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Deep Learning In Wireless Sensor Network

Nada B. Jarah *

Basrah University , Basrah, Iraq.Email: nadabadrjarah@yahoo.com

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ABSTRACT

In the era of the development of the Internet of Things, how collecting data from sensors located everywhere in society is an important issue, and in wireless sensor networks, distributed processing technology for deep learning using advanced computing and coordination between peripherals has attracted attention. In this study, a new architecture is proposed for the distributed implementation of deep learning in a wireless sensor network where the distributed application divides the middle layer of deep learning into each sensor with the purpose of reducing traffic and reducing the load, in order to improve data processing speed, but this is done by increasing the number of connections and energy consumption, and in order to evaluate the effectiveness of the proposed method, been compared the amount of data communication and accuracy of learning between learning by using Convolutional Neural Network (CNN) normally and the distributed learning, and this was done using the Raspberry Pi open-source hardware platform, the system that is low-cost and highly scalable in terms of sensor devices type and the number of sensor nodes, which makes them well suited to a wide range of applications related to environmental monitoring, the sensors device have been connected to hardware and software design. Some software components, such as operating systems, sensor/hardware drivers, may need development. In the proposed method, the amount of data is large because the result in the middle of the computation processing is sent and it can be predicted that the total computation processing time will be reduced because the computational processing handled by each node will be reduced by section processing. The concentration of energy consumption can also be suppressed because the proposed method achieves decentralization compared to performing all calculations with a single sensor.

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1. INTRODUCTION

In recent years, data traffic motion across networks has exploded due to the rapid development of communication and information equipment and technologies. However, current simple network control methods are said to be unable to cope with such a sudden increase in traffic. and deep learning has remarkable progress in research, is a technology that allows network administrators to achieve new intelligent traffic control. and Deep

∗Corresponding author:Nada B. Jarah

Email addresses: nadabadrjarah@yahoo.com

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learning has proven effective through applied research in many areas of information science, such as image recognition, speech recognition, robotics, self-driving, and natural language processing. On the other hand, in-depth education in network traffic monitoring has begun, and further development is expected.

In this study, been propose a new deep learning architecture that is distributed and implemented in a local wireless sensor network consisting of sensors that are data sources, distributed implementation protocol, and algorithm for that. The proposed method targets data (for example, temperature distribution) obtained by a two-dimensional network type wireless sensor network, assigning a unit role in deep learning to the sensor node.

The amount of processing for each node is distributed approximately evenly, and the exchange of data with adjacent nodes is reduced. In order to evaluate the efficacy of the proposed method, the data traffic for each specific node in the sensor network was compared with the aggregate type, which performs data collection and learning, and compares it with the load of the specific aggregated node. It was found that it was possible to design a deep learning parameter that could dampen the movement of each knot. In addition, the wireless sensor network system was developed using open source devices, this design has the advantages of low cost, easy to set up, and to maintain.

Wireless Sensor Network(WSN) It is a number of small devices called sensors that are distributed over a specific area to make certain measurements in order to communicate with each other and also send information to another node on the network called the base station or sink.

WSN does not contain an infrastructure, each node in WSN As a router, each WSN node also connects directly to other nodes within its transmission range or uses other nodes to transmit messages to the nodes out of its range, which is providing information about environmental conditions of temperature or pressure and is used in military applications, emergency response, or natural disaster.[1]

2. RELATED WORKS

The study [2] proposes a method for dividing the deep neural network into different layers to extract the distributed data and place it in the sensors. As a result, WSN's distributed data mining compute units share much of the burden of the fusion center calculation. The processing is done by DNNism due to the energy consumption of the data transmission and it is less than the transmission of the raw data. An error detection scenario has been created to validate this method. The results were 99% detection rate, WSN shares 64.06% of data mining account with 58.31% power consumption.

By using machine learning techniques In [3]there is no need for unnecessary redesign. Automated learning technologies are also practical solutions to maximize resource use, thereby enhancing the life of the sensor network. Comprehensive literature has been discussed on machine learning techniques that are used to address the problem of node localization in wireless sensor networks (WSNs). The strengths and weaknesses of each of the algorithms proposed in the literature are analyzed and evaluated against the problem developed. This is summarized in a comparative table to guide future designers in developing machine learning solutions appropriate to the application challenges identified in Arabization.

