

A Drone Remote Sensing for Virtual Reality Simulation System for Forest Fires: Semantic Neural Network Approach

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Abstract— Wild fires have significant impact on atmosphere and lives. The demand of predicting exact fire area in forest may help fire management team by using drone as a robot. These are flexible, inexpensive and elevated-motion remote sensing systems that use drones as platforms are important for substantial data gaps and supplementing the capabilities of manned aircraft and satellite remote sensing systems. In addition, powerful computational tools are essential for predicting certain burned area in the duration of a forest fire. The reason of this study is to build up a smart system based on semantic neural networking for the forecast of burned areas. The usage of virtual reality simulator is used to support the instruction process of fire fighters and all users for saving of surrounded wild lives by using a naïve method Semantic Neural Network System (SNNS). Semantics are valuable initially to have a enhanced representation of the burned area prediction and better alteration of simulation situation to the users. In meticulous, consequences obtained with geometric semantic neural networking is extensively superior to other methods. This learning suggests that deeper investigation of neural networking in the field of forest fires prediction could be productive.

Keywords- Drone Remote Sensing, Semantic Neural network, Machine Learning, Fire Simulator.

1. Introduction

Forest fires are common, especially some summer stages in India. Forest fires, frequently experienced in regions with hot, dry, or mediterranean climates, represent a risk to life and extent infrastructure [1]. In Andhra Pradesh, the geographical area has 160,204 sq. km, forest region has 24,424 km², change in forest cover reduced to 0.27% from 2013 to 2015 as per India State of Forest Report, 2015. Notwithstanding the fact that these fires can cause extensive economic damage they also threaten human life. Furthermore, the aftermath of forest fires can have other far-reaching consequences [2] [3]. For example, several substantial, chemical, mineralogical, and natural dust properties can be affected by wild fires. Negative things resulting from high levels of burn harshness include important removal of natural stuff, descent of equally soil structure and full of tiny holes. Also, the releasing hazardous chemicals significantly impacts human health and increase the risk of future diseases [4]. Wildfire smoke is accompanied by high concentrations of carbon dioxide, which can result in consequences such as headache, mental disorder, vomiting, confusion, unconsciousness, and smooth death [5]. Still at minor concentrations, the effects of carbon dioxide should not be neglected; persons with cardiovascular disease can occurrence chest pain and cardiac arrhythmia. A comprehensive learning track wildfire fire fighter deaths from 1990 to 2006 reported to facilitate 21.9 % of their deaths occurred from heart attacks.

Since 1860s, the first airborne photographs were taken by using balloons as platforms. Airplane is used as above ground pictorial platform in World Wars I&II. In 1960, the first invention of world orbit satellite was launching keen on breathing space with those are completely meant for investigation. Suddenly, above ground inaccessible sense plus space borne/ settlement distant sensing has slowly turned into famous terms [6]. Drones have been used for investigation from last decade in civilian purposes, although their modern appliance to inaccessible sensing is extremely quick. At present, drone is originate into the fields of meteorology, accuracy cultivation, animal observation, forestry, traffic monitoring, ground supervision, communications inspection, usual disaster management, rescue, wave emergencies and wilderness search



We may call this great-extent remote sensing plan is murmur distant sensing toward decide that commencing plane and satellite inaccessible sensing [8]. The capability of predicting fire evolution and area burned is crucial to justifying the immediate and important consequences of wildfires. Present researchers have attempted to cover this gap, mostly through statistical methods. So predictive techniques would enable decision makers to deal with large amount of data in a most timely manner [9]. The Wild land Fire Management Research, Development & Application Organization (2012) proposed a wild land fire decision support tool called Fire Spread Probability. It is a good probabilistic method that predicts fire expansion, and it will take time consuming for decision making. It addresses fire growth beyond the timeframes of reliable weather forecasts by using historic climatologically data. This method calculates and maps the probability that fire will spread to areas on the landscape based on the present fire boundary or explosion point [10].

In this paper, we intend a smart system based on neural network for the forecast of burned areas of forest fires. In order to build predictive models, we only considered data relating to forest characteristics and meteorological data. Drawing on the idea of using computational intelligence techniques, we employed supervised neural networks for forest fires, which were able to produce results significantly better than traditional methods [11].

