information bases collected into layer also termed it as Deep Belief Networks. The preparation cycle has been significantly further proficient towards a lot of information.

In 2008: Andrew NG's gathering next to Stanford began upholding aimed at the utilization of Graphics Processing Units. Along these lines, such as it could prepare Deep Neural Network toward accelerate the preparation timing through numerous folds. It might acquire common sense the area of Deep Learning to prepare upon a tremendous capacity of information productively.

In 2009: Discovering adequate named information is consistently been a test of the Deep Learning people group. During 2009 Fei-Fei Li, an Artificial Intelligence educator on Stanford dispatched ImageNet, collected an unrestricted information base of in excess of 14 million marked pictures. This will fill in like a standard towards the deep learning analysts where one might take an interest in ImageNet rivalries consistently.

In 2012: AlexNet, a Graphics Processing Unit executed the Convolutional Neural Network models planned by Alex Krizhevsky. AlexNet won Imagenet's picture grouping challenge by an exactness of 84%. This has been an immense hop upon 75% precision as prior model had accomplished. This success causes another deep learning blast worldwide.

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In 2014: Ian Goodfellow made GAN otherwise called Generative Adversarial Neural Network which opens a totally different entryway of use of deep learning into style, workmanship, technology, and so on.

In 2016: Deepmind's deep fortification learning models blows the humanoid boss into the unpredictable round of Go. The games are substantially further unpredictable compared to chess. Subsequently, these accomplishments catch the creative mind of everybody. Likewise, this yields the guarantee of deep learning towards an unheard-of level.

In 2019: Yoshua Bengio, Geoffrey Hinton, as well as Yann LeCun gained Turing Award 2018. They had tremendously added towards progressions into the region of DL as well as AI. It had been an extremely important occasion for the individuals who had worked perseveringly on neural networks.

III. DEEP LEARNING APPROACHES

Deep neural networks have been fruitful for supervised learnings, unsupervised learnings, Reinforcement learnings, just like hybrid learnings [7].

3.1 Supervised Learning: Into supervised learnings, the information factors spoke to since X is planned for outcome factors spoke to since Y through utilizing a calculation toward get familiar with the planning capacity f.

$$Y = f(X) \qquad (1)$$

The point of the learning calculation has surmised the planning capacity toward foresee the yield (Y) to another info (X). The mistake since the forecasts completed through preparing is utilized for addressing the yield.

3.2 Unsupervised Learning: Into unsupervised learnings, it has the information just as well as not any relating out-put toward plan. These learning plans toward find out around information through demonstrating the dissemination within information. Calculations could have the option for finding the energizing assembly existing into the information. Bunching issues and affiliation issues utilize

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unsupervised learning and these calculations, for example, K-implies calculation is utilized in bunching issues [8], Apriori calculation is utilized in affiliation issues [9].

3.3 Reinforcement Learning: Reinforcement learning utilizes an arrangement of remuneration also discipline towards preparing the calculation. Herein, the calculation otherwise a specialist gains as of their current circumstance. The operator gets prizes for right execution and punishment for wrong execution. For instance, think about the instance of a self-driving vehicle, the specialist receives a compensation to drive securely for objective also punishment to go rough terrain. Additionally, on account of a plug-in to play chess, the prize stage might be dominating the match as well as the punishment for being checkmated. The operator attempts toward amplify the rewards also limits the punishment. During fortification learning, the calculation isn't advised how to play out the learning; be that as it may, it works through the issue all alone [10].

3.4 Hybrid Learning: This alludes toward models which utilizes propagative (unsupervised) just like discriminatory (supervised) segments. The blend of various structures is utilized for planning a cross breed deep neural network. It is utilized towards activity acknowledgment of people utilizing activity bank includes also relied upon for delivering strongly preferable outcomes [11].

IV. DEEP LEARNING METHODS

Few of the ground-breaking strategies which is useful for deep learning calculation for diminishing the preparation time also for improving the models have been talked about into the accompanying area.

Back Propagation: While taking care of an advancement issue utilizing a slope-based strategy, back spread can be utilized to figure the angle of the capacity for every cycle [12].

Stochastic Gradient Descent: By means of the curved capacity within slope plunge calculations guarantees finding an ideal least without getting caught in a nearby least. Contingent on the estimations of the capacity as well as learning rates else stepping sizes, this might show up on the ideal incentive into various ways also habits [13].

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Learning Rate Decay: Altering the learning rates expand the exhibition as well as lessens the preparation season of stochastic inclination plummet calculations. The general utilized strategy should decrease the learning rates step by step, where one could roll out enormous improvements toward the start and afterward diminish the learning rate steadily in the preparation cycle. This permit calibrating the loads into the advanced phases.

Dropout: The overfit issue into deep NN is tended to utilizing the drop out procedure. These techniques are executed through haphazardly falling unit also its associations in preparing [14]. Dropout provides a successful regulation strategy for diminishing the overfit also improves speculation blunder. This provides a better exhibition upon supervised learning errands into Personal Computer visualization, computation science, record order, and discourse acknowledgment [15].

Max-Pooling: Into max-pooling a channel has been predetermined, also these channels are later executed over the non-overlapping sub-areas of the info considering the maximum of the qualities confined into the space like the yield. Dimensionally, just like the computation expense for becoming familiar with a few boundaries, can be decreased utilizing max-pooling [16].

Batch Normalization: Batch normalization decreases covariation move, accordingly quickening deep neural network. This standardizes the contributions towards a layer, against every smaller than usual bunch, when the loads are refreshed during the preparation. Standardization balances out learning and lessens the preparation ages. The soundness of a neural net-work is expanded through standardizing the yield as of the past enactment layers.

Skip-gram: Words inserting calculations are demonstrated utilizing Skip-gram. During the skip-gram models, two jargon word shares a comparable setting; at that point such words have been indistinguishable. For instance, the statements "felines are warm blooded creatures" as well as "canines are vertebrates" have been significant statements that has a similar signifying "are well evolved creatures." Skip-gram is executed through taking into account a setting space holding n words and trains the neural network by avoiding one of this term and afterward utilize the models for anticipating the omitted terms [17].

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Transfer learning: During transfer learnings, models prepared for a specific assignment has been misused for additional connected undertaking. The information got whereas tackling a specific issue is moved towards additional networks, where this has to be prepared at a connected issue. It takes into account fast advancement and upgraded execution while tackling the second issue [18].

V. APPLICATIONS

DL network is utilized into an assortment of utilizations, for example, self-driving vehicles, Natural Language Processing, Google's Virtual Assistant, Visual Recognition, Fraud discovery, medical services, recognizing formative [7] delay in kids, adding sound to quiet motion pictures, programmed machine interpretation, text to picture interpretation, picture to picture blend, programmed picture acknowledgment, Image colorization, seismic tremor expectation, market-rate determining, news collection and misrepresentation news identification.

VI. CONCLUSION

Deep learning is persistently developing; even quicker, there are various issues to manage and can be settled utilizing deep learning. Despite the fact that a entire comprehension of the functioning of DL has been as yet a puzzle, one could built machine more intelligent utilizing DL, here and there much more astute compared to humans. Presently the point is to grow DL model which works by portable towards making the application more astute also cleverer. Leave DL alone further contributed to the advancement of humankind and hence forming our area a superior spot for living.

