Smart Innovation, Systems and Technologies 394

Aboul Ella Hassanien
Dequan Zheng
Zhijie Zhao
Zhipeng Fan *Editors*

Business Intelligence and Information Technology

Proceedings of BIIT 2023

KES International

Springer

Smart Innovation, Systems and Technologies

Volume 394

The Smart Innovation, Systems and Technologies book series encompasses the topics of knowledge, intelligence, innovation and sustainability. The aim of the series is to make available a platform for the publication of books on all aspects of single and multi-disciplinary research on these themes in order to make the latest results available in a readily-accessible form. Volumes on interdisciplinary research combining two or more of these areas is particularly sought.

The series covers systems and paradigms that employ knowledge and intelligence in a broad sense. Its scope is systems having embedded knowledge and intelligence, which may be applied to the solution of world problems in industry, the environment and the community. It also focusses on the knowledge-transfer methodologies and innovation strategies employed to make this happen effectively. The combination of intelligent systems tools and a broad range of applications introduces a need for a synergy of disciplines from science, technology, business and the humanities. The series will include conference proceedings, edited collections, monographs, handbooks, reference books, and other relevant types of book in areas of science and technology where smart systems and technologies can offer innovative solutions.

High quality content is an essential feature for all book proposals accepted for the series. It is expected that editors of all accepted volumes will ensure that contributions are subjected to an appropriate level of reviewing process and adhere to KES quality principles.

Indexed by SCOPUS, EI Compendex, INSPEC, WTI Frankfurt eG, zbMATH, Japanese Science and Technology Agency (JST), SCImago, DBLP.

All books published in the series are submitted for consideration in Web of Science.

Aboul Ella Hassanien · Dequan Zheng ·
Zhijie Zhao · Zhipeng Fan
Editors

Business Intelligence and Information Technology

Proceedings of BIIT 2023

Springer

Editors
Aboul Ella Hassanien
Faculty of Computer and Artificial Intelligence
Cairo University
Giza, Egypt

Dequan Zheng
School of Computer and Information Engineering
Harbin University of Commerce
Harbin, Heilongjiang, China

Zhijie Zhao
School of Computer and Information Engineering
Harbin University of Commerce
Harbin, Heilongjiang, China

Zhipeng Fan
Harbin University of Commerce
Harbin, Heilongjiang, China

ISSN 2190-3018 ISSN 2190-3026 (electronic)
Smart Innovation, Systems and Technologies
ISBN 978-981-97-3979-0 ISBN 978-981-97-3980-6 (eBook)
https://doi.org/10.1007/978-981-97-3980-6

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Conference Committee

General Chair

Dequan Zheng, Harbin University of Commerce, China

General Co-chairs

Sabah Mohammed, Lakehead University, Canada
Jina Fiaidhi, Lakehead University, Canada
Luis Javier García Villalba, Universidad Complutense de Madrid, Spain
Yaoqun Xu, Harbin University of Commerce, China
Zeguo Qiu, Harbin University of Commerce, China
Ping Han, Harbin University of Commerce, China

Technical Program Committee Chairs

Zhijie Zhao, Harbin University of Commerce, China
Subramaniam Ganesan, Oakland University, USA

Technical Program Committee Co-chairs

Weipeng Jing, Northeast Forestry University, China
B. H. Kang, University of Tasmania, Australia
Naseer Al-Jawad, The University of Buckingham, UK

Publication Chairs

Tai-Hoon Kim, Beijing Jiaotong University, China
Aboul Ella Hassanien, SRGE, Egypt

Publication Co-chairs

Zhipeng Fan, Harbin University of Commerce, China
Carlos Ramos, ISEP/IPP, Portugal
Mohamed Hamdi, Elgazala Innovation Center, Tunisia

Local Organizing Committee Chairs

Xiaodong Su, Harbin University of Commerce, China
Haitao Xin, Harbin University of Commerce, China
Tai-Hoon Kim, Beijing Jiaotong University, China

Technical Program Committee Members

Aboul Ella Hassanien, College of Business Administration, Kuwait
Ajith Abraham, Norwegian University of Science and Technology, India
Alicja Wieczorkowska, PJIIT, Poland
Antonio Coronato, ICAR-CNR, Italy
Arbib Michael, University of Southern California, USA
Ashesh Mahidadia, University of New South Wales, Australia
Brian King, Purdue University, USA
Bong-Hyun Kim, Seowon University, Korea
Chantana Chantrapornchai, Silpakorn University, Thailand
Charalampos Z. Patrikakis, National Technical University of Athens, Greece
Chengcui Zhang, University of Alabama at Birmingham, USA
Chris van Aart, Sogeti B.V., Netherlands
Ching-Hsien Hsu, Asia University, Taiwan
D. Manivannan, University of Kentucky, USA
Duman Hakan, T Research and Technology, Germany
Gerald Schaefer, Aston University, UK
Giovanni Cagalaban, Hannam University, Korea
Hakan Duman, British Telecom, UK
Han-Chieh Chao, National Ilan University, Taiwan

