AN AUTOMATED FLOOD DETECTION & ALERT NOTIFICATION SYSTEM USING HYBRID DEEP LEARNING CLASSIFICATION APPROACH

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***Abstract*—**

Floods are some of the frequent natural calamities that bring about extreme destruction to any nation. They are usually as a result of precipitation and runoff of rivers especially whereby the rainy season is exceptionally high. Following the problems of global warming and drastic effects on the environment, flood has become a critical issue to the point of creating adverse influence on the mankind and infrastructure. Up to date sensor network technology has been applied in numerous fields such as water level fluctuation. Nonetheless, effective flood surveillance and instant notification system remain an important component since Information Technology facilitated applications are not utilized in this industry extensively. This paper is primarily aimed at designing and development of natural disaster prediction monitoring and alert sending system that assists in the provision of right decision and alerting of peoples at the right time. Initially, the database of Krishna Godavari region of Andhra Pradesh state areas stored in cloud is attained and are processed. Initially, the collected data is preprocessed. The feature extraction is employed using Adaptive polynomial based Linear discriminant analysis for feature extraction followed by feature subset selection. The best features were then optimized using the Convergent salp Swarm optimization algorithm after which the optimized output can be given as an input for the process of classification. The classification process is done using Hybrid Alex Net & Google Net classification. The performance estimation is made to prove the effectiveness of proposed scheme. The abnormal output from the classifier is given to Raspberry pi processor. The system then provides notification message by raspberry pi via alert &warning system which connects to web portal and alert server to send notification in case of emergency to the authorized person. The system instantaneously uploads and broadcast information through web base public network.

***Index Terms*— Floods, sensor network technology, Adaptive polynomial based Linear discriminant analysis, feature extraction, Convergent salp Swarm optimization algorithm, Hybrid Alex Net & Google Net classification, Raspberry pi processor, flood monitoring, warning system.**

I. INTRODUCTION

The natural hazards like floods, storms, tsunamis and the likes are a great threat to lives and properties around the world. The extreme rainfalls experienced have led to a massive growth in floods. History has indicated that flood is the most common natural hazard that constitutes 40 percent of natural disasters in the world.

Future hazard risk and climate change are imminent dangers to the developed and developing nations. Unless proper monitoring and proper justification mechanisms are put in place, these natural threats normally culminate into catastrophes with grave consequences in regards to, social inconveniences, loss of money and destruction of the city landscape. The one statistic that would be more shocking is the global impact of a flood, as there are many minor floods that result in the death of less than 10 people with100 or more people possibly being impacted and no state-of-emergency declared or call to action.

However, the present circumstances need better mechanisms of tracking and reacting to floods. Floods destroy much of the property, agricultural lands, crops, and livestock that cause immense losses to the economy, and minimizing the loss of lives is indispensable in the time when sustainability is being prioritized in a way [1].

It is a fact that natural calamities are unavoidable. However, their effects and intensity can be mitigated by well-managed systems on alerting and management. In Somalia, the risky unpredictable floods have taken place in certain towns last year, reported more than 100, 000 people had been displaced. A consequence in people of Somalia because of that river-flooding has so far. Huge numbers of people are evacuated and ran out of their homes. Impressively, the past 10 years have brought about tremendous opportunities whereby a successive line of intellectual engagements have found out how wireless sensor information and camera shots of Internet-of-Things (IoT) networks can advance flood management. [2].

Convolutional neural networks are methods of deep learning that have been confirmed to be practical in flood damage assessment, as well as associated studies have been developed promptly. The use of deep learning algorithms to predict flood water detection is also being improved to map surface water of Landsat images. According to the disparity between the nature of surface water and floods in satellite images, there is a greater challenge of flood extraction. In order to extract the flood boundary using satellite imagery, a semantic segmentation approach is realized. The suggested approach justifies the experimental findings in its usefulness. The dual-polarized synthetic aperture radar imagery and multispectral Landsat imagery compares the performance of incorporating the convolutional neural network to create the compound flood mapping. These research results showed that deep learning algorithms can be used to facilitate flood classification. Research on high quality large-scale flood annotation satellites is only in its infancy due to the unavailability of high-quality satellite data on the subject [3].

The study superimposed the path to proactive usage of the available opportunities which are provided by the Bigdata analytics (BDA) and Internet of things (IoT) together to perceive, track and anticipate the disaster conditions. The recent studies are examined through the potential BDA and IoT have in disaster management. Various related attributes are grouped into a thematic taxonomy and examined the most prevalent source of solutions to suggest a conceptual reference model on the placement of BDA- and IoT-based disaster management settings[4].

The primary goal that the paper seeks to achieve is the forecast of the flood disaster and caution of people against the damage of their lives and property using deep learning classification scheme.

The rest of the paper will be structured in the following way: Section II will be the study of various existing methods and reviews improved. The proposed work is presented in Section III. Section IV is the work of performance analysis of the proposed work and estimation of the results. Lastly, section V contains the conclusion.

II. Related Works

In the paper [5], the author has indicated that the most frequent and prevalent of all natural disasters is the flood. The frightening statistics in the deaths and financial costs that occur annually due to floods that occur all over the world demand the improvement in managing the risk of floods. This paper presents systematic review of the literature on the subject of IoT-based sensors and computer vision application in flood modelling, flood monitoring, mapping and alerting systems and the estimation of water level.

[6] Proposed concerning temporary water and permanent water during disasters of flood has effectively depended on change identification procedure based on multi-temporal imageries of remote sensors. Even the remote sensing images of flood disasters taken after the floods are difficult to estimate the type of water that happened during the disaster. Over the past years of evolution of studies, it is established that outstanding potential of multisource data fusion and deep learning algorithms have significant role to play in enhancing flood detection.

