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Advanced Weather Forecasting Prediction using Deep Learning

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Abstract: ***Weather forecasting has a pivotal role in everyday life, including worldwide agricultural and industrial sectors as these things are based on the weather conditions. Besides forecasting it is used to for the purpose of warning about the natural disasters. It is a technique, through which we can predict the weather condition of a given location, with the help of science for the purpose of observation of thriller weather. Through these technologies, we can mend a way to foresee natural stuffs like cloud cover, rain, snow, wind speed and temperature. Weather forecasting is used to determine the exactness of weather parameters then the future weather condition on the basis of this parameters. At the time of analyzing the existing data of the previous years it infuse proposed scheme or techniques which is with a tendency to conclude that, machine learning paradigm and allows to research the given set of knowledge and get the needed information from the given data, so through this we can track the unpredictable patterns of climatic conditions, a prognosticative model is also followed. For this work, various weather parameters were collected from national climate data center then with the help of Long-short term memory(LSTM) technique, the neural network is trained for various combinations. In the process of predicting the weather condition using LSTM, the neural network is practiced using different combinations of weather parameters like temperature, precipitation, wind speed ,pressure, dew point visibility and humidity. After training of LSTM model with these parameters we can predict weather condition.***

Keywords: Weather forecast, artificial neural network, LSTM, weather prediction, recurrent neural network

I. INTRODUCTION

Weather plays a great role in human life. Many of our daily activities and businesses depend on weather conditions. As well as, there will be a huge loss in life and property due to the unpredictable weather conditions. If its possible to foresee the weather conditions earlier, then we can prevent or minimize the losses. The atmospheric condition of the earth does not remain same at every time. We have various seasons like summer, winter, spring, autumn, Monsoon, etc.

Weather changes from time to time.

This weather change is rather normal and regular phenomenon of the world. Artificial neural network (ANN) is an effective technique to construct a computerized system that is capable of processing non- linear weather conditions inside a specific domain, and make predictions. It is inspired by biological neuron model. In artificial neural network numbers of highly nonlinear neurons are interconnected so as to forming a network.

ANN is with three layers our neurons and those are: Input layer, Hidden layer, And output layers. These neurons are connected by links which comprises of weight; weights are the connection quality which exists between the neurons in the system [10].

Basically ANN is the system that receives the input, process the data and then gives output with respect to input. More complex is the system, large is the network.

Neural network with multilayer has a input layer, one or more hidden layer and a layer of output. Weather, which is data-intensive; while the dataset, highly non-linear and so we can exactly foresee the weather condition with the help of ANN. On the basis of our needs, numerous neural networks are designed. Out of these various neural networks, Feed-forward neural network is used for both the purpose of predicting atmospheric condition and financial forecasting [10] .ANN and its advantages are like collecting data, detecting the trends in addition to this we can predict the pattern, through generalization; which is not provided at the time of training [9].

ANN, it is a tool with features like a effective data-driving technique and flexible computation; it captures non-linear with high accuracy and critical underlying characteristics of physical process. ANN, with it's unique features, forms machine learning office algorithms as simple task; while facing tough pattern new task.

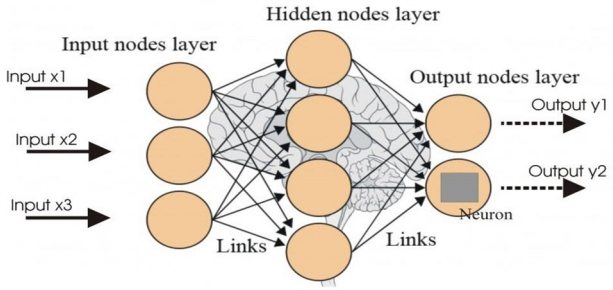

Fig.1: Basic ANN architecture

The above figure presents the architecture of artificial neural network that consists three layers. As mentioned before, the primary layer has neurons of input, the second layer has hidden neurons, and the third layer has output neurons. (Supervised neural networks) SNN are trained to give needed outputs in regards to the training set of inputs. It is trained by providing it with input and matching output patterns.

II. RELATED WORK AND LITERATURE SURVEY

In this section, the author presents the review of previous studies in weather prediction. The work done by different researchers and their comparison is mentioned below.

