Smart Antenna

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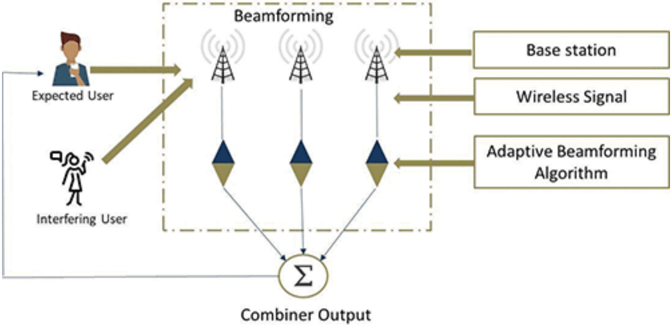
Overview

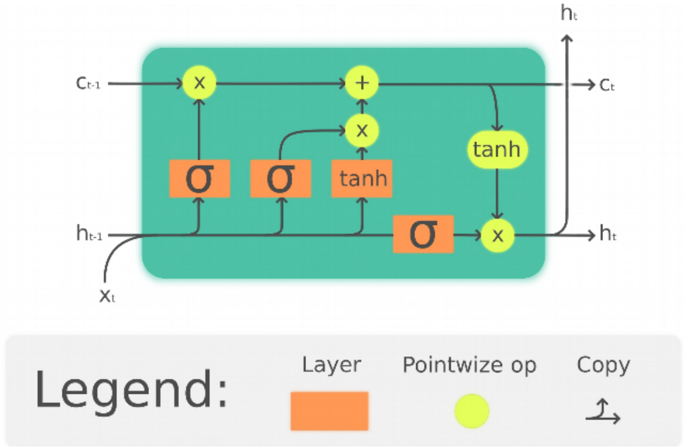
Introduction

- Smart Antenna:
  Smart antennas consist of more than an antenna. A smart antenna is a system involving multipleantenna elements and a digital signal processor to adjust the radiation. It is an antenna system which dynamically reacts to its environment to provide better signals and frequency usage for wireless communications.



- Why Smart Antenna:
  1)Diversity effect involves the transmission and/or reception of multiple radio frequency (RF) waves to increase data speed and reduce the error rate. Smart antenna technology can overcome these capacity limits as well as improve signal quality and let mobile telephones operate on less power [**?**].
  2)Extended range.
  3)More number of subscribers.

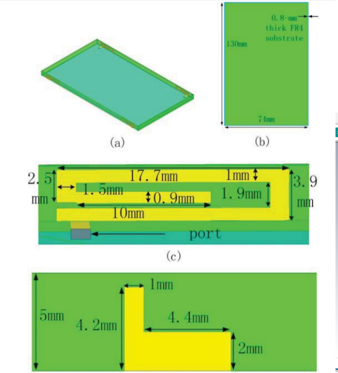
- our idea:
  1)Narrow beam generation through antenna designed in millimeter range frequency. 2)Allocation of this narrow beam to the desired user by predting the trajectory of desired user through Lstms(long short term memory networks).

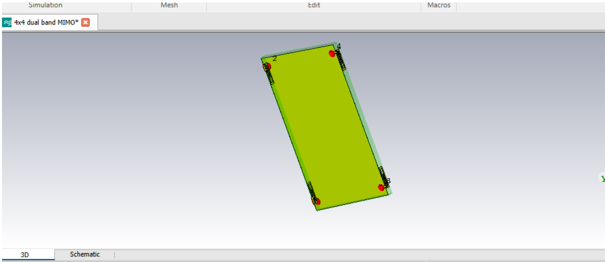


Antenna Design

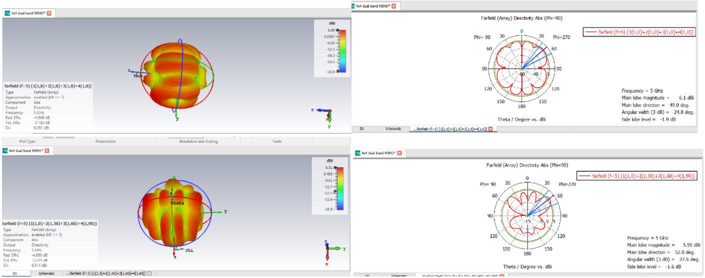
Dual Band MIMO Antenna:

Dual-band MIMO antenna which consist of four elements is proposed. The proposed antenna not only can operate in the dual frequency band of 3300- 3600 MHz and 4800-5000 Mhz but also a 12 dB of isolation is obtained [?]. The structure and dimensions of the proposed antenna array is shown in fig.