Hideyuki Suzuki, The University of Tokyo, Japan
Ismail Khalil Ibrahim, Institute of Telecooperation, Austria
James B. D. Joshi, University of Pittsburgh, USA
Jason Sigfred, Surigao Sur Polytechnic State College, Philippines
Javier Garcia-Villalba, Complutense University of Madrid, Spain
Jemal H. Abawajy, Deakin University, Australia
Ali Saberi, Distinguished Researcher in Iranian Researchers Network, Iran
Naveen K. Chilamkurti, La Trobe University, Australia
Noskov Mikhail Fedorovic, Siberian Federal University, Russia
Kamal Karkonasasi, Universiti Sains Malaysia, Malaysia
Harald Kitzmann, Kazakh University, Kazakhstan
Andrii Bieliatynskyi, National Aviation University, Ukraine
Anelia Kurteva, University of Innsbruck, Austria
Uduak Augustine Umoh, University of Uyo, Nigeria
Muhammad Hashim, National Textile University, Pakistan
Globa Larysa, National Technical University of Ukraine, Ukraine
Alex Mathew, Bethany College, USA
Levleva Olga T., Southern Federal University, Russia
Tan Xiao Jian, Tunku Abdul Rahman University College (TARUC), Malaysia
Antonio Lucadamo, University of Sannio, Italia
Anna Crisci, University of Naples Federico II, Italia
Mahfujur Rahman, Daffodil International University, Bangladesh
Nassira Achich, University of Sfax, Tunisia

Preface

This volume constitutes the refereed proceedings of the 2023 International Conference on Business Intelligence and Information Technology (BIIT 2023) held in Harbin, China, during December 17–18, 2023. BIIT 2023 is organized by the School of Computer and Information Engineering, Harbin University of Commerce, and supported by Scientific Research School of Egypt (STSEG). BIIT is organized to provide an international forum that brings together those actively involved in the areas of interest, report on up-to-the-minute innovations and developments, summarize the state of the art, and exchange ideas and advances in all aspects of business intelligence and information technologies. The papers cover current research in business intelligence and decision making, digital economy and digital technology, electronic commerce technology and application, image analysis and processing, information technology and applications, machine learning and deep learning and their applications.

The conference proceedings has six main tracks:

Part I: Automatic Control Technique
Part II: Business Intelligence and Decision Making
Part III: Digital Economy and Digital Technology
Part IV: Image Analysis and Processing
Part V: Information Technology and Applications
Part VI: Machine Learning and Deep Learning and Their Applications

On average, all submissions were reviewed by at least two reviewers, with no distinction between papers submitted for all conference tracks. We are convinced that the quality and diversity of the topics covered will satisfy both the attendees and the readers of this conference proceedings. We express our sincere thanks to the plenary speakers, workshop/session chairs, and International Program Committee members for helping us to formulate a rich technical program. We want to extend our sincere appreciation for the outstanding work contributed over many months by the Organizing Committee: local organization chair and publicity chair. We also wish to express our appreciation to the SRSEG members for their assistance. We want to emphasize that the success of BITT 2023 would not have been possible without the support of many committed volunteers who generously contributed their time, expertise, and resources toward making the conference an unqualified success. Finally, thanks to the Springer team for their support in all stages of the production of the proceedings. We hope that you will enjoy the conference contents.

Giza, Egypt — Aboul Ella Hassanien
Harbin, China — Dequan Zheng
Harbin, China — Zhijie Zhao
Harbin, China — Zhipeng Fan

About This Book

This book constitutes the refereed proceedings of the 2023 International Conference on Business Intelligence and Information Technology (BIIT 2023) held in Harbin, China, during December 16–17, 2023. BIIT 2022 is organized by the School of Computer and Information Engineering, Harbin University of Commerce, and supported by Scientific Research School of Egypt (SRSEG), Egypt. The papers cover current research in electronic commerce technology and application, business intelligence and decision making, digital economy, image processing and multimedia technology, signal detection and processing, and technology, information security, automatic control technique, data mining, software development, and design, blockchain technology, big data technology, and machine learning technology.

