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DYNAMIC LOCATION MODELLING IN 3D BEAMFORMING FOR 5G MOBILE COMMUNICATIONS

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ABSTRACT

Mobile communication system is designed to provide reliable communication with more number of services and with low cost among multiple users. Due to limited frequency spectrum and resources, mobile communication requires more development in case of both establishing communication and maintenance in service quality. To fulfill these requirements, 5G mobile communication is being developed to provide high quality reliable communication and quality of service, by using beamforming model. As the trend of next generation mobile communication, 3D directional transmission is considered to give enhanced coverage model and reusability of frequency. Phase arrayed antenna is used in this beamforming model to give orthogonal communication among users. In this paper, a new modeling of beamforming is applied to give a new dimension by considering altitude with potential field strategy. Here phase arrayed antenna is replaced by 3-D smart antenna to improve the performance of 5G mobile communications. Performance evaluation outcomes 3D beamforming leads 2D beamforming in terms of communication delay, and uplink downlink throughput.

Keywords: BDMA, 3D beamforming, Potential field, Line if Sight, Angle of projection.

1. INTRODUCTION

The technology of using multiple antennas (MIMO) plays a vital role in the development of mobile communication system to enhance the spectrum efficiency and quality of connection. Next generation mobile communication devices are being designed to equip with phase arrayed antenna to connect with more number of users simultaneously. 5G mobile communication is completely designed to create and maintain connection using beamforming strategy. These antennas initially connect using omni-directional beamforming and maintain connectivity using directional beamforming based on location of user devices. Random beamforming or spatial beamforming is used to connect with the mobile devices. 5G mobile device is created to support connection among more than billion of devices with 10 GB data rate.

This is drastically high speed communication in wireless devices with very low jitter and transmission delay. But this is still under development and only in white paper design. There is no complete structural design and communication paradigm for 5G communication. These 5G radio devices will be the future mobile phone which is used by billion of pupils in worldwide. And by using this anyone can access their resources such as remote files, video streaming and voice application as like local files.

Wireless communication has been established to access services on the Internet even its performance noticed as lower when compared to wired networks. Packet drops in wired networks are mainly due to congestion and less available bandwidth or traffic transmission rate is higher than maximum transmission rate. Hence, losses in wired networks can be seen as congestion indication. This is different in wireless networks where losses often occur for various reasons, for example due to interference or poor link quality (high distance between the base station and the mobile device).

Current trend in mobile communications continues to manipulate the way of people access information. Further improving and modulating strategies that enable human-centric and not-disconnected machine-centric networks will come to fulfill the user satisfaction and to modify end user transformation from one place to another along with the entire global telecoms industry.

Antennas are playing important role for data transmission in mobile communication. Phase arrayed antennas is used to create MIMO communication. Smart antenna [1] is made up of several antenna units, at where each of them is combined with a complex weighting coefficient which can be used deal with signal processing in spatial domain. By introducing a weighing coefficient based on delay, the antenna can be able to deal with signal in two domains which is both spatial and time domain. Spatial Division Multiple Access possible is made by Smart antenna, which is able to differentiate multiple access by different signal path while even with same time division, same frequency and address code. With the help of adaptive antenna theory and high resolution array signal processing, smart antenna gives a good promise for future wireless communications.

Beam forming [5] is new communication strategy to establish connection between devices which is most dominant and widely used techniques by using smart antennas. By combining radiation pattern of each antenna elements on the antenna arrays to form a directional and energy concentrated beam as a signal transformation. In the smart antenna, the number of antenna array system is merged in the RF part, and that controls every steering vector to the antenna array, to form a directive beam. Along with phases, weight is added on the amplitude phases of the signals from multiple antennas, the beam can have the ability of space selectivity.

2. RELATED WORK

One solution [11] to overcome those limitations could be the use of the coherent collocated MIMO digital array radar concept which would constitute a natural evolution of the Digital Beamforming radar. It consists in space-time coding on transmit of each individual transmitters (or sub-arrays), allowing to identify each of them by processing on receive, and hence to recover the angular directivity of the transmission antenna by Digital Beamforming of the transmission antenna. The angle domain explored simultaneously is the largest since it is equal to the individual transmitter beam width. It is worth noting that this coherent MIMO has nothing to do with non-coherent (or statistical) MIMO, that mainly exploits spatial diversity on target, using well separated (multi-static, none co-located) transmitting antennas.

