Management of Networks And Communications Systems Using Neural Networks And Software Defined Radio (SDR).

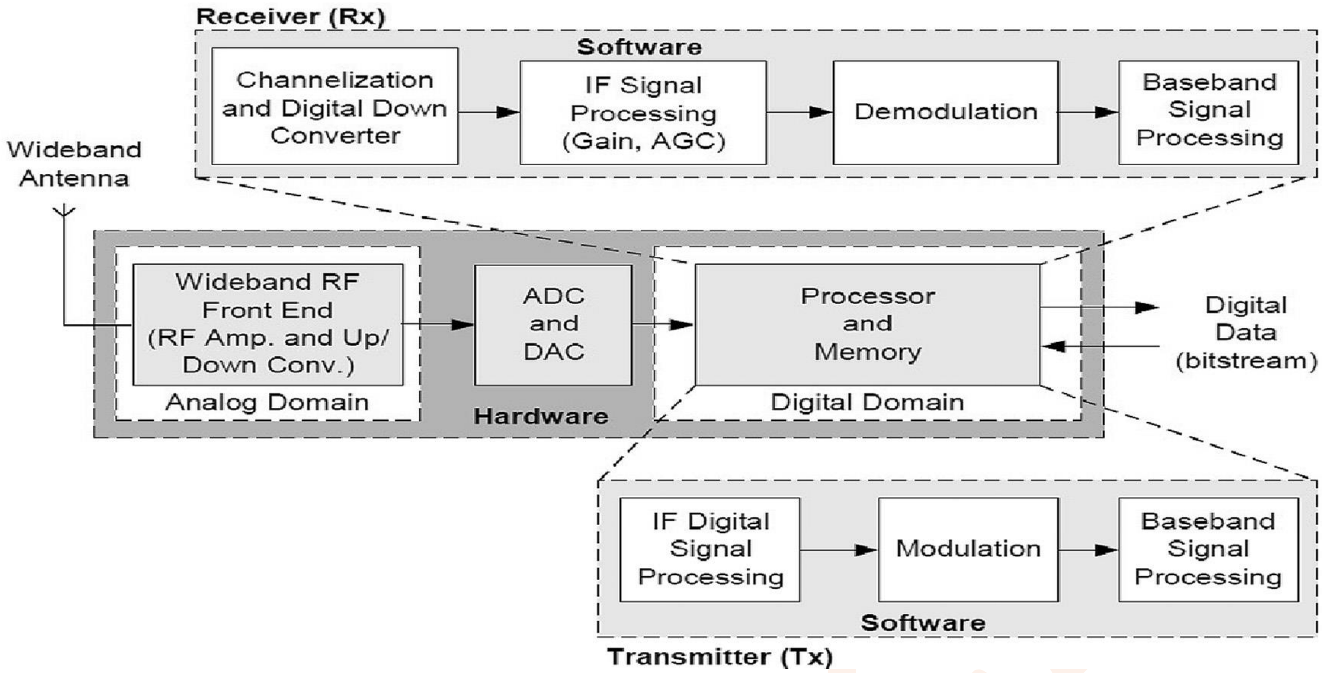
Abstract

Software-Defined radios (SDRs) are a popular platform for developing and implementing wireless protocols. Their basic architecture consists of radio front-ends hosted on an FGPA board, and a back-end processing host for running bulk of the signal processing in software. The two components are bridged, usually by an Ethernet or PCI interface that transports the radio samples. However, nowadays, path prediction is being extensively examined for use in the context of mobile and wireless computing towards more efficient network resource management schemes. Path prediction allows the network and services to further enhance the quality of service levels that the user enjoy. The approach will be a combinational one which is based on a neural technique and wireless nodes are able to self-organize in distributed form by using only local information. The extreme adaptability to the network conditions and application level constraints makes the proposed approach well suited for different communication scenarios such as standard observation or disaster recovery. The results are expected to support the significance of the study. The system performance will be evaluated by dealing with a suite of simulation tests to show as the controlled mobility paradigm, coupled with the intrinsic re-configuring SDR capabilities of such wireless devices, allows to increase the network performances both in terms of coverage and connectivity by dynamically adapting the modulation schemes to the specific communication scenario.