2. Methods

2.1 Study Area

The State of Andhra Pradesh is placed in the middle of eastern half of the Indian Peninsula lying between $12^{\circ} 41'$ – $19^{\circ} 54'$ N latitudes and $76^{\circ} 46'$ – $84^{\circ} 45'$ E longitudes. The Greater Visakhapatnam Municipal Corporation (GVMC) is one of the biggest fire areas in Andhra Pradesh. The Kambalakonda Reserved Forest spread over 7,146 hectares located near Visakhapatnam, Andhra Pradesh, India. In this study, artificial neural network has been used to detect forest fires. The developed algorithm detects the forest fire automatically and shows the value as '1'. If there is no forest fire it will show as '0'. This method reduces the cumbersome field work and it gives an accurate area and intensity of fire without much delay. In the light of developing technology Drone Remote Sensing also provides information of forest fire. This can be used as, when the forest fire breaks and reports the event to the concerned authority. The authors obtained besides neural network algorithm the remote sensing drone data can be coupled to arrive exact forest fire area.

This method curtail the time, money and man hours. Manual assessment takes more time and money. The manual survey may give some times ironies results. In view of that Artificial Neural Networks and Drone Remote Sensing technologies were studied to suggest alternative method to detect forest fires. The advantages of drone inaccessible sensing consist of small substance with prepared expenses, easily supervision of spatial and sequential decision, high-intensity data gathering and lack of threats to crews. This research involved in low-cost (\$150) and lightweight (1kg) fixed-wing murmur motorized through 2200 mah battery and video camera. That drone can fly over 25 minutes per mission and face a whole space of 15 to 20 km. Mostly, researchers assembled the murmur images in the direction of expand land use/ land cover maps at a spatial declaration of 5.1 cm, used the film recording to notice human being actions (e.g., burning and logging) and collective the symbolic and film information to review wildlife cluster and recognize vegetation and forest fires [7]. The recommended drone inaccessible sensing might guide toward main savings during requisites of time, manpower.

2.1 Standard training techniques

Empirical evaluation is the best solution for validation of semantic neural networks, i.e., testing of simulation and experiment. Standard methods to confirmation of neural networks are mainly based on practical estimation during replication and/or investigational difficult. So many methods are there for supervised training of neural networks but feed forward and back propagations are the best methods for identifying of burned area. Back propagation is a good technique for supervised education; it requires information position of the required production for numerous inputs and construction of preparation place. Generally this is used in supply overconfident neural networks. The basic attention is shared out the fault task diagonally the secreted layers then the total outcome should be place on production [11].

One of the feed forward artificial neural networks is multilayer perception that is mapping of set of input data with suitable output data. It has number of multiple layers with different nodes in a directed graph; every layer should be connected with next layers. Each node in the network may consist of activation function except input nodes. Where it may use multilayer perception technique with supervised learning and finally it shows a back propagation neural network. It is a standard linear perception model for obtaining of burned area information in forest fires [9].

2.2 Advanced training techniques

Neural networks signify a group of systems that do not robust into the present paradigms of software growth and documentation. In its place of being planned, a knowledge algorithm “teaches” a semantic neural network via a place of information. Regularly, the non-deterministic effect of the version, the semantic neural network is measured a “black box” and its reaction could not be expected. The testing of neural network with related information as that used in the preparation set, that is one of the only some method use to confirm that the network has sufficiently educated the contribution area. In general the instance, such conventional testing methods show sufficient for getting of a Semantic Neural Network System (SNNS). Though, in additional composite, security and task-significant systems, the standard neural network training and testing method is unable to supply a consistent means for their guarantee [8]. Therefore we introduced semantic neural network system, it shows guarantee of burned area in forest lands.

One of the main compensation of neural networks is their capability to take a broad view. This way that a qualified network categorizes information commencing similar group as the knowledge facts that was certainly not seen previously. Factual planet application developers usually contain a little fraction of every likely pattern designed for the invention of a neural association. Towards achieve finest simplification, the information position must be alive opening into three aspects: justification, preparation, test set and validation. Justification set has a minor proportion of instances from the original data set, and is used to decide whether certain network plan. If the validation is successful, then only we can do the training. The training set is useful in the direction of neural system intended for education plus modification. The hard position is then used towards determine presentation of the neural system with calculation of an incorrectness measure [10].