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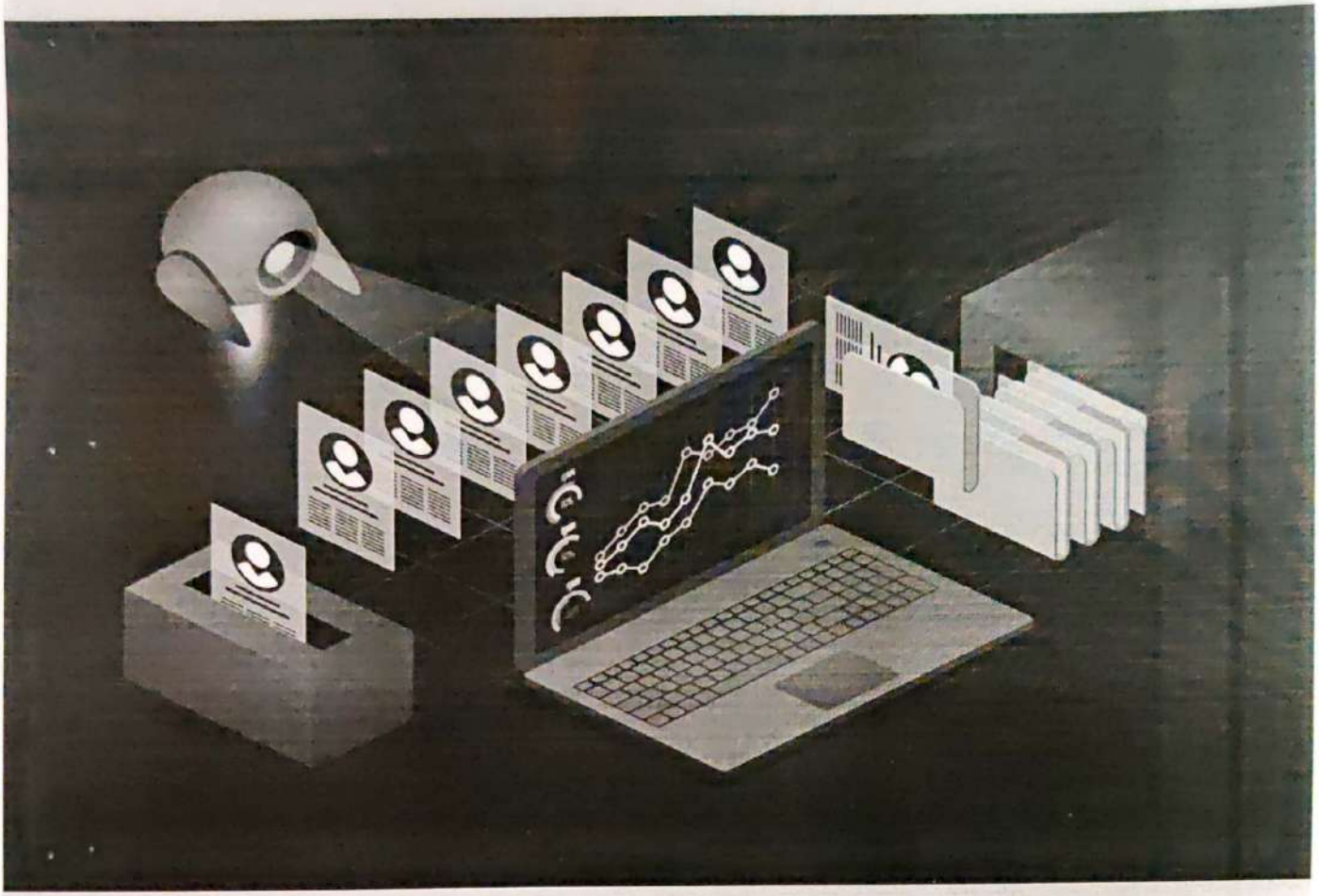
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Emerging Technologies in Engineering Research



Chapter 18: Big Data Analytics

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BIG DATA ANALYTICS

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Abstract: Recently, organization has started understanding the importance of data affability into enormous amounts towards settling upon the right selections as well as backing its methods. By the improvement of novel innovations, the Internet as well as informal organizations, the formation of hi-tech data has been constantly emerging. The word "Big Data" refers towards the varied mass of advanced data shaped by corporations as well as public whose attributes (massive volume, several structure, rapidity of formulating) need exact also gradually modern Personal Computing stockpiling as well as analysis devices. This chapter plans to characterize the plan of Big Data, its ideas, types and characteristics, just as the significance of Big Data Analytics.

Keywords: Big Data, Data Mining, Hadoop and Big Data Analytics.

I. INTRODUCTION

Big Data is frequently portrayed as amazingly huge data sets that have developed past the capacity to oversee and investigate them with customary data preparing devices. Scanning the Web for signs uncovers a practically general definition, shared by most of those advancing the philosophy of Big Data, that can be dense into something like this: Big Data [1] characterizes a circumstance in which data sets have developed to such huge sizes that ordinary data advancements can presently don't viably deal with either the volume of the datasets or the scale and development of the datasets. As such, the data set has developed so enormous that it is hard to oversee and significantly harder to collect value out of it. The essential troubles are the

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securing, stockpiling, looking, sharing, analytics, and visualization of data. There is considerably more to be said about what Big Data really is. The idea has developed to incorporate the size of the data set as well as the cycles engaged with utilizing the data [2]. Big Data has even gotten inseparable from other business ideas, for example, business intelligence, analytics, and data mining.

As analytics and exploration were applied to enormous data sets, researchers arrived at the resolution that more is better - for this situation, more data, more analysis, and more outcomes. Analysts began to join related data sets, unstructured data, authentic data, and ongoing data into the cycle, which thus brought forth what we currently call Big Data.

II. BIG DATA CHARACTERISTICS AND TYPES

2.1 Characteristics:

Maybe it is ideal to consider Big Data in multi-trademark terms, in which four qualities identify with the essential parts of Big Data. These qualities can be characterized as follows:

Volume: This represents the amount of information available – which is estimated as Gigabytes has been currently estimated as Zettabytes (ZB) otherwise Yottabytes (YB). The IoT (Internet of Things) has been making remarkable development into data. The volume of information has anticipated towards changing essentials in the future.

Velocity: This represents the rapidity where information is measure and gets accessible. It recollects the times of day-to-day groups, presently if it's not ongoing it's typically not sufficiently quick.

Variety: It represents perhaps the biggest test of big data. This tends to be not structured as well as this could integrate those countless various sorts of information as of XML towards audiovisual to SMS. Categorizing the information in a significant manner is no straightforward task, predominantly once the information itself varies rapidly.

Variability: This is hardly the similar like variety. A café might tender 6 exclusive combinations of espresso, yet on the off chance such as one gets a same combination daily also this taste

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distinctive constantly, and this shows variability. The equivalent is valid towards information, when the importance has been continually transforming this could hugely influence our information homogenization.

Veracity: It has been knotted by guaranteeing the information has been precise, that demands cycles towards shielding the terrible data as of aggregating into our framework. The utmost clear-cut model is contact which enters our endorsing robotization frameworks by bogus name as well as wrong communication information. How often have you seen Mickey Mouse in your database? It is the exemplary "trash in, trash out" challenge.

Visualization: This has been elementary nowadays. Using outlines as well as diagrams toward envision numerous multifaceted data has considerably further viable into transitory on significance compared to accounting pages as well as details stuffed by numbers plus recipes.

Value: It's the final game. Subsequent to tending to volume, velocity, variety, variability, veracity, and visualization – that consumes a ton of time, effort as well as asset – it needs certainty with the association for receiving value as of the information.

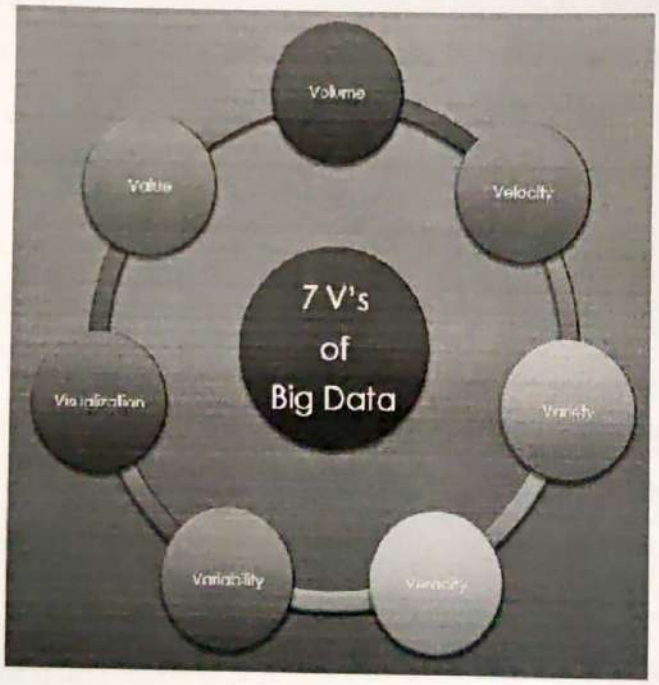


Figure.1: Seven V's of Big Data

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2.2 Types

- **Structured Data** – This represents the data that can be prepared, put away, and can be recovered in a fixed organization i.e., we can say that when data is put away and separated, it should be in a legitimate way/format.
- **Unstructured Data** – This sort of data comes up short on any structure and is put away for what it's worth. Breaking down such data is tedious just as trying.
- **Semi-structured Data** – This sort of data is a blend of the over two kinds of big data i.e., structured and unstructured data. It is otherwise called cross hybrid big data.