The work plans

(you depend on reference No-1)

1- Using MATLAB SIMULINK
2- Using SDR to compute the most suitable modulation scheme and the best position in order to improve both the coverage and connectivity in specific area.



3- Then use a (Neural *Network-Multi Layer Perceptron / Genetic for training)* technique and wireless nodes are able to self- organize in a totally distributed way by using only local information. I think local information mean we select the range of bandwidth (100M-10G) and we make table of result all modulation (M-FSK, M-PSK, M-QAM)

(*M = 2,4,8,16*) ranges with SDR and without SDR .

Note: - The towers (nodes) are moving but how? Artificial intelligence (Neural Network) to controls the system and (we use the GA- STP Salesman Travel

Problem Algorithm) for optimization. The movement of nodes is shown in figure below: -

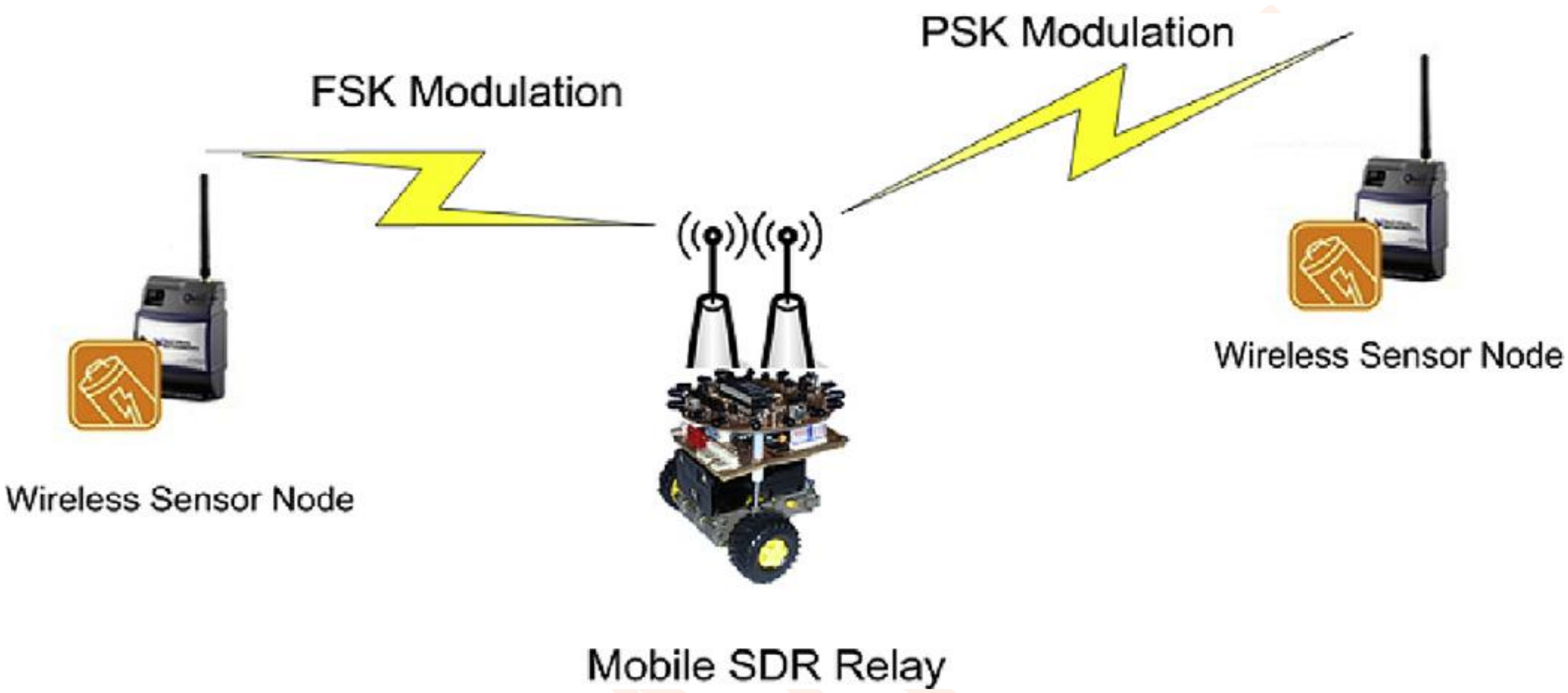


Table 3
Fixed nodes analysis supporting or not supporting SDR capabilities.

Output parameters	Without SDR	With SDR
