UNIVERSITI PUTRA MALAYSIA

TV GHOST CANCELLATION SYSTEM USING SWITCHED CAPACITOR CIRCUITS

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By

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Thesis Submitted in Fulfillment of the Requirements for the Degree of Master of Science in the Faculty of Engineering
Universiti Putra Malaysia

December 1998

To my parents, brothers and sisters

ACKNOWLEDGEMENTS

I would like first to thank our mighty god for shedding on me health and kept my brain working to the extend of completing this research which I hope will contribute to the welfare of our nation.

I would like at this juncture to express my deepest appreciation and gratitude to my kind supervisors Assoc. Prof. Dr. S. S. Jamuar and Ms. Nor Kamariah Noordin for their support and unlimited assistance and beneficial advise throughout the period of my study. Thanks and appreciation is extended to the members of the supervisory committee Dr. Bambang Sunaryo and Mr. Rahman Wagiran.

My thanks are also extended to the staff at the Graduate School Office for their help and cooperation. My appreciation and gratitude to all of the individuals at the Department of Electrical and Electronics Engineering, who had been cooperative.

I gratefully acknowledge the support of Ir. Dr. Norman Bin Mariun, the general manager of Control and Automation System Centre (CASC). My thanks and appreciation to my colleagues at the CASC for their help and suggestions during the research work.

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LIST OF ABBREVIATIONS

ADC	Analog to Digital Converter
ALU	Arithmetic Logic Unit
ASIC	Application Specific Integrated Circuits
CCD	Charge Coupled Device
CCIR	International Radio Consultative Committee
CMOS	Complementary Metal Oxide Semiconductor
DAC	Digital to Analog Converter
FCC	Federal Communications Commission
FIR	Finite Impulse Response
GCR	Ghost Cancellor Reference
HDTV	High Definition Television
IC	Integrated Circuit
IIR	Infinite Impulse Response
MOS	Metal Oxide Semiconductor
MPU	Micro-Processor Unit
NTSC	National Television Systems Committee
PAL	Phase Alternation by Line
PLL	Phase Locked Loop
RF	Radio Frequency
SAW	Sound Acoustic Wave
SC	Switch Capacitor

TV	Television
VBI	Vertical Blanking Interval
VCO	Voltage Control Oscillator
VCVS	Voltage Control Voltage Source
VLSI	Very Large Scale Integrated Circuits

Abstract of thesis submitted to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Master of Science.

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DECEMBER 1998

Chairman: Associate Professor S. S. Jamuar, Ph.D.

Co-Chairman : Nor Kamariah Noordin, M.Sc.

Faculty: Engineering

In the TV reception, picture quality has been one of the primary criterion in its design. The presence of ghost signals, which are due to reflections of TV signal from high rise building, towers, mountains, etc., is one of the major causes of distortion and is not avoided at the receiver end. The ghost signals are in fact time delayed versions of the actual transmitted signals at the receiver and have many adverse effects on picture quality due to partial cancellation of main signal. The perceptibility of the ghost signal is strongly subjective and is a function of picture content and quality. Thus it is essential to filter the ghost signals for better reception. In this thesis we present the design of a television ghost cancellation system using switched capacitor circuits.

Ghost cancellation is a nullifying operation and allows one to reduce its effect on the picture quality as much as possible. In this thesis two-stage switched capacitor

(SC) transversal filter has been used for reduction of distortion. The system has been able to suppress ghosts with delays ranging from 0.1 μs to 20 μs with ghost suppression threshold at 1 % amplitude. The algorithm uses a special training signal to determine the ghost's characteristics. For a single ghost once the ghost's parameters have been determined, the transversal filter delays the incoming signal by τ_d (the time delay of ghost) and multiplies it by a factor - G (G being the gain of ghost). The result signal is added to original signal. We obtain an output which gives no output due to original ghost but adds up another ghost. The process is repeated until the ghost's amplitude is within acceptable limits. In this thesis we have simulated the system at the block diagram level using MATLAB and at component level using PSpice. The results of the simulation are in close conformity with the theoretical value. This suggested circuit can be fabricated using the MOS technology allowing the manufacturer to provide a better quality in TV reception.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