Pushpa Mohan et al[1],proposed the suitable classification methods like Support Vector Machine (SVM), neural networks are employed for better classification outcome. These techniques will help in predicting the rainfall, crop yield forecasting and cost prediction of crops.

P.Shivaranjani et al[2],reviewed the machine learning algorithms to perform the weather prediction with data mining techniques for rainfall prediction.

Amruta A. Taksandeand et al[3],used the FP Growth Algorithm to generate decision trees and rules for classifying weather parameters such as maximum temperature, minimum temperature, rainfall, humidity and wind speed in terms of the month and year.

Basvanth Reddy et al[4],proposed weather prediction using big data environment and method used by them is hadoop with map reduces to analyze the sensor data, which is stored in the National Climatic center and provide better result.

Dr.S. Santhosh Baboo and Kadar Shereef (2010) A significant predicting system, used to forecasting weather with ANN. This paper illustrated how an intelligent system can be efficiently integrated form the purpose of predicting the weather condition with the neural network model 5].

Rohitkumarreddy, P. bhanusaikiran and P. Nithinchowdary (2015) Forecasting weather with ANN and data mining. In this work, the researcher made an effort to forecast the weather using both the exploration and sophisticated artificial neural networks [6].

Santhanam,Tiruvenkadam and A.C. Subhajini(2011) An important forecasting of weather with a radial basis function network. In this paper, on the basis of various facts derived from meteorological department, neural network was designed for forecasting weather[7].

SaktayaSuksri and WarangkhanaKimpan (2016) The training model of neural network for forecasting weather using the fireworks algorithm. In this paper the researcher has used fireworks algorithm to foresee the climatic condition of a day, especially the temperature which is highly depends on parameters from meteorological department [8].

III. RECURRENT NEURAL NETWORK AND LSTM

A recurrent neural system (RNN) is a class of ANN where connections between units form a coordinated chart along a sequence. This enables it to show dynamic temporal conduct for a time arrangement. This is improbable that feed forward neural network, recurrent neural network can use it's memory from internal storage to process sequences of inputs. RNN can recall vital things about the information they got, which empowers them to be extremely in forecasting what's coming next. This is the motivation behind why they are the favored technique for sequential data like time series, speech, text, financial data, audio, video, weather and much more because they develop a highly thoughtful of sequence and its context, compared to other techniques. In recurrent neural network, the data goes through a loop. When it settles on a decision, it takes into consideration about the present input and furthermore what it has got from the information it received previously. Long Short–Term Memory (LSTM) networks are an extension of recurrent neural network, which essentially broadens their memory. Along these lines it is appropriate to gain from

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imperative encounters that have long circumstances slacks in the middle. The units of Long-Short Term Memory networks are the supporting units to the surface of a recurrent neural network, which is then often known as an LSTM network. Long Short–Term Memory allow recurrent neural network's to recall their given information for a long time period. It is due to the recurrent neural network contain their data in memory that is much similar to the computer's memory in the light of the fact LSTM can read, write and erase data from its memory. In a recurrent neural network there are three gates. These are input, hidden and gate of output.