Contents

Part VI Machine Learning and Deep Learning and Their Applications

About the Editors

Dr. Aboul Ella Hassanien is Founder and Head of the Egyptian Scientific Research Group (SRGE) and Professor of Information Technology at the Faculty of Computer and Artificial Intelligence, Cairo University. He has more than 1000 scientific research papers published in prestigious international journals and over 60 books covering such diverse topics as data mining, medical images, intelligent systems, artificial intelligence, COVID-19, social networks, drones, and smart environment. He won several awards, including the Best Researcher of the Youth Award of Astronomy and Geophysics of the National Research Institute, Academy of Scientific Research (Egypt, 1990). He was also granted a scientific excellence award in humanities from the University of Kuwait in 2004 Award and received the scientific in Technology—University Award (Cairo University, 2013). Also, he was honored in Egypt as Best Researcher at Cairo University in 2013. He also received the Islamic Educational, Scientific and Cultural Organization (ISESCO) prize on Technology (2014) and the State Award for excellence in engineering sciences 2015. He won the Showman Foundation Award for Arab Researchers in 2016. He received the Order of Science and Arts of the First Class from the President of the Arab Republic of Egypt in 2017—the Cairo University Appreciation Award in 2021—the Siddiq Afifi Award in 2020. He received the State Award for Excellence in Engineering Sciences in 2017 and the Cairo University Appreciation Award in 2021 in Advanced Engineering Sciences. Also, he won the Scopus international award (2019). The Cairo University Appreciation Award in 2022 in Advanced Engineering Sciences and the Siddik Afifi Award in 2018.

Dequan Zheng has a B.Sc. (Harbin, China), an M.Sc. (Harbin, China), and a Ph.D. (Harbin, China) in Computer Science and Technology. He has a long experience in teaching various computing courses at Harbin University of Commerce and Harbin Institute of Technology. The courses he has taught have included Artificial Intelligence, Data Structures and Algorithms, Programming, Business Intelligence, and Data Analytics. He supervises undergraduate and postgraduate projects.

He has Natural Language Processing research in Artificial Intelligence and Business Data Analytics in Electronic Commerce, including Human–Machine Dialogue, Information Extraction, Data Mining, etc.

Zhijie Zhao Doctor of Engineering, is Visiting Scholar of New York University, Director of e-commerce and information processing laboratory and currently Professor of Harbin University of Commerce. He has more than 100 scientific research papers published in well-known journals and conferences, over 11 books and 7 invention patents. He has presided over and participated in more than 30 National Natural Science Foundation of China and other scientific research projects and won many scientific research awards. His main research fields include medical image processing, character image recognition, intelligent information processing, business intelligence, online reviews, and consumer engagement.

Zhipeng Fan Ph.D., is Associate Professor, Member of the Key Laboratory of Electronic, Commerce, and Information Processing; Member of China Computer Federation; Associate Editor of the *International Journal of Smart Business and Technology*; and *SCI Journal* Reviewer. His main research fields include business intelligence, blockchain theory and application, and signal and information processing. In recent years, he has published more than 20 papers in journals and 2 textbooks. He has completed more than 10 scientific research projects and obtained 2 national invention patents and 2 software Copyrights.

Part I
Automatic Control Technique

Chapter 1
Extraction of Small Resonance Signals in Strong Same-Frequency Background

Xuena Han, Hui Li, and Qitao Zhang

Abstract In practical engineering applications, attenuated sinusoidal signals are very common, but in most practical scenarios, such signals will be submerged in a strong background. When the frequency of the background signal is the same as the signal to be measured, this signal extraction of the difficulty of the process will increase sharply. This paper compares the effects of short-time Fourier transform, continuous wavelet transforms, and shallow neural networks on this practical physical problem. In the end, the results of the shallow neural network are relatively good, achieving a demodulation error of one thousandth, which is an effective solution to this physical problem.

1.1 Introduction

After centuries of fundamental physics research, it is believed that applied physics has already got a solid foundation to build on. Since the last century, modern applied physics has been well developed with increasing acquisition bandwidth, faster measurement speed, and stronger signal processing capability. However, the shortcomings are also obvious, under the increasingly practical demand, noise reduction under strong noise and signal extraction under strong background has become imminent problems. Fortunately, the emergence of algorithms makes it possible to resolve some difficult physical problems. This paper compares and discusses the extraction of the same-frequency and different-attenuation time signals under the background of strong resonance under a specific physical problem. From the perspective of time–frequency analysis, the effects of short-time Fourier transform,

X. Han · H. Li (✉) · Q. Zhang
Harbin University of Commerce, Harbin 150028, China
e-mail: hrbcu_lh@163.com

H. Li
Heilongjiang Provincial Key Laboratory of Electronic Commerce and Information Processing, Harbin 150028, China

A. E. Hassanien et al. (eds.), *Business Intelligence and Information Technology*, Smart Innovation, Systems and Technologies 394,
https://doi.org/10.1007/978-981-97-3980-6_1

continuous wavelet analysis, and shallow neural network in this specific physical problem are compared.

