Preface

The basic concepts of digital signal processing are taught to the students in engineering and science. The focus of the course is on linear, time invariant systems. The question as to what happens when the system is governed by a quadratic or cubic equation remains unanswered in the vast majority of literature on signal processing. Light has been shed on this problem when John V Mathews and Giovanni L Sicuranza published the book *Polynomial Signal Processing*. This book opened up an unseen vista of polynomial systems for signal and image processing. The book presented the theory and implementations of both adaptive and non-adaptive FIR and IIR quadratic systems which offer improved performance than conventional linear systems.

The theory of quadratic systems presents a pristine and virgin area of research that offers computationally intensive work. Once the area of research is selected, the next issue is the choice of the software tool to carry out the work. Conventional languages like C and C++ are easily eliminated as they are not interpreted and lack good quality plotting libraries. MATLAB is proved to be very slow and so do SCILAB and Octave. The search for a language for scientific computing that was as fast as C, but with a good quality plotting library, ended up in Python, a distant relative of LISP. It proved to be ideal for scientific computing. An account of the use of Python, its scientific computing package *scipy* and the plotting library *pylab* is given in the appendix.
Initially, work is focused on designing predictors that exploit the polynomial nonlinearities inherent in speech generation mechanisms. Soon, the work got diverted into medical image processing which offered more potential to exploit by the use of quadratic methods. The major focus in this area is on quadratic edge detection methods for retinal images and fingerprints as well as de-noising raw MRI signals.

The organization of the work is as outlined in Sec. 1.4 in page 20. The reader is advised to read this section before proceeding with the remaining chapters. The first two chapters give a concise introduction to quadratic systems. Chapter 3 gives a detailed account of the methodology of research adopted. The general design and implementation strategies in the research work are detailed in Chapter 4. The chapters from 5 to 8 detail the research work done in various applications. These chapters invariably contain a section devoted to the methodology of research for that specific application. Chapter 9 summarizes the work, highlighting the key merits of quadratic systems. The research contributions and the impacts to various stakeholders are discussed in Chapter 10. Every effort is made to enhance the readability of the thesis by adding as many post-script pictures as possible. The structure of the document is made easily navigable by including ample references, cross-references and mini-table of contents in every chapter. With this, it is hoped that the reader can go through the chapters and understand the research work on quadratic systems.

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