Coverage	61.57%	61.47%
$QoS_{connectivity}$	2.03%	12.20%
Energy per information bit	$2.4 \cdot 10^{-5}$ [J]	$2.75 \cdot 10^{-5}$ [J]
Nodes choosing 4-FSK	12.59%	0%
Nodes choosing 8-FSK	28.34%	38.57%
Nodes choosing 16-FSK	34.82%	43.92%
Nodes choosing 4-PSK	0%	0%
Nodes choosing 8-PSK	0%	0%
Nodes choosing 16-PSK	10.80%	10.94%
Nodes choosing 4-QAM	0%	6.57%
Nodes choosing 8-QAM	0%	0%
Nodes choosing 16-QAM	13.45%	0%

1- The neural network determines the movements of each wireless node and select the best Modulation type (M-FSK, M-PSK, M-QAM)

2- . (Neural *Network-Multi Layer Perceptron / Genetic for training and Salesman traveling problem for moving Nodes)*

3- The neural network consists in input, output and hidden neurons. Inputs are subdivided as follows:

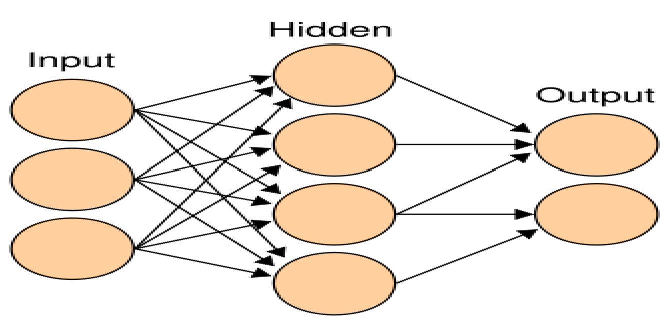
• 4 inputs to detect overlapping of sensing zone with neighbor- hood' sensing zone (1 for each direction);

• 4 inputs to detect missing of sink connection (1 for each direction);

• 1 to detect nodes in the same position.