In applied physics, exponentially decaying sinusoidal signals are quite commonly obtained. This often corresponds to the dissipation of light waves and sound waves at homogeneous media and surfaces [1]. In some general practical cases, the frequency of the former is Terahertz (THz) [2], and the frequency of the latter generally does not exceed Megahertz (MHz) [3]. For example, in a uniform circle, the center of the circle seems like a source of the sound wave, which can be resonant in the circle [4, 5]. Such sound waves are reflected at the boundary to form standing waves, and the life of this sound wave resonance corresponds to the decay time of the sine wave [6]. However, in practical applications, such signals are often submerged in the large background signal, which makes the actual signal extraction a very difficult problem.

This paper systematically analyzes the optimal algorithm for signal processing in this practical physical problem. Starting from the time–frequency analysis, the signal is first disassembled from the time and frequency domains to transfer the signal processing into the difference between decay time and spectrum width, thereby obtaining the effective information of the signal. At this stage, the measurement results of the short-time Fourier transform, and continuous wavelet analysis are compared respectively, and the shallow neural network is used for the final signal disassembly. The results show that the shallow neural network has more advantages than traditional time–frequency analysis methods, can overcome the constraints of time and space resolution, and effectively invert signals.

1.2 Target Problem

1.2.1 Problem Description

Acoustic frequency spectrum analysis is considered a powerful tool for device health diagnostics and environmental analysis. When vibration with a specific frequency is imposed on, the device will be resonant with the activate frequency and some frequency multiplication, and the decay acoustic wave can be used to demodulate much useful information such as the health status, the overload situation, and even the external environment of some section of the device [6–9]. Imagine a situation like this, a uniform cylinder is used as a device under test, a short section of it is placed into liquid and the other sections are exposed to air. As shown in Fig. 1.1, the section in liquid is named Section B, the others are named Sections A and C.

Because the reflectivity of acoustic waves between solid and outside of Section B and others are different, acoustic waves get different lifetimes in Section B and others [10]. Therefore, the function between acoustic lifetime and acoustic reflectivity is:

$$1\big/\tau = 1\big/\tau_{\text{int}} - V_L\big/2r\ln(R) \tag{1.1}$$

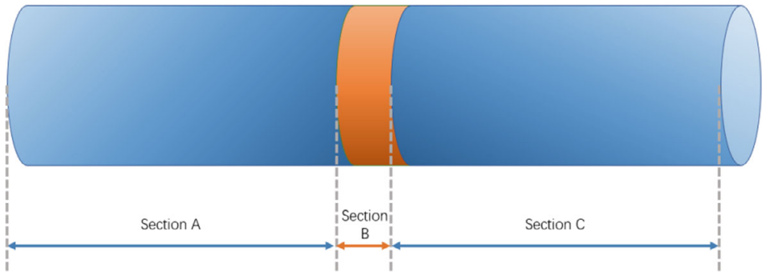

Fig. 1.1 Schematic diagram of the device under test

In which τ is the lifetime of the final acoustic wave, τ_{int} is the intrinsic acoustic lifetime, V_L is the longitudinal acoustic velocity, r is the radius of the cylinder, and R is the reflectivity. The lifetime of acoustic waves is equal to the full width at half maximum (FWHM) $\Delta\upsilon$, as shown in Eq. (1.2).

$$\Delta\upsilon = 1/\pi\tau \tag{1.2}$$

Therefore, the relationship between acoustic lifetime with reflectivity has been built up. The acoustic reflectivity is directly dominated by the kind of medium outside. However, the signal measured is summed by the signal from Section A, B, and C, to make matters worse, the amplitude of the signal from Section B is usually lower than the others, which induce the useful signal, that is the B signal, is usually submerged by the signal from Section A and C. The extraction of the B signal from the A and C signals is difficult.

1.2.2 Modeling

The resonance frequency of the cylinder can be obtained by finite element simulation. The material of the cylinder is set as aluminum, and the radius is 5 cm. The radial acoustic modes can be solved, and the frequency of these modes can be calculated, as shown in Fig. 1.2.

