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WIFI BASED SECURED DATA TRANSMISSION AND RECEPTION

Chakali Naveen Kumar[1], Chaluvadi Gowtham[2], D Mahakali Shankar[3], Karne Sampath Reddy[4], G. Bhagya Lakshmi[5]

[1,2,3, &4]Ug Scholar, Department Of Ece, Narsimha Reddy Engineering College (Ugc-Autonomous), Maisammaguda (V), Kompally, Secunderabad

[5]Assistant Professor, Department Of Ece, Narsimha Reddy Engineering College (Ugc-Autonomous), Maisammaguda (V), Kompally, Secunderabad.

ABSTRACT

A deep-learning-based channel estimation method for chaotic wireless communication is proposed in this letter, which is based on a deep neural network (DNN) pre-trained by the stacked denoising autoencoder (SDAE) structure. The DNN learns the channel parameters by using the autocorrelation function (ACF) of the received signal in the sense of minimizing the mean squared error (MSE). Numerical results demonstrate that the proposed scheme learns the channel very well and significantly outperforms the conventional schemes in terms of the channel estimation MSE, as well as the BER performance of the communication system. The proposed channel estimation method based on the ACF of chaotic signal is robust to the noise because of the effect of the double noise resistance operation including the autocorrelation operation and the denoising autoencoder. The proposed scheme is a blind identification method, which uses the received signal directly, by this way, saves the valuable bandwidth resource without any probe signal

INTRODUCTION

COMMUNICATION with chaos has attracted significant interest in the literatures [1], [2], [3], [4] since early 1990s. In recent years, more properties of chaos have been reported to be fit for wireless communication applications, such as the Lyapunov spectrum invariance property of chaotic signal after transmitted through wireless channel [5]. Chaos is proven to be the optimal communication waveform in the sense of very simple matched filter being used to achieve the maximum signal to noise ratio (SNR) [6]; the chaotic baseband waveform generated by the chaotic shape-forming filter (CSF) is proven to be topologically conjugate to the symbolic sequence [7], which means that arbitrary information sequence can be encoded into the chaotic waveform; the intersymbol interference (ISI) caused by multipath propagation can be eliminated in theory by using the proper decoding threshold [8], and the chaotic waveform can be used as the baseband signal under the conventional wireless communication system framework, in order to improve the bit error rate (BER) performance with the simpler and lower cost algorithm [9]. However, the distortion of wireless channel transmission in outdoor environment significantly degrades the performance of both the conventional wireless communication system and chaotic wireless communication system. A good channel estimation helps improving the BER performance, and making the communication system reliable. For this purpose, it is generally required to transmit a pilot sequence in the conventional estimation methods, such as the classical least squared (LS) approach, minimum mean squared error (MMSE) algorithm [10] and so on. On one hand, the conventional methods always need the pilot (training) sequence sent before the data sequence, which consumes the valuable bandwidth and reduces the data transmission rate. On the other hand, the conventional channel estimation methods are generally suffering from performance degradation due to the serious environment noise. To deal with these challenges, the autocorrelation function (ACF) property of the chaotic signal is exploited in [11], and it is used to identify the channel parameters without any pilot sequence, which improves the channel identification performance effectively. However, the blind channel identification based on ACF of chaotic signal is a complicated process by resolving a mathematical nonlinear problem.

LITERATURE SURVEY

S. Hayes, C. Grebogi, and E. Ott, "Communicating with chaos," Phys. Rev. Lett., vol. 70, no. 20, p. 3031, May 1993.

Control of chaos refers to a process wherein a tiny perturbation is applied to a chaotic system, in order to realize a desirable (chaotic, periodic, or stationary) behavior. We review the major ideas involved in the control of chaos, and present in detail two methods: the Ott–Grebogi–Yorke (OGY) method and the adaptive method. We also discuss a series of relevant issues connected with chaos control, such as the targeting problem, i.e., how to bring a trajectory to a small neighborhood of a desired location in the chaotic attractor in both low and high dimensions, and point out applications for controlling fractal basin boundaries. In short, we describe procedures for stabilizing desired chaotic orbits embedded in a chaotic attractor and discuss the issues of communicating with chaos by controlling symbolic sequences and of synchronizing chaotic systems. Finally, we give a review of relevant experimental applications of these ideas and techniques. A deterministic system is said to be *chaotic* whenever its evolution sensitively depends on the initial conditions. This property implies that two trajectories emerging from two different closeby initial conditions separate exponentially in the course of time. The necessary requirements for a deterministic system to be chaotic are that the system must be nonlinear, and be at least three dimensional.