[7] Said that flood as water overflowing on the ground, or build up on water that is significant to the life of humans. Nevertheless, it would be convenient to the people to avoid these floods in order to prepare ample time to evacuate the places that could be prone to floods before it hits. The primary goal is to present a new and strong model; this can be the real-time flood detection system relying on Deep Learning and Machine-Learning-algorithms capable of identifying the water level and quantifying the floods with the potential of humanitarian in order to avoid the outcomes of the disasters before these happen.

[8] The suggestion was that the forecasting of heavy rainfall is a very central issues in the branch of meteorology because it influences the life and economy of people. A deep neural network model to forecast extreme rainfall using the previous climatic parameters are learnt. A stacked auto-encoder is experimented on Mumbai and Kolkata, India, and was determined to be able to predict heavy rainfall measures of these areas. Extreme rainfall events that occur 6 to 48 h before the event has happened are predicted. These results have compared with other methods have led to better results derived by this method which are used in literature. The model can present an optimistic solution in predicting heavy rainfall 1 2 days ahead that can aid in reducing a lot of losses.

[9] The purpose of the study was to assess the susceptibility of flash-floods with a new hybridization style of Deep Neural Network (DNN), Frequency Ratio (FR) and Analytical Hierarchy Process (AHP). In this regard, a geospatial database of the flood consisting of 178 flood places and having 10 flash-flood predictors was structured and utilized. DNN is a probabilistic machine learning that was used to create an inference flash-flood model. The models being used were tested in terms of Area Under Curve, Receiver Operating Characteristic Curve and a few statistical measures to test their reliability. The outcome demonstrates that the two proposed ensemble models, DNN-FR and DNN-AHP can predict future flash-flood areas with the accuracy more than 92 percent and they are innovative tool in the study of flash-floods.

Suggested a strategy of big data-powered disaster response by sentiment analysis of individuals. The proposed solution gathers the information of a disaster shared on social networks and categorized them using the machine learning algorithm to the needs of those who are affected. This evaluation assists the rescue team and the emergency responders to advance superior strategies of successful information management of the rapidly shifting disaster situation.

[11] As long as the concepts of volunteered geographic information (VGI) are provided, which allows the masses to witness the times and locations when the events take place. In addition, the picture-based VGI is able to depict environmental changes and cataclysmic conditions, including flooding zones, and relative water levels. Image-based VGI which has been obtained by smartphone cameras has been used in flood detection in this learning. The water levels were offered using digital image processing and a photogrammetric technique.

[12] Expressed the application of synthetic aperture radar (SAR) data that may be easily identified in the utilities of flood management. However, not all of these events may be covered by the limited area observation with the help of a SAR image and hence, the sophisticated programming SAR acquisitions should be acquired. To continue with further development, the merit of all the satellite SAR sensors is currently in effect. The key findings of the observation of the river flood are also discussed in the given paper, and the position of further programming of the radar purchases is presented. The accuracy of the flood predictions and the reliability of the flood mapping algorithm is proved with the results.

The approach to big data applied to Weather forecasting was proposed by [13] as a vital and significant process in the everyday life of people. The task of big data analytics is to uncover the patterns of the hidden information and information that can be utilized to achieve a higher result. These analytics will get superior results in weather forecasting. The above mentioned categories have been compared in this paper in terms of scalability, accuracy and other Quality of Service issues and execution time.

The technique presented by [14] has an exponential growth in the provisioning of multimedia devices over the Internet of Things (IoT) and the multimedia big data (MMBD) is generated. This paper also discussed the distinctiveness and intricacy of MMBD computing to IoT applications. It is a broad taxonomy of the MMBD, which is abstracted into a new process model and then MMBD over IoT is constructed. This process model has tackled a number of research trials that have been allied with MMBD including reliability, heterogeneity, scalability, accessibility, and Quality of Service (QoS) requirements.

[15] Worded regarding big data as the understanding of large quantities of data which data is being generated on a daily basis in many areas due to the added use of technology and internet resources. Despite the different developments, management and analysis of big data are a challenge, to more challenging and comprehensive research. Along with the identification of the procedures and the methods of how bigdata might be tried and utilized.

The model of Satellite imagery proposed by [16] plays a dynamic role in research and developments to be studied. In high quality systems, computers record and process the satellite images to derive abstract facts. The primary objective is in the creation of software applications which can be used to extract the information and train themselves. This tracking system under examination is concerned with the tracking of regions using satellite snapshots and they can be documented to identify the different gadgets. As a rare resource to test satellite symbolism, calculations on the expenses of the machine learning are applied to this site. This is discussed in image classification techniques using machine learning techniques to improve Satellite Imagery.

[17] The implication regarding the use of big data which has introduced new opportunities to natural disaster management was proposed, primarily because of the diversity of the possibilities offered in the analysis, visualization and prediction of natural disasters. The primary idea of computer professionals and policy makers in various phases of managing the natural disaster is to leverage the finest of big data. It can be achieved by obtaining data in a variety of formats and loading it in a manner that would make it useful. This essay provides the condition of the technology in offering effective solutions to the management of natural disaster. The primary large data sources that can identify and track the natural hazards, researching the outcomes to reclaim and restructure processes are examined.

[18] Not only wrote about the potential of big data to work on the appropriate strategy against the impact of climate change but also about the improvement of the resilience of people because of the negative impact of the climatic changes. This regressive of bouncing back to the previous state following the negative impacts has been demonstrated through a systematic literature review. The big data technologies can be used to depict the data related to the existing problems, future problems, and the recuperation stages of the negative outcome of the climatic change.