In [4] the creation of SSAE Deep Distributed Learning Mobile Projects in the sink nodes and the WSN control nodes. Through training, the SSAE network architecture and model parameters were optimized. In the simulation, the effect of spatio-temporal data on the SSAE network architecture is compared. With Hash + LRU and Betw + LRU temporary strategy, caching and BPNN algorithms

The study [5] represents a possible solution in resorting to advanced machine learning techniques, due to the increase in data volumes and applications that depend on the algorithm. And the recent success of deep learning to tackle problems in this space. A comprehensive survey of the interoperability between deep learning and mobile and wireless network research has been surveyed.

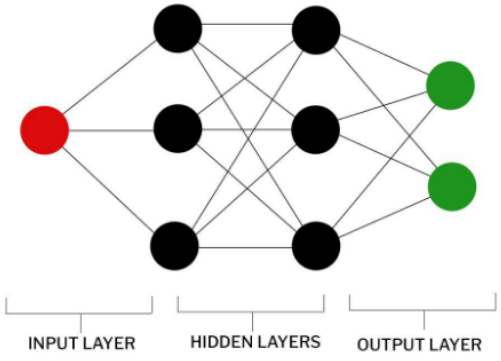
There are many technologies and platforms that facilitate the effective dissemination of deep learning on mobile systems. Encyclopedic research on mobile and wireless networks based on deep learning, according to

different fields, and discussed how to adapt deep learning to mobile device environments. And Identify current challenges and open future directions for research.

Previous studies have characterized deep learning distributed processing techniques using edge aggregation and collaboration between terminals in wireless sensor networks, as they improve data processing speed, but there is a problem with increasing connection volume and power consumption. In this paper, we study a distributed implementation method that divides the middle layer of deep learning into each sensor for the purpose of reducing the amount of communication and load on the cloud.

3. DEEP LEARNING

It is a machine learning method that relies on a multi-layer neural network with a deep hierarchy that allows computers to learn the tasks that humans naturally perform. Generally, machine learning requires that an algorithm be assigned separately to a data set that deepens the hierarchy of the neural network, figure(1) shows the structure of the neural network, as it contains an input layer, a hidden layer, and an output layer, and each layer has a structure in which multiple nodes (or units) are bound to the edges. This hidden layer can have multiple layers, each layer has a function called the activation function, and the edges can have weights. The value of each node is calculated from the value of the node in the layer before connecting to that node. That is, it is calculated from the value of the node in the previous layer, the weight value of the connecting edge, and the activation function of the layer[6]



Figure(1)The structure of the neural network

Deep learning technology supports the rapid development of artificial intelligence (AI), and its progress has led to practical applications in various fields.

Deep Learning increases the transfer and processing of information by increasing the number of intermediate layers, which makes it possible to improve the accuracy and diversity of feature values and improve prediction accuracy. Another deep learning feature is that the higher the amount of raw data, the greater the accuracy.

On the contrary, Deep Learning has weaknesses that if the test data is small, performance will not be obtained, and adjusting the definition results will be difficult.

There are three typical deep learning algorithms: [7]

(1) Auto Encoder (AE)

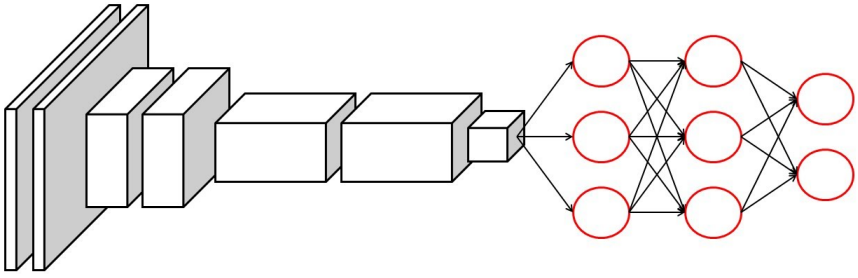
An important feature of the auto encoder is dimension reduction. An auto-encoder is a type of neural network that is used to acquire a feature expression with a reduced amount of information.

By reducing the dimension of the hidden layer, it is compressed to the amount of information, and the neural network must learn from the compressed data.