LITAR SUIS KAPASITOR UNTUK PENBATAHAN PEMBAYANG TV

Oleh

SEEDAHMED SHARIF MAHMOUD

DISEMBER 1998

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Dalam penerimaan isyarat TV kualiti gambar adalah ciri utama yang dipertimbangkan dalam rekabentuknya. Dengan kehadiran isyarat pembayang, yang disebabkan oleh refleksi daripada bangunan tinggi, manara, bukit dan lain-lain gangguan boleh terjadi dan tidak dapat dielakkan apabila tiba di bahagian penerimaan. Isyarat pembayang adalah penyebab kelambatan masa berbanding dengan isyarat asal pada penerima dan membawa banyak kesan sampingan kepada kualiti gambar disebabkan pembatalan isyarat utama. Persepsi penindihan ini adalah sangat subjektif dan merupakan fungsi kepada kandungan dan kualiti gambar. Oleh itu, penangkisan isyarat pembayang adalah penting demi penerimaan isyarat yang baik. Dalam tesis ini kami menerangkan rekabentuk pemansuhan pembayang televisyen dengan menggunakan litar suis kapasitor.

Pemansuhan pembayang adalah operasi yang unik dan membenarkan seseorang mengurangkan kesan pada kualiti gambar seberapa banyak yang boleh. Dalam tesis ini penangkis penukaran suis kapasitor (SC) dua peringkat digunakan untuk mengurangkan gangguan ini. Sistem ini didapati dapat menangkis pembayang dengan kelambatan daripada 0.1 mikrosaat kepada 20 mikrosaat pada titik pertukaran tangkisan amplitud 1%. Algorithm ini menggunakan isyarat khas untuk menentukan ciri-ciri pembayang. Untuk pembayang yang tunggal, sebaik sahaja parameter pembayang ditentukan, penangkis penukaran melambatkan isyarat masuk sebanyak τ_d (masa lambatan pembayang) dan didarab dengan faktor -G (G ialah nilai gandaan pembayang). Hasilnya ditambah kepada isyarat asal. Kami dapati keluaran yang dihasilkan itu tidak mengandungi pembayang asal, tetapi ditambahkan pula isyarat pembayang yang lain. Proses ini diulang sehingga amplitud pembayang berada dalam julat yang boleh diterima. Dalam tesis ini, sistem ini di simulasikan pada tahap gambarajah blok menggunakan MATLAB dan pada tahap komponen menggunakan Pspice. Keputusan simulasi adalah menghampiri nilai teori. Litar yang disarankan dapat difabrikasi dengan teknologi MOS dan membolehkan kualiti gambar yang lebih baik di terima oleh penerimaan TV.

CHAPTER I

INTRODUCTION

The recent phenomenal advances in the area of integrated circuit technology have allowed complex system to be integrated onto a single monolithic integrated circuit. Some of the applications, which required a large number of analogue and digital integrated circuits a few years back, can now be realised using just one or two applications specific integrated circuits (ASIC). The development of integrated circuit processing technology has reached a stage now where it is possible to integrate several millions of transistors onto a single silicon chips. The availability of such vast numbers of transistor has given a tremendous impetus to digital signal processing.

The emergence of complex digital integrated circuits has steadily displaced analogue solution for many applications by providing programmability, flexibility, and short design cycle. They provide good noise immunity as well. But for a digital system, to effectively interact with the inherently analogue world, require analogue signal conditioning and data conversion circuits. Thus the role of analogue circuits is not eliminated in solving a real life problem. Complete analogue system design will still be

required in applications in which the frequency of operation is too high for a digital implementation, or in low complexity circuits that do not justify digital implementation and in very low power applications. Physical matters that act upon our senses such as light or sound are of the analogue type. For this reason, electronic system such as audio and TV systems have developed along analogue lines.

