iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** II **Month of publication:** February 2018

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue II, February 2018- Available at www.ijraset.com

Application of Artificial Intelligence and Low-Power Wide-Area Network (LPWAN) in the development of Smart Cities

Tushar Bhatnagar[1]
[1]*AiSkill - Founder*

Abstract: ***There are several wireless technologies existing today to deploy wireless sensor network. They are suitable for different applications with regards to bandwidth and range. Currently Most of the IoT (Internet of Things) and M2M (Machine to Machine) solutions require long-range communication link with low bandwidth and are not well covered with traditional technologies. That is right time and place for LPWAN technology, which has been lying dormant for past few years. This is the technology should be quite good for these emerging sensor applications. With the emergence of Artificial Intelligence in the current world trends it is evident that the use of LPWANs would become the next big thing. As the title suggests the paper focuses on the application of Artificial Intelligence and LPWANs to achieve a low powered smart intra city network. There are ample IOT use cases, mainly in a business context, where applications need cheap mobile low power and long-range connectivity, whereas low bandwidth is more than enough for the same. That's essentially what LPWA and LPWA networks (LPWAN) are about. There are numerous providers of LPWAN solutions and many of them are deploying their networks at a very fast pace. There are several forms and viewpoints to LPWA networks and they all have a different approach to the market and the technology stack.***

Keywords: ***Artificial Intelligence, Low power wide area network (LoRa WAN), Regression, Deep neural network, block chain, Narrowband Fidelity (NB-Fi)***

I. INTRODUCTION

Internet of Things (IOT) is an extremely prominent topic of this decade which is keeping the internet community very active. There is no doubt about the market opportunities, which are tremendous. This has led to a lot of excitement and marketing hype with each player willing to position his technology or approach as being the best solution. For a new comer in this field, it is difficult to build a well-balanced thinking since data used to promote solutions sometimes appears to be incorrect or reports are biased. This paper is an attempt to provide an overview of the benefits of LPWAN (Low Power Wide Area Network) and how artificial intelligence in amalgamation with the same be used to shape a smart intra connected city. Digitization is growing enormously with the advent of machines and there is a tremendous amount of data that must be handled across those machines. To extract the needed data from such large dataset is a challenge. A lot of research is going on in this area. Machine learning is being widely adopted in the IOT industry. Deep Learning methods apply a set of machine learning algorithms at multiple levels for learning and predicting. Deep Neural Networks (DNN) are used for risk prediction models which could be extended with many hidden layers which could be an iterative training process. The network weights can be adjusted by minimizing the difference between the network outputs and the desired outputs and Thus the accuracy of the model can be increased by adopting this method for predictive analytics. Other approaches which use statistical training and predictive techniques do not support incremental learning as the neural networks.

II. INNOVATION OPPORTUNITIES

This section focuses on the application point of view using A.I. and LPWAN and how they could help in development of a smart intra city network.

A. Network and data usage

This technology does not rely on any GSM coverage (SIM Card/Carrier Network) or a power supply on site. This allows for LPWAN supported IoT applications anywhere and everywhere, inside and outside. LPWAN is a technology specifically designed for objects which infrequently needs to send small amounts of data. Because of which, the data usage is low. For the data usage via

LPWAN, data bundles are used which match with the amount of communication between the object and the system, the number of so-called uplinks and downlinks.

B. Secure Data Exchange

The data which the sensors send and receive is encrypted. To view the data and to identify the object to which the data is related, you require a set of keys (Public and Private). Each object can only be identified through its own key. The data measured by the sensors is also encrypted before being sent. This multi-level encryption ensures a secure data exchange. Further with the onset of Blockchain (Cryptography based data exchange) data security and privacy is not more a major challenge. The positive aspect of this technology is that all the entities which a part of this new system will have their own copies of the whole transactional data and thus consistency would be maintained throughout. Integrating A.I. into this system would be a huge asset as it could ease the governance and the process of data/money exchange.

C. Geolocation

With the help of LPWANs we could track and trace entities without the need of network or GPS modules. With each uplink the sensor not only sends sensor information, but also information regarding the object's location. Geolocation does not use a GPS module to determine an object's location, because that would not fit into the energy-conscious LPWANs concept. Instead, the signal captured by the 3 nearest gateways is used to calculate the object's current location (triangulation), after which an indication of the object's location is provided. The sensor's signal can be used to determine its location more accurately using additional technology. The advantage of geo location is that you can rely on an energy-efficient solution with minimal data usage and only when necessarily need to apply additional means.