The validating-training-testing method is the primary one, and repeatedly the simple, alternative structure designers believe intended for the assessment of a neural system. Finally, total evaluation is done with the frequent request of neural system preparation information followed with a demand of neural system testing facts to decide whether the neural system is suitable or not.

3. Semantic Neural Network System (SNNS)

Supervised is a faster learning algorithm, whenever the category nodes are increasing then it is supported to all incoming nodes. However, every learning stage should have a class with number of category nodes. Consequently, borrowing an uninterested node from an additional class, while an exact set runs away of casual class nodes, is not feasible. A casual node in supervised knowledge is open in the direction of signify some set. So that together networks be capable of perform the work quickly, because guidance moment be a little bit of instant and classification instance be a small number of seconds [06]. Given that together networks contain the similar categorization accuracy. For the duration of the education phase, the option cost is calculated intended for every dedicated class nodes for every one of heaps:

$$\begin{aligned} R &= \sum_{i=1}^{2M} (A_i \wedge W_{ijk}) \\ S &= \beta + \sum_{i=1}^{2M} W_{ijk} \\ T_{jk} &= R / S; j=1 \dots D(k); k=1 \dots N \end{aligned} \quad (1)$$

Where $A \wedge W$ means that retrieval of minimum value from (A, W) in fuzzy logic, W_{ijk} are the different weights (may change based on input values), which join every group node ‘jk’ in each heap ‘k’ among every contribution nodes i ($i=1 \dots 2M$), ‘M’ is the measurement of the normalized participation vector A[

0, 1], $D(k)$ is the number of dedicated nodes in the heap number 'k', 'N' is the total number of classes, and 'a' is the option parameter ($a > 0$).

In support of every heap, the highest option worth node is calculated among all its dedicated group nodes:

$$T_{jk} = \max\{T_{jk}; j_k = 1 \dots D(k)\} \quad (2)$$

The group alternative (attractive joint) is calculated with influential highest option rate joint in the middle of every nominee of every heaps:

$$T_{JK} = \max\{T_{jk}; J_k = J_1 \dots J_L\} \quad (3)$$

Significance occurs when the attractive joint corresponding cost is superior otherwise equivalent towards the pre determined observation factor:

$$\sum_{i=1}^{2M} (A_i \wedge W_{ijk}) / M \geq \phi \quad (4)$$

Group corresponding occurs when heap number is attractive joint that is equivalent towards the group rules of the present contribution. Whenever, together significance plus group corresponding occurred, every weights of the attractive joint must be qualified:

$$W_{ijk}^{\text{new}} = \beta (A_i \wedge W_{ijk}^{\text{old}}) + (1 - \beta) W_{ijk}^{\text{old}}; i = 1 \dots 2M \quad (5)$$

Otherwise, the cost of '-1' is assigned towards the option cost of this group joint to place it away of contest. Then next uppermost option cost joint is strong-minded from the heap of the before attractive joint, to symbolize its heap finally attractive joint is re-computed [19]. Where the observation parameter is

$$\Phi^{\text{new}} = \max\{\phi^{\text{old}}, \sum_{i=1}^{2M} (A_i \wedge W_{ijk}) / M\} \quad (6)$$

This has been recommended by Carpenter et al. (1997) in categorize to build the network to categorize uncommon measures. We remain doing this until any one of the dedicated group nodes can signify the present input or a novel node must be dedicated. In the later case, the input vector is assigned to the weight vector of the recently dedicated group node, and the observation factor is rearranged to its early value. At the last part of the preparation stage, the weights of every dedicated group nodes are overlooked. Throughout the categorization stage, the key vector is introduced towards the set of connections. The group joint by the highest option cost is calculated with every dedicated group nodes of every heaps [10].

4. Results

Throughout this research, the algorithm produced numerous techniques of SNNs. Let sought after to discover out what is the popular significant item to do through the network preparation in command to obtain most excellent grades. What proved away to be essential to achievement of preparation is a choice of suitable amount of unknown neurons through creating of a novel neural network. A single secreted layer is in most cases proved to be enough for the training success. Since it curved, in our experimentation is improved to employ additional neurons [13].

