

Preface

To know one's location accurately enough has been essential for all living beings for survival and prosperity, and human beings are no exceptions. For humans it is more so because we are far more mobile and peripatetic than any other species. As our range of mobility increased, knowing location precisely and immediately has become more important. Location determination is an ancient discipline with an extensive body of knowledge. This book tries to address only a segment of that space—especially indoor location.

My intent in writing this book has been to capture some of the recent practical developments that have occurred in technology and market. There have been innovations and inventions made in the last decades, that have made precise locationing a commodity. With cheaply available GPS and other emerging methods of locating oneself, or someone or something has become ubiquitous.

On the technology side there have been significant advances in the past few decades. We have gone from just being able to locate ourselves to a fuzzy locality to better than 1 m accuracy with GPS. While previously an expert was required to derive the location, nowadays pretty much everybody carries a highly accurate locationing device with them in their phone. This was made possible by advances on many different technologies—silicon, signal processing, radio communications, image processing and recognition, software. The locationing accuracy we have today in GPS would not have been possible unless all the above-mentioned technologies came together. In this book I address a handful of these technologies that I considered significant for locationing.

The success of any technology is measured by its adoption. One of the prime drivers for technology adoption is the economics or the business behind it. Whether a business can be built on the technology, determines its ultimate success. Business is a powerful force that propels rapid adoption and progress of technology. Without the business motives, the dispersion of technology is limited. Hence, I have included a chapter on the business aspects of location. There are a number of major players that play a big role in maintaining a thriving vibrant ecosystem.

Indoor location is becoming important only since the past few decades as we have started building large buildings and automated machines that are capable of travelling themselves. The basic indoor navigation tool has been the eyes since the beginning and that has sufficed for an overwhelming majority of cases. However with the growth of complex indoor environments and the need for productivity and efficiency, rapid and accurate determination of indoor location is becoming important where the eyes do not get enough visual cues.

There are seven chapters in this book including the Introduction. Each of the chapters can be read by itself. Many diagrams and equations are included to bring out the salient points clearly. Each chapter also includes extensive references for the interested reader to pursue further.

Chapter 2, Communications Technologies, goes over the basics of modern communication technologies such as coding, modulation, multi-path, spreading, OFDM, MIMO, 802.11 radio system, etc. This chapter is meant to be a very brief introduction to a very large field. A comprehensive treatment is out of scope for this book. The reader should consult some of the excellent references at the end of the chapter.

Chapter 3, Radio Frequency Positioning, is on the technique and methods used for determining location. The chapter goes over details of Time of Flight (ToF), Angle of Arrival (AoA), Signal Strength decay, etc. The chapter also presents some experimental results for the reader to get a better appreciation of the difficulties involved.

Chapter 4, Global Positioning System, goes over the details of GPS. The chapter dives into clock issues, errors correction, etc that are used on top of basic multi-lateration to arrive at meter accuracy. It looks into GPS signals and how those signals are used. It also goes into details of augmented GPS, such as AGPS, DSPS, etc.

Chapter 5, Non-radio-Based Indoor Positioning Systems, delves into sonic and ultrasonic technologies, Inertial Navigations, SLAM, etc.

Chapter 6, Some Real-World Indoor Location Systems, provides a glimpse of indoor location systems that are used for real-world applications.

Chapter 7, The Business of Location, provides some details and quantitative assessment on the different segment and size of the location industry.



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