III. ANALYSIS CATEGORIES OF BIG DATA

A significant number of those advances or ideas are not new but rather have come to fall under the umbrella of Big Data. Best characterized as analysis classes, these innovations and ideas incorporate the accompanying:

Traditional Business Intelligence (BI): This comprises of an overall cataloging of usages as well as improvements in communal events, incarceration, investigating, also providing admittance toward data. BI conveys noteworthy data, which helps endeavor clients settle on better business choices utilizing truth based emotionally supportive networks. BI works by utilizing a top to bottom analysis of definite business data, given by databases, application data, and other substantial data sources. In certain circles, BI can give authentic, current, and predictive perspectives on business activities.

Data Mining: This is a cycle in which information is examined as of alternative viewpoint also later converted to outline information that are considered helpful. Data mining is regularly utilized with data very still or with chronicled data. Data mining strategies center around demonstrating and information revelation for predictive, instead of absolutely descriptive, purposes—an ideal cycle for revealing new examples from huge data sets.

Statistical Applications: These gander on information using calculation reliant on factual ethics also frequently emphasis upon datasets recognized through reviews, inventory, as well as

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additional constant datasets. Measurable applications preferably carry examination observations which is used towards reading inhabited datasets towards gauging, examining, as well as predictive analysis. Precise information, such as, reviews as well as exploratory detailing, has been the vital hot spot of analyzable information.

Predictive Analysis: It's a subsection of factual application where datasets have been inspected toward concoct expectations, considering pattern as well as information collected as of database. Predictive analysis will in general be big in the monetary and logical universes, where moving will in general drive forecasts, when outside components are added to the data set. One of the primary objectives of predictive analysis is to recognize the dangers and open doors for business cycle, markets, and assembling.

Data Modeling: This is a theoretical utilization of analytics in which different "consider the possibility that" circumstances are operated through computation towards various datasets. Preferably, the displayed data alters depending upon the information made available for the calculation, which then gives knowledge through the effects of the alteration over the datasets. Data displaying functions completely through data visualization, where exposing information could assist by a precise commercial try.

The first analysis classifications establish just a segment of where Big Data is going and why it has inborn value to business. That value is driven by the endless journey for an upper hand, urging associations to go to enormous archives of corporate and outer data to reveal patterns, insights, and other significant data to assist them with choosing their best course of action. This has assisted the idea of Big Data to pick up prevalence with technologists and heads the same, alongside its related instruments, stages, and analytics.

IV. ANALYTICS OF BIG DATA

Big Data by and large alludes to data that surpasses the ordinary stockpiling, preparing, and processing limit of traditional database as well as data analyzing procedures. Like an asset, Big Data needs devices also techniques which is executed towards examining also separating examples as of enormous scope information [3]. The examination of organized information

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develops because of the variety and velocity of the information controlled. Consequently, it's not, at this point sufficient for examining information also generates report, the extensive variation of information implies that the frameworks set up should be fit for aiding the analysis of information. The analyzing comprises of consequently defining, inside a variation of quickly evolving information, the connections between the information to help into the misuse of it.

Big Data Analytics refers toward the method to gather, putting together, dividing up huge data sets towards finding various instances also additional valued information. Big data analytics has a bunch of developments as well as measures which need novel kinds of joining towards revealing huge hidden values as of huge dataset which is unique in relation to the distinctive one, further unpredictable, also of a huge fabulous scope. This principally centers around taking care of new issues otherwise longstanding issues into healthier as well as successful manners [4].

Types of Big Data Analytics

Descriptive Analytics:

This comprises of requesting the inquiry: What's going on? This has been a primer phase of information handling which makes a bunch of verifiable information. Data mining strategies put together information also support reveal designs which offers knowledge. Descriptive analytics gives upcoming possibilities as well as patterns furthermore provides a thought regarding anything may occur later on.

Diagnostic Analytics:

This comprises of requesting the inquiry: Why did it occur? Diagnostic analytics searches for the main driver of an issue. This has been utilized towards deciding how come somewhat occurred. These sort endeavors towards discovering also comprehend the reasons for occasions as well as practices.

Predictive Analytics:

This comprises of requesting the inquiry: What is probably going to occur? This utilizes previous information toward anticipate what's to come. It is tied in with gauging. Predictive

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analytics utilizes numerous methods such as data mining also man-made consciousness towards investigating existing information as well as build situations of which exactly may occur.

Prescriptive Analytics:

This comprises of requesting the inquiry: What should be finished? This has been devoted towards discovering the correct move that should be made. Descriptive analytics gives an authentic information, also predictive analytics assists conjecture which exactly with occurring. Prescriptive analytics utilizes such boundaries towards locating the finest arrangement.

V. HADOOP FOR BIG DATA APPLICATIONS

Big Data is assortments of data which is viewed as monstrous, difficult to store and measure, 10 years prior. The handling of such enormous amounts of data forces specific techniques. An exemplary database the board framework can't measure as much data. Hadoop is an open-source programming item that is cooperatively created and uninhibitedly circulated through the Apache Foundation – adequately, this has been a designer's toolbox intended for streamlining the structure of Big Data arrangements [5].

Hadoop has been utilized through organizations by enormous sizes of information toward measure. Between them is web monsters, for example, Facebook, Twitter, LinkedIn, eBay as well as Amazon. Hadoop has been an appropriated information preparing also the executives framework. This comprises a large number, together with: HDFS, YARN, Map Reduce. HDFS has been a circulated record framework which gives superior admittance to data across Hadoop bunches [6].

MapReduce has been a middle segment of the Apache Hadoop programming system. Hadoop allows tough, disseminated handling of gigantic not structured dataset through item PC groups, where every hub of the bunch incorporates their personal stockpiling. MapReduce assists two basic capacities: These packages out effort towards different hubs inside the group otherwise guide, also this coordinates as well as decreases the outcomes as of every hub towards a firm response towards a question [7].

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Hadoop depends upon two servers:

Job Tracker: It has just a single Job Tracker per Hadoop group. This gets Map/Reduce task toward executing as well as arranges its implementation upon the clusters. Once presenting our programming for execution over the Hadoop group, it's the JobTracker''s duty towards assembling an implementation idea. These implementation plans incorporate defining the hubs which comprise information toward work on, masterminding hubs for comparing through information, checking executing task, also relaunching task on the off chance that they fizzle [8].

Task Tracker: A few for every group. Performs the Map/Reduce effort on its own (like a Map and Reduce job through the related information). The Job Tracker worker has in correspondence by HDFS; this recognizes where the Map/Reduce program key-in information is also where the yield information should be put away. This would therefore be able to upgrade the dissemination of tasks as per the related information.

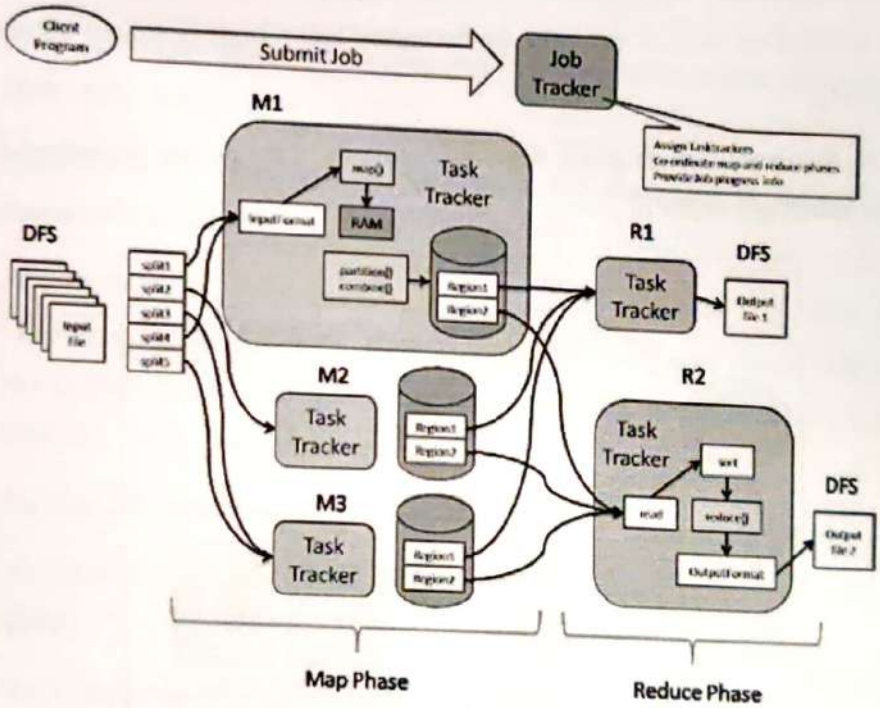


Figure.2: Hadoop Map Reduce Architecture

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For executing a Map/Reduce program, follow the below steps:

- Enter key-in information into HDFS
- Surrender the code towards the cluster's Job Tracker.
- Recover outcome information as of HDFS.

