

CCTV

Networking and Digital Technology
Second Edition

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**Networking and Digital Technology
Second Edition**

Vlado Damjanovski



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Preface

Closed Circuit Television, commonly known as **CCTV**, is an interesting area of television technology. It is usually used in surveillance systems, but a lot of components and concepts can be implemented in an industrial production monitoring system, or, equally, in a hospital or university environment. So, even though the majority of readers would be looking at this book as a great help in understanding and designing surveillance systems, my intention was not to limit the topics to this area only.

This book you are holding in your hands is a new and enhanced version of the previous edition of **CCTV**, which was published in 1999. During the past five years, so much has happened in the closed circuit television industry that there was a need for a new and updated edition. I was pleased to see the previous book being so highly valued by many readers, as well as constantly rated with five stars on many web sites, including the popular Amazon.com. This has made me even more committed to making this new edition even better and more informative. I certainly could not change the contents of the previous edition since the basics of CCTV are still the same, but I did “fine tune” certain sections, added some new illustrations, but most importantly I enhanced the contents with new chapters on Digital and Networking in CCTV.

I have tried to cover the theory and practice of all components and fundamentals of CCTV. This is a very wide area and involves various disciplines and technologies from electronics, telecommunications, optics, fiber optics, digital image processing, programming, and, as of the last few years, networking, IP communications, and digital image processing. So, my intention was to have a new book which still encompasses the basic concepts of CCTV but also includes, explains, and demystifies digital CCTV, video compressions, and networking.

Analog television is a complex technology, especially for people who have never had the opportunity to study it, but understanding digital is even harder without understanding analog CCTV. So, if you are not familiar with the analog CCTV, do not think even for a moment that you can bypass it and go straight to digital and networking. Everything makes so much more sense in the digital once you know the analog CCTV.

As with the previous edition I had to read and learn new things myself, and then I tried to put everything into the same style and perspective as the previous chapters. Understandably, I did not want to reinvent the wheel, but I made efforts to simplify and explain the most important aspects of these new technologies. I would not have felt comfortable writing about these new subjects if I did not have some practical experience (though modest, at least so far), so that I tried to see it from a CCTV practical perspective. Should you be interested in more in-depth knowledge of networking and digital there are numerous books I would recommend (some are listed in the Bibliography section), but this book will give you a good summary and basics about the relevant CCTV aspects.

As with the previous edition, I have deliberately simplified explanations of concepts and principles, made many illustrations, tables, and graphs for better understanding, and tried to explain them in a

reasonably plain language. Still, a technical-minded approach is required.

Keeping up to date with the latest technologies and products was made easier through my involvement as editor of the international magazine for Closed Circuit Television, **CCTV focus** (www.cctv-focus.com). You can find many new technological topics and most up-to-date articles on the magazine's web site. The **CCTV focus** magazine was launched in 1999, the same year the previous edition of this book was published, and it quickly became one of the most respected magazines in the CCTV industry. It has already been translated into Russian and most likely will be translated into Chinese and German as well. You will find it the best extension of this book, for it is continuously updated with the latest topics, most of which are downloadable in Acrobat PDF format.

Another associated web site that could be extremely useful is the **CCTV Labs** web site (www.cctvlabs.com). CCTV Labs is my own company, specializing in consultancy, design, training, and publishing. The CCTV Labs web site was started in 1995 with the very first edition of the book **CCTV** and is now one of the longest serving CCTV web sites on the Internet. My intention was to have as much useful information on this web site as possible, and I am proud to say that the CCTV Labs web site is now one of the most frequently visited web sites in the world (in the CCTV industry).

The CCTV Central section of the CCTV Labs web site lists all the known businesses in the world. By visiting the CCTV Labs web site, you have instant access to almost every CCTV product, company, and manufacturer. Soon we will have it categorized and will include search tools for finding products and technologies.

This book is intended for, and will be very helpful to, installers, salespeople, security managers, consultants, manufacturers, and everyone else interested in CCTV, providing they have some basic technical knowledge.

The specially designed CCTV test chart printed on the back cover of the book will help you in video-quality testing, as explained in the last chapter of the book. This will be very handy for evaluating cameras, monitors, and transmission, but also the playback quality of recording systems, regardless of the compression they use. For readers who need a bigger and better test chart, CCTV Labs produces a high-resolution, light-framed A3 format of the same chart, which can be ordered from the CCTV Labs web site. The CCTV Labs test chart has been widely accepted, to the point that over 500 manufacturers and businesses worldwide are now using it. It is a great tool to check the quality of your system and compare it with others.

