APPLICATIONS OF NEURAL NETWORKS IN WIRELESS COMMUNICATIONS

Snuti Kumari

Department of Electronics and Communication Engineering
Dronacharya College of Engineering
Mahamaya Technical University, India
km.snuti@gmail.com

Garima Rathi
Department of computer science Engineering
Institute of information technology and management
Guru Gobind Singh Indraprastha University
garimarathi11@gmail.com

***Abstract*— In** recent years, the use of neural networks (NNs) for wireless-communication becoming wider and has been getting momentum. The basic purpose of applying neural network is to change from the lengthy analysis and design cycles required to develop high-performance systems to very short product-development times. There is an overview of different applications of neural network techniques for wireless communication and a description of future research in this field.

***Keywords*—** Neural networks, applications of neural network, land mobile radio cellular systems, antennas, microstrip antennas, antenna arrays, multi-band antennas, wideband antennas.

I. INTRODUCTION

The term **neural network** was traditionally used to refer to a network or circuit of biological neurons.

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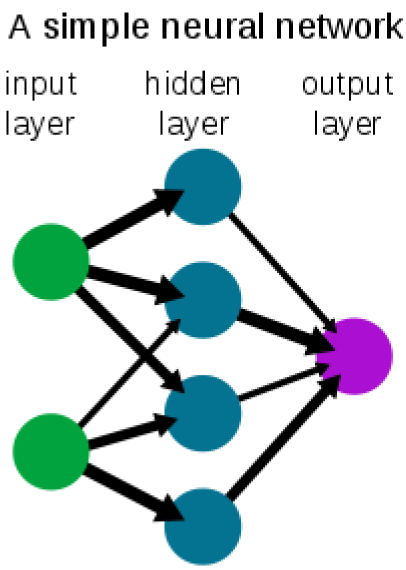


The term biological neural networks , made up of real biological neurons, or artificial neural networks, for solving artificial intelligence problems. A biological neural network is composed of a group or groups of chemically connected or functionally associated

neurons.

A single neuron may be connected to many other neurons and the total number of neurons and connections in a network may be extensive. It resembles the brain in two respects:

1. Knowledge is acquired by the network through a learning process.
2. Interneuron connection strengths known as synaptic weights are used to store the experiential knowledge.

A list of some of the applications of neural networks for wireless communications

Applications	Purpose/Advantage	Type of Network Used
Microstrip antenna analysis	To develop fast ANN models for microstrip antennas, to avoid lengthy full wave EM analysis with a faster method	Multilayer feed-forward network
Direction-of-arrival (DOA) estimation	To reduce the computational complexities of the previously available	Radial basis-function network

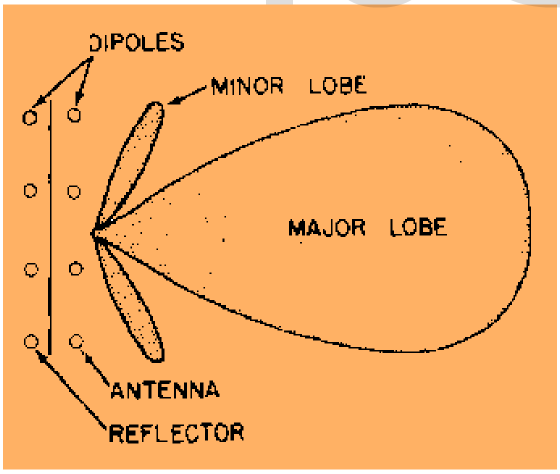
	methods DOA estimation	
Adaptive beamforming	Real-time implementation of beamformer to respond to the time-varying environment	Hopfield network, radial-basis-function network
Wideband mobile antenna design	To avoid lengthy full-wave EM analysis with a faster method	Multilayer feed-forward, knowledge based nema1 network

A. Antennas

- Antenna (radio), also known as an aerial, a transducer designed to transmit or receive electromagnetic (e.g. TV or radio) wave.
- Television antenna (or TV aerial), is an antenna specifically designed for the reception of broadcast television signals.
- Antennae Galaxies, the name of two colliding galaxies NGC 4038 and NGC 4039.