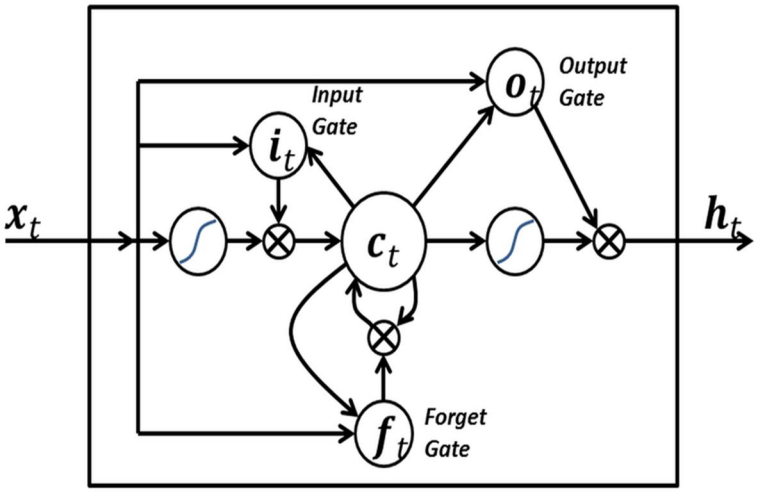


Fig.2: A simple LSTM gates

IV. PROPOSED METHOD

In this paper the proposed weather forecasting model, used the recurrent neural network with LSTM algorithm essentially intends to gather data that is weather parameters, like temperature, humidity, pressure, dew point, wind speed, precipitation and visibility. These are considered as neurons of input to recurrent neural network. Weather forecasting is done by collecting information related today weather in regards to the previous and the present condition of the weather and utilizing this information to train LSTM model. The proposed tool for forecasting the weather with recurrent neural network is given below **Fig.3**.

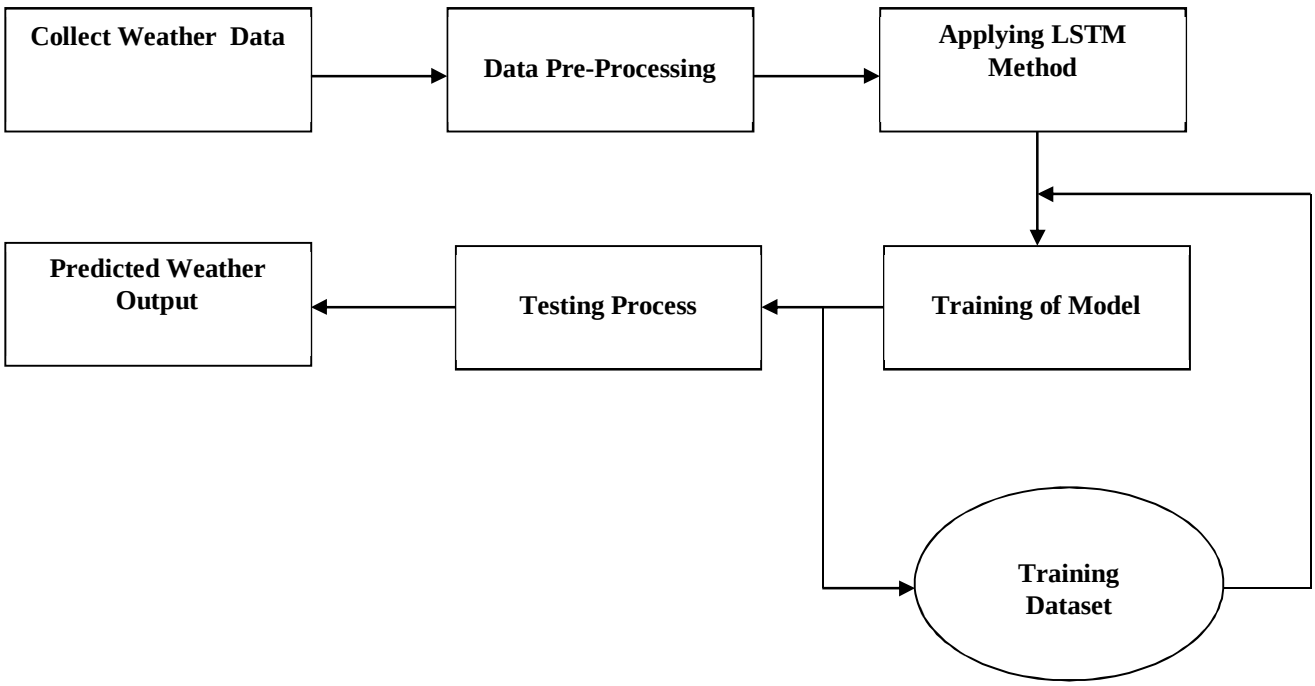
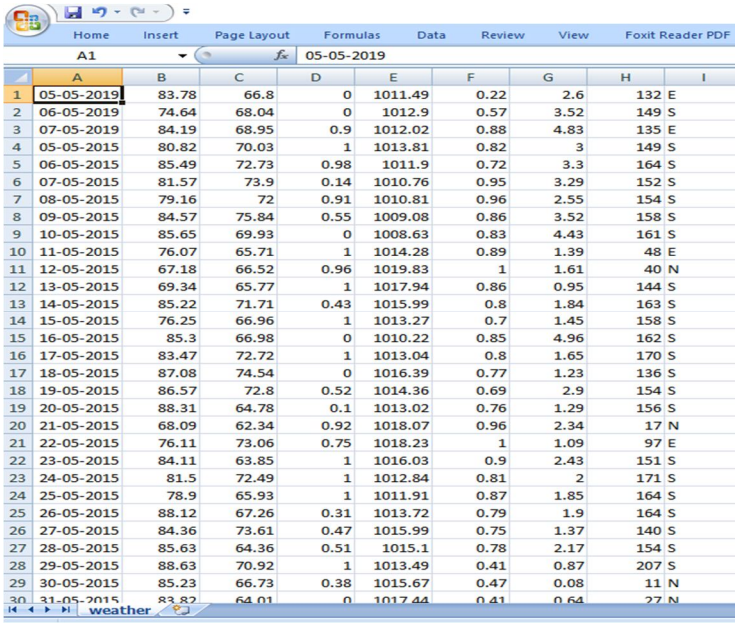


