

Cambridge University Press

978-0-521-87309-3 - Ultra-wideband Positioning Systems: Theoretical Limits, Ranging Algorithms, and Protocols

Zafer Sahinoglu, Sinan Gezici and Ismail Guvenc

Table of Contents

[More information](#)

# Contents

<i>Preface</i>	<i>page ix</i>
<b>1 Introduction</b>	1
1.1 Trends in location-aware applications	2
1.2 Taxonomy of localization systems	6
1.3 Ranging and localization with UWB	10
1.4 Problems	19
<b>2 Ultra-wideband signals</b>	20
2.1 Definition of UWB	20
2.2 International regulations for UWB signals	24
2.3 Emerging UWB standards	32
2.4 Problems	42
<b>3 Ultra-wideband channel models</b>	44
3.1 UWB versus narrowband	45
3.2 UWB channel characterization	49
3.3 UWB channel measurement campaigns	53
3.4 Problems	61
<b>4 Position estimation techniques</b>	63
4.1 Measurement categories	64
4.2 Position estimation	74
4.3 Position tracking	92
4.4 Problems	97
<b>5 Time-based ranging via UWB radios</b>	101
5.1 Time-based positioning	101
5.2 Error sources in time-based ranging	103
5.3 Time-based ranging	108
5.4 Fundamental limits for time-based ranging	117

---

5.5	Maximum likelihood-based ranging techniques	125
5.6	Low-complexity UWB ranging techniques	133
5.7	Problems	145
<b>6</b>	<b>Ranging protocols</b>	148
6.1	Layered protocols	149
6.2	Time-based ranging protocols	150
6.3	Ranging in IEEE 802.15.4a standard	158
6.4	Problems	180
<b>7</b>	<b>Special topics in ranging</b>	181
7.1	Interference mitigation	182
7.2	Coded payload modulation	196
7.3	Private ranging	198
7.4	Problems	202
<b>8</b>	<b>Practical considerations for UWB system design</b>	203
8.1	Signal design for ranging	203
8.2	Link budget calculations	210
8.3	Hardware issues	214
8.4	Problems	225
<b>9</b>	<b>Recent developments and future research directions</b>	227
9.1	Development of accurate ranging/positioning algorithms	227
9.2	Training-based systems and exploiting the side information	229
9.3	NLOS mitigation	231
9.4	Multiple accessing and interference mitigation	232
9.5	Cognitive ranging and localization	233
9.6	Anchor placement	235
9.7	UWB radar in health-care	236
9.8	UWB for simultaneous localization and mapping	237
9.9	Secure ranging and localization	238
9.10	Concluding remarks	240
<i>References</i>		241
<i>Index</i>		265