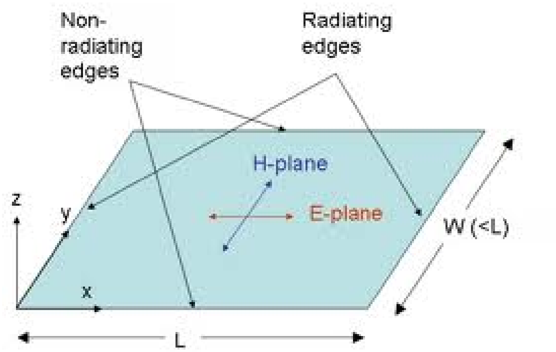
1. Antenna array

- Antenna array (electromagnetic) a group of isotropic radiators such that the currents running through them are of different amplitudes and phases.



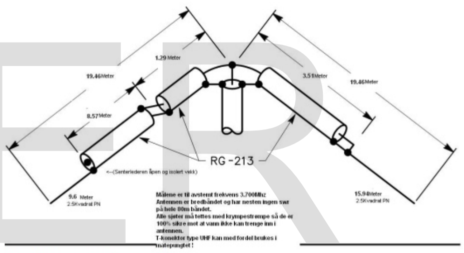
2. Microstrip antennas

These antennas are popular for low-profile applications at frequencies above 100MHz (λ<3).They commonly consist of a rectangular square metal patch on a thin layer of dielectric (called the substrate) on a ground plane. Patches may be photoetched making them adapted for low-cost, mass production.



3. Multi-band antennas

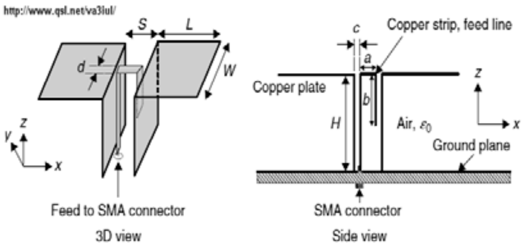
An antenna designed to operate on several bands. These antennas often use designs where one part of the antenna is active for one band, and another part is active for a different band. A multiband antenna may have lower than average gain or may be physically larger in compensation.



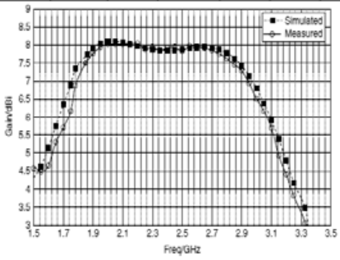
80-Meter DX Special,
an antenna optimized for the phone portions of the 3.5-MHz band. The coax segment lengths total to one quarter-wavelength. The overall length is the same as that of a conventional inverted V dipole.

4. Wideband antenna

In communications, a system is **wideband** when the message bandwidth significantly exceeds the coherence bandwidth of the channel. A wideband antenna is one with approximately or exactly the same operating characteristics over a very wide passband. It is distinguished from broadband antennas, where the passband is large, but the antenna gain and/or radiation pattern need not stay the same over the passband.



Parameters	a	b	c	d	H	L	S	W
Value/mm	9.5 (0.079λ)	22 (0.183λ)	1 (0.008λ)	4.91 (0.040λ)	30 (0.25λ)	30 (0.25λ)	17 (0.141λ)	60 (0.5λ)



B.Non-linearity

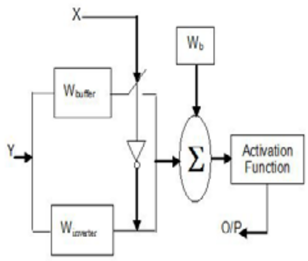
On observing any wireless engineering phenomenon- the design or analysis of antennas, estimation of direction of arrival, adaptive beamforming techniques, etc. - it is noted

That these always have a quite nonlinear relationship with their corresponding input variables. The inherent nonlinearities associated with these phenomena makes them ideally suited for neural networks. Multilayer neural networks are employed to model such nonlinear relationships.

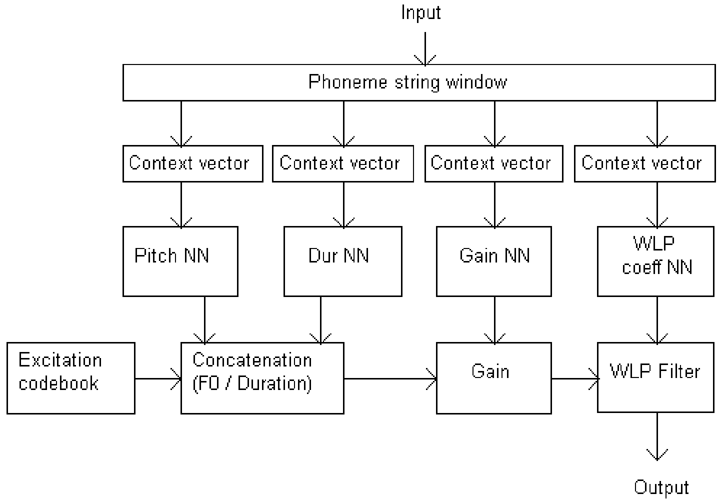
C. Reduction of Mathematical Complexity

The use of neural networks can considerably reduce the complexity. A straightforward application of a neural network uses the data derived from this complex mathematical

Procedures to train a neural network. After proper training, these neural models can be used in place of the computationally intensive physics/EM--based models to speed up the analysis.