[19] defined how to identify the largest volume of a nationwide flood, using annual years of time series data between 2015 in order to use best the application of optical satellite data. Flood disaster risk reduction was made by calculating synchronized floodwater index (SfWi). The flood monitoring and mapping through various satellites is a critical process and therefore, the risk assessment is possible. The transboundary rivers flowing across the delta between Bangladesh and eastern India demonstrate that a propensity of flood risk was revealed as a result of the spatial and temporal dynamics of the maximum flood extent during the 2015 monsoon season (Ganges, Brahmaputra and Meghna (GBM). The maximum flood extent as indicated by SfWi was verified based on the 20 years of flood histories.

[20] Recommended the way of investigating and tracking unnatural climatic changes and overseeing Air Quality (AQ), particularly in.

Morocco with Remote Sensing (RS) methods. The various facets of the used satellite data were expounded and demonstrated that satellite data could be embraced as Big Data (BD). This study has estimated a Hadoop BD architecture and how to effectively process RS environmental data, which is useful in managing unfavorable climatic conditions and avoid natural calamities.

[21] described the process of Digital elevation model (DEM) which has been utilized in the reduction and control of flood risk. A number of classification techniques have been generated to abstract DEM out of point clouds. A novel procedure of raw point cloud classification and ground point filtering based on deep learning was suggested and evaluated on LiDAR and UAV data. The eye-to-the-pixels and precision analysis ensuring the presence of a deep learning-based filtering of point clouds revealed that the use of the former is a suitable method of ground classification.

[22] Said the study that uses Unmanned Aerial Vehicles (UAVs) in coming up with an automated imaging system that is able to identify areas covered by inundation using aerial imagery. Here Haar cascade classifier was investigated to identify landmarks which include buildings and roads based on the aerial images taken by UAVs and locate areas of floods. The discovered landmarks are incorporated into the training data that could be utilized to train an algorithm of deep learning. Considering the input case study images, the general accuracy of 91% is achieved in identification of flooded and non-flooded areas. The real-time flood inundation systems will therefore convert the disaster management systems according to the current smart cities initiatives.

[23] Recommended the use of Internet of Things (IoT) and machine learning (ML) techniques in the recent past to identify the incidence of floods with respect to humidity, rainfall, water flow, temperature and water level among others. Deep Neural Network has been applied based on the above to predict occurrence of flood based on intensity of rainfall and temperature. In addition to this, a deep learning model is compared with other machine learning models including support vector machine (SVM), Naive Bayes and K-nearest neighbor (KNN) based on accuracy and error. The deep neural network is only applicable at maximum accuracy prior to the floods according to the monsoon parameters, hence the inefficacy of flood forecasting.

PROPOSED WORK

In this section, a full description of the given technique is used. At the first stage, the sensed data in cloud is pre-processed and extracted features are achieved by Adaptive polynomial based linear discriminant analysis. The features that are obtained are subjected to feature subset selection and the salient features are chosen.

A. Cloud storage data acquisition.

The internet of things and big data are seen to be involved in the flood detection with the optimized convolutional deep neural networks projected. In this, the stage is being initiated by the training of the suggested CDNN to detect floods and the flood related big data is being fed to the system which includes the sensed information's such as Humidity, Rain Sensor, Water Flow and Water Level among the others and then the distributed filesystem. The information is sent and stored in the remote cloud storage where a few servers of third parties are found rather than a single server. In this case, cloud storage has numerous benefits that include protection, security and financial gain. Such data is supported and stored at these remote storage networks.

This perceived information is preconstituted to receive suitable information with redundancy.

The optimization process is executed by the Convergent salp Swarm optimization algorithm to evaluate finest fitness function and also to enhance the accuracy in prediction and hence programmed by the Hybrid Alex Net and Google Net classification method. The received outputs are categorized into normal and abnormal, and the abnormal objects are handled by the Raspberry pi processor board, comprising of GPS and Wi-Fi devices. The whole plan of suggested strategy can be seen as follows.

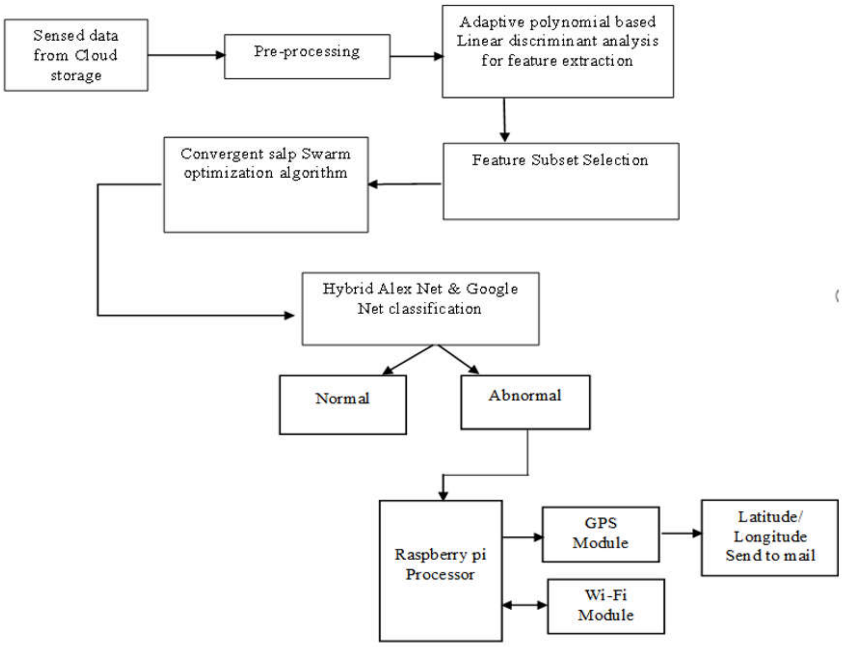


Figure 1 Overall flow of proposed model

(i)Pre-processing:

Pre-processing is aimed at eliminating the redundant information and sorting the valid data. The pre-processing is performed in this step after elimination of repetitious data. The pre-processing method has two stages namely, missing value imputation and normalization that are discussed in the following steps,

(a)Missing value imputation:

There are also missing values that have been substituted with the average of the non missing values. Mathematically that is expressed as follows,

$$O_n=\frac{O_{n-1}+O_{n+1}}{2},\ n \in N \quad (1)$$

Where, O_n missing value, O_{n-1}denotes the preceding value from the missing value, and O_{n+1} denotes the successive value from the missing value, N denotes the natural numbers (explicitly, N=1, 2, 3, ….).