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In wireless communications, Diversity of antenna has two main factors: the diversity of communication, that uses the nature of multiple transmission to a single receiver (MISO) that can increase the strength of the signal at very low SNR, and it won't affect the data rate of the communication; while the diversity of reception, which uses single transmitter and multiple receivers (SIMO), that can used to combine the same signal and increase the SNR, that leads to increase in the coverage. MIMO can increase the data rate and spectrum [3] efficiency by taking the advantage of spatial multiplexing [7].

The advantage of 3-D beam is obvious, it has been nominated in the standard that 3-D beam forming [10] and pre-coding can increase the SNR of the target user. The antenna array system can trace the location of the user, and supply a dynamic coverage to reduce the interference among users so that the total capacity of the system can be increased. Besides, the 3-D beam forming can also be combined with 3-D MIMO technique, according to the channel information; the super narrow beam can be formed towards a single user, which is more accurate than the conventional beam forming that can provide the beam at range of a sector.

The basic idea of the MIMO concept is to be able to perform the transmit array beamforming by digital signal processing on the receive side. This implies that we are able to select one transmitter while rejecting the others as perfectly as possible when computing the matched filter. The problem is similar to the channel access method in digital communications (several transmitters sharing the same transmission medium) and so, the basic principles are very close. This ability to separate the transmitters through signal processing means that the transmit signals have to be orthogonal to each other's whatever the relative delay between received echo and replica is.

In an RBF scheme, the time–frequency resources for communication are divided into many small time–frequency blocks (TFBs), each of which can apply a specific random weight vector. For a large enough number of TFBs, the average power of their random patterns in each direction is nearly equal since no direction is preferable to others; thus, omni-directional coverage is achieved. For a receiver in a certain direction, the beamforming gain fluctuates when the pattern changes from TFB to TFB. It is a similar effect as time- and frequency-selective fading, although the receiver is not moving. Channel coding and diversity techniques can be utilized to overcome these imperfections. If a same pattern sequence is applied on both the data and the pilot, the receiver will treat the beamforming gain as part of the channel response. Therefore, the RBF scheme is transparent to the receiver. This feature would facilitate its utilization in the current existing systems, such as TD-SCDMA and LTE, without the need for standard works.

3. BDMA USING 3-D SMART ANTENNA

The Beam Division Multiple Access technique is the next generation communication paradigm at which the antenna plays a significant role based on the locations of the mobile stations with respect to base station as reference point. The beam angle between Mobile stations and a base station is allocated based on the Line of Sight and angle of projection, at which the communication is established and transmission is possible between the mobile users. This model is completely designed based on the projected location information of the user from the service station.

Beamforming is the process generating signal beam based on location and distance of a user from the base station. In 5G mobile communication, beamforming plays a vital role while establishing connection among multiple users. Beam generation is purely based on light of sight and angle of projection between the mobile cellular user and wireless base station.

There are two set of beams are generated while transmitting and exchange of data among user namely, uplink and downlink beams. To create this beamset uplink and downlink beam generator is used in both base station and mobile device. This beam generator is equipped with phase arrayed antenna in base station to generate more beams simultaneously to connect with more number of mobile users in mean time.

Initially base station generates and sends a broadcast message omnidirectionally. To achieve this phase arrayed antenna is rotated to equip as a omnidirectional antenna, and this generates the signal in all 360 degree. The antenna used in base station has many arrays nearly millions of small beam generators for both uplink and downlink. While receiving the broadcast message from the base station which and all surrounded within its communication range, generates a connection message with its identity which is used to identify device uniquely, and send to base station.

This can be achieve either in omnidirectional or in computed angle based directional. The base station verifies its identity and its subscription from its connected database that contains information about all mobile users. Once verification get succeed, the base station computes its location distance from the signal strength using tworay propagation model.

And the incoming data angle is computed from directional antenna which is connected in network interface. Once the angle and distance are computed by taking z axis as reference (x,y) location is estimated, By taking x as reference (y,z) location is computed, and by taking y as reference (x,z) location is calculated.