According to the actual scene, the mode $R_{0,6}$ with frequency 177.3 kHz is selected as activate frequency. Set the amplitude of the background to 1, and the signal to be around 0.05, the decay time of the background is 0.05 ms, and the signal decay time is higher than the background one. The measured, background, and signal in the time domain are shown in Fig. 1.3.

Fortunately, although the frequency of the signal and background is the same, and the amplitude of the signal is much smaller than the background, the spectrum width is different. Impose Fourier transform on the signal above, the spectrum can be obtained in the frequency domain (Fig. 1.4).

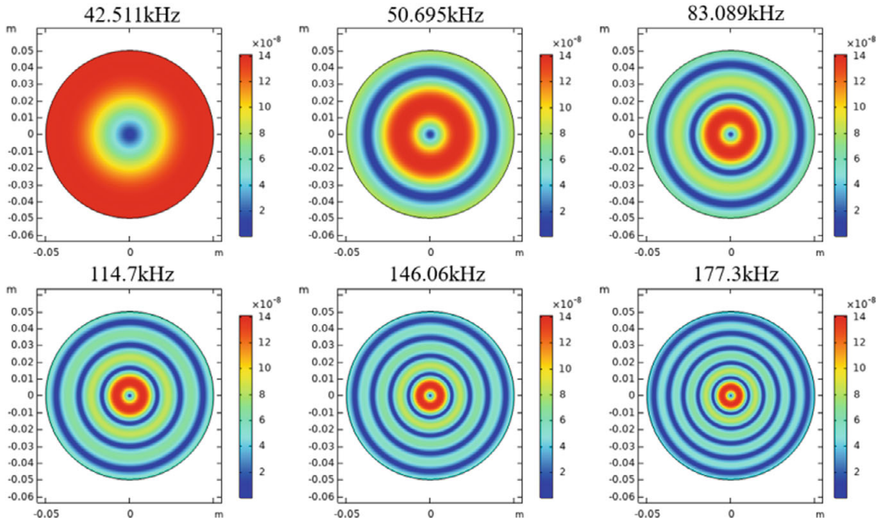

Fig. 1.2 Simulated radial acoustic modes of $R_{0,1}$ to $R_{0,6}$, the resonance frequencies are marked above

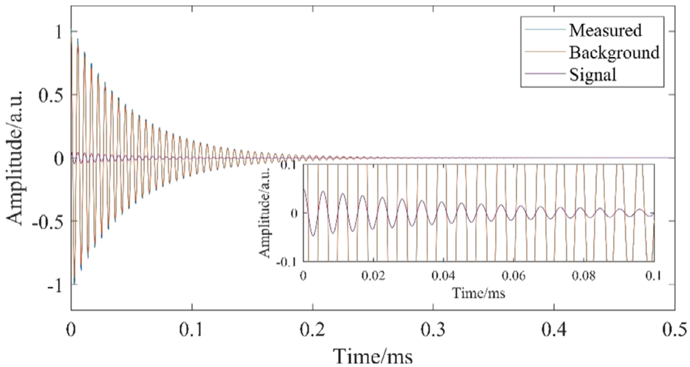

Fig. 1.3 Schematic diagram of the modeled measured, background, and signal

Notably, the frequency spectrum of the signal cannot be obtained by Fourier transform directly because of the Background, but, due to the longer duration of the signal compared to the background, it is believed feasible to use time–frequency analysis to get the signal information.

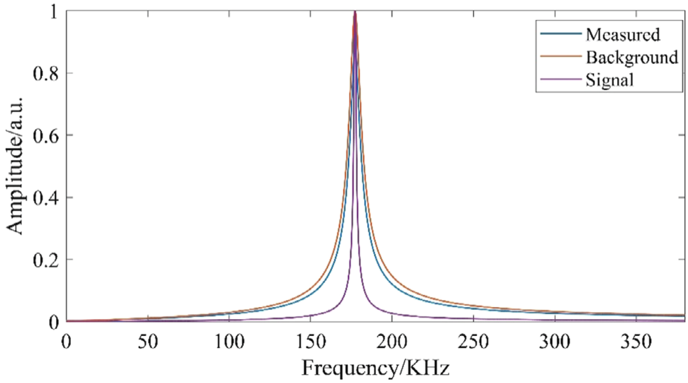

Fig. 1.4 Frequency spectrum of the model measured, background, and signal

1.3 Demodulation

1.3.1 Short-Time Fourier Transform

Short-time Fourier transform is considered a powerful tool for time–frequency analysis. How short-time Fourier transform works is that segment the signal and pan the window so that the frequency mapping on time can be calculated.