That shown in figure below:-

(Neural *Network-Multi Layer Perceptron)*



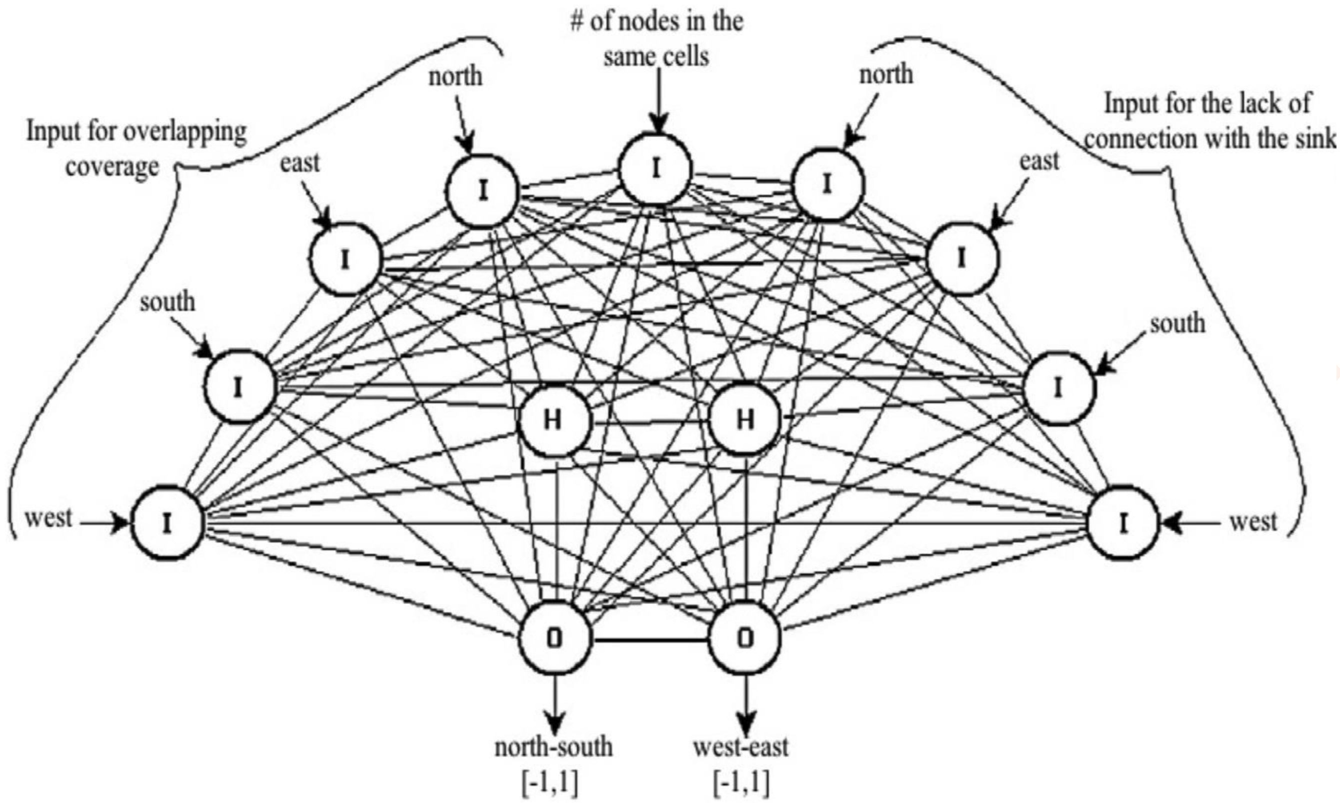


Fig. 3. Neural network architecture of one node.

(Assuming a square field of $n \times n$ cells, the node can move in one of the four allowed directions or remain in the current cell)

4- A conventional and real-value Genetic Algorithm (GA) is used in the training phase of the Neural Algorithm.

5- pseudo-code of the Neural/Genetic algorithm.