Block diagram for methods,techniques and algorithm



by simulation or experimentally. Preprocessing of input and output data sometimes reduces the training time of the network to a large extent.

3. Applications

Microstrip antenna analysis

ANN can be used efficiently to design of various types microstrip antenna. In study a comparative evaluation of different variants of back propagation training algorithm has done for the design of rectangular microstrip antenna. ANN can also be used to calculate different

Parameters of circular microstrip antenna such as resonant frequency, input impedance etc. Sufficient amount of work indicates how ANN can be used efficiently to Design circular and rectangular microstrip antennas. Also ANN can be used to calculate different parameters of rectangular microstrip antenna such as radiation efficiency, resonating frequency ,directivity ,feed position , resonant frequencies of triangular and rectangular microstrip antennas , resonant resistance calculation of electrically thin and thick rectangular microstrip antennas input impedance of rectangular microstrip antennas.

4. Future trends

Recent advances and future applications of NNs include:
Integration of fuzzy logic into neural networks

- Fuzzy logic is a type of logic that recognizes more than simple true and false values, hence better simulating the real world. For example, the statement today is sunny might be 100% true if there are no clouds, 80% true if there are a few clouds, 50% true if it's hazy, and 0% true if rains all day. Hence, it takes into account concepts like -usually, somewhat, and sometimes.

- Fuzzy logic and neural networks have been integrated for uses as diverse as automotive engineering, applicant screening for jobs, the control of a crane, and the monitoring of glaucoma.

Pulsed neural networks

- "Most practical applications of artificial neural networks are based on a computational model involving the propagation of continuous variables from one processing unit to the next. In recent years, data from neurobiological experiments have made it increasingly clear that **biological neural networks, which communicate through pulses, use the timing of the pulses to transmit information and perform computation.** This realization has stimulated significant research on pulsed neural networks, including

2. Problem faced while using neural network and their solutions

1. In using neural network, first problem we come across is to be checked for its suitability neural-network implementation.
Sol. It is advisable not to resort to neural network techniques for simple linear functions, or for problems that can be implemented through a direct, closed-form formula.

2. The accuracy of a properly trained network depends on the accuracy of the data used to train the network. Sol. Care should be taken while generating training data, whether the data are generated

- Improved stock prediction.
- Common usage of self-driving cars.
- Composition of music.
- Handwritten documents to be automatically transformed into formatted word processing documents.
- Trends found in the human genome to aid in the understanding of the data compiled by the Human Genome Project.
- Self-diagnosis of medical problems using neural networks.

- theoretical analyses and model development, neurobiological modeling, and hardware implementation.

Hardware specialized for neural networks

- Some networks have been hardcoded into chips or analog devices.This technology will become more useful as the networks we use become more complex.
- The primary benefit of directly encoding neural networks onto chips or specialized analog devices is SPEED!
- NN hardware currently runs in a few niche areas, such as those areas where very high performance is required (e.g. high energy physics) and in embedded applications of simple, hardwired networks (e.g. voice recognition).
- Many NNs today use less than 100 neurons and only need occasional training. In these situations, software simulation is usually found sufficient
- When NN algorithms develop to the point where useful things can be done with 1000's of neurons and 10000's of synapses, high performance NN hardware will become essential for practical operation.

Improvement of existing technologies

- All current NN technologies will most likely be vastly improved upon in the future. Everything from handwriting and speech recognition to stock market prediction will become more sophisticated as researchers develop better training methods and network architectures.

NNs might, in the future, allow:

- Robots that can see, feel, and predict the world around them.

Conclusions

High-performance antennas are being developed to satisfy the competing demands of emerging wireless applications.This article reviewed the current applications of neural networks in
These high-priority areas, and traced the further avenues in which neural networks could play a major role. Recently, the possibility **of** developing antenna designs that in some way exploit the properties of fractals to achieve the goals of compact size, low profile, conformal, and multi-hand antennas, at least **in** part, has attracted a lot of attention. Neural networks can also find suitable places for analysis of these antennas.

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