In the standard techniques we used double-layer architecture, but they did not show results. Number of tests was done throughout experiment; finally conclude sensitivity of neural networks has low and high values of parameters [12]. However, semantic neural networks algorithm shows the training techniques between standard and advanced. Where training attempt seven, thirteen and twenty five shows best results than others. Where Training Attempt (TA), Number of Hidden Neurons (NHN), Number of Hidden Layers (NHL), Training Set (TS), Maximum Error (ME), Learning Rate (LR), Momentum (MT), Number of Iterations (NoI), Total Mean Square Error (TMSE). Table 1 describes standard training techniques in forest fires data. Table 2 describes advanced training techniques in forest fires data [9].

Table1. Standard training techniques for forest fires data

TA	NHN	NHL	TS	ME	LR	MT	NoI	TMSE	PB	NT
01	02	01	Full	0.01	0.2	0.7	NC (>9117)	/	/	No
02	02	01	Full	0.01	0.4	0.7	NC (>46847)	/	/	No
03	02	01	Full	0.01	0.6	0.6	105	0.0593	/	No
04	05	01	Full	0.01	0.2	0.7	6993	0.0252	02/05	No
05	05	01	Full	0.01	0.4	0.7	13	0.0332	05/05	Yes
06	05	01	Full	0.01	0.7	0.7	10	0.0344	05/05	Yes
07	05	01	Full	0.01	0.7	0.3	13	0.0327	05/05	Yes
08	09	01	Full	0.01	0.2	0.7	837	0.0596	20/05	No
09	09	01	Full	0.01	0.4	0.7	28	0.0333	05/05	Yes
10	09	01	Full	0.01	0.7	0.7	19	0.03495	05/05	Yes
11	09	01	Full	0.01	0.5	0.3	23	0.0329	04/05	Yes
12	09	01	Full	0.01	0.7	0.1	18	0.0331	05/05	Yes
13	09	01	Full	0.01	0.7	0	14	0.0328	05/05	Yes
14	43	02	Full	0.01	0.2	0.7	690	0.0556	02/05	No
15	43	02	Full	0.01	0.4	0.7	3408	0.0414	01/05	No
16	43	02	Full	0.01	0.7	0.7	NC (>30000)	/	/	No
17	43	02	Full	0.01	0.3	0.4	961	0.0601	01/05	No

Table2. Advanced training techniques for forest fires data

TA	NHN	NHL	TS	ME	LR	MT	NoI	TMSE	PB	NT
18	09	1	/	10%	90%	0.01	0.2	0.7	/	2
19	09	1	10%	70%	30%	0.01	0.2	0.7	Yes	540
20	09	1	10%	70%	30%	0.01	0.4	0.7	Yes	270
21	09	1	10%	70%	30%	0.01	0.7	0.7	Yes	146
22	43	2	10%	70%	30%	0.01	0.2	0.7	Yes	9207
23	43	2	10%	70%	30%	0.01	0.4	0.3	Yes	1256
24	84	2	10%	70%	30%	0.01	0.7	/	Yes	1806
25	84	2	30%	80%	20%	0.01	0.7	/	Yes	1246
26	09	1	30%	80%	20%	0.01	0.2	0.6	Yes	944
27	43	2	30%	80%	20%	0.01	0.2	0.3	Yes	540
28	43	2	30%	80%	20%	0.01	0.5	0.6	Yes	1485
29	09	1	30%	60%	40%	0.01	0.7	0.7	Yes	142
30	43	2	30%	60%	40%	0.01	0.4	0.7	Yes	80
31	84	2	30%	80%	40%	0.01	0.7	/	Yes	1326

(a) Now the network just finished training in 105 iterations. Total net error is satisfactory and we can now access the test. The data set for testing will be already created data set. (b) The network completed training for 6993 iterations. This result already indicates slowly moving in the right direction. Total net error that we will not tolerate will be over 5 percent. All values of total net error below this value will be acceptable for our case. (c) Now the network completed training for 13 iterations. Let's go now to test the network. (d) In only 10 iterations process of training is finished [14]. Hoping to get even better results we will do the test with whole data set. (e) We can see that process of training is finished in 837 iterations. Let's see the test results. (f) The above image the entire network is effectively skilled. That carried only two iterations for preparation procedure to conclude. (g) We can see that training process is finished after 540 iterations, that is good. Now we want to see the results of testing another 30% of data, which did not appear in this training data. (h) After 1806 iterations process of training is finished. The results may show the test with

rest 30%. (i) It has 1246 iterations with end process. The following Figure 1 shows total number of test samples from training attempts from one to twenty nine [15].