The spectrum of the measured signal is regarded as the overlay of the spectrums of the signal and background. However, the amplitudes of the signal and background do not show the same decay trend due to the different lifetimes. Therefore, for a signal with a lifetime much longer than the background, the spectrum located away from time 0 is considered less affected by the background. This gives us the possibility to distinguish the signal.

The crucial factor of the short-time Fourier transform is the determination of window parameters. There is a very important contradiction, between the time resolution and frequency resolution. The windows act as units for the Fourier transform, which means when the window is wide, the time corresponding will be wasted, and the information near time 0 cannot be obtained, when the window is narrow, that is, there are fewer points for Fourier transform, the spectrum resolution will serious loss. To obtain the fine spectrum away from time 0, a wider window should be chosen for a higher spectrum resolution. The simple rate is 5.000,000, and the width of the window is 1024, corresponding to a time resolution is 0.205 ms, and a frequency resolution is 4.88 kHz.

However, the information from 0 to 0.102 ms is wasted due to the wide window used. The spectrums of 0.102 and 0.8 ms are shown in Fig. 1.5 with the measured, background, and signal spectrum correspondingly.

As seen, although the frequency resolution is higher enough, the spectrum obtained by short-time Fourier is not narrow than the signal spectrum. That is because, although the amplitude of the background has decayed a lot, it is still not negligible at

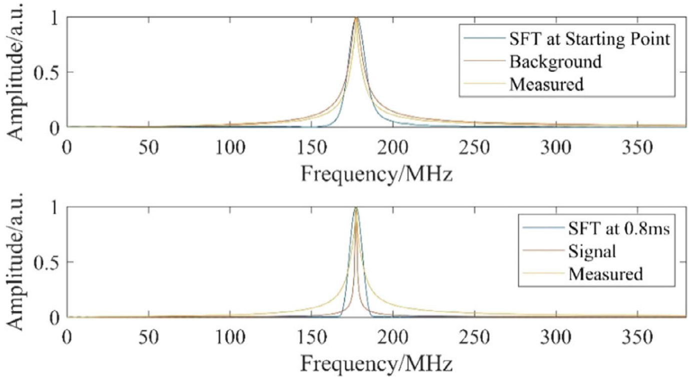

Fig. 1.5 Spectrums obtained by short-time Fourier transform and Fourier transform

0.8 ms, which is far away from the starting point. It is inevitable when the amplitude of the signal is much less than the background, both with the contradiction between time and frequency resolution.

1.3.2 Continuous Wavelet Transform

As we discussed in the last subsection, the short-time Fourier transform is powerful; however, the contradiction between time resolution with frequency spectrum resolution is unconquered. Continuous wavelet transform is usually considered the alternative. In the process of the continuous wavelet transform, the width of the window is not fixed but flexible, a short wavelet is used to act with the signal; therefore the contradiction between the time and frequency spectrum can be conquered to a certain extent. The CMOR wavelet with narrow bandwidth and corresponding frequency is used here.

The spectrum comparison is shown in Fig. 1.6. The spectrums of 0.03 and 0.8 ms are shown with the measured, background, and signal spectrum correspondingly.

As seen, although the frequency resolution is higher enough, the spectrum obtained by continuous wavelets transform is not narrow than the signal spectrum, too, because of the unignored amplitude difference between the background and signal. Nonetheless, the results show better performance than the short-time Fourier transform, because of the variable size of the window.

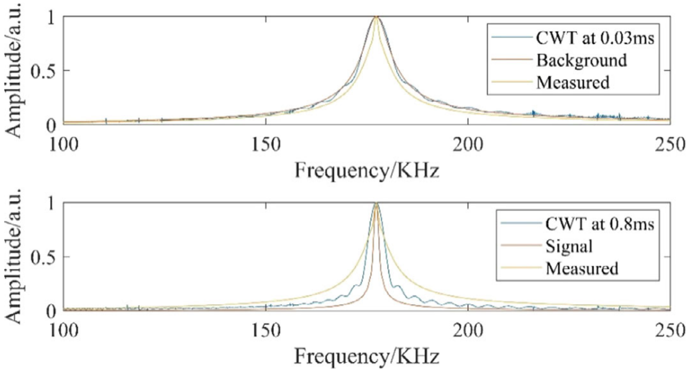

Fig. 1.6 Spectrums obtained by continuous wavelets transform and Fourier transform

1.3.3 Shallow Neural Network

Strictly, the shallow neural network is not a time–frequency analysis tool in the conventional sense. When the traditional tool is disabled, the neural network is usually miraculous. According to the target problem, a corresponding shallow neural network is built up, with 2 hidden layers and 10 neurons. The measured time trace is used as input, with the signal decay time as the output variable from 50 to 500 μs, with the unit of 1 μs. 1400 samples are used to train the neural network, 300 were used for validation, and 300 were used to test. The regression of the neural network is shown in Fig. 1.7.