The evolution process of the television receiver technology has been quite eventful starting as a vacuum tube based system. This was replaced by discrete semiconductor devices followed by hybrid circuits. Now the receiver circuits are well organised as various functional modules as integrated circuits. All this has resulted in better picture quality, reliability and reduction in cost of the TV receiver. Picture quality has been one of the primary criterion in the design of TV receivers. Advances in digital technology and IC processing techniques have meant that sound, light and colour values can be expressed and manipulated in digital form. But at either end of the signal chain a transducer, which converts analogue signal to digital at the transmitting end and vice versa at the receiving end, must be employed.

With present analogue public broadcast system, digital processing has been employed in the receiver set by converting the analogue composite video signal into digital composite video signal. Digital signal processing technique is then used to produce an extremely steady picture display. Flickering of the lines and fields may be eliminated with the use of memory device. One of the advantages of the digital signal processing is realised during production of the receiver set. The testing and the

calibration process becomes much simpler during manufacturing. Figures 1.1 and 1.2 shows simplified block diagram of TV receivers using analogue and digital signal processing techniques.

High definition digital television, which has its beginning in early 70's, has not yet shown its impact in the television transmission. There are number of different issues where a common standard does not exist. It is expected that High Definition Television (HDTV) is going to bring further improvement in the picture quality.

Ghost Signal

One type of distortion known as ghost signal at the receiving end has been overlooked by the designers. The presence of ghost signals, are due to reflections of TV signal from high rise buildings, towers, mountains, moving targets, etc. (Figure 1.3). This is one of the major causes of distortion which is very difficult to avoid at the receiver end. The ghost signals are time delayed and time varying versions of the actual transmitted signals at the receiver and have many adverse effects on picture quality due to partial cancellation of main signal. In its simplest form the ghosts are specular reflections from a large, flat, uniformly conducting surface received at the receiver end along with direct transmitter receiver path. The prominent sources are reflections from high rise buildings, uneven terrains, moving targets, movement of transmitting antenna with wind (resulting in change in polarity of ghosts). Figure 1.4 shows a real ghosted

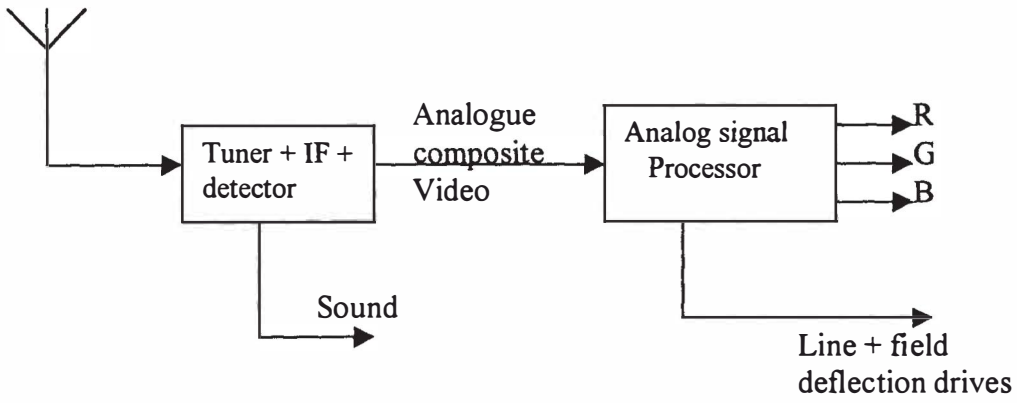

Figure 1.1 Simplified Block Schematic of TV Receiver using Analog Signal Processing