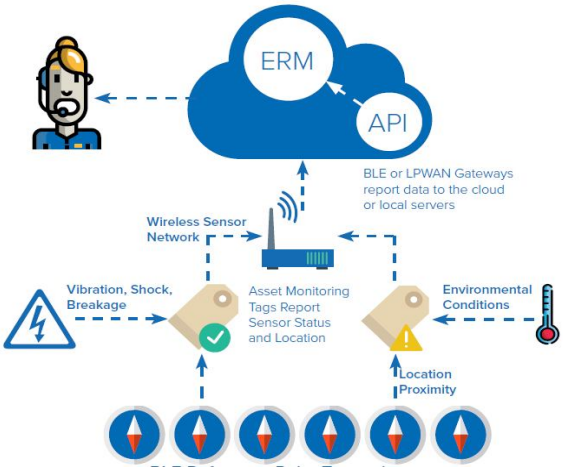
D. Application of LPWAN in daily life

The following are the applications of LPWANs and is the junction where our A.I. begins to assess the data provided

1) Street Lighting
2) Waste Management
3) Agriculture
4) Tracking Entities
5) Banking
6) E-Commerce (Hyperlocal Markets)
7) Smart Parking
8) Indoor asset location
9) Sensor Network etc.

E. Proposed Structure Of An Lpwan

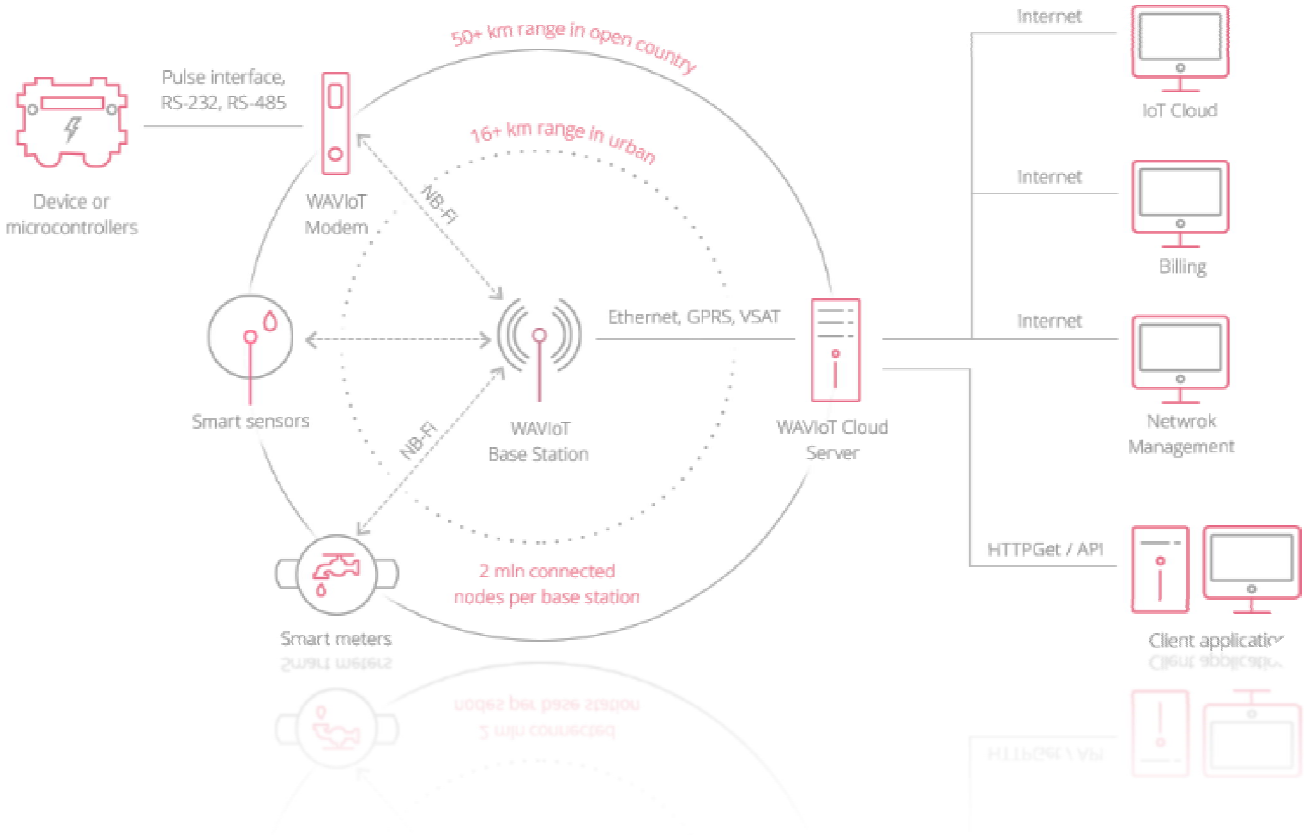
The following the proposed structure of an LPWAN. The devices are connected to the common network and the common network consists of hosted application which further assist in data interpretation, prediction and processing.