(b) Normalization:

During this sub-phase, the data is put in a scale to fit within a specific range.

Despite the variety of types of normalization,

minimum maximum normalizations are made. In this case, the min-max normalizations are used to correct a given range of the data. min max Normalizations transforms a value O to N_P that fits in the gamut [0, 1]. It is provided by the below Eq. (2),

$$N_P=\left(\left(\frac{(O-O_{min})}{(O_{mac}-O_{min})}\right)*(1-0)+0\right) \quad (2)$$

Where, N_P signifies the normalization, 0 and 1 implies the range, O_{min} minimum value and O_{max} denotes the maximum value.

B. Feature extraction using Adaptive polynomial based linear discriminant algorithm:

The machine learning and pattern classification applications are used to extract feature in the preprocessed data further using Adaptive polynomial Linear Discriminant Analysis (APLDA). The APLDA makes use of the effect of the eigenvectors to enhance the strength of the extracted feature to the classification accuracy.

Suppose there are p patterns classes,n_s denotes the number of samples of the sth class=$\sum_{s=1}^{p} n_s$ is the total number of all the sample data. The column vector $x_j^s \in R^m$ represents the jth sample of the sth class. In APLDA, a projection vector is attempted to be estimated to increase the distance between the samples of different classes and reduce the distance between the same classes. LDA is determined using the following to get this projection vector.

$$v=\arg\max_{v}\frac{v^T S_b v}{v^T S_w v} \quad (3)$$

Where S_b *and* S_w are the between class and within -class scatter matrices respectively. S_b and S_w are calculated as follows.

$$S_b = \frac{1}{n}\sum_{s=1}^{p} n_s (u_s - u)(u_s - u)^{\mathrm{T}} \quad (4)$$

$$S_w = \frac{1}{n}\sum_{s=1}^{p}\sum_{j=1}^{n_s}(x_j^s - u_s)(x_j^s - u_s)^{\mathrm{T}} \quad (5)$$

where $u_s = \frac{1}{n_s}\sum_{j=1}^{n_s} x_j^s$ denotes the mean feature of samples of the sth class, u = $\frac{1}{n}\sum_{s=1}^{p}\sum_{j=1}^{n_s} x_j^s$ is the mean feature of all samples. Generally, problem (1) is equivalent to the following optimization problem.

$$a = \arg\min_{a^T} a^T(S_w - \lambda S_a)a \quad (6)$$

where λ is a small positive constant.

By solving Eq.(6), we can spot that the optimal projection vector a is the eigen vector corresponding to the minimum eigenvalue of $S_w = \lambda S_b$a. Typically, one projection vector is not sufficient to distinguish a number of classes. In practice, in real-life applications, we more or less choose a set of projection vectors that meet the optimum criterion.

C. Feature Subset Selection

Among the most important ones in deep learning neural networks is feature subset selection. Goals of feature selection include prevention of over-fitting and model development. This is a cost effective approach.

The features obtained are as an input to the feature selection method. A feature selection method can be explained as the selection of the subset of features from F = $f_1, f_2 \ldots f_n] \in R^{m\times n}$ is a set of *n* samples. The *i*th sample f_i is represented as a column vector $f_i = [f_{1,i}, f_{2,i}, \ldots\ldots f_{m,i}]^T \in R^m$. Suppose Q is the learned projection matrix and q_i is the *i*th row vector of Q, $i \in [1;m]$. Projected sample p_i is

$$p_i = \mathrm{Q}^{\mathrm{T}} f_i \quad (7)$$

$$\begin{aligned} p_{1,i} &= q_{1,1}f_{1,i} + q_{2,1}f_{2,i} + \cdots + q_{m,1}f_{m,i} \\ p_{2,i} &= q_{1,2}f_{1,i} + q_{2,2}f_{2,i} + \cdots. + q_{m,2}f_{m,i} \\ &\vdots \\ p_{m,i} &= q_{1,m}f_{1,i} + q_{2,m}f_{2,i} + \cdots + q_{m,m}f_{m,i} \end{aligned} \quad (8)$$

Needless to say, when a row or rows of projection matrix Q is or are identical to zero, some features which are represented by that specific row or rows would be deemed as irrelevant or unnecessary feature and, hence, they may be dropped. This feature is the selection feature, i.e., the most discriminative features of the original data are chosen to classify them and it turns out that the selection x most discriminative features of m features is the same as the constraint problem below.

$$\|\overline{\mathrm{Q}}\|_0 = \mathrm{x} \quad (9)$$

Solving the matrix equation (8) the solution is obtained as eqn (9). The above analysis demonstrates the good feature selection property.