Every Task Tracker reports its position consistently over heart-beat bundles. On the off chance that a Task Tracker comes up short, the Job Tracker tells the rearrangement of the task to another hub:

Name Node: Special on the bunch. This saves data around document names also its qualities. This has been the expert of the HDFS which rules servant Data Node.

Secondary Name Node: The Secondary Name Node screens the condition of the HDFS group also acquires "depictions" of the information confined into the Name Node. In the event that the Name Node comes up short, at that point the Secondary Name Node is utilized instead of the Name Node [8].

Data Node: Numerous through group. Saves the substance of the records themselves, divided into chunks (64KB as a matter of course).

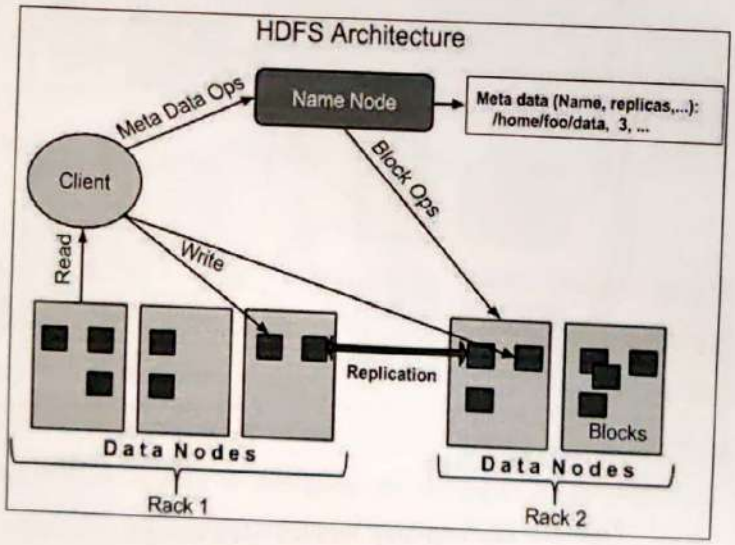


Figure.3: HDFS Architecture

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VI. CONCLUSION

Big data alludes toward the arrangement of mathematical information delivered through the utilization of novel innovations for individual or expert purposes. Big Data analytics has the way toward inspecting such information toward reveal shrouded beatings, business patterns, client inclinations as well as additional helpful data to settle on the correct choices. Big Data Analytics has been a quickly developing innovation. This is received through the utmost sudden ventures also turned into a business all alone. In any case, analysis of such information into the structure of the Big Data has a cycle which appears to be once in a while very nosy.

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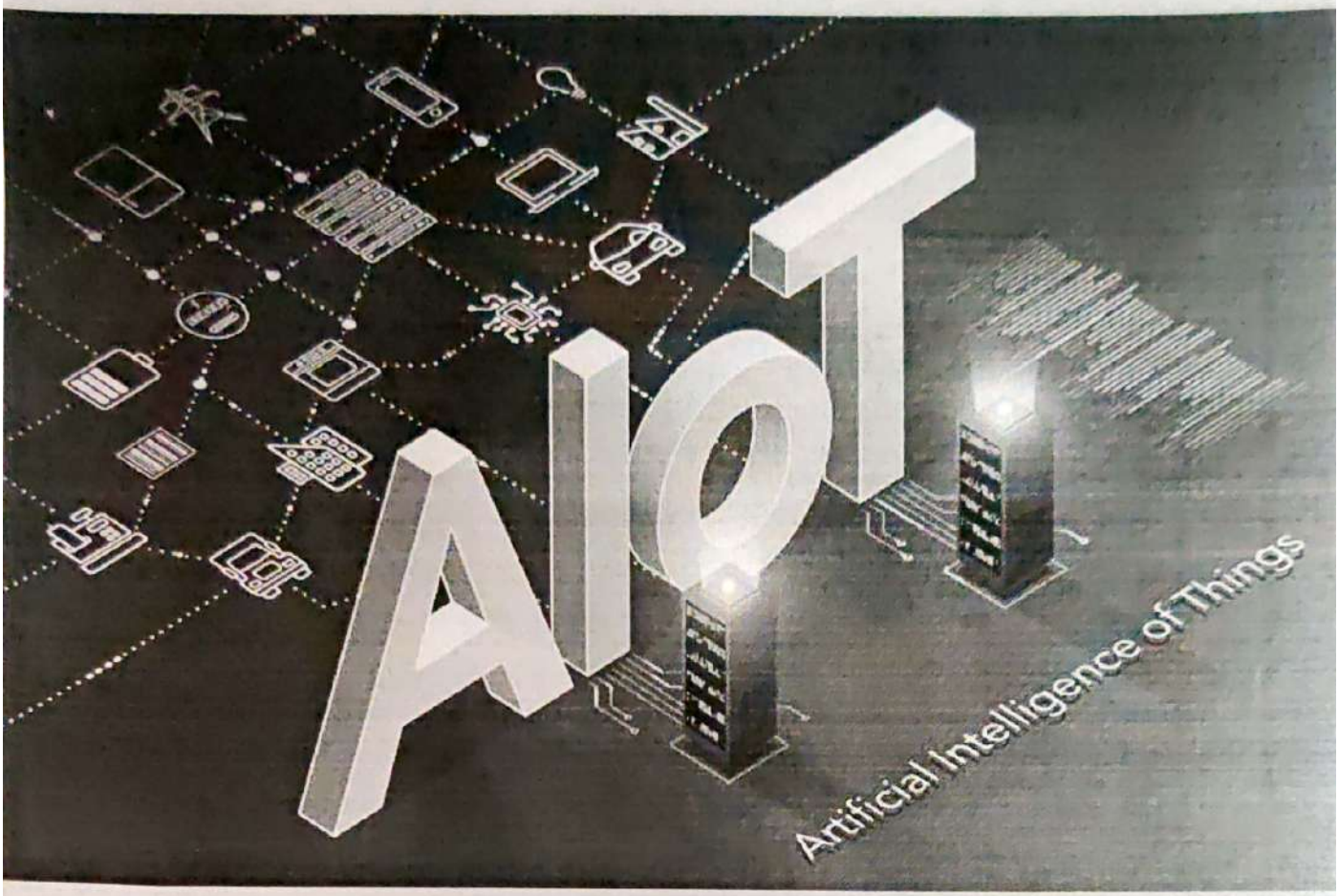
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Emerging Technologies in Engineering Research



Chapter 26: Artificial Intelligence of Things

Dr. Murugananth Gopal Raj
D. Sathish Kumar
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K. Sivasankari

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ARTIFICIAL INTELLIGENCE OF THINGS

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Abstract: The aim of the chapter provides an overview of the area of Artificial Intelligence of Things (AIoT). We will discuss the definition of AIoT, look at needs in AIoT, segments in more detail, and discuss a number of applications. Due to the nature of the subject, we cannot be exhaustive, but rather want to give a feeling for research in the combined field of Artificial Intelligence and Internet of Things.

Keywords: Artificial Intelligence of Things, Artificial Intelligence and Internet of Things.

I. INTRODUCTION

Artificial Intelligence of Things (AIoT) is a moderately new term and has as of late become an intriguing issue which joins two of the most sultry abbreviations, Artificial Intelligence (AI) and Internet of Things (IoT). IoT comprises of interconnected things with worked in sensors and can possibly generate or gather an immense measure of information. The information can be then investigated and used with AI for critical thinking or dynamic [1]. Without AI, IoT would have restricted worth. Simulated intelligence can increase the estimation of IoT; then again, IoT can advance the learning and intelligence of AI.