III. METHODOLOGY

Among categories of LPWAN are NB-Fi and LoRa WAN network. These networks have been designed especially for IoT and M2M applications and are mainly architected as a star topology network with no mesh. Autonomous smart devices communicate with gateways on a wide-area. All data collected from gateways are processed on the servers and displayed in client IoT cloud platform.

Structure is as follows:



The solution is well suited for worldwide deployments, supporting radio hardware and compliant MAC architectures in 915 MHz, 868 MHz, and 433 MHz ISM bands, as well as other sub-GHz license-free spectrum bands.

A. Artificial Intelligence

The application values of LPWAN evolve in three stages: data collection, data analysis and forecasting. As far as long-term industrial values are concerned, LPWAN should serve as important foundation for AI machine learning and forecasting capability while AI will impact telecom operators in three major aspects: consumer services, big data analysis and network architecture. The system uses neural algorithms and machine learning for network self-management minimizing human involvement and optimizing a dozen of network parameters automatically.

The components involved are as follows:

1) Digital Assistant
2) Intelligent Tracking
3) Intelligent Routing
4) Chat Bots
5) Scope for natural language processing (NLP)

B. Extensible Application Interfaces (APIs)

The data flow may be easily integrated with the clients existing ERP / IT system or frontend through HTTP-Get/Post /APIs. Our A.I. would be hosted on the central node which would further expand to the individual nodes for better performance and to establish an offline (Without cellular network) intelligent intracity network.

C. Deep Neural Network

Deep Learning has been very famous of late and a lot of research is going on over it. The reason to implement this is because of its capability for the neural network model to increase the performance and response time of the system. Selection of relevant parameters among the data is done to find the dependency among the variables. It can reduce the complexity of the problem to a large extent. Neural networks hence serve a huge purpose in machine learning. Deep learning methods are part of distributed representation learning algorithms that try to organize information from the data by discovering features that compose multilevel distributed representations. Deep neural networks are typically trained, by updating and adjusting neurons weights and biases, utilizing the supervised learning back propagation algorithm in conjunction with optimization technique such as stochastic gradient descent. Transfer learning is used in many areas of machine learning without retraining the whole system and DNNs are well suited for the transfer learning.