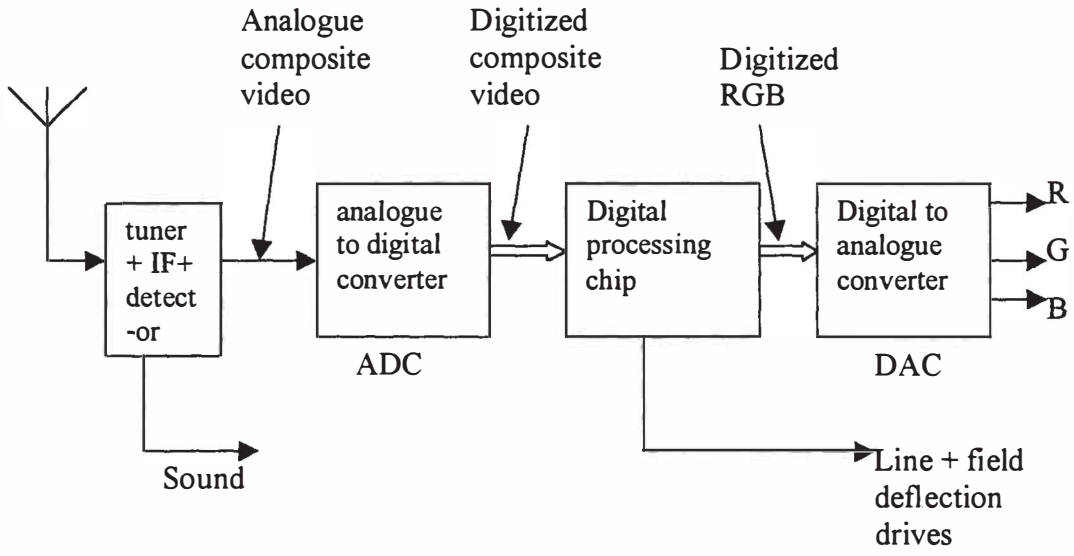

Figure 1. 2 Simplified Block Schematic of TV Receiver using Digital Signal Processing

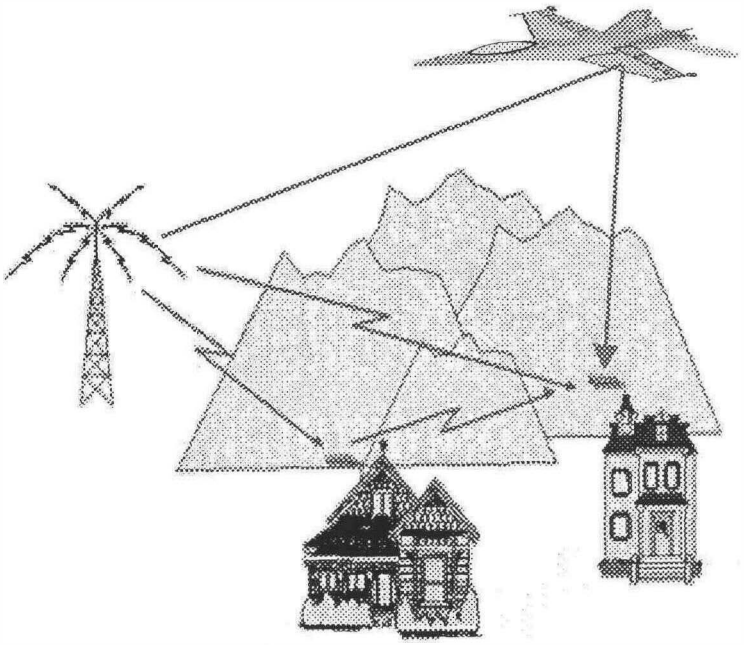

Figure 1. 3 Multi-path Signal

Figure 1.4 Ghosted Picture

picture in which the ghost amplitude is 20 % of the original signal while the ghost delay is 15 microsecond (approximately 1/4 of the length of the picture), (Sherratt, 1998a). In this picture, the ghost arrives such that the ghost carrier is inphase with the picture carrier resulting in an amplitude scaled and delayed version of the original picture since only I ghost is detected, and the other type of ghost, is a phase quadrature (Q ghost), which does not appear in this picture.