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In any case, there are numerous difficulties while sending AIoT practically speaking. For example, the edge figuring issues for addressing the inactivity of sending colossal IoT information in organizations and accomplishing constant reactions with superior AI for dissecting the gigantic information. Security issue is another urgent test to give wellbeing and protection in AIoT applications. AI is one of the potential advancements to be used in AIoT system insurance. Also, there are numerous different issues identified with the expanding current AIoT systems and applications. Since the blend of AI and IoT, in particular AIoT, has different possible applications in reality.

II. ARTIFICIAL INTELLIGENCE OF THINGS

The AIoT is the blend of AI advancements with the IoT foundation to accomplish more effective IoT tasks, improve human-machine collaborations and upgrade information management and examination [2]. Simulated intelligence can be utilized to change IoT information into valuable data for improved dynamic cycles, subsequently making an establishment for fresher innovation, for example, IoT Data as a Service (IoTDaaS).

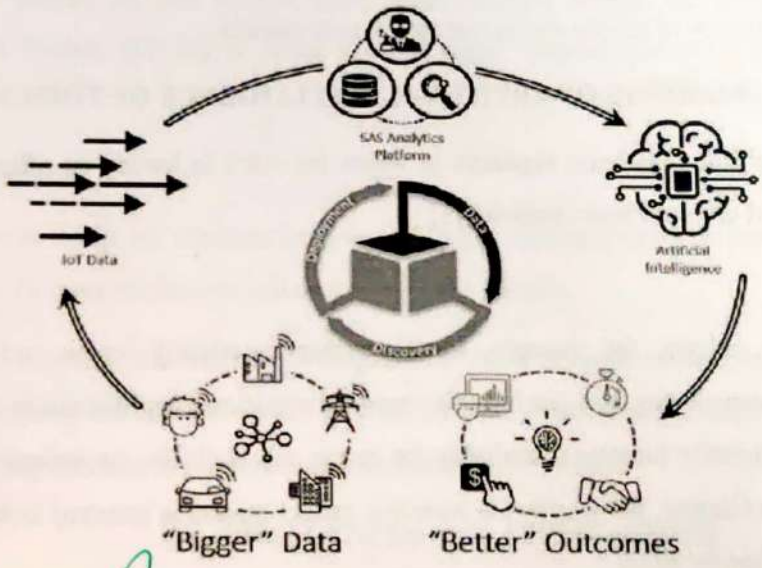


Figure.1: How AIoT Works

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AIoT is groundbreaking and commonly gainful for the two kinds of innovation as AI enhances IoT through AI abilities and IoT enhances AI through network, flagging and information trade. As IoT networks spread all through significant enterprises, there will be an inexorably huge measure of human-situated and machine-generated unstructured information. AIoT can offer help for information investigation arrangements that can make an incentive out of this IoT-generated information.

With AIoT, AI is installed into framework segments, for example, programs, chipsets and edge registering, all interconnected with IoT organizations. APIs are then used to broaden interoperability between segments at the gadget level, programming level and stage level. These units will zero in fundamentally on streamlining system and organization tasks just as removing an incentive from information.

While the idea of AIoT is still generally new, numerous prospects exist to improve industry verticals, for example, endeavor, modern and shopper item and administration areas, and will keep on emerging with its growth. AIoT could be a suitable answer for tackle existing operational issues, for example, the cost related with powerful human capital management (HCM) or the intricacy of supply chains and conveyance models.

III. SEGMENTS OF ARTIFICIAL INTELLIGENCE OF THINGS

There are four significant segments in which the AIoT is having an effect: wearables, smart home, smart city, and smart industry [3]:

3.1 Wearables

Wearable gadgets, for example, smart watches ceaselessly screen and track client inclinations and propensities. Not just has this prompted significant applications in the wellbeing tech area, it additionally functions admirably for sports and wellness. As indicated by driving tech research firm Gartner, the worldwide wearable gadget market is assessed to see more than $87 billion in income by 2023.

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3.2 Smart Home

Houses that react to all your solicitations are not, at this point confined to sci-fi. Smart homes can use machines, lighting, electronic gadgets and then some, learning a homeowner's propensities and creating computerized "uphold."

This consistent access likewise achieves extra advantages of improved energy effectiveness. Therefore, the smart home market could see a compound annual growth rate (CAGR) of 25% among 2020-2025, to reach $246 billion.

3.3 Smart City

As an ever increasing number of individuals rush from rustic to metropolitan zones, urban communities are developing into more secure, more helpful spots to live. Smart city advancements are keeping pace, with ventures going towards improving public wellbeing, transport, and energy effectiveness.

The pragmatic utilizations of AI in traffic light are now getting clear. In New Delhi, home to a portion of the world's most traffic-clogged streets, an Intelligent Transport Management System (ITMS) is being used to make 'constant powerful choices on traffic streams'.

3.4 Smart Industry

To wrap things up, ventures from assembling to mining depend on computerized change to turn out to be more productive and decrease human mistake.

From constant information investigation to store network sensors, smart gadgets help forestall expensive mistakes in industry. Truth be told, Gartner additionally gauges that more than 80% of big business IoT ventures will incorporate AI by 2022.

IV. CHALLENGES AND APPLICATIONS

IoT comprises of interconnected things with worked in sensors and can possibly generate or gather an immense measure of information. The information can be then examined and used

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with AI for critical thinking or dynamic. Without AI, IoT would have restricted worth. Man-made intelligence can duplicate the estimation of IoT; then again, IoT can advance the learning and intelligence of AI.

In any case, there are numerous difficulties while sending AIoT by and by. For example, the edge figuring issues for settling the inactivity of communicating gigantic IoT information in organizations and accomplishing continuous reactions with superior AI for breaking down the enormous information. Security issue is another pivotal test to give wellbeing and protection in AIoT applications. AI is one of the potential advances to be used in AIoT system security. Moreover, there are numerous different issues identified with the expanding present day AIoT systems and applications.

Since the blend of AI and IoT, in particular AIoT, has different possible applications in reality. The combo of internet of things and smart systems makes AIoT an incredible and significant apparatus for some applications [4]. Here are a few,

Smart Retail: In a smart retail climate, a camera system furnished with PC vision abilities can utilize facial acknowledgment to recognize clients when they stroll through the entryway. The system assembles intel about clients, including their sexual orientation, item inclinations, traffic stream and the sky is the limit from there, breaks down the information to accurately foresee customer conduct and afterward utilizes that data to settle on choices about store tasks from promoting to item arrangement and different choices. For instance, if the system identifies that most of clients strolling into the store are Millennials, it can promote out item commercials or in-store specials that appeal to that segment, in this manner driving up deals. Smart cameras could distinguish customers and permit them to avoid the checkout like what occurs in the Amazon Go store.

Robot Traffic Monitoring: In a smart city, there are a few commonsense employments of AIoT, including traffic observing by rambles. On the off chance that traffic can be checked continuously and changes in accordance with the traffic stream can be made, clog can be diminished. At the point when robots are conveyed to screen a huge zone, they can communicate

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traffic information, and afterward AI can break down the information and settle on choices about how to best reduce gridlock with acclimations as far as possible and timing of traffic signals without human contribution. The ET City Brain, a result of Alibaba Cloud, improves the utilization of metropolitan assets by utilizing AIoT. This system can distinguish mishaps, unlawful stopping, and can change traffic signals to assist ambulances with getting patients who need help quicker.

Places of business: Another territory where artificial intelligence and the internet of things meet is in smart places of business. A few organizations decide to introduce an organization of smart ecological sensors in their place of business. These sensors can distinguish what staff are available and change temperatures and lighting in like manner to improve energy proficiency. In another utilization case, a smart structure can handle building access through facial acknowledgment innovation. The mix of associated cameras and artificial intelligence that can analyze pictures taken progressively against a data set to figure out who ought to be allowed admittance to a structure is AIoT grinding away. Likewise, workers wouldn't have to check in, or participation for compulsory gatherings wouldn't need to be finished, since the AIoT system deals with it.