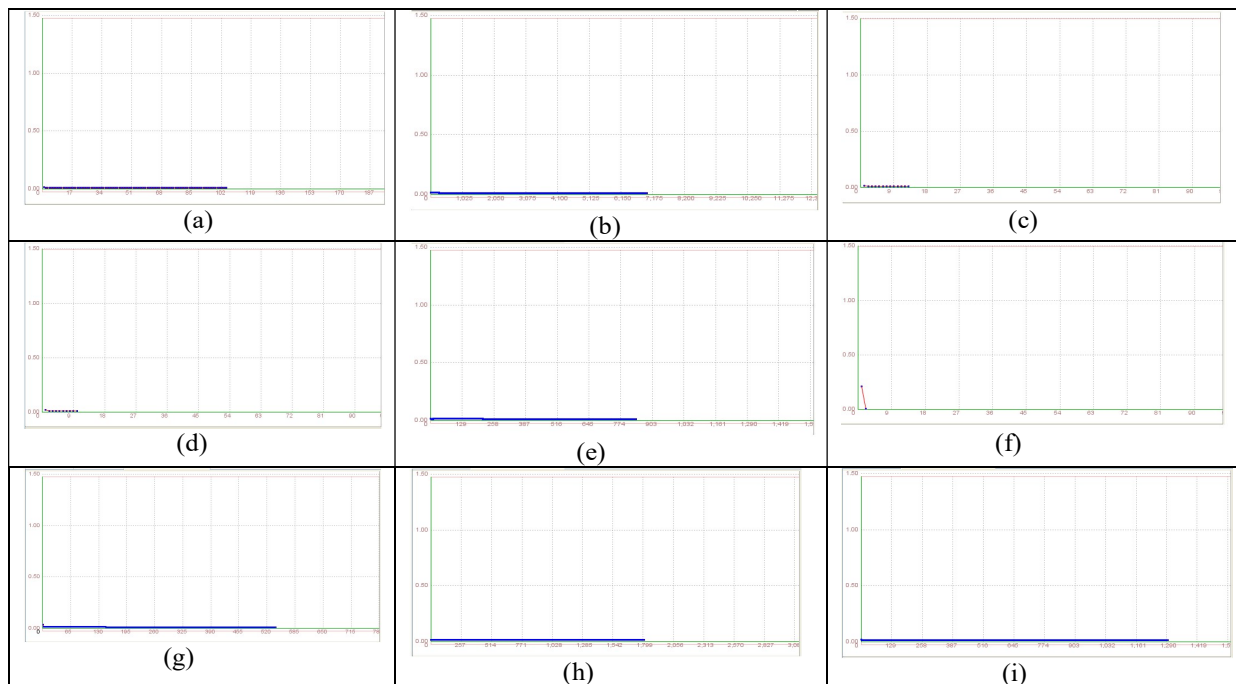


Figure1. Total number of test samples from training attempt from 1 to 29.

Then we need to train the neural network with training set that contains 80% of instances with learning rate 0.7. After 1246 iterations process ends, and we may seen the training was successful. The entire mean square fault in this case is radically minor than out the earlier attempt, i.e., 0.03599245182360657 of accuracy. This is the best solution for obtaining of suitable results in semantic neural network system.

5. Conclusion

The new genetic operators of neural networking, called geometric semantic operators, enclose the very attractive assets suggest a uni modal robustness of landscape for several problems consisting of corresponding input data into well-known output values, those are failure and classification instances of the universal trouble. Now we showed a novel smart neural network based system that makes employ of these operators to examine burned neighbourhood. The most important goal was expansion of a system for predicting the quantity of area that will be burned for the duration of a forest fire, based on open associations between meteorological data, forest-related data, and the sum of burned area. The comparatively small MAE obtained from investigational consequences showed that geometric semantic neural networking outperforms standard artificial intelligence and produces outcome with the purpose of superior or equivalent to the ones achieved with modern machine learning methods designed for this application.

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