The perceptibility of presence of ghosts is strongly subjective and is a function of picture content and quality. The ghost signals may partially cancel the main signal and reduce the total received signal. Sometime the ghost signals may arrive earlier than the main signal and this might cause a smear of the original pictures. Colour problem will result if the ghost's chroma burst overlaps the main signal's chroma burst and incorrect hue and saturation occur on the entire picture. It may also result in multiple traces. Thus it is essential to filter the ghost signals for better quality reception. Ghost cancellation is a nullifying operation and allows one to reduce its effect on the picture quality as much as possible. The process of ghost cancelling is critical and complete cancellation of ghost signal is impossible (Yamamoto et al., 1977; Makino et al., 1978; Ciciora et al., 1979). However marked improvement can be seen in the quality of picture using a dynamic ghost reduction system in a TV receiver.

Definition of the Problem

In this research, we have tried to implement a ghost cancelling network using a switched capacitor (SC) circuits for International Radio Consultative Committee (CCIR) system B for television transmission. The main characteristics of this system standard are included in appendix A.

The project aims at eliminating ghost signals, which are received at the receiver with delays ranging from 0.1 μs to 20 μs with ghost suppression threshold at one percent amplitude. The ghost cancellation system should be effective for multiple and complex ghost. It should have the capability to suppress ghosts automatically without modification in the transmission system. The system uses analogue ghost cancellation based on switched capacitor circuits. The system has the advantage of being integrated on a single chip with low power consumption.

CHAPTER II

LITERATURE REVIEW

Introduction

The broadcast terrestrial television transmission is naturally associated with multiple paths due to the reflections of TV signal from static and moving objects. As a result from these reflections multiple copies are produced with amplitude scaled, time displaced and carrier phase shifted replica of the transmitted signal. This phenomenon is known as ghost problem which leads the research interest deeply into ghost reduction systems. Recently, many researchers have focused into the possibility of using advanced signal processing techniques for the cancellation of ghost.

There are two ways of incorporation of ghost cancellation system in the TV receiver. The system can be incorporated either at radio frequency (RF) stage (before the detector) or at base-band stage (after being detected). In this thesis, we will primarily consider the ghost cancelling techniques at the base-band stage in the receiver chain, but for completeness let us examine the techniques used for ghost reduction schemes at the RF stage.

At RF stage a highly directive horizontally polarised antenna can reduce the pickup of multi-path signals if they arrive from different direction than the main signal. But if the main and ghost signals arrive along the same direction then the main signal and the ghost adds up and it will give distorted signal. So we need a highly directive polarised antenna.

Circular polarisation can also be used for reducing the problem of ghost. Electrical field can be generated by a signal as a rotating field with entire clockwise or anti clockwise polarisation. When a circularly polarised signal is reflected from a surface, its direction of polarisation reverses. Antenna constructed for a particular type of polarisation will reject the opposite sense signal. Hence, if a circularly polarised signal and a reflected version arrive at a circularly polarised receiving antenna, the ghost signal will be attenuated.

The two techniques suffer from the drawback that the consumer must recognise that there is a ghosting problem first and then look for its solution of finding a suitable antenna system. These approaches for ghost reduction offer incomplete solution at best and is not practical.

The process of demodulating the TV signal also adds additional distortion which has to be compensated along with any base-band ghost cancellation system.

It is expected that if the ghost cancellation scheme is incorporated at the base-band stage as shown in Figure 2.1, the additional distortion at the base-band stage can be compensated along with the distortion due to presence of ghost.

Baseband Ghost Reduction Scheme

Ciciora et al. (1979) proposed ghost cancelling at the baseband to gain the advantage of using semiconductor based filters. Base-band ghost reduction requires an adjustable filter to compensate for the multi-path signals. The requirement of a ghost cancellation system revolve around a filter that is used for cancellation and its corresponding controller. The filter forms the ghost reduction system, and the controller used in conjunction with this filter will optimise its performance. This system in the block schematic form is shown in Figure 2.2.

There are two functions for the controller. It does the function of signal acquisition, and signal processing which will implement the correction algorithm. In addition any system support that the filter requires such as refreshing the coefficients would be handled by the controller (Ciciora et al., 1979).

In trying to understand the hardware requirements of a ghost cancellation, some knowledge is required concerning the sampled data filters (Oppenheim and Schafer, 1975). Two categories of filters are generally used in these applications, namely the