Fleet Management and Autonomous Vehicles: AIoT is utilized to in armada management today to help screen an armada's vehicles, decrease fuel costs, track vehicle support, and to recognize perilous driver conduct. Through IoT gadgets, for example, GPS and different sensors and an artificial intelligence system, organizations can deal with their armada better gratitude to AIoT. Another way AIoT is utilized today is with self-governing vehicles, for example, Tesla's autopilot systems that utilization radars, sonars, GPS, and cameras to accumulate information about driving conditions and afterward an AI system to settle on choices about the information the internet of things gadgets are gathering.

Autonomous Delivery Robots: Similar to how AIoT is utilized with self-ruling vehicles, self-sufficient conveyance robots are another illustration of AIoT in real life. Robots have sensors

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that assemble data about the climate the robot is navigating and afterward settle on second to-second choices about how to react through its installed AI stage.

V. CONCLUSION

In this chapter titled "Artificial Intelligence of Things", we have discussed about the short introduction of AIoT, how it will work, what are the segments of AIoT with real time example and also discussed about the realistic models of AIoT. In future, we can use this AIoT technique in many equipments implementation and also we can use this AIoT technique for bringing better performance of many appliances.

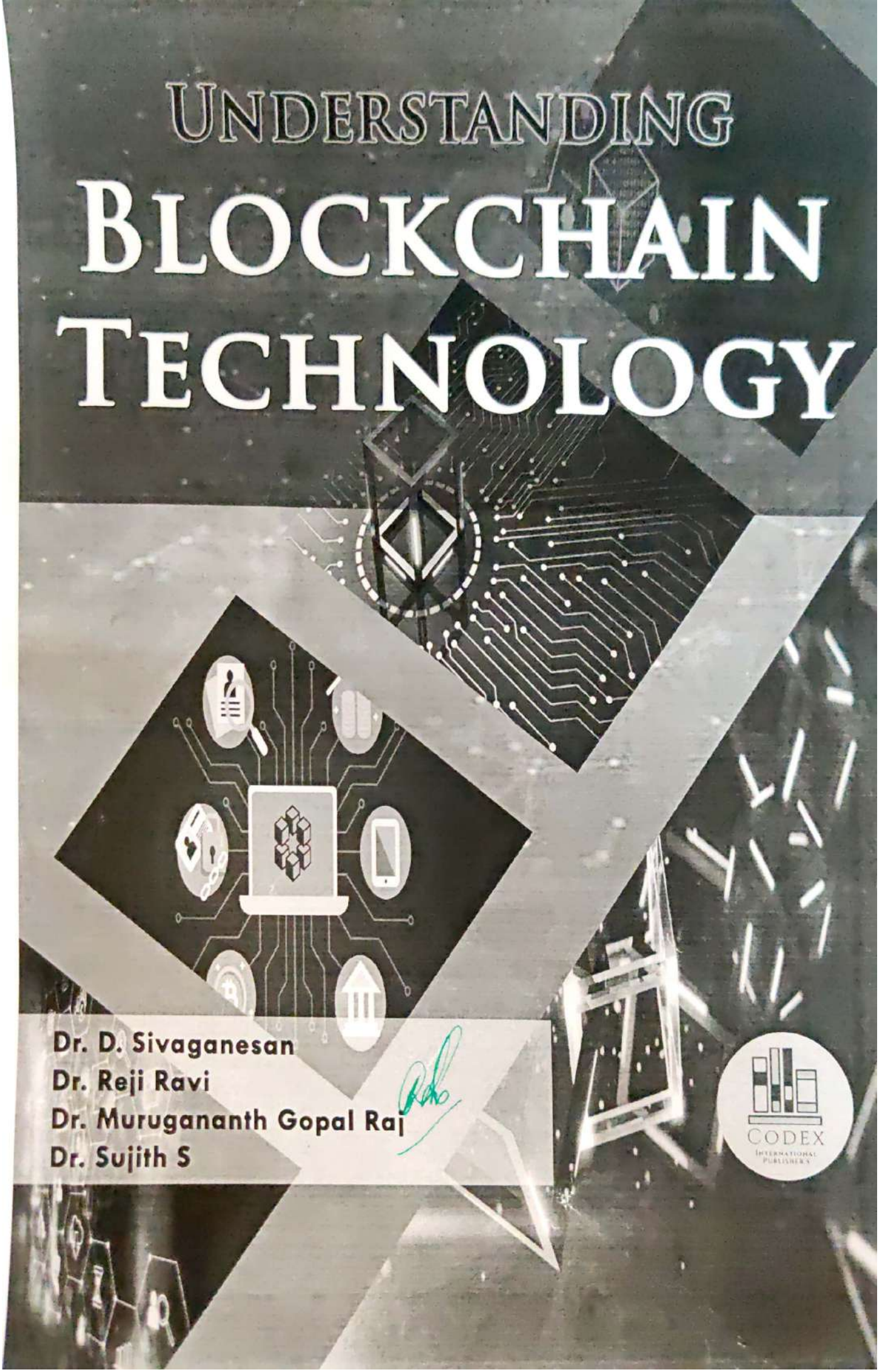
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UNDERSTANDING BLOCKCHAIN TECHNOLOGY



Dr. D. Sivaganesan
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SUSTAINABLE DEVELOPMENT MODEL – AHALIA CAMPUS IN KERALA

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THEME: RAINWATER HARVESTING

ABSTRACT

Ahalia is the largest edu-health campus in the State of Kerala, located in a water scarce and rain shadow region, close to Plachimada, from where Coca Cola had to leave, after being forced to stop ground water tapping. The second biggest industrial region of Kerala, Kanjikode, is adjacent to the Ahalia Campus. Two decades back, the Ahalia Campus was founded on an arid extent of land, with very rare green sprouts and absence of water. Rain water conservation has done miracle to this campus and it is now a fully green water conserved campus, the largest in Kerala. Over the past two decades, Ahalia Campus has constructed ten rainwater harvesting lakes with a total capacity of approximately 230 Million litres. These lakes are designed and constructed considering the topography of the land. Channels and pipes, above and below the water surface, are made to ensure that rainwater from rooftops, roads and other catchment areas is directed to these rainwater harvesting lakes for in-situ reuse rather than allowing run off. A rainwater harvesting system comprises of various components such as pipes or drains for transporting rainwater, chambers for intermediate diversion, filtration tanks and storage tanks. Rainwater harvesting has always been proposed as a solution to recharge the local aquifers and ensure water availability in water-scare zones. While this technique is a long-term and cost-effective solution and relatively less complex to construct, the availability of land is often the bottleneck. LDPE sheets are placed in the borders at the lowest elevation (or level) to prevent water from overflowing to the surrounding region. During heavy rainfall, when the lakes overflow, chambers divert water to the surrounding areas. The water conservation efforts in Ahalia campus have been recognized several times by the Kerala State Pollution Control Board (PCB). The presence of these lakes have greatly benefitted the campus and the nearby locality by maintaining the water table high, especially during the hot summers. Besides this, these water bodies help in maintaining a thriving eco-system and is a source of relaxation for human body and mind. The development of the Ahalia Campus in this arid region has become a saga in the history of Kerala. At present, this self-sustained campus is accommodating 10 academic institutions including IIT Palakkad, 4 hospitals, a medicine manufacturing unit, a large herbarium, a heritage village, a rock sculpture museum, a children's village, a dozen lake houses, half-a-dozen theme parks, etc., making it a centre of attraction for movie makers. It has become a destination for students' visit from many institutions. The campus also has its own production of grains, vegetables, flowers, milk, egg, etc., making it a loveable place to stay, self-sustained in water, energy (wind) and much more. This paper discusses the real-life story in words and pictures of the development from scratch of this wonderful campus, by judicious water conservation.

Keywords: rainwater harvesting, conservation, ground water, self-sustained, eco-system

1. INTRODUCTION

With the world developing at a rapid pace, governments and international bodies have understood the need to focus on sustainable development; that is development that meets the present needs

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of the people while ensuring nature's resources are reserved for future generations. One of the most important players in sustainable development is the environment. This is evident in the fact that five out of the seventeen sustainable development goals (SDGs) of the United Nations Development Programme are directly related to the environment [1]. India too has a strong commitment to the implementation of the seventeen SDGs as well as a high priority to the 2030 Agenda for Sustainable Development [2].

