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Joint Time Delay and Frequency Estimation Based on Deep Learning

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Abstract

This article introduces to the best of our knowledge a novel approach for simultaneous estimation of time delay and frequencies in noisy complex sinusoidal signals received at two spatially separated sensors. The proposed method comprises two main components. Firstly, a Convolutional Neural Network (CNN) regression model is employed to estimate frequencies using data from the first sensor. The model is trained on a synthetic dataset specifically designed for this task. Secondly, a deep learning model is developed, incorporating densely connected layers and dropout layers for regularization, to effectively estimate the time delay between the received signal copies at the two sensors. Extensive computer simulations demonstrate the effectiveness of the proposed method, showcasing its accuracy in joint time delay and frequency estimation. This deep learning-based technique offers a promising alternative to classical signal processing approaches, enabling advanced signal analysis in diverse engineering domains. © 2024 by the authors.

Author keywords

convolutional neural networks; deep learning; delay and frequency estimation; temporal patterns

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Impact of Mobility Model on LoRaWan Performance

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Abstract

LoRaWan (Long Range Wide Area Network) is a low-power wireless technology with an extended range. It is utilized frequently in Internet of Things (IoT) applications. Consequently, numerous IoT applications and solutions incorporate mobility. However, the increasing number of End Devices (ED) and mobility models of nodes impact the network performance of LoRaWAN (packet size, latency, energy consumption, and Packet Delivery Ratio (PDR)). This paper studies the influence of mobility models on the performance of LoRaWAN by using different scenarios under extensive simulations with the Network Simulator (NS3), including the random waypoint model, the Gauss Markov model, and the constant position model. The results indicate that the manner in which nodes move significantly impacts network performance; for instance, the Gauss-Markov model maintains a high level of network performance. To validate the simulation results, Extensive experiments have been conducted with the Lora end device CubeCell HTCC-AB01 model in a variety of scenarios by analyzing the RSSI (Received Signal Strength Indicator) level in urban and rural areas using a large number of trajectories.

Author keywords

lora; LoRaWan; LPWAN (low-power, wide-area networks); mobility model; NS3; RSSI

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A Semantic-Based Middleware for Supporting Heterogeneity and Context-Awareness Within IoT Applications

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Abstract

Internet of Things technology, or IoT, is changing people's lifestyles. Smartwatches, smart cars, smart homes, smart farms, and more – IoT has already been incorporated into a variety of products and services. To efficiently manage interactions between currently deployed smart things and applications, IoT vendors worldwide continually introduce different middleware platforms to meet application development requirements. Therefore, finding a suitable IoT middleware is a major issue faced by developers, especially when the system contains heterogeneous smart things and generates a vast amount of heterogeneous data. Most existing IoT middleware models do not satisfy all functional requirements and are tailored to specific system layers. To address these issues, this paper proposes a middleware model based on semantic web technologies and context-aware computing as an enhancement of the previously developed middleware MSOAH-IoT (A Middleware based on Service Oriented Architecture for Heterogeneity Issues within the Internet of Things). It uses a low-level ontology to automatically register, classify and then identify heterogenous smart things. The developed middleware provides a search engine to determine the appropriate smart object to respond to incoming requests of real-time measurements from the user/application layer. © 2024 by the authors.

Author keywords

context-awareness; internet of things; middleware; ontology; semantic web technologies

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A Wide Band Antenna for both S-Band and C-Band Satellite Communication Applications

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Abstract

For existing and upcoming satellite communications applications on a variety of platforms, including cars, fishing boats, ships, aircraft, and submarines, wide-band antenna technology is currently crucial. These days, platforms are utilized for a variety of tasks, including geographic scanning, mining, depth detection, underwater scanning, and looking for other items like ships, mountains, and erratic geographic areas. It takes effective wide-band antenna technology to carry out such tasks on a variety of platforms. As a wide-band antenna for S-band and C-band satellite communications, a new design of rectangular dual patch antennas with a resistive loading approach has been put forth in this work. The antenna may be made small and compact for high-speed data, voice, and video broadcasts through satellites because it operates in the S-band and C-band frequencies. The simulation results were generated using Computer Simulation Technology Studio software, and analyzed for four important parameters like axial ratio, 3 dB beam width, gain, and Voltage Standing Wave Ratio (VSWR). A broader bandwidth has been attained with the newly developed rectangular twin patch antenna employing a resistive loading method. Finally, it is demonstrated that the recommended rectangular twin patch antenna with resistive loading performs better for both S-band and C-band satellite communication applications. © 2024 by the authors.

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Efficient and Accurate Indoor Positioning System: A Hybrid Approach Integrating PCA, WKNN, and Linear Regression

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Abstract

The high-precision Indoor Positioning System (IPS) is a captivating area of research that has made significant advancements in recent years due to the increasing demand for its applications. Our study proposes an innovative approach to improve indoor positioning accuracy by integrating Principal Component Analysis (PCA), weighted k-nearest Neighbors (WKNN), and Linear Regression (PCA-WLR). This hybrid strategy enables the system to leverage the unique characteristics of each model, capturing intricate patterns and correlations in the data. Experimental evaluations on a publicly available dataset demonstrate the superiority of our hybrid approach. The Root Mean Squared Error (RMSE) achieved is 1.97 meters, and the mean distance error is 2.23 meters. Remarkably, the ensemble outperforms individual methods in other studies on the same dataset, showing 10.8% to 17.2% improvement in accuracy. Notably, our proposed hybrid approach significantly reduces training time from 581.3599 seconds to 8.8814 seconds, representing an impressive reduction of approximately 98.47%. Similarly, testing time is reduced from 10.1721 seconds to 0.0176 seconds, indicating a substantial decrease of around 99.82%. These significant reductions in training and testing times underscore the efficiency and effectiveness of our proposed ensemble model, making it highly practical for real-time applications. © 2024 by the authors.

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GFDM-OQAM Performance Analysis Using Linear Equalization for Audio Transmission

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Abstract

In order to minimize Inter-Carrier Interference (ICI), Inter-Symbol Interference (ISI), and Out of Band (OOB) impacts on Orthogonal Frequency Division Multiplexing (OFDM) systems, strong wireless communication performance is required. The use of Generalized Frequency Division Multiplexing (GFDM) is based on the requirement for a block-based multi-carrier technology in which each subcarrier is generated with a filter in the form of non-rectangular pulses known as pulse shaping. Meanwhile, Offset QAM (OQAM) is used to achieve better spectral efficiency than QAM and simultaneously reduce the occurrence of ICI and ISI. In this study, the effect of adjusting the roll-off factor value on the pulse shaping filter utilized is examined in order to detect the original signal supplied by the transmitter using two linear equalizations: Zero Forcing (ZF) and Minimum Mean Square Error (MMSE). The results show that the Signal to Noise Ratio (SNR) used in this study is varied from 0 dB to 15 dB, and the Bit Error Rate (BER) obtained when the SNR is 15 dB on GFDM-OQAM using ZF and MMSE are 0.03872 and 0.01986 respectively. Then this study indicates that the GFDM-OQAM system using MMSE equalization has a better BER value than the GFDM-OQAM system using ZF equalization. In addition, the greater the use of the roll-off factor, the lower the performance of the BER system because there is a greater excess bandwidth which is linear with the magnitude of the roll-off factor. © 2024 by the authors.

Author keywords

Generalized Frequency Division Multiplexing (GFDM); Minimum Mean Square Error (MMSE); offset QAM; pulse shaping; roll-off factor; zero forcing