As shown, the performance of the neural network is much better than the methods above. The applied performance of the neural network is proved by a new database with 2000 samples, the result is shown in Fig. 1.8, with the red line meaning the decay time of the signal, and the blue line means the error between the real decay time and the solution demodulated by the neural network. The total error is less than 0.5 μs.

1.4 Discussion

To demodulate the decay time of the signal which is hidden in a strong background signal with the same frequency. Both short-time Fourier transform and wavelet analysis were attempted on this signal for time–frequency analysis. However, due to the contradiction between frequency resolution and time resolution and the particularity of the signal, these two methods cannot achieve accurate demodulation. Shallow neural networks show excellent adaptability to this problem, which is in line with its research properties for practical physics. Taking this problem as a black-box problem, using the measured signal as input and the decay time as the output to train the neural

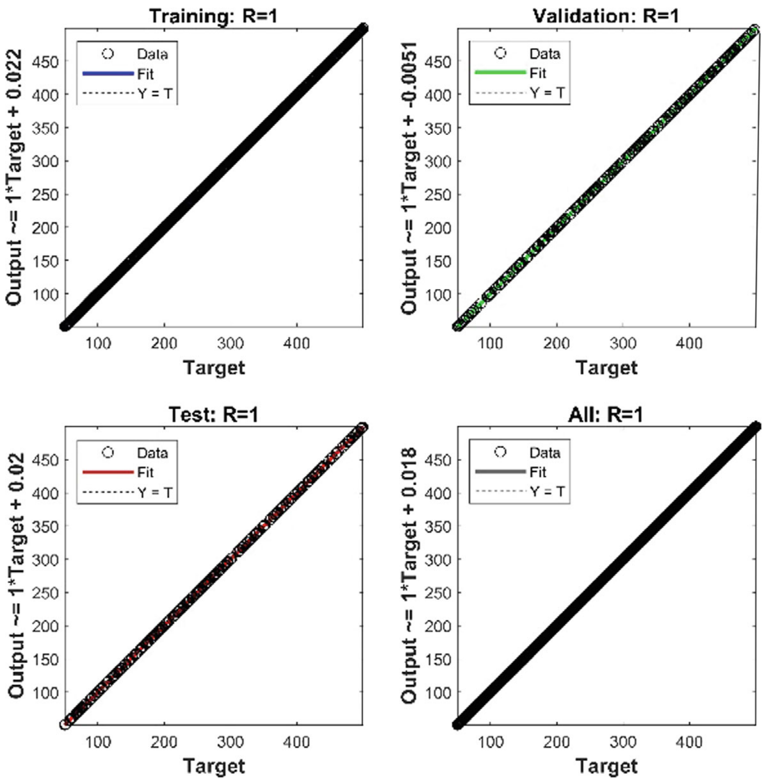

Fig. 1.7 Regression of the neural network

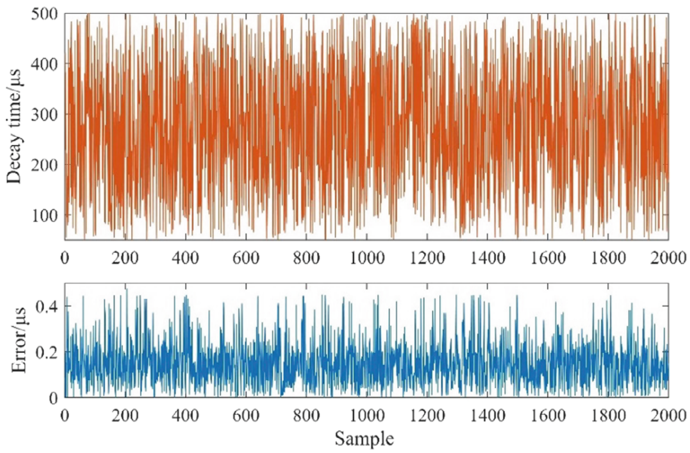

Fig. 1.8 Comparison between the real decay time and the demodulation error of the neural network. The red line is the real decay time, with a unit of us, and the blue one means the error

network, we get quite good results. The solution provides new processing ideas and stronger solutions.