D. Optimization of extracted features using Salp Swarm Optimization algorithm:

Another optimization method is adhered to in order to obtain the most suitable features in order to be used in fitness. Salp swarm optimization algorithm (SSOA) is a good method to identify the robust features. Salps is like jellyfishes in tissues and locomotion. They are more percentages of water in their bodies. They travel by contracting its body hence pumping water out of their jellied bodies alter its positions. Salps in oceans swarm in a process known as salp chain. This act assists salps during foraging to allow them to move better. The optimization problems are tested by modeled salp chains, in a mathematical form.SSOA is initiated by simply secluding the population into two categories.that is the leader and the supporters. The front salp of thechain is referred to as the leader, and the rest of the salps are referred to as the. supporters. The salps place is specified on n-dimensional. that indicate the search space of a problem and n is an indicator.the problem's variables. These salps search after a food source.which defines the object of the swarm. This position ought to be updated regularly and therefore, the following equation is adopted.

do with the salp leader this:

$$y_j^1 = \begin{cases} S_j + c_1\left(\left(ub_j - lb_j\right) * c_2 + lb_j\right) c_3 \le 0 \\ S_j - c_1\left(\left(ub_j - lb_j\right) * c_2 + lb_j\right) c_3 > 0 \end{cases} \quad (10)$$

y_j^1: The position of the leader in the j th dimension, where food source in this dimension is S j, the upper and the bottom limits are ub j and lb j respectively. c 2 and c 3 are chosen randomly between 0 and 1 to sustain the search. space. Moreover, c 1 is the most crucial coefficient in this algorithm, because of the fact that it governs the trade-off between the exploration and the exploitation phase and is measured by the following formula:

$$c_1 = 2e^{-\left(\frac{4t}{t_{max}}\right)^2} \quad (11)$$

where t and t_{max} indicate the current iteration and the max iterations number, respectively. The leader's position is updated first then, SSOA starts to update the supporter's position using the following equation:

$$y_j^i = \frac{1}{2}\left(y_j^i + y_j^{i-1}\right) \quad (12)$$

y_j^i is the i-th supporter's position within j-th dimension and i is greater than 1. The concluding steps of the SSOA are given as an Algorithm:

Algorithm 1 Salp Swarm Optimization Algorithm

```
Set a population Y.
    repeat
    Compute the objective function for each solution y_i
    Update the best salp (solution) (F -Y^b).
    Update c_1 using Eq. (11)
  for i =1: N do
      if i == 1 then
          Update the position of salp using Eq. (10)
      else
          Update the position of salp using Eq. (12)
      end if
    end for
  until (t<t_max)
  Return the best solution F
```

E. Classification of features using Hybrid AlexNet and GoogLeNet

The input images are detected and classified by use of the hybrid AlexNet GoogLeNet classified method. AlextNet consists of 8 fully connected layers comprising of five convolutional and three fully connected layers. The final learning of the suggested scheme of visual information is the use of both the scene-level and object specific information to represent the images of the disaster. A model that is trained on ImageNet is associated with object specific information and the model trained on the data of the place is supposed to reveal information on the scene level. In Hybrid AlexNet GoogLeNet model, the final layer of the network contains an average pooling layer; that is separate and unlike max pooling layer of AlexNet. This is referred to as an Inception Network because it has more 3 layers than AlexNet. AlexNet GoogLeNet hybrid is a powerful model that offers detection and classification problem solutions. In this architecture, the different features are extracted in a single layer. This helps in boosting the neural network. During extraction, it possesses additional options of resolving the task. It may convolute the input or just simply pool it. Most of the inception modules in existence in final architecture are in sequence. The hybrid Alexnet GoogLeNet trains the neural network faster than Visual Graphics Group because the option of the pre-trained GoogLeNet is condensed. It is possible to extract the features of the various inputs of different sizes and they have used 1x1, 3x3, and 5x5 kernels per cell. High level structures found in the network model but involve heavy computations are done by convolutions with higher spatial kernels such as 5x5 and 7x7. There are two auxiliary outputs that are connected to the neural network to advance the overall performance. There was no visible influence of the primary auxiliary output on the final quality of neural network. The performance of the system was revealed by the additional auxiliary outputs. In this thicken connected network, all neurons are linked together through all the input neurons and output neurons. This led to the discovery of the GoogLeNet because of the correlations between them that the activation in a deep network is redundant. The real structure of the deep neural networks has a sparse connectivity among the initiations. The abnormal and normal photographs belonging to the presented dataset can be categorized using the given pseudocode, which is presented below.

Algorithm 2 Pseudocode for Hybrid AlexNet and GoogLeNet

```
//It detects and classifies the image
//Input: It can be a image or video
//Output: Detecting image using bounding box
v ← b.shape
half ← self.ta // 2
sqr p ← P.sqr(v)
multi_channel ← P.alloc(0., b, ch + 2*half+v)
sqr p ←P.set_subtensor(multi_channel,sqr p)
size ← self.t
beta ← self.beta / self.ta
for r in range(self.ta):
size← beta * sqr(ta)
size ← size ** self.ta
x ← x / size
return x
```

F. Alert Notification System:

The abnormal output from the classifier is given to the alerting system. There are three modules involved in this process. They are: Raspberry pi processor, GPS Module and Wi-Fi module.

(i)Raspberry pi Processor:

The alert system works with the help of Raspberry Pi processor. Raspberry is a minicomputer with the components mounted on a small area motherboard, which runs under of Linux operating system. It can be connected to monitor, keyboard and mouse. It includes HDMA port, 4 USB ports, 40 GPIO pins, Arm 11and SD card slot. Processor functions at 3.3 V, memory is 1GB RAM. This low-cost board has lot of conventions like real-time applications, education, home and industrial automation and commercial product. As many sensors are available to measure different environmental conditions like humidity, temperature, rainfall, precipitation etc. they are connected to the Raspberry

Pi processor. This sensor doesn't need more power supply and its cost is less.

Raspberry Pi is connected to all the components, code dumped in SD card is inserted in processor. The system is programmed using Python programming language.

(ii)GPS Module:

Global Positioning System (GPS) is a worldwide facility provided for 24 hours.It is a satellite based service established and implemented by United States Department of Defense.