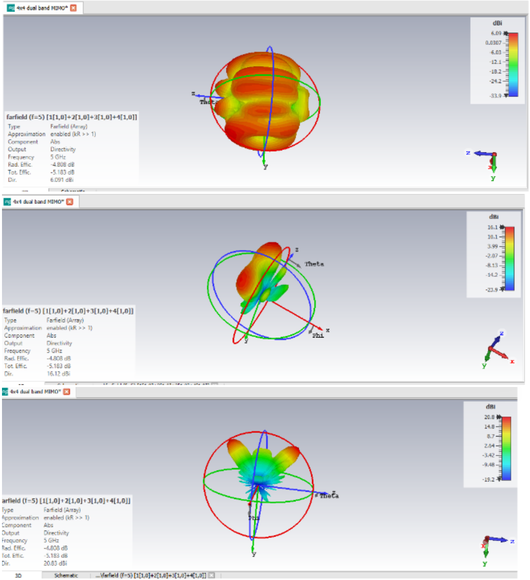


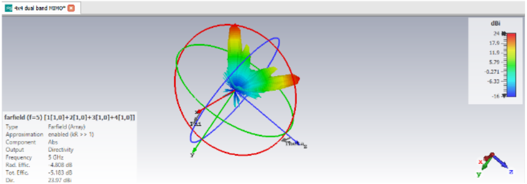


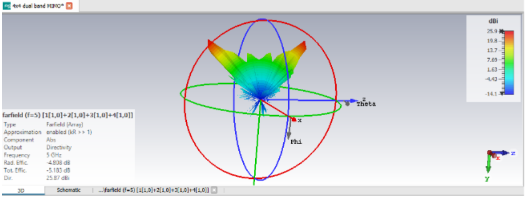
- Simulation Results



- Simulation Results




4x4 dual band MIMO*
dBi
24
17.9
11.9
5.79
-0.271
-6.33
-16
farfield (f=5) [1[1,0]+2[1,0]+3[1,0]+4[1,0]]
Type Farfield (Array)
Approximation enabled (kR >> 1)
Component Abs
Output Directivity
Frequency 5 GHz
Rad. Effic. -4.808 dB
Tot. Effic. -5.183 dB
Dir. 23.97 dBi
Phi
Theta
x
y
z


4x4 dual band MIMO*
dBi
25.9
19.8
13.7
7.69
1.63
-4.43
-14.1
farfield (f=5) [1[1,0]+2[1,0]+3[1,0]+4[1,0]]
Type Farfield (Array)
Approximation enabled (kR >> 1)
Component Abs
Output Directivity
Frequency 5 GHz
Rad. Effic. -4.808 dB
Tot. Effic. -5.183 dB
Dir. 25.87 dBi
Theta
Phi
x
y
z
3D
Schematic
...\farfield (f=5) [1[1,0]+2[1,0]+3[1,0]+4[1,0]]

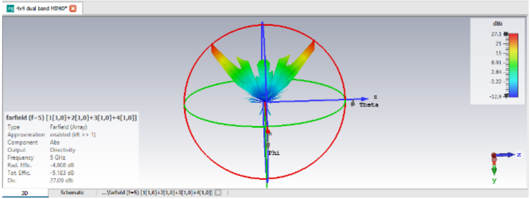
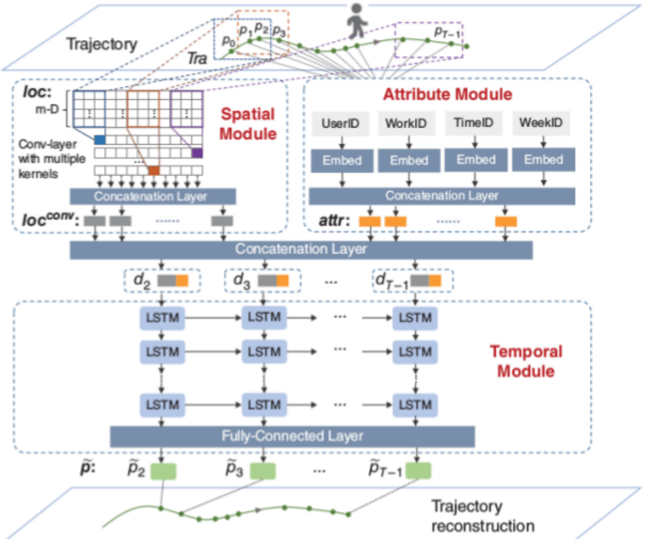