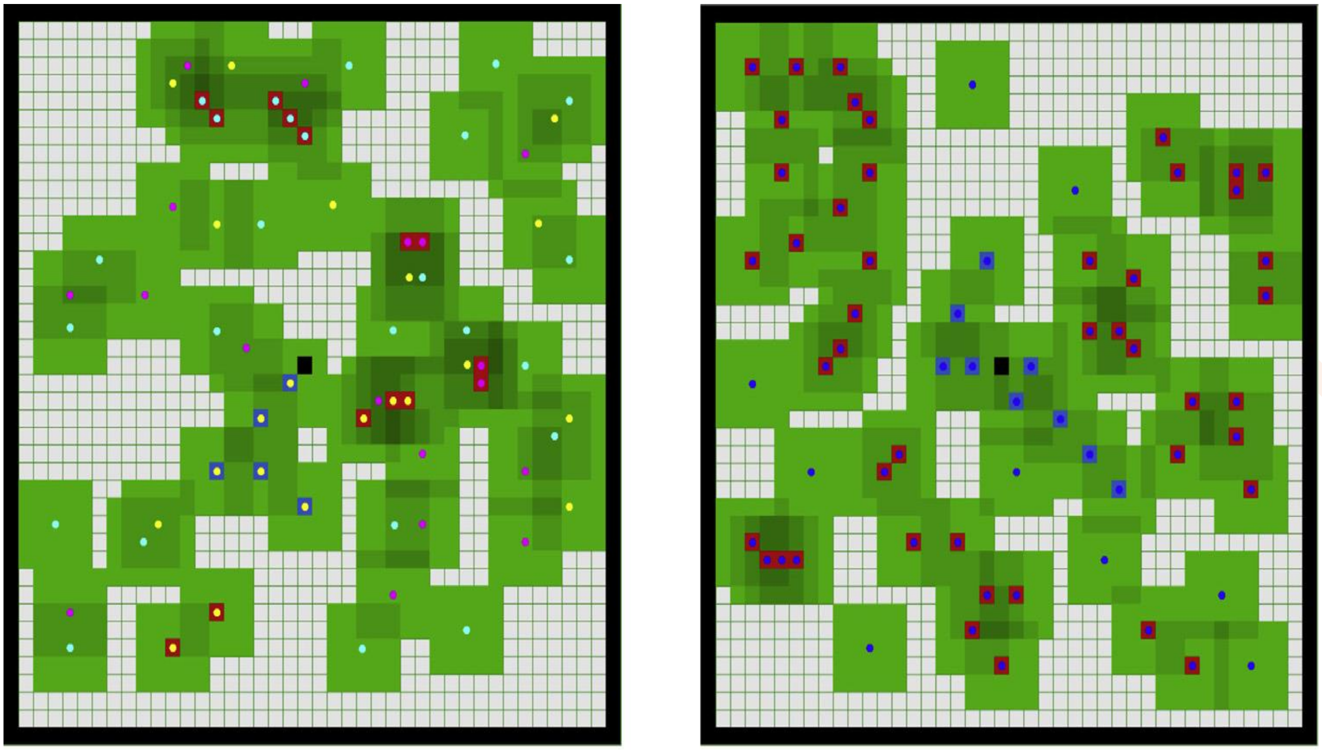
Algorithm 1 Neural/Genetic algorithm.

Random Deployment of Wireless Devices;
for all generation *i* **do**
  for all chromosome *j* **do**
    for all node *n* **do**
      while $time < time_{MAX}$ **do**
        Compute the new position of *n* through the neural algorithm;
        Compute the modulations that *n* must use to reach either the other nodes and the sink by guaranteeing a specific QoS; (see Section 4.4);
        Among all the modulations satisfying the QoS choose those that require less energy (this only a possible choice, we could also consider the modulations that maximize the throughput, etc.) (see Section 4.5);
      end while
    end for
    Compute chromosome fitness *j*;
  end for
  Consider the chromosome with the highest fitness value, apply genetic operators and then consider it as input for the next generation *i+1*;
end for

Table 2
Values of the relevant parameters used for the simulations.

Device parameters	
Power spent in *transient* mode (P_{tr})	100 [mW]
Time spent in *transient* mode (T_{tr})	5 [μs]
Wavelength (λ)	0.125 [m]
Information bits (L)	1000 [$bits$]
Receiver noise figure (N_f)	10
Bandwidth (B)	10 [kHz]
Scenario parameters	
Path loss exponent (γ)	3.8
Critical distance (d_0)	1 [m]
PSD of the noise ($N_0/2$)	$10^{-15}/2$ [W/Hz]
Bit Error Rate ($BER_{threshold}$)	10^{-3}
Maximum number of time steps	100
Genetic algorithm parameters	
% of elite selection (e)	15%
% of mutation (mu)	45%
% of crossover (c)	30%
% of created offsprings (off_c)	5%
% of selecting an offspring (off_s)	5%

At last we get the result that we want is shown in figure below:-



(a) (b)