D. Regression Analytics

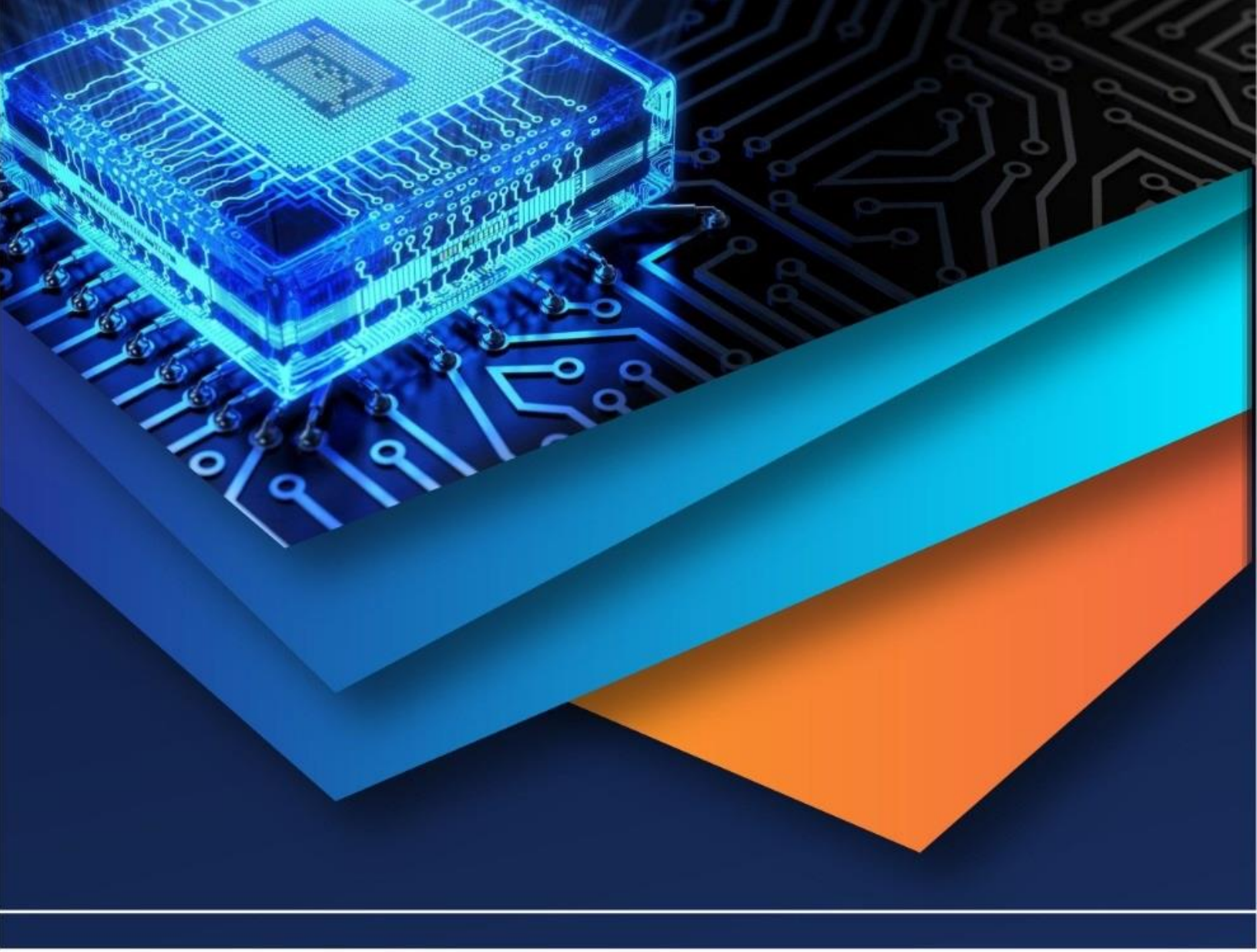
It is a predictive modelling technique which investigates the relationship between a dependent (target) and independent variable (s) (predictor). This technique is used for forecasting, time series modelling and finding the causal effect relationship between the variables. Various types of regression are linear, polynomial, stepwise, logistic regression etc. Thus, embedded methods within our model consist of two types of regression techniques LASSO (L1) and RIDGE (L2) regression. Recursive Feature Elimination (RFE) is also used along with L1 regression but in terms of Area under Curve (AUC) parameter L1 is more stable and accurate.

IV. CONCLUSION

Low Power Wide Area Networks or LPWANs provide significant improvements in terms of power consumption, coverage, deployment cost and pricing over cellular and other M2M connectivity technologies, and as a result strong adoption of unlicensed LPWAN solutions is expected in the coming years. As such, the forecasted numbers, growth margins, potential revenues and variety of IoT application domains that can be reached through LPWAN technologies in unlicensed spectrum are huge. Due to the lack of inter-technology coordination, and the strong potential of future performance degradation due to large-scale interference, sub-GHz networks might become a victim of their own success and become unusable in the future. To remedy this, this paper proposes a conceptual coordination framework to uniformly manage an ecosystem of coexisting wireless sub-1GHz LPWANs and this concept simplifies the IoT service instantiation. To realize this goal, multiple research innovations are needed and as such, the paper outlines only a few of the innovation outcomes.

REFERENCES

[1] “LoRaWAN: What is it? - A technical overview of LoRa and LoRaWAN”, A technical overview of LoRa and LoRaWAN, LoRa Alliance Technical Marketing Workgroup 1.0, November 2015.
[2] WG802.11 - Wireless LAN Working Group, "802.11ah-2016 - IEEE Approved Draft Standard for InformationTechnology",https://standards.ieee.org/findstds/standard/802.11ah-2016.html, February 2017 release.
[3] M. Park, “IEEE 802.11ah: sub-1-GHz license-exempt operation for the internet of things,” IEEE Communication Magazine., vol. 53, no. 9, pp. 145–151, Sep. 2015.
[4] L. Tian, J. Famaey, L. Latré, “Evaluation of the IEEE 802.11ah Restricted Access Window Mechanism for dense IoT networks,” IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM), 2016.
[5] K.H Chang and B. Mason, "The IEEE 802.15.4g standard for smart metering utility networks," Smart Grid Communications, 2012 IEEE Third International Conference on, Tainan, 2012, pp. 476-480.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY