Improvement in computational complexity of the MIMO ML Decoder in high mobility wireless communication systems using non-stationary IMT-A

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***Abstract* -** *The MIMO has attracted a lot of attention recently as a promising technique that can enhance the system performance and link reliability. The high mobility wireless communication faces the problem of providing the reliable communication over rapidly varying radio channels. Measurements have demonstrated that the standard channel models, like IMT-A,WINNER-II models offer stationary intervals considerably larger than high mobility wireless systems. The stationary interval defined, maximum time duration over which channel satisfy the WSS condition. In this project a non-stationary model with time varying parameters like number of clusters, angle of departures, angle of arrivals power and delays of angle of arrivals along with the statistical parameters like spatial cross correlation function and temporal auto correlation function will be discussed. At the receiver, the signal considered, is from the multiple transmits antennas, as a vector. The traditional search method determines component in the transmitted vector, one by one. It is known that order of decisions on signal components has large impact on the computational complexity of the search part. QR decomposition with sort, determines an efficient order of decisions on signal components, decreases the computational complexity of the search part with little increase of computational complexity in pre-process part. The search part can be regarded as shortest path problem in a weighted graph and use of the Dijkstra's algorithm significantly reduces the computational complexity of the search part.*

***Keywords* - IMT-Advanced, MIMO, Non-Stationary, time varying parameters, statistical parameters, Dijkstra's Algorithm.**

INTRODUCTION

MIMO technology has attracted the lot of attention recently as a promising technique that can enhance the system performance. The channel has a noteworthy part in deciding the unwavering quality of the method. In high mobile wireless communication the data transmission is of high data rates, the large amount of data at the receiver, it makes very difficult for the receiver to isolate the each user data which is having the high accuracy. Due to this, the data corruption and the reliability of the channel get effected. In order to overcome this problem the amount of data has to be minimized by the help of some technique. QR Decomposition is technique. QR decomposition technique is used in a way to reduce the complexity at the receiver by following some steps. QR decomposition with sorting further reduces the complexity at the receiver. An algorithm called Dijkstra's algorithm find the shortest path from one source to the destination. This results in reduced complexity at the receiver.

QR DECOMPOSITION AND SORTING

In this technique the signal travels through the channel. The faded signal matrix is received at the receiver. Since the received signal is in the vector form it undergoes into conversion as matrix. A standard low pass equivalent is generated as

$$\vec{r} = H\vec{s} + \vec{n}$$

H as fading channel matrix,$\vec{s} \in S^t$ is transmitted signal $\vec{n}$ is additive white Gaussian noise, S is signal constellation. Let *H=QR* be QR decomposition, $\overline{s'}$ be an ML estimate of $\vec{s}$ .Let

$$||\vec{r} - H\vec{s}||=||\vec{r} - QR\overline{s'}||$$

$$=||Q^*\vec{r}-Q^*QR||$$

$$=||Q^*\vec{r}-R\overline{s'}||$$

is the minimum value among all transmitted signals in S^t. We will formally review the original method in search part[].It tries to find a vector $\overline{s'} \in S^t$ within the sphere of radius $\sqrt{C}$ and the centre $\vec{r}$

and considers the in equality condition

$$||Q^*\vec{r}-R\overline{s'}||\leq C. \qquad (1)$$

The t-th column in $Q^*\vec{r}-R\overline{s'}$ is qt-$R_{t,t}s'_t$ and

$|qt - R_{t,t}s'_t|^2 + \sum_{i=i+1}^{r} |q_i|^2 \leq C$ is necessary condition for (1). So we choose $\hat{s}_t$? **S** with $/qt - R_{t,t}\hat{s_t}/2 \leq C$ as a candidate of *t-*

th component in $\vec{s'}$ Considering (t - 1)-th and t-th columns in Q⍰$\vec{r}$ - $R\vec{s'}$, we choose $\hat{s}_{t-1}$ ⍰ **S** with

$$\|\begin{pmatrix} q_{t-1} \\ qt \end{pmatrix}\begin{pmatrix} R_{t-1,t-1} & R_{t-1,t} \\ & 0 \end{pmatrix}\begin{pmatrix} \widehat{s_{t-1}} \\ \hat{s}_t \end{pmatrix}\|^2$$

$$+\sum_{i=1+1}^{r} |q_i|^2 \leq C$$

as a candidate of (t - 1)-th component in $\vec{s'}$. Remaining is resolved in a comparable manner. If there is no candidate $\hat{s}_i$ ⍰ **S**, then we rechoose $\widehat{s_{i+1}}$ .When we determine $(\hat{s_1}, \ldots, \hat{s_t})$, we set the new radius to $/\vec{r} - (\hat{s_1}, \ldots, \hat{s_t})/$ //and repeat the search part. The last found vector is the ML estimate of the transmitted signal. On the off chance that there is no conceivable transmitted flag in the circle with starting span c then we announce eradication or increment the range c

Need for Sorting

The sorting is process of arranging the items systematically. Ordering and categorizing. With this procedure we get a qr disintegration of the segment permuted network of $\widehat{H}$ of H. In the event that we apply the customary inquiry part in segment 2 with then we get all the more proficiently the permuted variant of the ml appraise$\vec{s'}$. The ML estimate $\vec{s'}$ can be obtained by the permutation.