It offers, three-dimensional information of the location along with precised velocities and timing services with a greater accuracy. Everybody can utilize the service at free of cost. Calculating the 3D position is normally done by the tracking device that waits until the GPS module is accessible on the signal of no less than four satellites. The coordinates of the tracked position are defined by three values, they are latitude, longitude and altitude. The tracking device transmits those coordinates and other information to a fixed IP address at a fixed port for exact server. Launching a GPRS connection will help in transmission of those data by using the GSM MODEM. GPS in Flood Management is being utilized progressively for flood assessment, including location of surface structures, the integration of inventory mapping and roughness providing information on flow emplacement parameters. In handling flood disaster GPS and SAR (Synthetic Aperture Radar) imageries are used to estimate flood water depth.

(iii)Wi-Fi module:

The Wi-Fi network has been the most robust technology that enables an electronic device to share the information, data or connect to the Internet in a wireless manner through the radio waves. It is readily available, in that, it is high bandwidth, cheap, extensive equipment compatibility, and no charge ISM frequency. Nowadays, the exposure of the Wi-Fi signal is experienced in many common areas, such as residence, the office building, restaurants, supermarket, and shopping malls. Wi-Fi module provides an appropriate way through which a raspberry pi processor acquires more operations. The Wi-Fi module comes with on-board antenna that links to Internet. The module has different operational modes depending on various requirements and application situation, we can choose the most appropriate mode. The data will be transmitted to the target server automatically by setting the time in the processor by the Wi-Fi module. The module is linked to the Internet wirelessly on the network router.

Thus, the Raspberry pi processor connected to the GPS module and Wi-Fi module process the abnormal data found on flooded sites. The GPS system tracks the latitude and longitude of the location to be affected. This will send the alert notification mail to the corresponding server based on the longitudes and latitudes attributes using the Wi-Fi module. The user receives the alert mail regarding flood overflow with the appropriate location details.

IV. Performance Analysis

The performance analysis of proposed technique is estimated and the achieved outcomes are illustrated in this section.

(i) Analysis of flooded Krishna and Godavari River region:

The history of flood discharge data in the past years and future forecast on rainfall are examined. Andhra Pradesh has the second longest KM of coastal line at 1037 KM long. The State is susceptible to post-monsoon floods because of more than 35 large and small rivers that traverse the State. Among the similar features of the two rivers are that they are very wide and carry outliers in the form of deltas, they both release high amounts of water during the monsoon season (June to early Sept) and low levels during the dry season (October to late May), and they both empty into the Bay of Bengal.

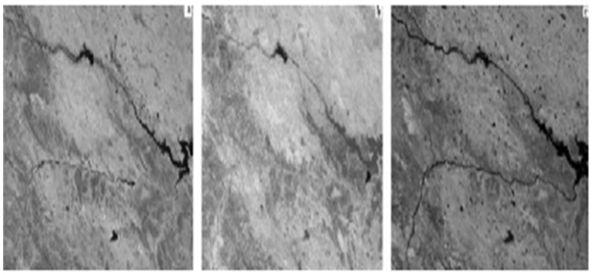
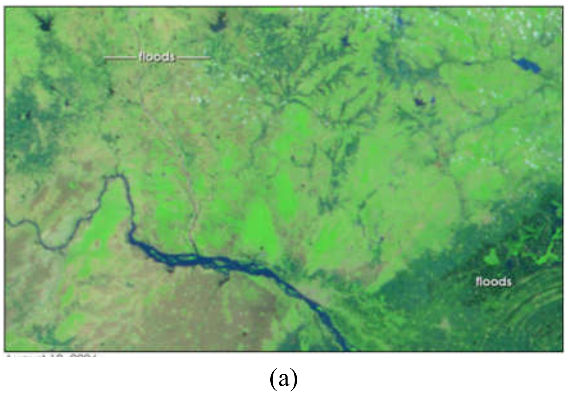


Figure 2 (a) Original Modis Satellite Image of Krishna river Region before Flood (b) Original Modis Satellite Image of Krishna river Region During Flood and (c) Original Modis satellite Image of Krishna river Region after Flood.

Fig.2 displays the satellite image of floods in Krishna and Godavari region during October to November 2009 with before images of floods and after floods.



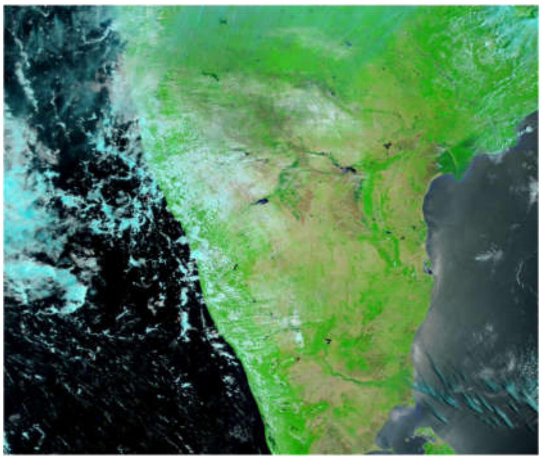
(a)

(b)

Figure 3 Flooded Krishna River Region from Satellite Imagery. (a)after flood (b)before flood

The rains that occurred in India due to the monsoons caused floods in most of the region and this began in May and extended into August 2006. On August 19, NASA took the best picture of the floods in the south-eastern state of Andhra Pradesh which was taken by the MODIS (Moderate Resolution Imaging Spectroradiometer) on the Terra satellite. In Fig.3(b)the first picture it can be seen that, the Krishna River is swollen than what it was in early July, Fig.3(a) before the rains began in this area. Massive overflow also appears along the banks of the tributaries of the Krishna that deviate off the river in vivid blue veins in the same way that tree branches do in winter. There is water in the lower-right corner of the picture that darkens the wetland between the Krishna and the Godavari River, which lies just to the right of the picture.

(a)



(b)

Figure 4 View of flood affected areas through satellite in Krishna River (a)Image after flood (b)Image before flood.