From these three set values, exact location of mobile device is computed as (x, y, z) dimension. After computing the location of mobile device, beamforming angle is computed in 3D model, this angle of projection is used to generate the uplink beam from base station to mobile station. From this uplink value, downlink angle also computed by subtracting angle from 360 degree.

Now, the phase arrayed antenna is rotated based on the beamforming angle with respect to mobile user. And uplink downlink information is transmitted to mobile station in connection success reply message. The mobile device receives this reply and rotates its beamforming inversely based on uplink and downlink information received in the reply message.

After rotation of mobile user antenna, the communication and exchange of data is initiated between user and base station. And this model is executed in periodic manner to compute both angle and distance from RSS value. To achieve the orthogonal communication among user from the single mean frequency division duplexing is applied with Beam division multiple access. And hence this model is known as FDD combined BDMA (FDD-BDMA).

4. SMART 3D BEAMFORMING

- At commence base station it applies flow propagate content omni-directionally, which make a basic communication in 360 grade.

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- If any moveable device betrayed to encounter this propagate content executes scanning action to communicate gateway.
- Upon encountering of base station propagate content, moving station consists and ACK content to base station.
- By meeting this ACK content or reading content, base station execute emplacement and acceleration demodulator to approximate actual emplacement precisely in both 2D and 3D space.
- Once emplacement is calculated then 3D beamforming angle is calculated (both uplink and downlink).
- At present base station's downlink ray source to produce downlink ray is accomplished and radio beam is rendered and so content that admits uplink, downlink ray entropy is broadcasted by indicating action.
- After encountering this pointing moving station downlink ray source is adapted in both slant and breadth of the ray to transmit with base station.
- Concurrently, base station ray source also adapted in both uplink and downlink ray generation.
- This ray creation is applied by means of intelligent 3D beaming aerial instead of phase range aerial.
- There's a covering pattern is accomplished in both base station and in mobile station to handle the mobility of devices.
- A oscillating propagate content is channelized in both stations to update actual emplacement and acceleration of mobile device. By means of this beamforming angle is updated periodically.
- In this, 2d beamforming is calculated initially using the formulae,

  x = distance * arcsin(theta) and

  y = distance * arccos(theta). where theta is angle between user and base station in x,y dimension space.

  After computing this 2d angles based on x and y, location estimation is executed with respect to x and z dimension.

  x = distance * arcsin(pi) and

  y = distance * arccos(pi). where pi is angle between user and base station in x,z dimension space.
- This interlacement model projected in 3D space as follows,

  x = distance * arcsin(theta)*arcsin(pi)and

  y = distance * arccos(theta)*arccos(pi).
- So the generality model is,

  dr = |dx,dy|

  where dy and dx are interlacement distance of 3D beamforming.
- If this 3D beamforming model is executed in m x n MIMO unit, then total no of beamforming angles to be computed as minimized to mn instead of (mn)2. This is achieved by means projecting angles in 3D space. This is complementary model for 5G communications.

5. PERFORMANCE EVALUATION

Since there is specific simulator is available to test this 5G model, MATLAB is used for simulation. And performance evaluation is conducted between 3D antenna and 2D antenna. Evaluation is conducted in terms of uplink and downlink throughput, delay and SINR (Signal to noise interference ratio).