QR DECOMPOSTION WITH SORTING

We will describe the QR decomposition with sort. Watch that in the conventional qr decay is equivalent to the standard of the principal section vector of H. In order to minimize$R_{1,1}$, we replace the first column of H with the column with minimum norm. Let H be the column replaced version of H .Register a unitary lattice with the end goal that the main section of is the of $Q1H$ is $\widehat{R'_{1,1}}$, 0,0, ,,,0^T. Let $\widehat{H}2$ be (r - 1) × (t - 1) submatrix of Q 1H with the first column and the first row of Q 1H removed. Replace the first column of$\widehat{H}2$ with the column with minimum norm in$\widehat{H}2$. Let H_2 be the column replaced version of$\widehat{H}2$. Compute a unitary matrix Q'_2 such that the first column of Q_2H_2 is $(R2{,}2{,}0{,}\ldots{,}0)^T$.The Calculation process is recursively rehashed until i =t

DIJKSTRA'S ALGORITHM

Dijkstra's algorithm is an algorithm used for finding the shortest paths between the nodes in a graph. In high mobility wireless communication system, the information accumulated at the receiver is very large. In order to satisfy the needs of the user the huge information is partitioned by using the QR Decomposition with sort. The information is pre-processed in the decomposition process and the sorting; the processing part is further reduced. The computational complexity is reduced. The use of algorithm for the sorted output finds the shortest path from source to destination. The only thing that increased here is the space for processing.

RESULTS

The final result is to find the shortest path from source to destination point. The shortest path is found for the calculated signal output. Scatter plot is the first result from where the scatter outputs are calculated after passing the Rayleigh fading channel. Performing the QR decomposition and the sorting, the output is applied for the algorithm process. The output from algorithm is represented in graph.

The shortest path values for the calculated scattered output are represented..

Scatter Plot

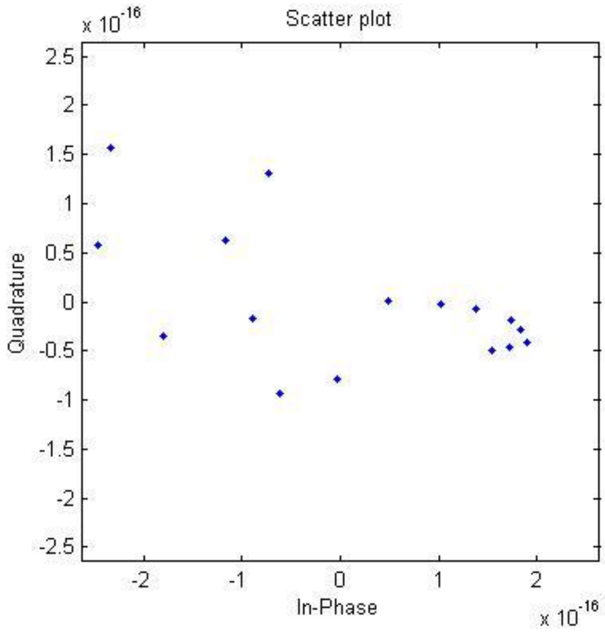

Fig:-Scatter Plot of the Input Signal

Shortest Path Values

```
>> dist

dist =

     0

>> path

path =

   255

>> pred

pred =

  Columns 1 through 27

   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN

  Columns 28 through 54

   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN

  Columns 55 through 81

   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
Start                                                                                                                                                  OVR
```



```
  Columns 82 through 108

   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN

  Columns 109 through 135

   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN

  Columns 136 through 162

   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN

  Columns 163 through 189

   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN

  Columns 190 through 216

   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN

  Columns 217 through 243

   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN

  Columns 244 through 255

   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN     0

fx >>
```

CONCLUSION

The shortest path distance form source node to the destination node can be found using this method in high mobility wireless communication system. In order to achieve this some exemptions are considered like more space for processing. In future the shortest path can be achieved by minimizing the space complexity.

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