Fig. 6. Fixed nodes communication scenario: (a) No mobility without SDR, (b) No mobility with SDR.

in Fig. 6 (a) the circles representing the nodes, are colored in different ways according to the different supported modulation schemes (i.e., yellow for FSK, cyan for QAM and magenta for PSK)

In briefly

1-MATLAB
2-SDR- we build the SDR architecture for relay node (the nodes moved by using neural network and genetic GA-STP algorithm) that make the coverage and connectivity the best status.
3-Data set-we select (100M-10G) we make the data set from 100M to 10G and that be input for SDR and neural network control all system inputs and the nodes movement.
4- Select different type of modulation then record result then we can compere between of them and effect of SDR on any type
5-We took into account a 40 ×40 cells field, where 64 nodes are placed in a random way according to an uniform distribution and apply neural network to control on the movement of the nodes according to coverage and connectivity of area.
6- Also the sensing radius of the nodes is *r* = 2 [*cells*] and it expresses the number of cells that

nodes are able to cover in each of the four main direction (north, south, east and west). For the neural network, we use 9 input neurons, 2 hid- den neurons and 2 output neurons. For the genetic algorithm, we use 300 chromosomes and 100 generations. All the results have been averaged over 10 different runs to respect a confidence interval of 95%. (in19 reference in folder -sminar-f) you can see.

7-*6.1. Validation of the optimization model we use the (GA-STP Algorithm)*

8-Select three different modulation schemes (MFSK, MPSK, MQAM) with three different symbol levels *M* (4, 8, 16) thus the set of possible choices is extended to nine.

9-In this work, we decided to use the relation between cut-offrate and pre-detection SNR to model.

10- *4.4. BER computation------compute the BER value related to each specific modulation scheme,* 11- The SNR *affect?*

12- In an effective way to the setting of (α and β) on system then we will change the value of them and see the result.

*13-**Fig. 9.** Neural/Genetic algorithm supporting mobility and percentage of nodes with SDR capabilities: (a) Coverage ratio, (b) QOS connect i v it y _ rat io , (c) Fitness.*

*14-**Fig. 10.** Neural/Genetic algorithm supporting SDR capabilities and percentage of mobile nodes: (a) Coverage ratio , (b) QOS connect i v it y _ rat io , (c) Fitness.*

*15-**Fig. 7.** Neural/Genetic algorithm supporting mobility without SDR capabilities: (a) Coverage, (b) QoS connectivity , (c) Fitness.*

*16-**Fig. 8.** Neural/Genetic algorithm supporting mobility and SDR capabilities: (a) Coverage, (b) QoS connectivity, (c) Fitness*

Notes: - Then we will do this in practice and see the result to compare the result that we getting *without SDR and with SDR and Mobility and No Mobility*

Then we select the best type of modulation and select the problem to solve.

باختصار

الهدف من البحث استخدام (الراديو المعرف برمجيا) بسيطرة النيورل والجنتيك باستخدام خوارزمية (البائع المتجول) لسيطرة على حركة النودات والهدف لتحسين كل من التغطية وجودة الاتصال

Algorithm that used in our search and we select Salesman algorithm for optimization and nodes movement

---

Algorithm 1 Neural/Genetic algorithm.

Random Deployment of Wireless Devices;
for all generation *i* **do**
  for all chromosome *j* **do**
    for all node *n* **do**
      while $time < time_{MAX}$ **do**
        Compute the new position of *n* through the neural algorithm;
        Compute the modulations that *n* must use to reach either the other nodes and the sink by guaranteeing a specific QoS; (see Section 4.4);
        Among all the modulations satisfying the QoS choose those that require less energy (this only a possible choice, we could also consider the modulations that maximize the throughput, etc.) (see Section 4.5);
      end while
    end for
    Compute chromosome fitness *j*;
  end for
  Consider the chromosome with the highest fitness value, apply genetic operators and then consider it as input for the next generation *i+1*;
end for
