International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 04 | Apr 2021 www.irjet.net p-ISSN: 2395-0072

Spectrum Prediction using Convolutional Neural Network and Regression Neural Network

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Abstract - *Spectrum data contains much dimensional information, such as location, frequency, time, and signal strength. In practical conditions, a portion of spectrum data entries may be unavailable due to interference during the acquisition process, the compression during the sensing process, etc. In this paper, we focus on spectrum prediction use convolutional neural network (CNN) for feature extraction and using regression neural network (RNN). In this project we mainly focus on prediction and missing components analysis. Inorder to get the accuracy in prediction and the missing component analysis is accurated. For that, 3d filter and 3d wavelet transformer are used to detect the variation in parameters such as date, time, frequency and strength. By using 3d filter and 3d wavelet transformer the data is reconstructed inorder to get more efficency.*

Key Words: **spectrum data, spectrum prediction, regression neural network, convolutional neural network, 3d filter, 3d wavelet transform.**

1. INTRODUCTION

Nowadays, efficient and intelligent spectrum resource management has emerged as an important problem in various fields, and dynamic spectrum access based on spectrum sensing offers an effective way to improve the spectral efficiency, where the dynamic access opportunities of secondary users are enhanced without disturbing the normal spectrum usage of primary users. The number of users of wireless communication is exponentially increasing every year, this leads to a scarcity due to the limited spectrum resources available for signal transmission. Though the resource is scarce, the more concerning part is that there is a high inefficiency in the usage of the available spectrum. According to the present fixed allocation spectrum transmission strategy, it is a highly increasing concern, that is spectrum prediction causes extensive concern. Spectrum prediction is a technique of inferring the future state of radio spectrum from already known/measured spectrum occupancy statistics, or deducing the whole spectrum situation from sparse spectrum data samples. By effectively exploiting the inherent correlations and regularities among spectrum data. As an important application of prediction techniques in spectrum data analytics, spectrum prediction is an effective technique complementary to spectrum sensing, helping reduce time delay and energy consumption involved in spectrum sensing and increase the system throughput of spectrum access.

2. RELATED WORK

Recently in spectrum allocation system, the centralized authorities allocate the spectrum such that the band allocated to each user is valid for an extended period and that too for a very large geographical area. This system has led to large proportions of the spectrum under utilized, the best solution is dynamic spectrum allocations (DSA). If we represent Primary users as PU and secondary uses as SU, allocation of spectrum to SU is done on a dynamic basis as they share the spectrum with PUs according to the availability of the local spectrum. To find the availability of spectrum, a spectrum sensing or prediction method is used to determine if the spectrum is passive if it is available to be allocated to a different unauthorized user. The goal is to predict the state of the spectrum with the least error possible. The prediction predicts the highest probability of vacancy in broadband and multi-channel detection scenarios. This prediction helps in where and when the transmission can be carried out by SUs without causing disturbance to PUs.

In spectrum prediction was finished utilizing a linear filter model followed by a sigmoid change. The presentation of the predictor endured because of non-deterministic nature of the binary series. A multi-dimensional logistic regression model was applied to binary spectrum occupancy characterization and prediction has been proposed in [1]. Spectrum sensing is an important function for the unlicensed users to determine availability of a channel in the licensed user's spectrum and using the neural network model in [2] for prediction. Spectrum prediction infers the future possibly unknown/unmeasured radio spectrum state from historically known/measured spectrum data by exploiting the inherent regularities. Spectrum prediction can provide forecast views of the spectrum utilization of various wireless services, and has a wide range of applications in wireless networks [3]. Spatio-temporal spectrum prediction calculations for cognitive radios (CRs) are created using the framework of dictionary learning and compressive sensing. Batch and online choices are introduced, where the online calculation includes low complexity and memory requirements. Numerical tests verify the performance of the proposed methods [4]. Prediction can be used to diminish the negative effect of such latency. In this paper, this latency is outlined, and an approach for prediction of channel state utilizing higher-order hidden Markov model (HMM) is proposed [5]. To overcome the issue, fast and efficient spectrum sensing technique is proposed for cognitive radios by improvising the Discrete Wavelet Packet Transform (DWPT) for multiresolution interweaved systems. The proposed scheme not only increases the system speed but also decreases complexity. Simulation results are utilized to analyse the system performance and mathematical analysis for computing framework complexity [6]. As the research moves along, the inherent regularities between spectrum state evolutions of similar frequency points or in the spectrum state evolution over time of one frequency point, have been revealed [7]. Then research on joint spectrum prediction techniques to further enhance the effectiveness and accuracy of prediction became the standard [8].