Fig.3: Block diagram for proposed method

V. EXPERIMENTAL RESULT

To experiment the proposed model, the historical weather dataset is taken from Dark Sky (Weather Data Provider) from November 2008 to November 2018 years of data used for training .2019 data used for testing. The dataset contain many weather attributes like temperature, humidness, condensation, pressure, visibility and climatic condition .These attributes are the given information to the neural network and trained using LSTM algorithm .The experiment result shows that an appropriate accuracy can be achieved using LSTM technique. The experimental result is shown below. **Fig.4**



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	A	B	C	D	E	F	G	H	I
1	05-05-2019	83.78	66.8	0	1011.49	0.22	2.6	132	E
2	06-05-2019	74.64	68.04	0	1012.9	0.57	3.52	149	S
3	07-05-2019	84.19	68.95	0.9	1012.02	0.88	4.83	135	E
4	05-05-2015	80.82	70.03	1	1013.81	0.82	3	149	S
5	06-05-2015	85.49	72.73	0.98	1011.9	0.72	3.3	164	S
6	07-05-2015	81.57	73.9	0.14	1010.76	0.95	3.29	152	S
7	08-05-2015	79.16	72	0.91	1010.81	0.96	2.55	154	S
8	09-05-2015	84.57	75.84	0.55	1009.08	0.86	3.52	158	S
9	10-05-2015	85.65	69.93	0	1008.63	0.83	4.43	161	S
10	11-05-2015	76.07	65.71	1	1014.28	0.89	1.39	48	E
11	12-05-2015	67.18	66.52	0.96	1019.83	1	1.61	40	N
12	13-05-2015	69.34	65.77	1	1017.94	0.86	0.95	144	S
13	14-05-2015	85.22	71.71	0.43	1015.99	0.8	1.84	163	S
14	15-05-2015	76.25	66.96	1	1013.27	0.7	1.45	158	S
15	16-05-2015	85.3	66.98	0	1010.22	0.85	4.96	162	S
16	17-05-2015	83.47	72.72	1	1013.04	0.8	1.65	170	S
17	18-05-2015	87.08	74.54	0	1016.39	0.77	1.23	136	S
18	19-05-2015	86.57	72.8	0.52	1014.36	0.69	2.9	154	S
19	20-05-2015	88.31	64.78	0.1	1013.02	0.76	1.29	156	S
20	21-05-2015	68.09	62.34	0.92	1018.07	0.96	2.34	17	N
21	22-05-2015	76.11	73.06	0.75	1018.23	1	1.09	97	E
22	23-05-2015	84.11	63.85	1	1016.03	0.9	2.43	151	S
23	24-05-2015	81.5	72.49	1	1012.84	0.81	2	171	S
24	25-05-2015	78.9	65.93	1	1011.91	0.87	1.85	164	S
25	26-05-2015	88.12	67.26	0.31	1013.72	0.79	1.9	164	S
26	27-05-2015	84.36	73.61	0.47	1015.99	0.75	1.37	140	S
27	28-05-2015	85.63	64.36	0.51	1015.1	0.78	2.17	154	S
28	29-05-2015	88.63	70.92	1	1013.49	0.41	0.87	207	S
29	30-05-2015	85.23	66.73	0.38	1015.67	0.47	0.08	11	N
30	31-05-2015	83.82	64.01	0	1017.44	0.41	0.64	27	N