A. Dmitriev, A. Kletsov, A. Laktyushkin, A. Panas, and S. Starkov, "Ultrawideband wireless communications based on dynamic chaos," J. Commun. Technol. Electron., vol. 51, no. 10, pp. 1126–1140, Oct. 2006.

In recent years, many communication systems that use a function to encode an information in a chaotic signal were proposed. Since every transmission channel is bandlimited in nature, it is required to determine and to control the chaotic signal spectrum. This way, a bandlimited chaos-based communication system (CBCS) was proposed using digital filters and chaotic synchronization. As the filters modify the original chaotic system, it is necessary to study how their insertion affects chaotic synchronization. In this work, we present a digital discrete-time bandlimited CBCS system analysis, considering practical settings encountered in conventional communication systems. The proposed system is based on master–slave chaotic synchronization and the required conditions for its synchronization is obtained analytically for a general *K*-dimensional chaos generator map. The performance of this system is evaluated in terms of bit error rate. As a way to improve the signal to noise ratio, we also propose to filter the out-of-band noise in the receiver. Numerical simulations show the advantages of using such a scheme. In a digital chaos-based communication system (CBCS), each bit of information is transmitted using a different fragment of a chaotic signal [15], [16]. Thus, it differs fundamentally from the conventional digital communication systems, where each symbol is associated with a constant and predefined waveform.

H. P. Ren, C. Bai, Q. J. Kong, M. S. Baptista, and C. Grebogi, "A chaotic spread spectrum system for underwater acoustic communication," Physica A Stat. Mech. Appl., vol. 478, pp. 77–92, Jul. 2017.

Acoustic communication is a key technology to exchange information underwater, which is of great significance to explore marine resources and to marine defense. The underwater acoustic channel is a time-space-frequency varying channel characterized by serious multipath effect, limited frequency band, complex environmental noises and significant Doppler frequency shift phenomenon, which makes underwater acoustic communication with low Bit Error Rate (BER) to be a challenging task. A novel chaotic spread spectrum acoustic communication method with low BER is proposed in this paper. A chaotic signal, generated by a hybrid dynamical system, is used as a spread spectrum sequence at the transmitter end. At the receiver end, a corresponding chaotic matched filter is used to offset the effect of multipath propagation and noise. The proposed method does not require the complicated equalization and modulation–demodulation technologies that are necessary for conventional acoustic communication. Simulation results show that the proposed method has good anti-interference ability and lower BER as compared to other traditional methods. The ocean occupies two-thirds of the surface of the earth, containing abundant energy and mineral resources. With the increasingly prominent problems such as resource shortage, environment pollution monitoring, national security, defense, and so on, the development and exploration of marine resources becomes the focus of scientific and technological research. Acoustic communication is a key technology to exchange information underwater [1], since acoustic signals, in contrast to optic and radio signals, can propagate in water for long range distances.

H.-P. Yin and H.-P. Ren, "Direct symbol decoding using GA-SVM in chaotic baseband wireless communication system," J. Frankl. Inst., vol. 358, no. 12, pp. 6348–6367, Aug. 2021.

To retrieve the information from the serious distorted received signal is the key challenge of communication signal processing. The chaotic baseband communication promises theoretically to eliminate the inter-symbol interference (ISI), however, it needs complicated calculation, if it is not impossible. In this paper, a genetic algorithm support vector machine (GA-SVM) based symbol detection method is proposed for chaotic baseband wireless communication system (CBWCS), by this way, treating the problem from a different viewpoint, the symbol decoding process is converted to be a binary classification through GA-SVM model. A trained GA-SVM model is used to decode the symbols directly at the receiver, so as to improve the bit error rate (BER) performance of the CBWCS and simplify the symbol detection process by removing the channel identification and the threshold calculation process as compared to that using the calculated threshold to decode symbol in the traditional methods. The simulation results show that the proposed method has better BER performance in both the static and time-varying wireless channels.

H. P. Ren, M. S. Baptista, and C. Grebogi, "Wireless communication with chaos," Phys. Rev. Lett., vol. 110, no. 18, 2013, Art. no. 184101.

The modern world fully relies on wireless communication. Because of intrinsic physical constraints of the wireless physical media (multipath, damping, and filtering), signals carrying information are strongly modified, preventing information from being transmitted with a high bit rate. We show that, though a chaotic signal is strongly modified by the wireless physical media, its Lyapunov exponents remain unaltered, suggesting that the information transmitted is not modified by the channel. For some particular chaotic signals, we have indeed proved that the dynamic description of both the transmitted and the received signals is identical and shown that the capacity of the chaos-based wireless channel is unaffected by the multipath propagation of the physical media. These physical properties of chaotic signals warrant an effective chaos-based wireless communication system. Nowadays, wireless communication [1,2], ranging from satellite communication and global positioning system (GPS) navigation [3], underwater wireless sensor networks [4], personal mobile phones to portable Wi-Fi applications, is closer to our daily experiences than it used to be. Reliability of the communication is compromised due to several physical constraints affecting the information signal, such as amplitude damping, filtering that causes modification both in the phase and amplitude of the signal, multipath propagation (a signal that travels along many different paths and arrives many times at the receiving location) that causes serious interference, time-varying characteristics, and noise.