In order to perform long-term spectrum prediction, the tensor model is presented and a long-term spectrum prediction scheme based on tensor completion (LSP-TC) is proposed in [9]. There are some conventional methods for spectrum detecting, such as energy detection, matched filter detection, cyclostationary feature detection, covariance-based detection, and wavelet-based detection [10]. A prediction model composed of Long Short Time Memory (LSTM) layers is developed in this paper and then is trained through supervised learning before prediction. Impact of different LSTM network depth and width on the prediction accuracy is also studied in this paper together with Back Propagation (BP) neural network performance [11]. Recently, the deep learning tool is well studied in image classification [12] and speech recognition process [13]. In this paper [14], prediction using higher-order HMM is proposed to make a better use of the information of historical states that contains abundant clues for prediction of future states. In first-order HMM has been utilized to predict channel state for spectrum sensing.

The new data sequence is the mix of the historical data sequence and the predicted value obtained by pre-fill. However, the missing values and anomalies in the historical data sequence do exist, which may harm the characteristic consistency of the chose information grouping. Tensor is the extension of vector and matrix to higher dimensions. As a fundamental numerical instrument, it has been widely applied in data analysis and mining [15],[16],[17]. The existing HaLRTC algorithm and its variant have shown their steady and accurate performance on the tensor completion in computer vision and spectrum map development in [18], [19]. Another interesting point is related to the prediction/inference is image inference and it has taken a great deal of research on restoring or estimating the missing part of the image [20].

3. PROPOSED SYSTEM

In this project we mainly focus on prediction and missing components analysis The proposed system says that to get the accuracy in prediction and the missing component analysis is accurated. Inorder to get better result prediction algorithm is changed. Missing component is then spectrum sensed. While spectrum sensing some datas will be missed. This missed data is reconstructed and then processed. For that, 3d filter and 3d wavelet transformer are used to detect the variation in parameters such as date, time and strength. By using 3d filter and 3d wavelet transformer the data is reconstructed inorder to get more efficency. Then the data is processed. Then given to convolutional neural network (CNN). Mainly classification of data are done at CNN network. CNN is used for feature extraction. After feature extraction the datas are given to regression network. These are frequency dependent features. Regression network or neural network is used to train the network. After that trained network will give needed data.

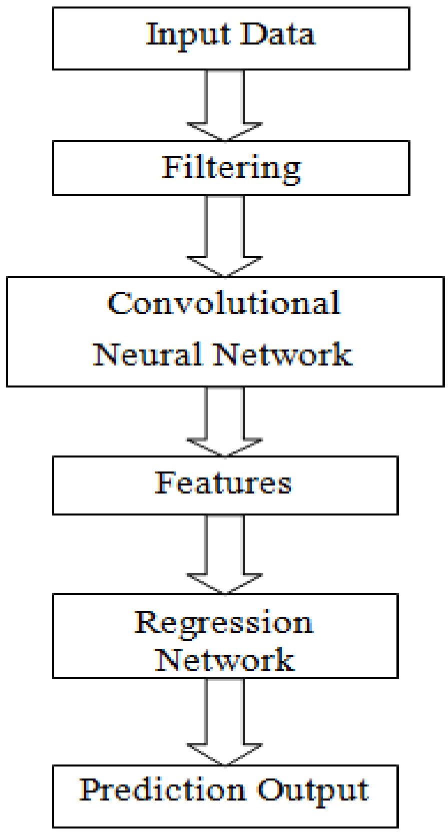

Fig -1: Block diagram of proposed system

4. EXPERIMENTAL RESULTS

In this experiment, a typical which has been proved to work successfully consists in using a pre-trained CNN as a feature extractor, by providing an input to the network and reading the output, which can then be used to train a data. This approach is especially useful if the dataset on which the network was trained is similar to the target dataset, as the patterns learned by the convolution bits are likely to be similarly discriminative. From the real world commonly employed for training general-purpose CNNs, it is a convenient alternative since it only requires to train the regression network, which takes as input, features extracted from the CNN. This technique greatly speeds up training and helps prevent over filtering, as the beginning arrangement might be as of now near a decent nearby least and probably not going to be "moved" excessively far. Designed by using a pre-trained convolutional model as convolutional network of our system, followed by best-performing regression network identified in the feature extraction experimental scenario.