4x4 dual band MIMO*
dBi
27.1
21
15
8.91
2.84
-3.22
-12.9
farfield (f=5) [1[1,0]+2[1,0]+3[1,0]+4[1,0]]
Type Farfield (Array)
Approximation enabled (kR >> 1)
Component Abs
Output Directivity
Frequency 5 GHz
Rad. Effic. -4.808 dB
Tot. Effic. -5.183 dB
Dir. 27.09 dBi
Theta
Phi
y
z
3D
Schematic
...\farfield (f=5) [1[1,0]+2[1,0]+3[1,0]+4[1,0]]

Figure no.	Main Lobe to Side lobe ratio	3dB Beamwidth(degrees)
2a	-3.21	24.8
2b	-0.66	18.4
2c	-1.16	11.7
2d	-1.24	8.3
2e	-1.05	6.5
2f	-0.48	5.2

  As the number of antennas are increasing 3db beamwidth is decreasing. Since 3dB beamwidth is very small it comes under Narrow beam. By adjusting phases and magnitudes of antennas we can get high main lobe to sidelobe magnitude .

Tragectory Prediction

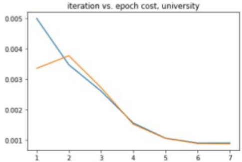


- Lstm Networks :
  Trajectory prediction can be viewed as a sequence generation task where we are interested in predicting the future trajectory of people based on their past positions. Recurrent Nurel Network(RNN) models for sequence prrediction tasks, we propose an LSTM model which can learn general human movement and predict their future trajectories[**?**].

- Training and Testing results:

```
('Train iteration', 1, 'train loss:', 0.005003572981028507)
('Train iteration', 1, 'dev loss:', 0.003355906632107993)
('Train iteration', 2, 'train loss:', 0.003474856972590916)
('Train iteration', 2, 'dev loss:', 0.003772919299080967)
('Train iteration', 3, 'train loss:', 0.0026066928785035593)
('Train iteration', 3, 'dev loss:', 0.002721314764736841)
('Train iteration', 4, 'train loss:', 0.001554645492514181)
('Train iteration', 4, 'dev loss:', 0.001512650111302112 6)
('Train iteration', 5, 'train loss:', 0.001056791873027881)
('Train iteration', 5, 'dev loss:', 0.001047269564393597 4)
('Train iteration', 6, 'train loss:', 0.0008963728983265657)
('Train iteration', 6, 'dev loss:', 0.0008785741791749995)
('Train iteration', 7, 'train loss:', 0.0008986188855487854)
('Train iteration', 7, 'dev loss:', 0.0008699880961406355)
```

```
('number i: ', 465, 'iteration: ', 1524, 'cost: ', array([0.02144858]))
('number i: ', 466, 'iteration: ', 1672, 'cost: ', array([0.01886506]))
('number i: ', 467, 'iteration: ', 1808, 'cost: ', array([0.01830542]))
('number i: ', 468, 'iteration: ', 1812, 'cost: ', array([0.01816398]))
('number i: ', 469, 'iteration: ', 1794, 'cost: ', array([0.01797719]))
('number i: ', 470, 'iteration: ', 1789, 'cost: ', array([0.01796732]))
('number i: ', 471, 'iteration: ', 1411, 'cost: ', array([0.02219168]))
('number i: ', 472, 'iteration: ', 1396, 'cost: ', array([0.02221413]))
('number i: ', 473, 'iteration: ', 1389, 'cost: ', array([0.02227078]))
('number i: ', 474, 'iteration: ', 1406, 'cost: ', array([0.02240618]))
('number i: ', 475, 'iteration: ', 1440, 'cost: ', array([0.02201221]))
('number i: ', 476, 'iteration: ', 1554, 'cost: ', array([0.01871184]))
('number i: ', 477, 'iteration: ', 1745, 'cost: ', array([0.01740353]))
('number i: ', 478, 'iteration: ', 1796, 'cost: ', array([0.01759543]))
('number i: ', 479, 'iteration: ', 1785, 'cost: ', array([0.01769305]))
('number i: ', 480, 'iteration: ', 1776, 'cost: ', array([0.01769562]))
('number i: ', 481, 'iteration: ', 1378, 'cost: ', array([0.02211546]))
('number i: ', 482, 'iteration: ', 1423, 'cost: ', array([0.02219775]))
('average cost: ', array([0.01994767]))
```




```
('Test loss:', 0.0005968359269900248)
```

References I