In this paper, we discuss about Ahalia Health, Heritage and Knowledge Village (AHHKV) [3] (fondly called Ahalia Campus) in Palakkad District, in the State of Kerala, India. The focus on health, heritage and knowledge is visionary and critical as they are inherited from the past, maintained in the present and bestowed for the benefit of the future generations. While still in its infancy, Ahalia Campus has come a long way in its vision of becoming a sustainable model. Section 2 describes Ahalia Campus in more detail. Section 3 covers the major efforts taken by the Campus in becoming water, energy and food self-sufficient.

2. ABOUT AHALIA CAMPUS

Ahalia is the largest edu-health campus in the State of Kerala, located in a water scarce and rain shadow region, close to Plachimada, from where Coca Cola had to leave, after being forced to stop ground water tapping. The second biggest industrial region of Kerala, Kanjikode, is adjacent to the Ahalia Campus. Two decades back, the Ahalia Campus was founded on an arid extent of land, with very rare green sprouts and absence of water. Rain water conservation has done miracle to this campus and it is now a fully green water conserved campus, the largest in Kerala.At present, this self-sustained campus is accommodating ten academic institutions including IIT Palakkad, four hospitals, a medicine manufacturing unit, a large herbarium, a heritage village, a rock sculpture museum, a children's village, a dozen lake houses, half-a-dozen theme parks, etc., making it a centre of attraction for movie makers. A few of these are shown in Figures 1 to 5. It has become a destination for students' visit from many institutions. The campus also has its own production of grains, vegetables, flowers, milk, egg, etc., making it a loveable place to stay, self-sustained in water, energy and much more.



Figure 1: Ahalia School of Engineering and Technology



Figure 2: Ahalia Ayurveda Medical College Hospital

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Figure 3: Ahalia Diabetes Hospital



Figure 4: Ahalia Foundation Eye Hospital



Figure 5: Ahalia Heritage Village

3. DEVELOPMENT OF A SUSTAINABLE ECO-SYSTEM IN AHALIA CAMPUS

3.1. Rainwater harvesting

Rainwater, where it falls naturally, is often not sufficiently or efficiently managed. Rainwater harvesting is a technology used for collecting and storing rainwater from rooftops, land surface or rock catchments using simple techniques. A rainwater harvesting system comprises of various components such as pipes or drains for transporting rainwater, chambers for intermediate diversion, filtration tanks and storage tanks. Thus, rainwater harvesting is a cost-effective and relatively lesser complex way of water conservation while ensuring sustained long-term supply of water, especially in those areas where there is inadequate groundwater supply or surface resources.Rainwater harvesting has always been proposed as a solution to recharge the local aquifers and ensure water availability in water-scare zones [4]. While this technique is a long-term and cost-effective solution and relatively less complex to construct, the availability of land is often the bottleneck.

Over the past two decades, Ahalia Campus has constructed ten rainwater harvesting (RWH) lakes with a goal of being water self-sufficient. The total capacity of these lakes is approximately 230 million litres. A view of some of these lakes are shown in Figures 6, 7 and 8. These lakes are designed and constructed considering the topography of the land. Channels and pipes, above and below the water surface, are made to ensure that rainwater from rooftops, roads and other catchment areas is directed to these rainwater harvesting lakes for in-situ reuse rather than allowing run off.LDPE sheets are placed in the borders at the lowest elevation (or level) to prevent water from overflowing to the surrounding region (refer Figure 9). During heavy rainfall, when the lakes overflow, chambers divert water to the surrounding areas. The water conservation efforts in

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Ahalia campus have been recognized several times by the Kerala State Pollution Control Board (PCB). The presence of these lakes have greatly benefitted the campus and the nearby locality by maintaining the water table high, especially during the hot summers. Besides this, these water bodies help in maintaining a thriving eco-system and is a source of relaxation for human body and mind.



Figure 6: RWH lake beside the lake houses



Figure 7: RWH lake in front of Ahalia Foundation Eye Hospital

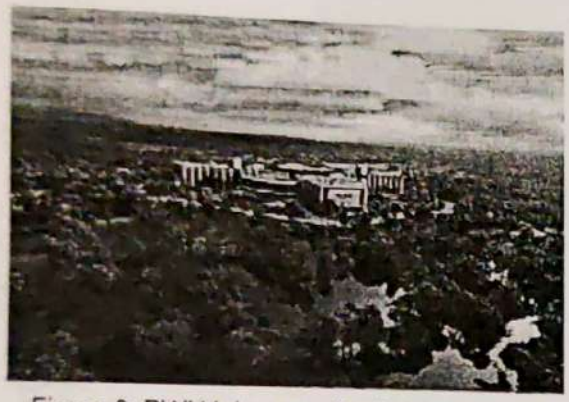


Figure 8: RWH lake near Ahalia Women and Children's Hospital



Figure 9: LDPE sheet laying in one of the borders of the RWH lake

3.2 Renewable energy efforts

Ahalia's endeavor towards energy self-reliance, energy secured future and developing clean energy started more than a decade ago. The efforts to explore the wind potential of Kanjikode area, where the campus is located, were initiated through various studies andan 80 m lattice wind mast of make Suzlon was commissioned in May 2007 in the campus and wind data was measured at 80 m, 65 m and 50 m levels for the period from April 2008 to March 2009. Subsequently a separate company, Ahalia Alternate Energy Pvt. Ltd. (AAEPL), was formed to channelize and prioritize the efforts in developing renewable energy in the year 2013. The company embarked upon the ambitious project of commissioning 8.4 MW at its campus in Kanjkode - the first of its kind by a Private investor in the state, after due discussion with Kerala State Electricity Board (KSEB).

As per the on-site wind data wind turbine generators, each having a capacity of 2.1 MW, are placed at four different locations which yields the highest wind generation. These are shown in Figures 10 and 11. The hub height of the turbines is at 90 metres above ground level to obtain the maximum wind generation. The rotor is of horizontal axis type and the rotational direction is clockwise. Depending upon the wind speed and direction, the blade angle and angle of turbine is controlled. The SCADA system is used for acquiring the generation data on a daily basis. The

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power output of the generator is 690 V which is converted into 22 kV (grid voltage) using a step up transformer. All the machines are connected to the 22 kV grid and thus work in Independent Power Producer (IPP) mode. The machines were commissioned on 22 February 2016 (one machine) and 23 March 2016 (three machines) respectively, under IPP mode and started injecting power to the grid.

The project with investment of more than Rs. 50 crore was executed under the direct control of AAEPL in a span of just one year. The technical, administrative, strategic and liaison wings of AAEPL worked in tandem and in coordination with the wind turbine manufacturer to achieve the enviable task within the minimum time frame and budget. Snaps of some of the logistical work are seen in Figures 12, 13 and 14. The machines have injected 65 million units to the grid till 31 July 2019. It is noteworthy that these machines exceeded the pessimistic generation predictions of AAEPL teamby 10-20%, validating the estimates and the risk taken by the first renewable (wind) energy private entrepreneur of the state. This higher generation efficiency is again an indication of the site-machine matching practiced by AAEPL, as the yield is much higher than the other two projects in the same region.

It is pertinent to state that the project undertaken and commissioned by AAEPL is the first project in Kerala, where the developer is also from the state, who technically involved in the planning, installation and commissioning of the project. Ahalia Alternate Energy Ltd has a competent team and is sharing its exposure and expertise in the field of wind energy by providing consultancy services to M/S V Guard, Kottakkal Arya Vaidya Sala etc. Ahalia Alternate Energy is consultant to Swedish consortium of E4T micro-grid concept in Andaman and Nicobar Islands in 2015-16, a partnership venture of KTH – The Royal Institute of Technology, Stockholm and Swedish Energy Agency under the aegis of MNRE.

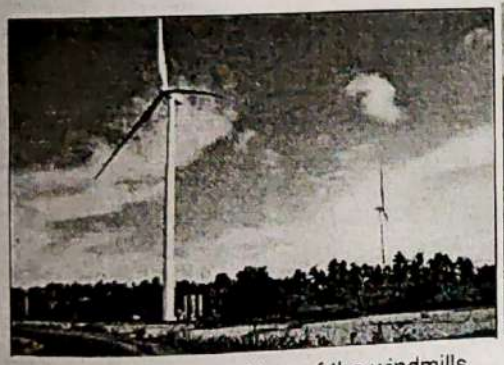


Figure 10: A view of two of the windmills



Figure 11: An aerial view of the four windmills. Ahalia Public School and one of the RWH lakes are also seen.