weather

Fig.4: Data Training process using LSTM

```
x_cols = [
 'temp_high_1','temp_low_1','precip_prob_1','pres_mbar_1','cloud_cover_1
','wind_speed_1','wind_deg_1'
,'temp_high_2','temp_low_2','precip_prob_2','pres_mbar_2','cloud_cover_2
','wind_speed_2','wind_deg_2'
,'temp_high_3','temp_low_3','precip_prob_3','pres_mbar_3','cloud_cover_3
','wind_speed_3','wind_deg_3'
,'temp_high_4','temp_low_4','precip_prob_4','pres_mbar_4','cloud_cover_4
','wind_speed_4','wind_deg_4'
,'temp_high_5','temp_low_5','precip_prob_5','pres_mbar_5','cloud_cover_5
','wind_speed_5','wind_deg_5']

for x in range(len(coef)):
    print(x_cols[x], "\t", abs(round(abs(coef[x]),4)))
```

```
temp_high_1      0.1027
temp_low_1       0.0062
precip_prob_1    0.9783
pres_mbar_1      0.0013
cloud_cover_1    0.6407
wind_speed_1     0.1428
wind_deg_1       0.0018
temp_high_2      0.0278
temp_low_2       0.0249
precip_prob_2    0.0745
pres_mbar_2      0.0276
cloud_cover_2    0.5555
wind_speed_2     0.0055
wind_deg_2       0.0021
temp_high_3      0.0983
temp_low_3       0.0761
precip_prob_3    0.3238
pres_mbar_3      0.0354
cloud_cover_3    0.5112
wind_speed_3     0.1983
wind_deg_3       0.003
temp_high_4      0.0059
temp_low_4       0.0456
precip_prob_4    0.0509
pres_mbar_4      0.015
cloud_cover_4    2.7029
wind_speed_4     0.3188
wind_deg_4       0.0028
temp_high_5      0.2845
temp_low_5       0.6415
precip_prob_5    0.9382
pres_mbar_5      0.1908
cloud_cover_5    9.8008
wind_speed_5     0.3083
wind_deg_5       0.0096
```

