PN Acquisition Using Adaptive Thresholding and Smart Antenna for Direct Sequence CDMA Mobile Communication

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ABSTRACT

- This research work presents an efficient pseudo-noise (PN) code acquisition scheme for wideband direct-sequence code division multiple access (DS-CDMA) communication using smart antenna and adaptive thresholding constant false alarm rate (CFAR) detection.
- The CFAR processor considered is the censored mean level detector (CMLD) which is based on order statistics.
- The communication channel is a Rayleigh slowly fading multipath channel.
- The performance of the proposed scheme is analyzed and simulated.
- The results show the robustness of the proposed communication system in a multiple access interference (MAI) environment.

INTRODUCTION

- In mobile communications the receiver receives multiple copies of the transmitted signal from several paths.
- The MAI signals are common in DS-CDMA communication systems.
- All these circumstances have serious effects on the PN code acquisition performance.

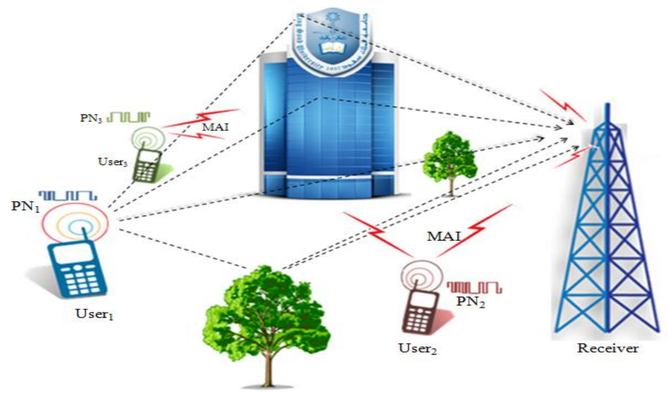

Figure 1. Mobile DS-CDMA communications system.

- In order to provide a high quality communication, it is essential to acquire the PN code both quickly and accurately.

OBJECTIVES

- Studying efficiency of PN acquisition and mean acquisition time in the proposed communication system [1] under various design parameters using:
  - Wideband CDMA communication,
  - Smart antenna, and
  - Adaptive thresholding CFAR detection based on order statistics.

MATERIALS & METHODS

Concepts needed to build this system:

- Spread spectrum communication with direct sequence (DS) code division multiple access technique (CDMA).
- Adaptive thresholding CFAR detection .
- Smart antenna.

DS-CDMA Communications

- The DS spread spectrum offers many significant advantages for present-day communication systems.
- In the DS, a PN code is used for spreading and despreading purpose.
- In the DS-CDMA, each user has its own PN code.

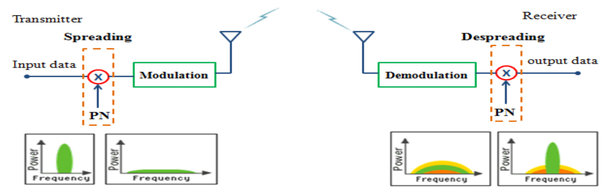

Figure 2. Direct sequence spread spectrum technique.

Smart Antenna

- A smart antenna is a combination of an antenna array and a digital signal processing (DSP) unit that changes its radiation pattern adaptively.
- It has a good ability in combating MAI signals, tracking mobile signals, reducing multipath fading, and improving signal power gain.

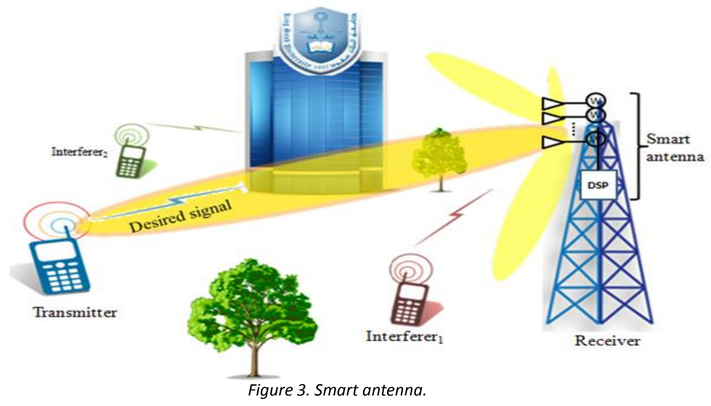

Figure 3. Smart antenna.