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Figure 12: Transportation of the hub of the windmill



Figure 13: Transportation of the blade of the windmill



Figure 14: Unloading of one of the sections of the windmill

3.3 Agriculture and livestock

Ahalia Campus has an extensive green belt that is used for various agriculture and environment related projects. There are earmarked locations for cultivation of paddy, herbal plantation (medicinal plants of five thousand different varieties, Figure 15 shows one of these), vegetables (such as tapioca, radish, brinjal, ladies finger, cabbage, etc.), palm trees, cashew trees, mango trees, coconut trees, bamboo (refer Figure 16), jasmine plantation, neem trees, flowering plants (refer Figure 17) and other spice trees. As part of our afforestation efforts, every year around thousand saplings are grown, planted and taken care of (refer Figure 18). Our water conservation efforts have significantly helped us maintain our landscapes during the summer season as well. In addition to these, there is a farm in the campus with cattle, poultry, goose, turkey, rabbits and goats (refer Figure 19). Fish farming and sericulture are other activities.

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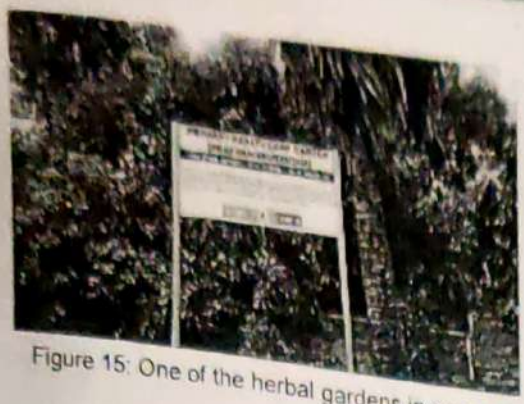


Figure 15: One of the herbal gardens in campus



Figure 16: Bamboo park



Figure 17: Rose garden

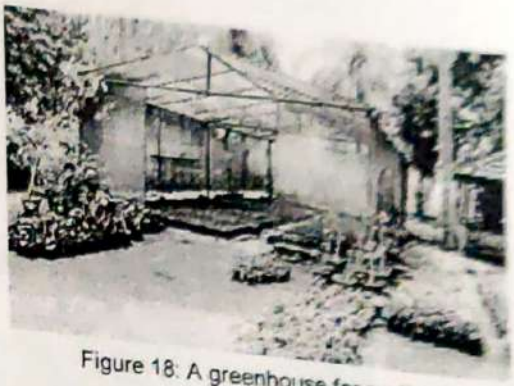


Figure 18: A greenhouse for saplings

4. CONCLUSION

To summarize, Ahalia Campus in an excellent example of an inclusive development model that keeps both nature and the people in mind. The rainwater harvesting farms and the 8.4 MW wind energy project were amongst the first in the state of Kerala. The development of this campus in this arid region has become a saga in the history of Kerala. While much has been achieved, Ahalia Campus constantly strives to move forward in the fields of healthcare, education and heritage while maintaining its harmony with nature.

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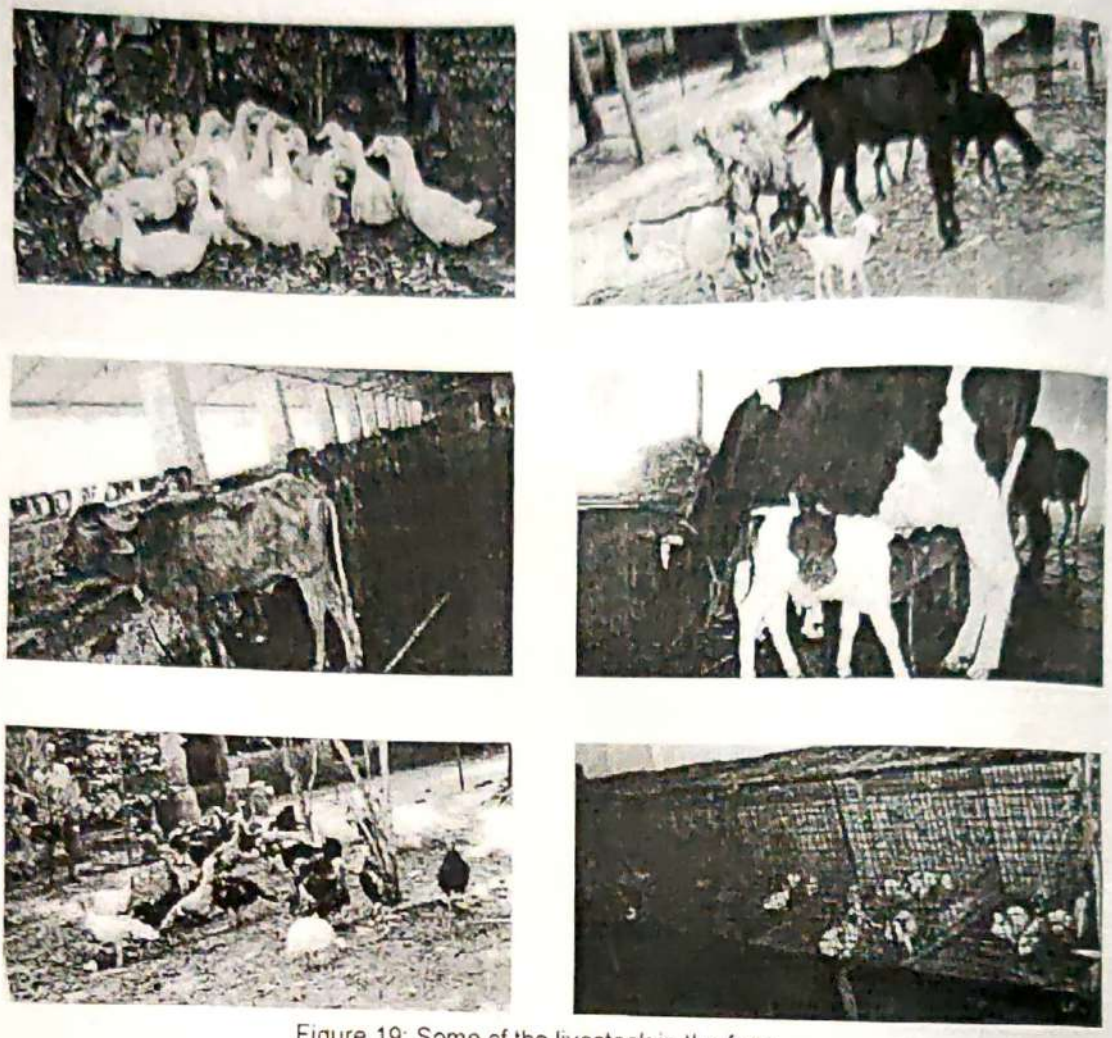


Figure 19: Some of the livestock in the farm

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Asymmetrical Seven Level CHB Inverter based Voltage Compensation Device for an 11kV Distribution System

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Abstract: *This paper presents a Distribution Static Compensator (DSTATCOM) with a sinusoidal pulse width modulated (SPWM) Cascaded H Bridge (CHB) multilevel inverter for shunt compensation of distribution system. The advantages of DSTATCOM are power factor improvement, voltage regulation and harmonic mitigation in distribution line and load balancing. CHB inverters are used widely because of their simplicity, modularity and reduced switching losses. Here a seven level cascaded H bridge based DSTATCOM is considered for the voltage sag compensation of an 11 kV distribution system. The software used is MATLAB. The performance of multilevel inverter is investigated and Total Harmonic Distortion (THD) is noticed.*

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Modelling of Temperature Stresses on Fly Ash Concrete Pavements by Artificial Neural Network

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Abstract: *In this study, artificial neural network models have been developed for concrete and fly ash concrete slabs of sizes 1000mm x 1000mm with various thickness 150mm, 200mm, 250mm and 300mm. The data used in the artificial neural networks includes temperature differential (°C), thickness of slab (mm), Modulus of Elasticity (MPa) and Poisson's ratio were taken as input layers and an output layer which is temperature stresses, the test results have shown that NN have strong potential for predicting the temperature stresses in fly ash concrete pavements.*

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