Fig.5: weather prediction output

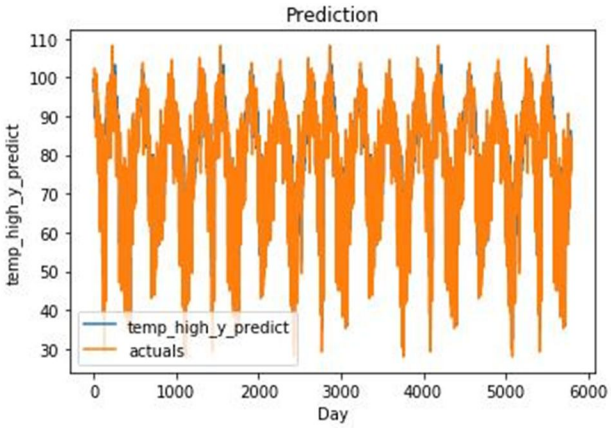

Fig.6: Temperature prediction results1

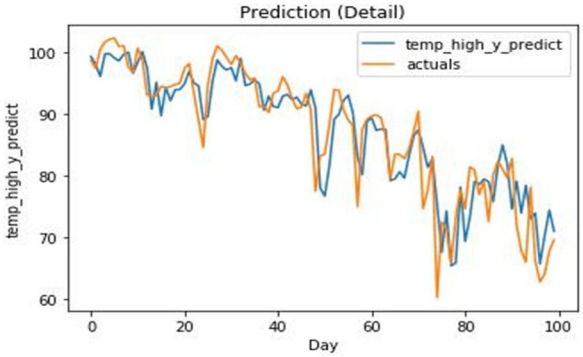

Fig.7: Temperature prediction results2

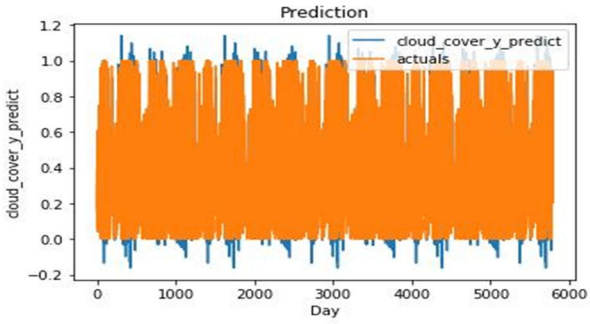

Fig.8: Cloud Cover prediction results1

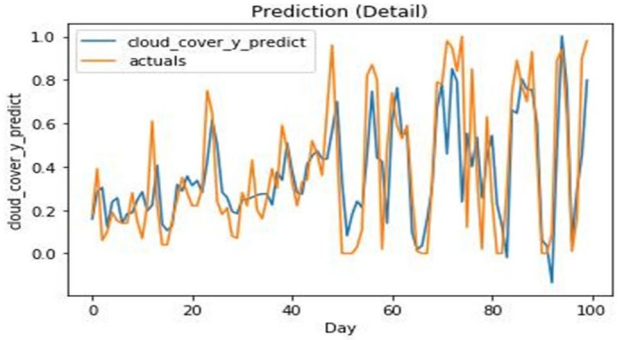

Fig.9: Cloud Cover prediction results2

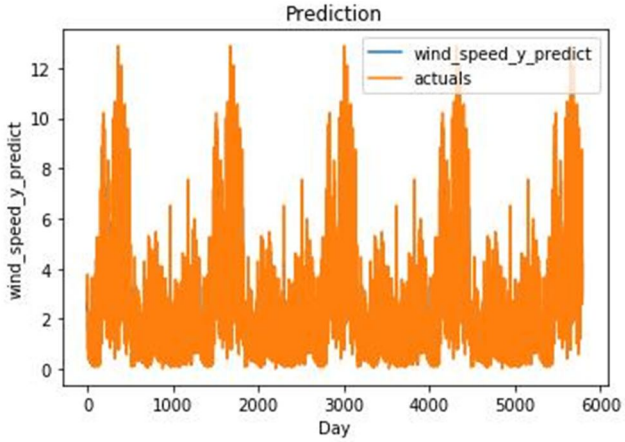

Fig.10: Wind Speed prediction results1

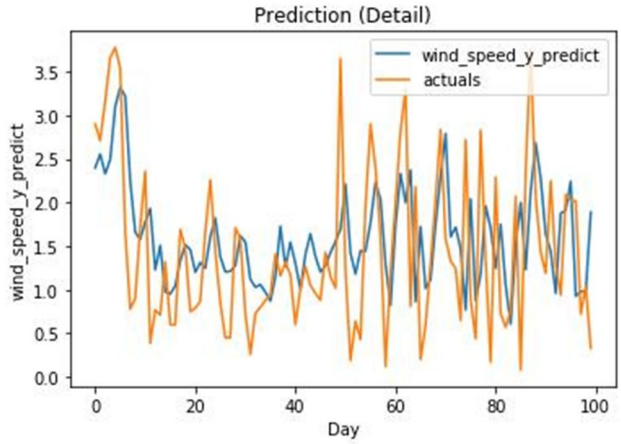

Fig.11: Wind Speed prediction results2

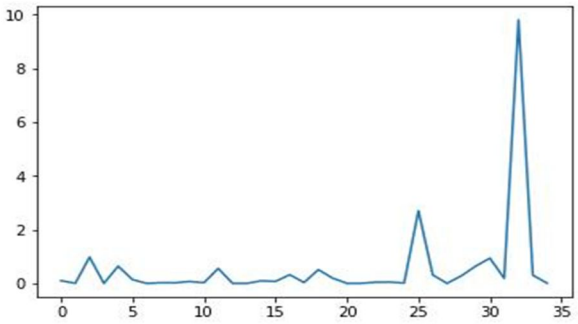

Fig .12: For high temp prediction, the most relevant features were the cloud cover measurements of the previous 2 days

VI. CONCLUSION

Both machine learning algorithms using weather data lead realistic perfection were outflanked by proficient climate or weather determining directions or forecasting, demonstrating that over longer timeframes, our models may beat proficient ones. In this research work, a proposed tool for forecasting weather system is implemented using recurrent neural network with LSTM technique. In this model the data is trained using LSTM method. From experimental result, it is observed that LSTM neural network gives a substantial results with high accuracy among the other weather forecasting techniques. Future work might explore ways to extend the proposed here to allow weather stations to be added or removed over time. Another possible research direction is to explore ways of leveraging datasets where different values have different predictor variables.