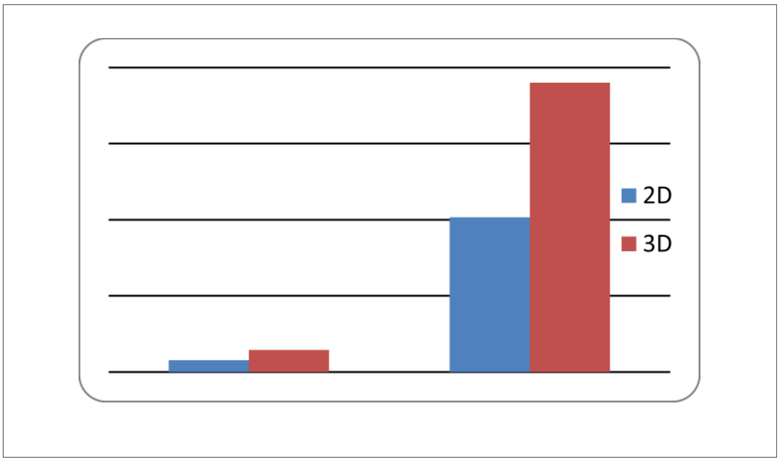

Figure 1. Throughput comparison between 2D and 3D beamforming

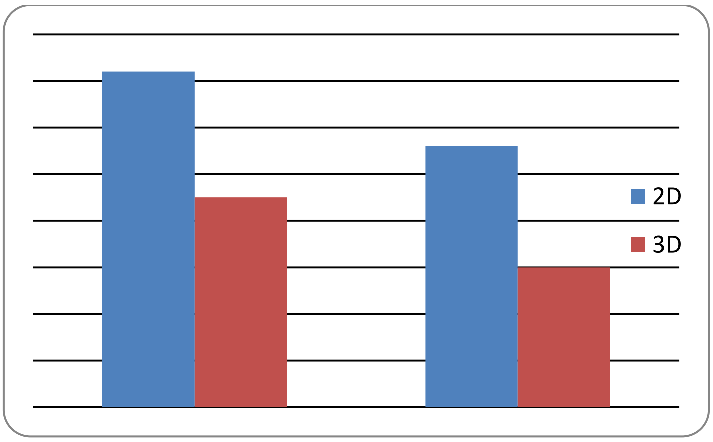

Figure 2. Delay comparison between 2D and 3D beamforming

Figure 1 and 2 shows the comparisons between 2D and 3D beamforming in terms of throughput and delay respectively.

1. Throughput is calculated as no of bits transmitted per unit time.
2. Delay is computed as average time taken to complete the transmission
3. SINR is computed as ratio of Signal quality and Interfered noise.

It outcomes in both uplink and downlink communication 3D beamforming performs well compare to 2D beamforming. In case of throughput 3D beamforming achieves more uplink and downlink bit rate. Similarly for delay 3D beamforming transmits packet in low delay compare to 2D beamforming.

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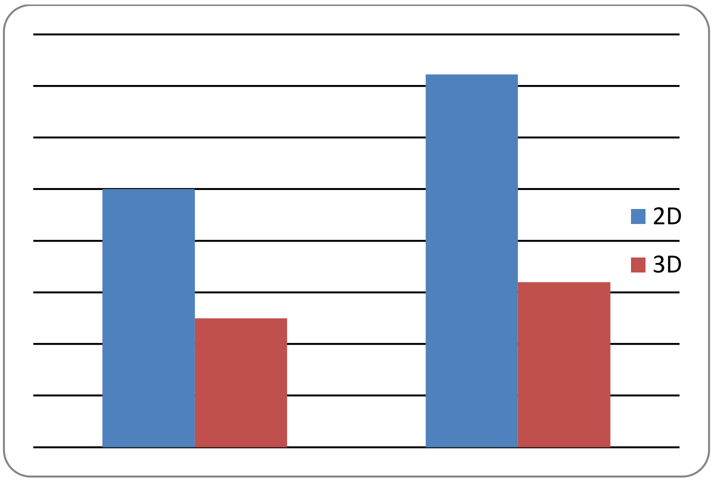

Figure 3. SINR comparison between 2D and 3D beamforming

Figure 3 shows the SINR comparison between 2D and 3D beamforming. It shows 3D smart beamforming produces better performance by giving low SINR compare to 2D beamforming. So finally we can conclude 3D smart beamforming will produce better results compare to 2D beamforming. So this model can be used for 5G mobile communications.

6. CONCLUSION

Fifth generation of mobile communication model is to be developed by using beamforming strategy. By using this model communication paradigm, user can access their files and online resource at high speed and low latency. Proposed 3D intelligent beamforming model can be used to improve the significance of 5G mobile communications. FDD combined BDMA model is modeled with 3D smart beamforming to enhance the quality of communication between mobile device and base station significantly. By means of this communication the user can access their remote machine resource in very low latency and with high data rate.

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