At the time the two south Indian states to be affected are the Andhra Pradesh and Karnataka. In fig.4, there is a section of Krishna River that empties into the Bay of Bengal located in Andhra Pradesh. The highest-ranked image taken was by MODIS (The Moderate Resolution Imaging Spectroradiometer) on NASA Terra satellite during October and the lowest-rank months was received on September. In fig 4(a), bare ground is pink-beige, vegetation is bright green, clouds are pale turquoise and water is blue. In Fig 4(b) on September, the majority of the channels are dry and only a small drip of deep blue water can be seen which seems to dry before reaching the coast. The deep water is definitely not visible by MODIS when it is very shallow and the river channels might contain more water than this image suggests. During October however, the channels are filled to the brim with water. On October, the Krishna River recorded the highest discharge of water at Prakasam Barrage which replaced the previous record made by the river in 1903 when no dams on the river were recorded by Press Trust of India.

Figure 5 Satellite image of Krishna and Godavari River flooding

The hardest hit area was an east west band of heavy rain in the states of Andhra Pradesh, east coast, and Karnataka, west coast. Millions of people were evacuated between the two states. The torrential rains swept away farms, homes and infrastructure. In this image, the amount of rainfall in September and October was shown. The highest rainfall is over 600 millimetres which is in blue. The most light are those in pale green. The estimates of rainfalls represented in the image in fig (5) at the near-real-time, multi-satellite precipitation analysis of NASA in the Goddard Space Flight Center.

Figure 6. Flooding in Krishna and Godavari river-Satellite View

In Fig.6.The two Deltas in South India are Godavari and Krishna rivers. The Krishna River (southwest, lower in image, the mouths of the Godavari River (northeast; upper in image) empty into the Bay of Bengal in this low-oblique, northwest-looking photograph. The river also traverses the Deccan Plateau and empties into the Bay of Bengal southwest of the Godavari River Delta.so the monsoon results in heavy flood discharge in these delta regions.

Figure 7. Satellite Image of Floods in Krishna Godavari

Influenced by low-pressure, crushed crops in thousands of acres, massive floods of the rivers Krishna and Godavari submerged quite a lot of villages and ruined crops in thousands of acres. This is depicted in fig.7 and the flooding on Krishna River had an adverse effect on the city of Vijayawada and other neighbouring areas. The flow of Godavari flood surpassed the mark of twenty lakh cusecs. The four days have been a succession of rains, which have flooded East and West Godavari through more than 200 villages.
districts.

The flow of the floods in annual basis was sorted in descending order and recorded the top figure and so on. Considering the values, obtained the recurrence interval or return period and positions of the probability. The frequency and likelihood of flooding discharge is first determined using the technique of Gumbel. Standard deviation and frequency are used to determine the level of flood discharge. The total flood discharge is determined by taking into account the area and the quantity of discharge of floods.

Table1 District wise Flooded areas

Regions	**West Godavari**	**East Godavari**	**Krishna**	**Guntur**
Area Affected(%)	2.82	22.13	32.30	27.59
Total area(Sq.km)	323	2091	1386	718

Area Affected(Sq.km)	9	463	448	198

In Table1, the flood affected districts of West Godavari, East Godavari, Krishna, Guntur area details are collected are classified with percentage of areas, and total area in square kilometres. Also areas flooded in square kilometre are tabulated. Using this data's a chart is derived.

Based on the Fig.8, the maximum expansion of the hazard zone has been observed in the locality of the river or stream systems up to 30 km of the position of the current coastline. Multi-hazard susceptibility sector has recorded in the whole area of 1147.51 sq km amid the 4572.47 sq.km. Krishna is seen to be the most vulnerable and West Godavari is the least vulnerable districts to the coastal multi hazard vulnerability.

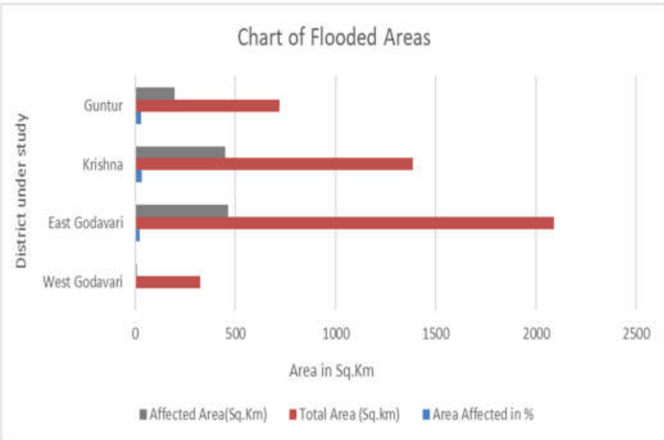


Figure 8 District wise chart of Flooded areas

Table2 Calculation of flood discharge using Various Return periods in Krishna-Godavari region.

Return period P in years	Mean (X_f)	Standard Deviation (S_f)	Frequency factor (K_f)	$X=x+K_f \times S_f$ (TMC)
5	519.64	17.59	0.913	1744.57
10	519.64	17.59	1.615	1784.78
20	519.64	17.59	2.289	1823.33
50	519.64	17.59	3.161	1873.34

In Table 2, by the Gumbel's method calculated the values for the future prediction which may include the surrounding areas of the AndraPradesh. Gumbel's method is used for the prediction of flood in the future. The estimated flood discharge for the next 20 years will be 1823.33 TMC and the estimated flood discharge for the next 50 years be 1873.34 TMC.