Regression neural network is a variation to radial basis neural networks and it can be used for regression, prediction and classification. RNN represents an improved procedure in the neural networks based on the nonparametric regression. The idea is that each training sample will represent a mean to a radial basis neuron. No activation function is used for the output because it is interested in predicting numerical values directly without transform.

The simulations performed for this project have been carried out in MATLAB. MATLAB is a powerful high level language for scientific computations build up by Math works.

From this experiment we trained the network is belong to figure 2 and show training progress of Convolution Neural Network for Regression.

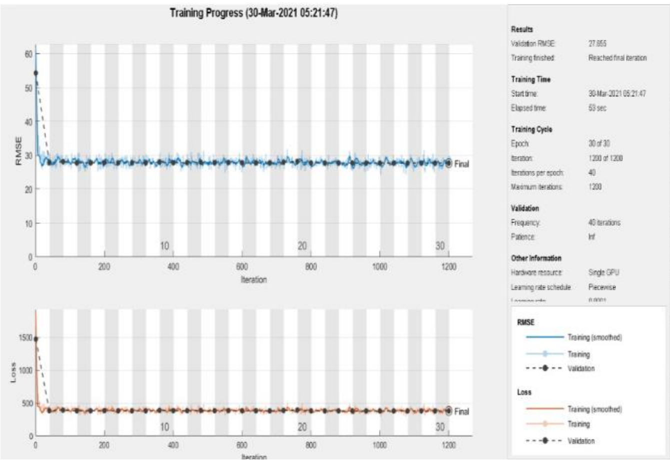

Fig -2: Train CNN for Regression

To analysis the performance of a neural network after it has been trained, the results show a regression for the training, validation and test data as shown in figure 3.

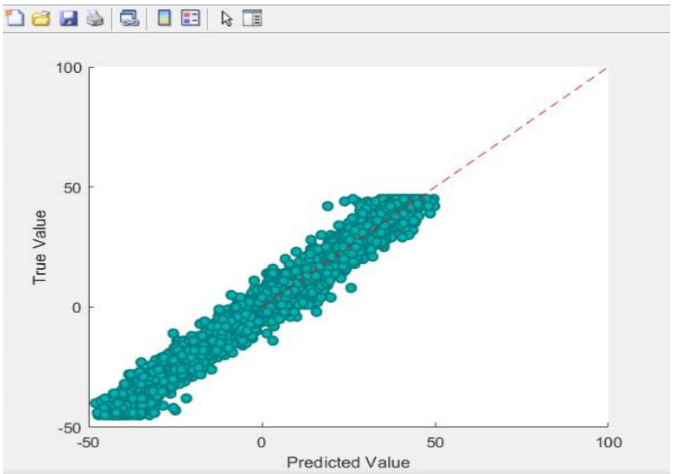

Fig -3: Prediction of trained regression neural network

5. CONCLUSIONS

However, with the increasingly large number of devices, traditional technology of spectrum sensing is confronted with unaffordable energy consumption and processing delays, etc. Different from spectrum sensing, spectrum prediction offers an alternative way for data collection, where internal relations over time and frequency contained in the spectrum data can be fully utilized. As an important application of prediction techniques in spectrum data analytics, spectrum prediction is an effective technique complementary to spectrum sensing, helping reduce the time delay and the energy consumption involved in spectrum sensing and increase the framework throughput of spectrum access. In this project we mainly focus on prediction and missing components analysis. And we focus on spectrum prediction using regression neural network and use convolutional neural network for feature extraction. Experiments on spectrum prediction with real-world satellite spectrum data show the good performance of predicting the spectrum situation, expanding the utility of spectrum prediction.

REFERENCES

[1] S. Yarkan and H. Arslan H, “Binary time series approach to spectrum prediction for cognitive radios,” in Proceedings of IEEE Conference on Vehicular Technology (VTC), pp. 1563–1567, Sept. 2007.

[2] V. K. Tumuluru, W. Ping, and D. Niyato, “A neural network based spectrum prediction scheme for cognitive radio,” In Proc. IEEE ICC, pp. 1-5, 2010.