The process of compression is called an encoder, and the process of decompression is called a decoder. Encoders can represent inputs in lower dimensions, and decoders have the ability to recover from lower dimensions.

(2) Convolutional Neural Network (CNN)

As the name implies, it is an addition wrapped to the usual neural network. It is a neural network that provides a torsion layer that creates information about the area in the filter. It is a kind of deep learning and the Deep Neural Network(DNN) is similar to the multi-layer Perceptron. CNN networks are usually used in Computer vision applications, and visual scene analysis, as it is characterized by the presence of one or more hidden layers, which extract the features in images or video clips, and a fully-linked layer to produce the output, and that the main components of the convolutional neural networks are: the input layer Convolutional Layer, Activating function, Pooling Layer, Fully-connected Layer, and Output Layer, figure(2) represents Model of a convolutional network.[8]



Figure(2) CNN

4. THE PROPOSED METHOD

In this paper, the suggestion is a distributed application for deep learning in wireless sensor networks. By dividing the deep learning middle layer into multiple blocks, these blocks are installed on multiple sensors to perform data processing in a distributed way to reduce movement and achieve load reduction.

Figure(3) shows the operating procedure for the proposed method:

First: The first multiple layers are assigned to the input layer and intermediate layer to the n1 node that gets the data.

Second: The remaining intermediate layers are divided and allocated to the n2 and n3 relay nodes, the fully connected layer and the output layer are allocated to the final node n4.

Third: any node in the operation must send the result to the next node using wireless communications and sends the n4 output result to the server.

Fourth: If the calculation of the hidden layer was completed during the transfer of data by multiple hops, the subsequent sensors do not perform the Computational processing and transfer it to the sink node by multiple hops.

Fifth: On the other hand, if the number of hops is insufficient and data processing is not completed upon reaching the sink node, the server performs the computational processing of the remaining middle layer.