(ii)Performance Analysis of various techniques:

The proposed model is analysed and comparative study is done. For comparative analysis, we performed classification with algorithms: SVM, ResNet, VGG 16, VGGNet 19 and the proposed model.
For all experiments, we have estimated the precision, recall, and F1 score and overall accuracy (OA). The calculations are done as follows:

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

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

$$F1=2\cdot\frac{Precision.Recall}{Precision+Recall} \quad (15)$$

$$OA=\frac{TP+TN}{TP+FP+TN+FN} \quad (16)$$

Where, true positive is denoted as TP, which is the number of samples properly classified as flooded sites; true negative is denoted as TN, which is the number of samples properly classified as non-flooded sites; false positive is denoted as FP, which is the number of samples incorrectly classified as flooded sites; false negative is denoted as FN, which is the number of samples incorrectly classified as non-flooded sites

Table 3 Comparative analysis of prediction ability of existing and proposed methods

Techniques	Precision	Recall	F1-score
SVM	0.816	0.823	0.819
ResNet	0.918	0.834	0.875

VGG 16	0.894	0.720	0.782
VGG Net 19	0.910	0.841	0.867
Hybrid AlexNet GoogLeNet (Proposed)	0.924	0.859	0.888

Table 3, shows the comparative study of prediction ability of the existing and proposed techniques. The projected analysis is compared with existing techniques like SVM, ResNet, VGG 16, VGGNet19, Hybrid AlexNet GoogLeNet (proposed)technique in terms of precision, recall and F1 score. The outcome shows that the proposed technique is better than existing methods.

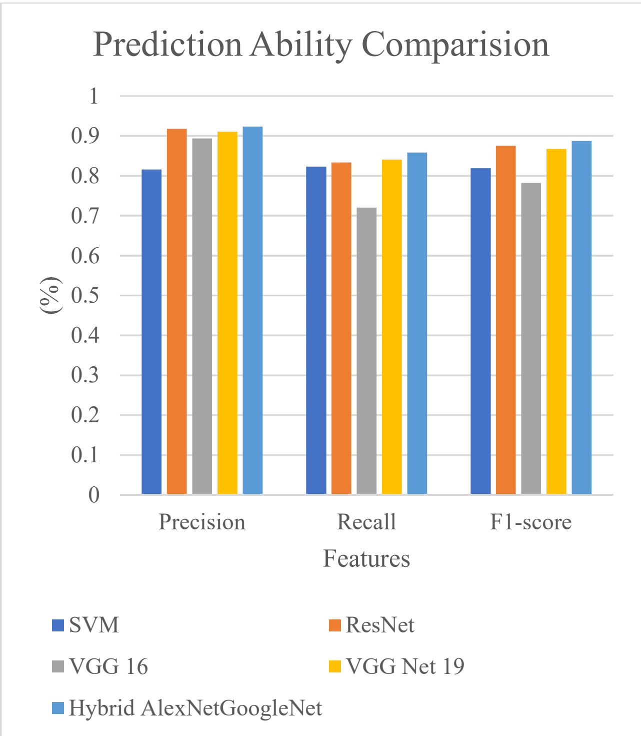


Figure 9 Comparative Prediction Analysis

Fig.9 is the graphical illustration of comparative analysis of prediction ability of both existing and proposed techniques with the metrics such as Precision, Recall and F1-score. The proposed scheme has achieved better outcome of metrics like precision, recall and F1-score.

Table 4. Comparative analysis of overall accuracy of prediction [22]

Techniques	Overall accuracy
SVM	88.08
ResNet	86.98
VGG 16	90.45
VGG Net 19	89.78
Hybrid AlexNet GoogLeNet	97.86

Table4.displays the comparative analysis prediction of overall accuracy of the existing and proposed technique. The proposed method Hybrid AlexNet GoogLeNet is compared with existing methods like SVM, ResNet, VGG 16 and VGGNet 19. The results observed shows that the proposed technique is accurate with 97.86% output.

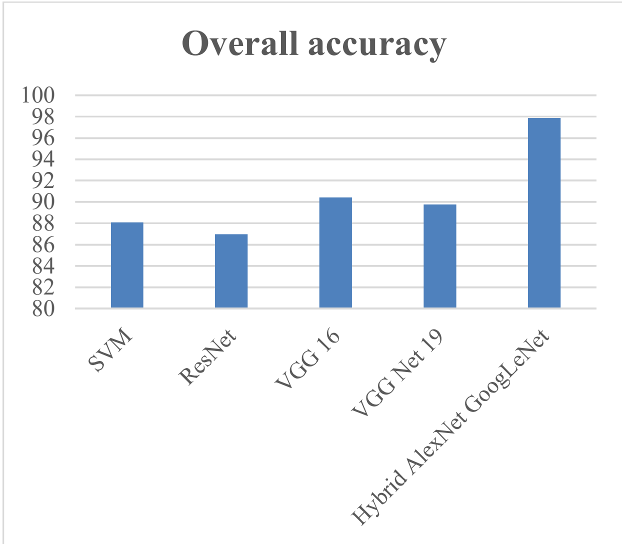


Figure 10. Comparative Accuracy Analysis

The graphical analysis of fig.10 shows 97.8% accuracy of Hybrid AlexNet GoogLeNet model which derived higher performance compared to SVM, ResNet, VGG 16 and VGGNet 19. Hence the technique used is better when compared to the earliest techniques.

V. Conclusion

A hybrid deep learning method with automated flood monitoring and alert system is adapted by the classification approach in this scheme. To begin with, sensed data from cloud is pre-processed and the features are taken out using Adaptive polynomial based linear discriminant analysis. The extracted features were processed in feature subset selection and the projecting features are selected. Then the selected features were evaluated and improved for the prediction accuracy by using using Convergent salp Swarm optimization algorithm and the features are optimized. The optimized output was then programmed by the Hybrid Alex Net and Google Net classification approach and the abnormal output are identified.

These abnormal entities were processed by the Raspberry pi processor alerting system with GPS and Wifi modules.The corresponding latitude,longitude of the flooded location was identified and sent as mail by the Raspberry pi processor. The results obtained were compared with the predefined models and analysed that the proposed scheme has better overall accuracy in terms of precision, recall and f1-score. Also, the warning system function has alerted at the proper time by sending the mail to the server.

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