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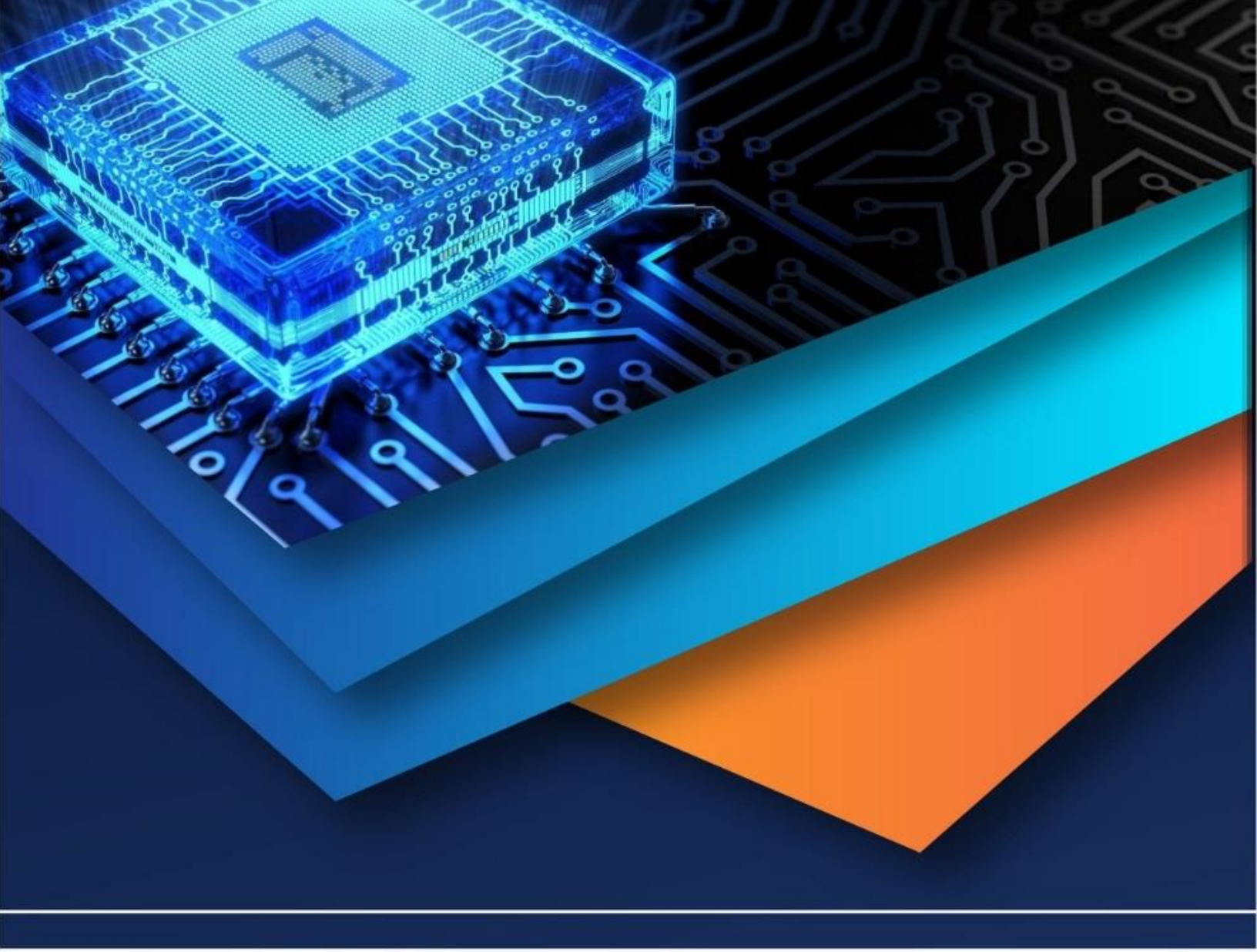

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