[3] X. Xing, T. Jing, W. Cheng, and Y. Huo, “Spectrum prediction in cognitive radio networks,” IEEE Wireless Communications, vol. 20, no.2, pp. 90-96, Apr. 2013.

[4] Seung-Jun Kim, Georgios B. Giannakis, “Cognitive radio spectrum prediction using dictionary learning,” IEEE Global Communications Conference (GLOBECOM), Dec. 2013, pp. 9-13.

[5] Z. Chen and R. C. Qiu, "Prediction of channel state for cognitive radio using higher-order hidden Markov model,'' in Proc. IEEE Southeastcon, Mar. 2010, pp. 276_282.
[6] Z. Tian and G. B. Giannakis, "A wavelet approach to wideband spectrum sensing for cognitive radios," in Proc. IEEE Int. Conf. Cognitive Radio Oriented Wireless Networks and Commun. (Crowncom), Mykonos Island, Greece, June 2006.
[7] G. Ding et al., "Robust online spectrum prediction with incomplete and corrupted historical observations,'' IEEE Trans. Veh. Technol., vol. 66, no. 9, pp. 8022_8036, Sep. 2017.
[8] G. Ding, J. Wang, Q. Wu, L. Yu, Y. Jiao, and X. Gao, ``Joint spectral temporal spectrum prediction from incomplete historical observations,'' in Proc. Signal Inf. Process., Dec. 2015, pp. 1325_1329.
[9] J. Sun et al., ''Long-term spectrum state prediction: An image inference perspective,'' IEEE Access, vol. 6, pp. 43489–43498, 2018.
[10] T. Yucek and H. Arslan, "A Survey of Spectrum Sensing Algorithms for Cognitive Radio Applications," IEEE Communications Surveys & Tutorials, vol. 11, no. 1, pp. 116–130, 2009.
[11] L. Yu, J. Chen, and G. Ding, "Spectrum Prediction via Long Short Term Memory," to appear in Proceedings of IEEE International Conference on Computer and Communications (ICCC), 2017.
[12] Alex Krizhevsky, Ilya Sutskever, and Geoffrey E Hinton, "Imagenet classification with deep convolutional neural networks," in Advances in Neural Information Processing Systems 25, F. Pereira, C J C Burges, L. Bottou and K. Q. Weinberger, Eds., pp. 1097-1105. Curran Associates, Inc. 2012.
[13] A Graves, A. R. Mohamed, and G. Hinton, "Speech recognition with deep recurrent neural networks," in 2013 IEEE International Conference on Acoustics, Speech and Signal Processing. May 2013, pp. 6645-6649.
[14] Z. Chen, Z. Hu, and R. C. Qiu, "Prediction of channel state for spectrum sensing using hidden Markov model," submitted to IEEE DySPAN2010.
[15] E.E.Papalexakis,C.Faloutsos,andN.D.Sidiropoulos,''Tensorsfordata mining and data fusion: Models, applications, and scalable algorithms,'' ACM Trans. Intell. Syst. Technol., vol. 8, no. 2, p. 16, 2016.
[16] M. Xu, S. Li, J. Lu, and W. Zhu, ''Compressibility constrained sparse representation with learnt dictionary for low bit-rate image compression,'' IEEE Trans. Circuits Syst. Video Technol., vol. 24, no. 10, pp. 1743–1757, Oct. 2014.
[17] K. Li, L. Gan, and C. Ling, ''Convolutional compressed sensing using deterministic sequences,'' IEEE Trans. Signal Process., vol. 61, no. 3, pp. 740–752, Feb. 2013.
[18] J. Liu, P. Musialski, P. Wonka, and J. Ye, "Tensor completion for estimating missing values in visual data," IEEE Trans. Pattern Anal. Mach. Intell., vol. 35, no. 1, pp. 208-220, Jan. 2013.
[19] M. Tang, G. Ding, Q. Wu, Z. Xue, and T. A. Tsiftsis, "A joint tensor completion and prediction scheme for multi-dimensional spectrum map construction," IEEE Access, vol. 4, pp. 8044-8052, 2016.
[20] [20] M. Bertalmio, G. Sapiro, V. Caselles, and C. Ballester, "Image inpainting," in Proceedings of the 27th annual conference on Computer graphics and interactive techniques, pp. 417-424, Jul. 2000.