In addition to the test chart, CCTV Labs has also produced a specialized programmable test pattern generator (CCTV Labs TPG-8), the only such tool in the industry. It offers solid reference signals for testing a variety of system parameters. This is not part of the book, although it has been designed as a logical extension of the CCTV Labs test chart, so we decided to offer a special discount of 10% to all readers who decide to order it and mention this book as a reference.

So much has changed in the five years since the last edition of this book was published by Butterworth-Heinemann (now Elsevier) that the question became not whether a new edition should be written but only when.

I would like to thank many readers who have already made numerous suggestions and corrections. Readers who themselves write technical articles would know that no matter how many times one goes through one's own text will still find things that could be corrected, or be said somehow differently, and unavoidably there will be some errors, although I did my best to eliminate them. So please, feel free to write to me if you find something needs to be changed or corrected for future editions. I am especially thankful to Nicolas Echave from Argentina, for his observations and suggestion in the section for calculating the light falling onto an imaging chip, as well as Bernard Cuzzillo from Berkeley, California, for his suggestions regarding correct light measurements using a photo camera.

I would also like to thank my colleague Les Simmonds for his assistance in providing me with some nice oscilloscope measurements and screen shots.

I owe special thanks to Elsevier and its staff for making this book a reality, and in particular, I would like to thank Pam Chester, Jennifer Soucy, and Sarah Hajduk.

This book has been made possible by Elsevier, as well as the CCTV manufacturers who have believed in me and co-sponsored this edition. These are: Ademco Video Systems, Axis Communications, Bosch Security Systems, Dallmeier Electronic, Elbex, Fast Video Security, Geutebrück, ITV, and Pelco.

The biggest thanks should go to **CCTV Labs** and **CCTV focus** magazine for their "loss of productivity" during my engagement with this book.

Thank you for purchasing the book and I hope you enjoy reading it.



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CCTV

Introduction

This book has 14 chapters and they are written in a logical order.

Chapter 1, **SI units of measurement**, introduces the basics of the units of measurement which I thought are important to mention, even though they are not only a CCTV subject, but rather a technical issue. Many products, terms, and concepts exist in the world of CCTV which sooner or later need to be referred to with a correct unit. SI units are suggested by the ISO (the International Standardization Organization), and if we accept these units as universal it will make our understanding of the products and their specifications clearer and more accurate. I have also listed the common metric prefixes because I have found a lot of technicians do not know them. If you are an engineer or have a good technical background, you may not find this chapter of interest, so you can go directly to Chapter 2.

Chapter 2, **Light and television**, starts with a little bit of history so we can gain a wider perspective of the television revolution. Then we go to the very basics of human vision: light and the human eye. It is necessary to explain the human eye and how it works because television relies greatly on the human eye's physiology. It is interesting to compare the similarities between the eye's and the camera's operation.

Optics in CCTV is Chapter 3, which focuses on the first and important product used in CCTV, the lens. Apart from the discussion on how lenses work and what their most important features are, there is also a practical explanation of how and what to adjust (ALC and Level) on a lens, how to determine a focal length for a particular angle of view, and very important for CCTV, how back-focusing should be done. Also, C and CS-mounts are discussed and explained, as well as various chip sizes.

Chapter 4, **General Characteristics of television systems**, is very important, especially for readers without prior knowledge of how television works. I have discussed both major standards PAL and NTSC. I do apologize to readers using the SECAM for not going into detail on this standard. I simply could not find sufficient literature to study it, although there are many similarities with PAL, at least in the number of lines and fields per second used. General discussion on resolution is also included, and more importantly the difference between a broadcast signal and CCTV video signal. Near the end of the chapter I have also mentioned the most common instruments used in TV and what they measure. At the end, I have included tables that show the differences between various television system subgroups, as well as a listing of all the countries in the world with their adopted TV system.

Chapter 5, **CCTV cameras**, is probably the most interesting chapter in the book. It discusses at length the concepts of CCD cameras, various designs, and camera specifications. Here, I have also included a discussion of measurement and calculation of light coming onto a camera, power supplies, and voltage drops. I consider these very important practical issues which I have been asked about very often. Although they seem trivial, a lot of problems have been caused by improper camera setting or powering (unregulated or overrated power supply, thin wires, high-voltage drop). I found it suitable to discuss this issue in the camera section because power supplies form a part of the camera assembly. I have also included, at the end of this chapter, a very practical checklist which you or your installers can use in order to make the CCTV installation trouble free.

CCTV monitors are discussed in Chapter 6, and I have devoted space to both B/W and color monitors. Obviously, my main concentration is on the CRT monitors, as they are the most common in CCTV today. You will find explanations on various important issues associated with monitors, like gamma, the impedance switch, and viewing conditions. At the end of this chapter, I have included a description of some major new developments in the display technology. At the time of the release of the previous edition of this book, many of these technologies were only technical news, but today some of them have been or are being widely adopted.

