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Machine Learning Modeling for IoUT Networks

Internet of Underwater Things

Springer

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Preface

Our objective of writing this book is to draw some outlines to enable the reader to find a good source of knowledge that could help them to understand applied technologies in underwater communication as well as the existing challenges and some suggested solutions.

The first aim of this book is to shed light on the leading variable physical properties of water that affect the transmission of the core carrier for underwater communications, i.e., acoustic waves, and what leads to changes in its characteristics, e.g., intensity, resulting in inaccurate production of the deployed technologies that build on the assumption of fixed speed transmission of sound in underwater environments.

The second major aim is to investigate the application of machine learning (ML) techniques in settling diverse challenges that are encountered during deployment of underwater technologies, such as the Internet of Underwater Things (IoUT) and multi-modal underwater networks, and to capitalize on their merits. In addition, ML has the capabilities to treat the traditional underwater model-driven problems by considering the enormous measured data into appropriate data-driven problems and handle them to design a proper and adaptive behavioral modeling of these problems. This overcomes the main underwater problem where there is still no generic model that exists for the underwater environments because of the extremely harsh and fluctuating nature of such ambiance over the spatio-temporal domains since the ML techniques, unlike the theoretical systems, do not rely on explicit or certain propagation models or assumptions.

The book provides IoUT network and node structure and the ML modeling for underwater communication in Chap. 1, the key physical variables of water and their interrelationships in Chap. 2, an example of channel modeling and an adaptive transmission framework for underwater networks in Chap. 3, two examples of the positioning systems in Chap. 4, and application of the decision tree as a classifier and dynamic modeling using neural networks for underwater techniques. The book also proposes in Chap. 6 some challenges faced by underwater communication and some glimpses of the solutions from both communication and data science perspectives.

Finally, we hope this book satisfies the need of the community members and they find it interesting and fruitful.

Nanshan, China Ahmad A. Aziz El-Banna
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Contents

Acronyms

ADCs	Analog-to-Digital Converters
AF	Amplify-and-Forward
ANNs	Artificial Neural Networks
AoA	Angle of Arrival
AWGN	Additive White Gaussian Noise
BER	Bit-Error-Rate
Bval	Best Validation
CFNN	Cascade-Forward Neural Network
CM	Confidence Metric
DDNN	Distributed Delay Neural Network
DF	Decode-and-Forward
DNN	Deep Neural Network
DT	Decision Tree
DyNets	Dynamic Neural Networks
FFNN	Feed-Forward Neural Network
GPS	Global System Positioning
IoT	Internet of Things
IoUT	Internet ofUnderwater Things
KPV	Key Physical Variables
ML	Machine Learning
MSE	Mean Squared Normalized Error
NAR	Nonlinear Autoregressive
NARX	Nonlinear Autoregressive Exogenous
NNs	Neural Networks
pH	Power of Hydrogen
PSK	Phase Shift Keying
QAM	Quadrature Amplitude Modulation
RNN	Recurrent Neural Network
ROV	Remotely Operated Underwater Vehicle
RSS	Received Signal Strength
RSSI	Received Signal Strength Indicator

SER	Symbol Error Rate
TDLs	Tapped Delay Lines
TDNN	Time Delay Neural Network
TDoA	Time Difference of Arrival
ToA	Time of Arrival
TPLs	Transmission Power Levels
UWSNs	Underwater Wireless Sensor Networks