Adaptive Thresholding CFAR Processing

- Fixed threshold allows intolerable increase of false alarms.
- Adaptive thresholding to maintain the probability of false alarm at the design value.
- The CFAR processing is well developed in the field of automatic and adaptive radar signal detection.
- Its idea is to estimate the background noise power, which is unknown, from a reference window consisting of a number of cells to set the threshold adaptively.

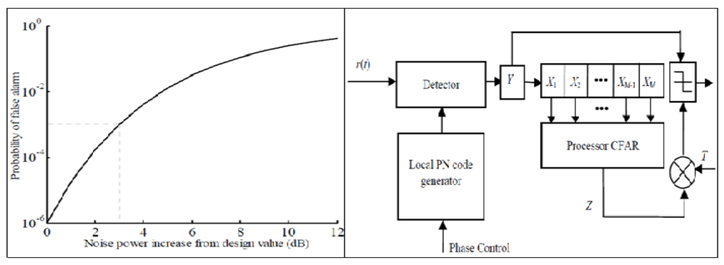

Figure 4. CFAR processing.

The Proposed System

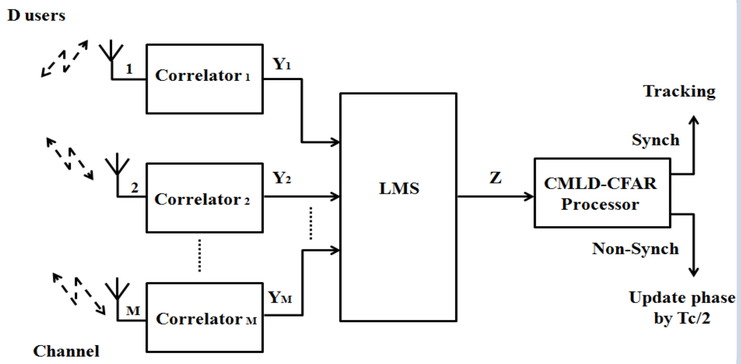

Figure 5. Block diagram of the proposed communication system.

- All antenna elements are employed in the PN code acquisition.
- The smart antenna performs adaptive beamforming by using the least mean square (*LMS*) algorithm.
- The adaptive threshold is determined by applying the *CMLD-CFAR* processing that censors the interfering signals (multipath and MAI) to avoid unnecessary high threshold.

RESULTS & DISCUSSIONS

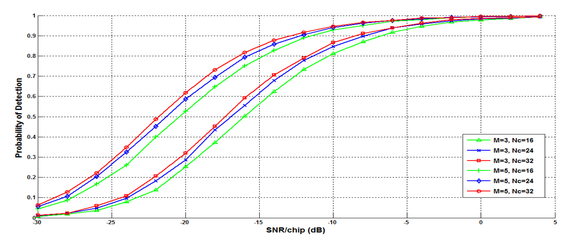

Figure 6. Effect of the number of antenna elements M and the number of reference cells N_c on the detection performance.

The figure shows :

- The detection performance improves significantly as the number of antenna elements (M) increases.
- Increasing the reference window size (N_c), increases the detection probability.
- The effect of the M on the probability of detection is much more pronounced than N_c.

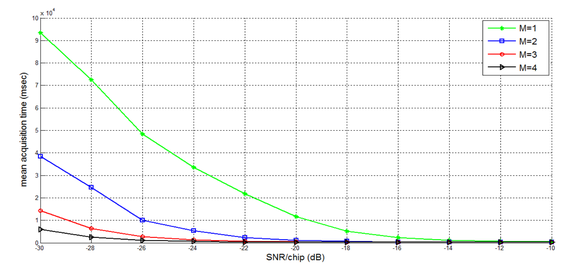

Figure 7. Effect of M on the mean acquisition time.

The figure shows :

- A large improvement in mean acquisition time from the single antenna element case.
- Increasing the M , decreases the mean acquisition time.

CONCLUSIONS

- Employing all antenna elements of smart antenna showed a large improvement in the detection and the mean acquisition time performances.
- Increasing the number of reference cells enhances the detection performance.

REFERENCES

[1] A. Sofwan and M. Barkat, "PN code acquisition Using Smart antennas and adaptive thresholding trimmed-mean CFAR processing for CDMA communication," in *Spring World Congress on Engineering and Technology* (SCET2012), Xi'an, China, 2012.

[2] M. Barkat, *Signal Detection and Estimation*, 2nd Edition, Artech House, Boston, MA. 2005.

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