In Chapter 7, **Video processing equipment**, I have encompassed the “good old” sequential switchers and then the matrix switchers, as representatives of the “analog” processing range, and of course quads, multiplexers, video motion detectors, and frame stores as representatives of the “early digital” range.

Chapter 8, **Analog video recorders**, discusses their very important role in CCTV. Although slowly being forgotten, the VHS format is explained as it is still a common type, but I have also included the S-VHS format. Digital video storage, however, is becoming increasingly popular, and I found it important to say a few words about it in a new chapter.

Chapter 9, **Digital video**, is the main reason for this new book. From the time of the previous edition of this book (1999) when digital was only hinted, now (2005) there is almost no system installed without a digital video recorder or network in place. This heading discusses all the intricacies of digital, and why it is important to compress. Also, it analyzes the various compressions and puts them in a logical order.

Transmission media, Chapter 10, is one of the biggest owing to the large variety of transmission types used in CCTV. Clearly, the coaxial cable is the most common and widely accepted, so I have dedicated most of the space to the coaxial cable concept. Through my practical experience, and I believe a lot of readers will agree, I have found that the majority of problems in the existing or just recently installed CCTV systems are due to bad cable installations and/or terminations. So I have devoted some space on the actual termination techniques. In the rest of the chapter you will find explanations on the other media, like twisted pair, microwave, RF wireless, infrared, telephone lines, and, the most important for the near future (at least in my opinion), fiber optics. You will find quite a lot of space devoted to fiber optics, starting with the explanation of the concepts, light sources used in fiber, cables, and installation techniques. This technology is not as new as some may think; rather, it has become very affordable and easier to use and thus more common in larger CCTV systems.

Chapter 11, **Networking in CCTV**, includes the other important new technology we now face: Networking and IT technology. This goes hand in hand with the digital CCTV, but logically comes after the Transmission Media chapter as it does belong to the transmission section. The Networking in CCTV chapter does not intend to substitute the more in-depth literature you can find on networking and IT technology (since there is plenty of it around) but it gives the “non-IT” reader some basic concepts and understanding of the increasingly more important Information Technology.

Chapter 12, **Auxiliary equipment in CCTV**, includes the good old discussion on pan and tilt heads, housings, lighting, infrared lights, ground loop correctors, lightning protection, video amplifiers, and distribution amplifiers.

The previous twelve chapters focus on the equipment side of a CCTV system, so in Chapter 13, **CCTV System design**, I discuss my understanding of how to design a CCTV system. This chapter is based purely on practical experience and on feedback from installers and users. You do not have to accept this as the only way to design a system, but I have certainly found it is very efficient and accurate. In this chapter I have also included the actions taken after the system design is finished and installed. These are: commissioning, training, and handing over. Preventative maintenance is often forgotten, but it is an important part of a complete CCTV system offer. Even if preventative maintenance is done after the system is finished I think it is important for this to be listed here as part of the complete picture of CCTV.

The last, Chapter 14, **Video testing**, advises readers on the usage of the CCTV Labs test chart, which I traditionally put at the back cover of the book in order to help you measure and test video. Many people found the CCTV Test Chart very useful, and, not surprisingly, it has become a de facto industry standard, so it might be interesting to know how to use it. We regularly update and enhance the chart adding some more useful features. Now you can use the test chart not only to determine camera resolution, but also to see if you can recognize a person at a certain distance. For the more dedicated CCTV technicians, the same test chart is also available on A3 format, foam framed, and printed on a nonreflective chemical proof paper with durable and stable colors. Also, the full description on how to use the Test Chart, apart from appearing in the book, is also available on our web site. Finally, there is the new CCTV Labs test pattern generator, the first programmable test pattern generator in the industry, designed and manufactured according to our specifications. Unfortunately, we cannot include this product with the book, but hopefully, by reading how useful it can be in your video tests, you may be able to order via the CCTV labs web site (www.cctvlabs.com).

Appendix A, **Common terms used in CCTV**, explains exactly what the heading says. I have tried to include all the terms, acronyms, and names one might come across in CCTV and accompanying fields.

In Appendix B, **Bibliography and acknowledgments**, you can find some interesting reference material and web sites, some of which I have used in the preparation of this book.

In Appendix C, **All the CCTV Links in the World**, we include a complete listing of all known CCTV businesses in the world, courtesy of **CCTV Labs** and **CCTV focus** magazine.

I hope that this book will be very helpful and informative in all your CCTV work.