N. J. Corron and J. N. Blakely, "Chaos in optimal communication waveforms," Proc. R. Soc. A Math. Phys. Eng. Sci., vol. 471, no. 2180, Aug. 2015, Art. no. 20150222.

The properties of nonlinear dynamics and chaos are shown to be fundamental to optimal communication signals subject to two practical and realistic design requirements: (i) operation in a noisy environment and (ii) simple hardware implementation. Starting with a simple electronic circuit, a linear filter receiver is presumed, and the matched optimal communication waveform that maximizes the receiver signal-to-noise performance is derived. A return map using samples from this optimal waveform is conjugate to a shift, thereby implying the waveform is chaotic. The optimal communication waveform for a second simple receiver is similarly derived, and it is found to be an exact solution to a physically realizable chaotic oscillator. Thus, a practical consequence of chaos in these waveforms is the potential for simple and efficient signal generation using chaotic oscillators. A conjecture is made that the optimal communication waveform for any stable infinite impulse response filter is similarly chaotic. In modern communications technology, the suitability of a method for conveying information is evaluated in terms of quantifiable metrics, such as performance, efficiency, complexity and cost. A communication method is deemed optimal if it maximizes one or more of these metrics. Pioneering work by Nyquist, Shannon, Wiener and others in the past century established a rigorous theoretical framework for identifying such optimal methods [1,2]. For example, a fundamental performance metric is the signal-to-noise ratio at the receiver. A famous result from communication theory holds that this ratio is maximized by a receiver that forms the correlation of the incoming received waveform with a reference copy of the transmitted waveform [3].

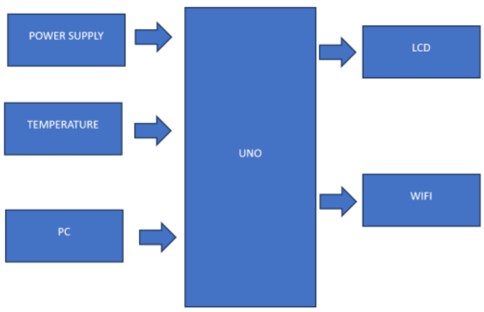
3.EXISTING SYSTEM

Nowadays confidential data transfer is a crucial task in many multinational companies, military departments, intelligence and surveillance departments, and so on. In such departments and companies lots of efforts are put forth for securing confidential data. Therefore, they need Data encryption and decryption for their applications. An example, which is given below describes data encryption and decryption to secure data using Zigbee wireless communication technology for short and long distances. With help of many encryption and decryption techniques we can achieve the goal of secure communication

3.1. PROPOSED SYSTEM

Everyone in this world wants to be safe and secure. When it comes to the safety and security of Multinational companies, Military, Army, the situation becomes more complicated. Even a common man puts his maximum efforts to protect his data. One of the popular methods to protect the data in a more secure way is to encrypt the data while sending and when received, decrypt the data to retrieve the original message. Before transmitting the data, the data will be converted into an unreadable form and will be sent. At the receiving end, the reverse of encryption carries on to get back the original message. Thus the data will be protected in every way by following the encryption and decryption standard formats. Wireless makes this project more flexible. Standard algorithms require software to be installed into the system before actually using them and hardwired connections. The hardware connections and cabling can be completely eliminated in this project

3.2. BLOCK DIAGRAM



BLOCK DIAGRAM DESCRIPTION

REGULATED POWER SUPPLY:

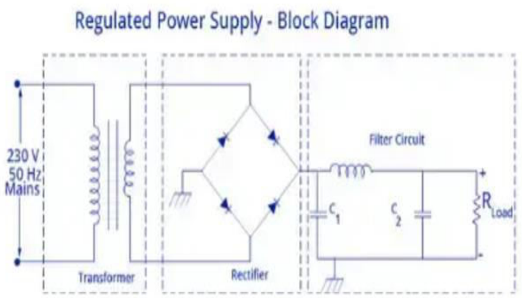


Fig: Regulated Power Supply Diagram

A regulated power supply provides a stable DC output by transforming variable AC input.

Component Overview: The essential components of a regulated power supply consist of a transformer, rectifier, filter, and regulator, each vital for ensuring a stable DC output.

The rectification process involves diodes transforming alternating current (AC) into direct current (DC), sometimes using full-wave rectification to optimize efficiency.

