CHAPTER 3

1 Literature Review and Prior Art

The mobile receiver sensitivity improvement is not a recent problem. Rather, this need was there since from the early days of the receiver design. There are many factors which govern mobile receiver’s cost, size, and performance. So, finding the optimum solution for this problem is not very easy task. There are some prior arts exist for improving the receiver sensitivity level. But, some of these are either not applicable for mobile terminals, or some of are too complex to implement in a mobile receiver. Also, some improvement areas are not explored properly or not explored at all. Here, below some related research papers, books and patents are mentioned (more details are given in the appendix), which are studied in detail to know more about the prior art e.g. what is already explored by other researchers. Then the gaps in the prior research works are identified and based on that, this present research work is scoped and designed to fill the identified research gap.

Research Papers


This papers presents number of system issues and design considerations for designing a multi-standard mobile receiver system for the future technologies. This suggests several improvement ideas in RF, Analog to digital converter and digital baseband processing.


This research investigates robust demodulation of Gaussian Minimum Shift Keying (GMSK) signals, using demodulator diversity and real-time bit-error-rate (BER) estimation. GMSK is a digital modulation scheme for sending binary information and it is the most prominent modulation type among the wireless communication standards. The investigation focuses on GMSK demodulators used in channels typically found in wireless environments. Interference comprises of one impairment, which limits performance in wireless systems, and a robust demodulator is a demodulator that performs well in the presence of interference and with realistic fading channels.

In this paper, Iterative Equalization and Decoding is explored for the GSM System using turbo principle. This shows that the turbo principle helps to mitigate the effect of ISI and also works very well, even if extrinsic information is not available for all the transmitted bits including the protected bits (Class-I & Ia bits) and un-coded bits (class-II bits). This requires higher memory e.g. more cost and imposes lot of delay due to extra complex processing load and interleaving.


In this paper, decoding calls on iterative processing in which each component decoder takes advantage of the work of the other at the previous step, with the aid of the original concept of extrinsic information. For sufficiently large interleaving sizes, the correcting performance of turbo-codes, investigated by simulation, appears to be close to the theoretical limit predicted by Shannon.


This paper introduces a new blind MIMO communication scheme allowing the transmission over a frequency selective channel. It consists in extracting symbols emitted by sources. The scheme uses 2 transmit antennas and K (K>2) received antennas.


In this paper, simple special cases of space–time trellis codes and space–time block codes are considered, namely the delay-diversity and the Alamouti scheme. The performance improvements obtainable by means of these techniques in the case of a typical urban (TU) wireless channel are demonstrated both on the basis of analytical and simulation results. For the delay-diversity scheme, a lower bound on the bit-error probability is derived and an optimization of the intrinsic delay parameter is considered.


In this paper, techniques for the frequency error estimation, timing recovery improvement are suggested. Common methods for DCR radio for GMSK modulated signal reception are studied.

This paper presents the design methodology and underlying algorithms of a tool developed for automated receiver design and optimization for fourth generation (4G) wireless communication systems. An algorithm to systematically design and optimize the receiver budget for the multi-standard case is introduced. The goal of this algorithm is to find a multi-standard receiver budget that meets or exceeds the specs of the addressed wireless standards, while keeping the requirements of each of the receiver blocks as relaxed as possible.


In this paper, the serial implementation of MSK modems for high data-rate applications is studied, where the balancing and timing requirements of parallel implementations are avoided. The serial implementation does require close approximation of the required bandpass conversion and matched filters.


In this paper (published by myself) different RF down conversion techniques for mobile receiver are compared and different advantages and disadvantages are provided for each of these architectures. The corresponding design solutions are also proposed for better receiver RF front-end design.

**Technical Books**


This book provides many details about the digital communication systems and its characterization. This discusses about the performance of optimum receiver for memoryless modulation and optimum receiver design for signals with random phase in AWGN channel. This provides details about the channel capacity and coding gain. Some concepts mentioned here is very useful for the exploration of this present research work on receiver sensitivity improvement.


This provides methods and concepts of mathematical statistics, which can be applied to the communication receiver design. The use of the statistical approach has resulted not only in a better understanding of the theory of communications but also in the practical development of new transmitter and receiver design in different wireless channel environments.

This book provides the details about the fading channel characterization and modeling which helps to analyze the bit error rate in a wireless fading channel for receiver design. This book provides some mathematical tools for analyzing and modeling different fading scenarios and provides useful expressions for evaluating average error probability performance. This also discusses about Optimum Receivers for Fading Channels and different methods for designing optimum receiver in a AWGN channel.


This book provides some details about the goals and objectives for shaping the global wireless future, vision and requirements of the wireless world. This also discusses about the new air-interface technologies and deployment Concepts. This also provides concepts of reconfigurability. This will be useful for this research work.


This book walks through mobile phone operating principles, system infrastructure, TDMA-FDMA-CDMA-OFDMA techniques, mobile phone hardware anatomy, software and protocols, and internal modules, components, and circuits. It presents all problems associated with mobile wireless channels and recommends corresponding design solutions to overcome or mitigate those issues. Mobile RF front-end, digital baseband design techniques, and associated trade-offs are also covered. Author (myself) also discusses about the productization aspects and reviews new areas of research and developments for different mobile phone systems over generations. These concepts and details helped to explore further for the mobile receiver sensitivity improvement problem in much better way.

**Technical Articles**


The method of least squares is about estimating parameters by minimizing the squared discrepancies between observed data, on the one hand, and their expected values. This is most commonly used in channel estimation method in a mobile receiver. This paper is useful for exploring different channel estimation techniques for receiver sensitivity improvement.
Patents


In this patent a new technique is proposed to enhance the detection performance of the receiver by increasing the receiver complexity. The detection performance can be enhanced in relation to one or more performance aspects, such as ISI aspect, AWGN aspect, CCI aspect, sensitivity aspects or other aspects. The detector may be configured or reconfigured to enhance one or more particular performance aspects.


This patent shows a new technique about when to turn on the digital receiver components to receive the proper transmitted signal. A control circuit is coupled to the correlator to selectively activate flash ADC in digital receiver portion of the baseband processor. The analog correlator replaces the RSSI for sniffing, whether a received signal is present or not.

These research works are extensively studied and the research gaps are identified in receiver module design and mentioned in the appropriate chapters. All the possible areas in the receiver design including RF and Baseband are explored and different new techniques are suggested for sensitivity improvement. So, here the objective of this research work is to explore different areas of the receiver design, (as given in objective section) and to find out the optimum solution and propose the new design solutions to achieve this.