RESUMÉ DE LA THÈSE EN ANGLAIS

The purpose of this thesis is to provide solutions to challenges facing the wireless localization and tracking techniques, with a special focus on Non Line of Sight (NLoS) effect arising from the presence of obstacles between the mobile station and the base station.

In the case of mobile tracking algorithms, adaptive component and subspace analysis are important tools frequently used for different parametric estimation. We present in the first part of this thesis, an extensive study of this subject and we propose fast and efficient subspace tracking methods.

The document is structured in three parts gathering several chapters:
- Subspace Tracking for Signal Processing.
- Mobile Localization in Wireless Networks.
- Appendix

Part I: Subspace Tracking for Signal Processing

In the first part, various theoretical aspects for adaptive subspace tracking in signal processing are presented.

We start first by a global introduction. In chapter 1, an overview of subspace tracking methods is illustrated.

In chapter 2, we propose fast adaptive algorithms for minor and principal component analysis. We start first by proposing new fast methods using Householder Transformation for extracting the desired minor eigenvectors of a covariance matrix. The two proposed methods are referred to as; MCA Orthogonal OJA using Householder Transform (MCA-OOJAH) and MCA Orthogonal FRANS using Householder Transform (MCA-OFRANS).

We propose next a fast PCA algorithm using Givens Rotations for tracking the desired principal eigenvectors of a covariance matrix, we refer to this new algorithm as Principal Component extraction using the Orthogonal PAST method (PC-OPAST).

Finally, we study the MCA case where we elaborate a fast MCA algorithm for positive Hermitian covariance matrix associated with time series. This latter method is referred to as Minor Component extraction using the YAST-PGS algorithm (MC-YAST-PGS).

Theoretical Convergence analysis and numerical stability analysis are provided in this chapter. Simulation results are presented to assess the performance of our algorithms and compare them with other existing methods.

Chapter 3 relates to subspace analysis. To this end, we propose fast adaptive algorithms for minor and principal subspace analysis.

The first new method referred to as Fast Orthogonal OJA (FOOJA) estimates the minor or the principal desired subspace of a covariance matrix. Another fast MSA method (YAST-PGS) is proposed in this chapter to extract the desired minor subspace of a positive Hermitian covariance matrix associated with time series. Theoretical stability analysis and simulation results are provided to illustrate the tracking capacity of the proposed algorithms.

In chapter 4, we present an application of the subspace tracking for mobile localization. Indeed, we propose an adaptive mobile localization method using Time Of Arrival (TOA) and Direction Of Arrival (DOA) estimates. Simulation results prove the good estimation and tracking performance of the proposed method in typical propagation environments.

Part II: Mobile Localization in Wireless Networks

This part deals with mobile localization in wireless networks and more precisely in the UMTS-FDD mode. Before presenting our contributions, we show in chapter 5, a brief summary on the evolution of cellular systems, and an overview of UMTS positioning methods. In chapter 6, we present an efficient TOA estimation method using RAKE-CFAR technique that reduces the effect of the
hearability problem on mobile positioning in UMTS-FDD mode. Realistic simulation results show the accuracy improvement provided by the proposed method over a simple Rake receiver.

In chapter 7, a new Mobile Station (MS) localization method is provided using Round Trip Time (RTT) measurements in the UMTS-FDD mode. The new methods take into account possible large RTT error measurements caused by Non Line of Sight (NLoS). The mobile position is then obtained only from the three most reliable RTT among the set of all RTT estimates when available. This method is also efficient even if all RTT measurements correspond to the LoS case. More precisely, this algorithm allows the selection of the least ‘noisy’ RTT when all measurements are of LoS type. Simulation results show the gain of positioning accuracy provided by the proposed algorithm.

In chapter 8, we propose an adaptive Interactive Multiple Models (IMM) Unscented Kalman Filter (UKF) with an efficient RAKE-CFAR method for mobile tracking in NLoS situation. This new algorithm is based first on an efficient and adaptive TOA estimation method, and an IMM-UKF method in order to operate in Non-Line-of-Sight situations and to track manoeuvring mobile. Realistic simulation results are presented in the UMTS-FDD mode to show the tracking accuracy provided by our proposed algorithm.

Part III: Appendix
The appendix provides in chapters 9 and 10 complete proofs of some results of Part I and II and contains some details about the UMTS simulator.