Filter Function: Filters, including capacitor and LC kinds, mitigate ripple and stabilize the DC output voltage.

Regulatory Mechanism: Regulators modulate and stabilize output voltage to safeguard against input fluctuations or load variations, crucial for a dependable power supply.

MICRO CONTROLLER

ARDUINO

The Arduino is a series of microcontroller boards designed to facilitate electrical design, prototyping, and experimentation for artists, hackers, amateurs, and even professionals. Individuals use it as the cognitive component for their robots, to create innovative digital musical instruments, or to develop a system that enables houseplants to notify you via Twitter when they want water. Arduino boards, namely the basic Arduino Uno, are constructed around an ATmega microcontroller, which functions as a comprehensive computing unit including a CPU, RAM, Flash memory, and input/output ports, all integrated into a single chip. In contrast to a Raspberry Pi, it is designed to connect various sensors, LEDs, tiny motors, speakers, servos, and similar components directly to these pins, which may read or output digital or analog voltages ranging from 0 to 5 volts. The Arduino interfaces with your computer by USB, allowing you to program it in a straightforward language (C/C++, akin to Java) using the complimentary Arduino IDE by uploading your developed code to the board. Once programmed, the Arduino may operate via a USB connection to your computer or independently without it—requiring just a power source, devoid of a keyboard or display

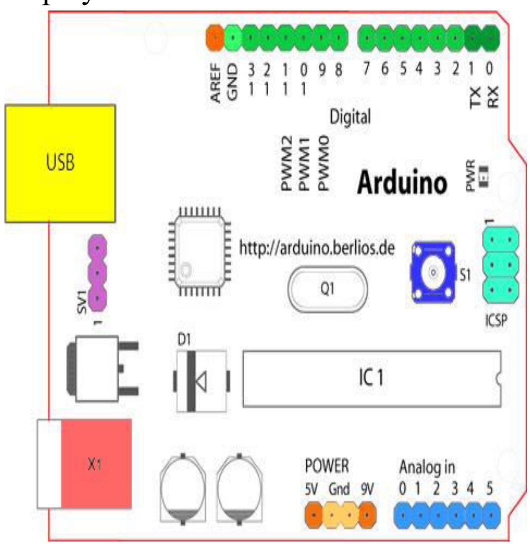


Fig: Structure of Arduino Board

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ESP8266 WI-FI MODULE:

In 2014, an ESP8266 Wi-Fi module was introduced and developed by third-party manufacturers like AI thinkers, which is mainly utilized for IoT-based embedded applications development. It is capable of handling various functions of the Wi-Fi network from another application processor.

It is a SOC (System On-chip) integrated with a TCP/IP protocol stack, which can provide microcontroller access to any type of Wi-Fi network. This article deals with the pin configuration, specifications, circuit diagram, applications, and alternatives of the ESP8266 Wi-Fi module.

What is the ESP8266 Wi-Fi Module?

An ESP8266 Wi-Fi module is a SOC microchip mainly used for the development of end-point IoT (Internet of things) applications. It is referred to as a standalone wireless transceiver, available at a very low price. It is used to enable the internet connection to various applications of embedded systems.

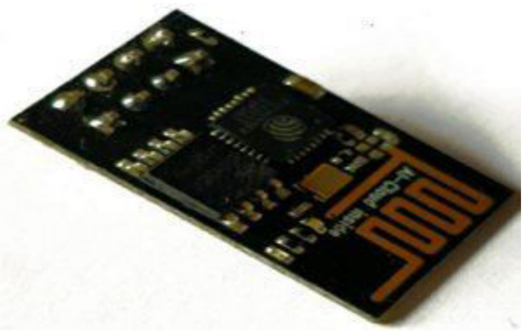

Fig ESP8266 Wi-Fi Module

SENSOR A sensor is a device that identifies and reacts to certain stimuli from the physical world. The input may consist of light, heat, motion, moisture, pressure, or several other environmental phenomena. The output is often a signal that is either translated to a human-readable format at the sensor site or transferred electronically via a network for interpretation or further processing.

CONCLUSION

To summarize, a novel channel estimation scheme using the DNN with pre-trained SDAE is proposed in this letter, which is based on the ACF property of the chaotic baseband signal generated by the CSF. The strong noise reduction and generalization abilities of SDAE make the channel estimation MSE performance and the corresponding BER performance of CBWCS better than that using the same DNN structure without pre-trained SDAE, as well as present superior performance than those of the blind ACF analytical method, and the conventional non-blind LS method using chaotic driven signal. Moreover, by using off-line training mechanism, the computational complexity is a less concern, which is beneficial to the real-time communication applications.

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