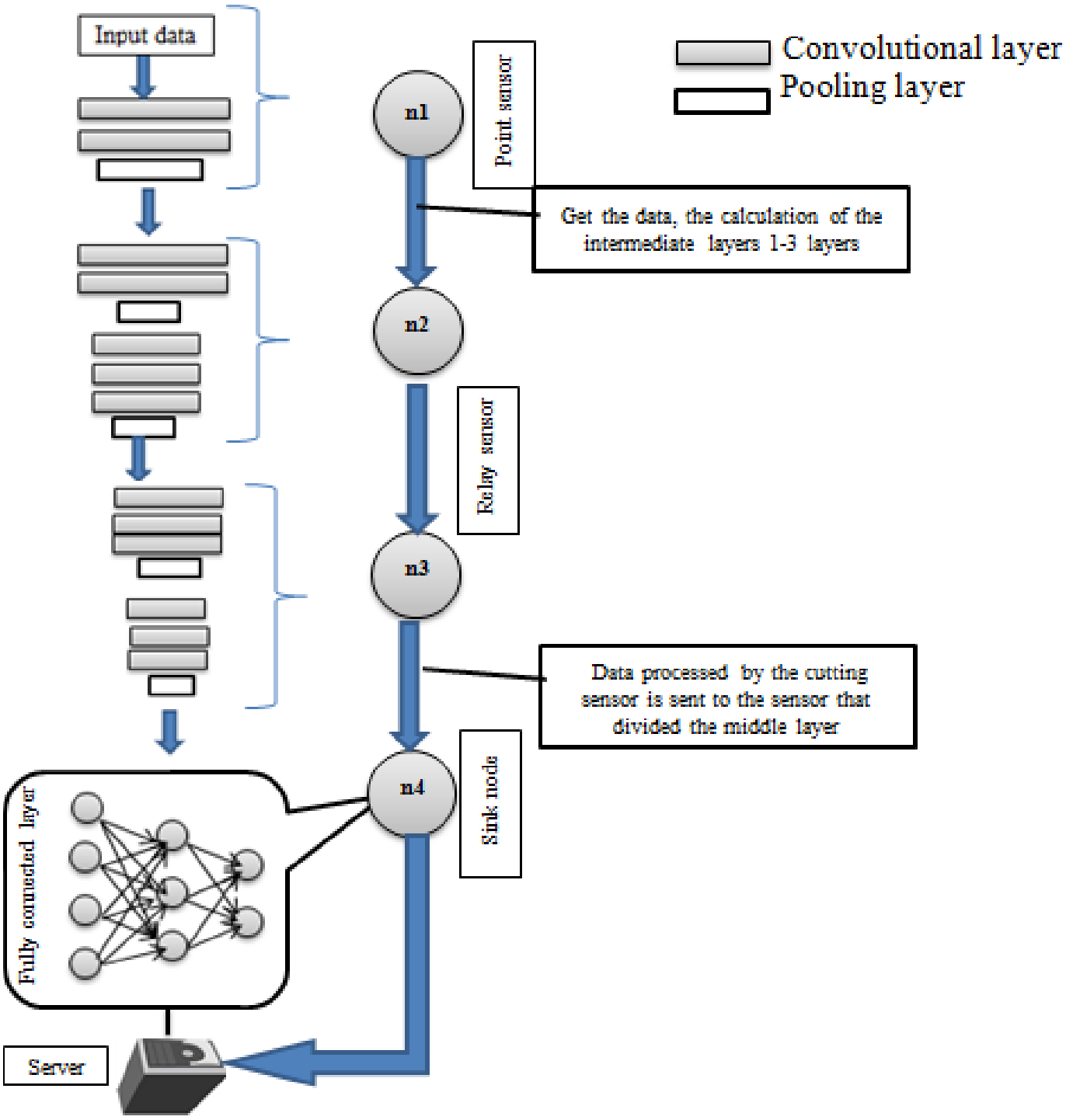


Figure.3 The proposed method

5. IMPLEMENTATION TOOLS & DISCUSSION

In this paper, the used the following tools and programs suitable in terms of low costs and the ability to develop a wide range of applications related to environmental monitoring:

(1) VGG16, which is a 16-layer network program, of which 13 are convolutional and 3 layers (FC (Fully Connected)) [9]

(2) The TensorFlow Library is one of the most popular Deep Learning libraries today - a flexible data flow-based programming model, as well as a single machine and distributed applications for this programming model. The system derives from real-world experience in researching and publishing over a hundred machine learning projects across a wide range. [10].

(3) Inception-v3 is a convolutional neural network, in the inception architecture, computational efficiency and fewer parameters are realized. [11]

(4) As a sensor node, use 4 Raspberry Pi, which is an electronic device that represents a small integrated computer with minimal energy consumption, and through which an environmental monitoring application can be made, such as using a thermometer system, and it has USB and HDMI ports and a network port, where one of the main advantages of the design In the integration of the wireless sensor gateway node, database server and web server, , Which, after initialized, can be easily operated without a header (i.e. without a monitor, mouse and keyboard). Equip appropriate design for various environmental monitoring applications and data collection. [12]

In this research, the use of program VGG16 and Inception-v3 that detect objects on TensorFlow. Four Raspberry Pi's are used as sensor nodes. In order to evaluate the performance of the proposed method, Focus on the total amount of transmitted data and the calculation processing time.

Focusing on the total amount of transmitted data, when performing all calculation processing with n1, only the output result is transmitted, so the data amount is small. In the proposed method, the amount of data is large because it transmits the results during the arithmetic processing. Next, focus on the calculation processing time. When performing all arithmetic processing in n1, it becomes slow considering the calculation processing capacity. In the proposed method, the calculation processing performed by each node is reduced by the division processing, so that the total calculation processing time can be predicted to be reduced. From the viewpoint of power consumption, the proposed method achieves decentralization compared to performing all arithmetic processing with a single sensor, so it is thought that concentration of power consumption can be suppressed..

6. CONCLUSIONS

The provides basic sensor data processing technology that is essential for achieving various applications using sensor data and introducing the latest sensor data processing technology using deep learning. As a new method for deep learning and data processing was proposed using it in WSN, then implemented distributed layer hidden processing for deep learning as a distributed method in wireless sensor networks. The data generated continuously from each WSN sensor node is treated as two-dimensional or three-dimensional geographic data (for example, temperature data, etc. from other environmental conditions). It targets a convolutional neural network (CNN) that can achieve high accuracy in this field and realizes it in a distributed environment by allocating each CNN to one of the sensor nodes in WSN.

In the future, so the plan to evaluate through implementation experiments and consider a way to take into account the communication and orientation environment when increasing the number of sensors.

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