1.5 Conclusion

In this paper, short-time Fourier transform, continuous wavelet analysis and shallow neural network are used to deal with the same physical problem, small signal extraction in strong co-frequency background. In this process, continuous wavelet analysis shows stronger processing capability than short-time Fourier transform, but it is still difficult to reproduce small signals individually from the perspective of time–frequency analysis. In this regard, the shallow neural network showed more processing performance and finally achieved a demodulation error of fewer than 0.5 μs.

Acknowledgements This work is supported by the Natural Science Foundation of Heilongjiang Province of China (No. LH2020F007).

References

1. Thurston, R.N.: Elastic waves in rods and clad rods. J. Acoust. Soc. Am. **64**(1), 1–37 (1998)
2. Jin, L., Liang, Y.: Fiber laser technologies for photoacoustic microscopy. Vis. Comput. Ind. Biomed. **4**(1), 11 (2021)
3. Liu, J., Yuan, L., Lei, J.: Micro-cantilever-based fiber optic hydrophone fabricated by a femtosecond laser. Opt. Lett. **42**(13), 2459 (2017)
4. Sittig, E.: Visualization of plane-strain vibration modes of a long cylinder capable of producing sound radiation. J. Acoust. Soc. Am. **48**(5B), 1150 (1970)
5. Doolittle, R.: Sound scattering by elastic cylindrical shells. J. Acoust. Soc. Am. **39**(2), 272–275 (2005)
6. Puttmer, A., Hauptmann, P., Henning, B.: Ultrasonic density sensor for liquids. IEEE Trans. Ultrasonics Ferroelect. Freq. Control **47**(1), 85–92 (2000)
7. Aralaguppi, M., Jadar, C.V., Aminabhavi, T.: Density, viscosity, refractive index, and speed of sound in binary mixtures of acrylonitrile with methanol, ethanol, propan-1-ol, butan-1-ol, pentan-1-ol, hexan-1-ol, heptan-1-ol, and butan-2. J. Chem. Eng. Data **44**(2), 216–221 (1999)
8. Bai, X., Ma, J., Li, X.: Focus-tunable fiber-laser ultrasound sensor for high-resolution linear-scanning photoacoustic computed tomography. Appl. Phys. Lett. **116**(15), 153701 (2020)
9. Grace, O.: Circumferential waves on solid cylinders. J. Acoust. Soc. Am. **39**(1), 173–174 (2005)
10. Yao, X.: Phase-to-amplitude modulation conversion using brillouin selective sideband amplification. IEEE Photon. Technol. Lett. **10**(2), 264–266 (2002)

Chapter 2
Coverage Optimization of WSN Based Upon Improved Salp Swarm Algorithm

Jin-tao Yu, He Tong, Xiao-wei Lu, Zhen-hua Gao, and Dai-zhi Jin

Abstract In line with the problem of caused by high aggregation in random deployment of wireless sensor networks, a new coverage strategy because of improved salp swarm algorithm is proposed. Firstly, logistic mapping is used to initialize, which makes the population well-distributed in the search space, and improves the diversity of its initial individuals and the convergence speed of its prophase; Secondly, the sine cosine strategy is introduced in the leader stage to boost the global and local exploration capability of this algorithm; finally, Gaussian mutation operators and greedy selection strategies are added to the follower stage, and the optimal individual parameter evolution results are selected, which improves the algorithm development ability. The experimental consequence demonstrates that under the same scenario, the improved algorithm can availably reduce the redundancy of sensor nodes and greatly improve the convergence speed and coverage.

2.1 Introduction

Wireless sensor network (WSN) consists of a great quantity of densely distributed terminal network nodes, which has the ability of communication, compute and sensing. The wireless sensor network formed by its large-scale deployment can monitor the monitoring area and is widely used in the fields of auxiliary agricultural production, environmental monitoring, and intelligent home appliances. In the application process, the sensor nodes are primarily deployed by random sprinkling. Because of the random deployment location, there is a coverage blind area, which is difficult to effectively cover the area to be monitored, thus affecting the monitoring ability of the network. Changes in the environment of the monitoring area and changes in the mobility of sensor nodes will reduce the network coverage and thus affect its monitoring ability. Therefore, it is necessary to adjust and deploy the sensor

J. Yu · H. Tong (✉) · X. Lu · Z. Gao · D. Jin
School of Computer and Informaton Engineering, Harbin University of Commerce, Harbin 150028, Heilongjinang, China
e-mail: tonghe7126@163.com

A. E. Hassanien et al. (eds.), *Business Intelligence and Information Technology*, Smart Innovation, Systems and Technologies 394,
https://doi.org/10.1007/978-981-97-3980-6_2