Research on Intelligent Control System of Electrical and Electronic Technology of Computer Big Data Optoelectronic Communication

Chuantao Ma
School of Physics and Electronic Engineering
Taishan University
Tai'an, 271000, China
mcht@tsu.edu.cn

Jing Xiao*
School of Physics and Electronic Engineering
Taishan University
Tai'an, 271000, China
xiaojingzx@163.com
* Corresponding author

Jing Lu
School of Physics and Electronic Engineering
Taishan University
Tai'an, 271000, China
lujing@tsu.edu.cn

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***Abstract*—The photoelectric communication remote control system is realized by combining AVR microcontroller with virtual instrument. This design is composed of temperature control module, DC drive module and PC control module. The system uses ADN8830 with high temperature control precision as the main control element. Through the research of temperature control network and power amplifier circuit control system is formed. With ADN2830 as the core, the high precision digital potentiometer is used to accurately adjust the injection current of the laser through serial connection and parallel. The human-machine interface of PC is realized by C# programming. The control part of PC completes the overall control of the entire electrical circuit through serial communication. The slave end is the actuator, which determines the communication criteria between nodes according to the application-level protocol of CAN Kingdom. The experimental results show that this scheme can achieve 0.01℃ temperature control accuracy and 0.01 mA temperature control accuracy, and can realize stable operation of pulsed laser well.**

Keywords—Communication protocol, upper computer interface, real-time monitoring, laser chaos, precise control, temperature control module

I. INTRODUCTION

Coherent optical communication has attracted much attention for its advantages of high sensitivity, high frequency selectivity, high information transmission rate and high confidentiality. Some scholars have proposed broadband wireless broadband access schemes based on different modulation modes, which are expected to achieve broadband wireless broadband network broadband access. The use of coherent optical communication technology can improve the detection of signals received in air and space communications [1]. Some scholars have introduced coherent optical communication technology based on continuous variables. Some scholars put forward the non-contact detection technology, it has some problems such as phase sensitivity, difficulty in spectrum matching and easy to be affected by external interference. This paper presents a CAN communication system based on STM32. The temperature compensation and power amplifier circuit are designed to form a complete closed-loop temperature control system [2]. With ADN2830 as the core, the injection current of laser is precisely regulated with the combination of high precision dual channel digital potentiometer AD5172. Using the VISA node function provided by LabVIEW, a hardware platform based on serial communication is built to monitor the whole circuit.

II. DESIGN OF INTELLIGENT CONTROL SYSTEM FOR PHOTOELECTRIC COMMUNICATION

A. System Architecture

The method is based on Lab-VIEW software, through the intelligent remote control and control of the power supply of each component in the continuous variable dependent optical system. A PC developed with LabVIEW can be operated from a Web page to a lower computer. PCI6111E acquisition board is used to collect the optical signal from the secondary end, and then it is processed to generate the corresponding control signal, and then the serial communication module in Lab-VIEW is used to send the corresponding control information to the AVR microcontroller. After receiving instructions, the microprocessor performs related operations [3]. At last, the power supply status of each module is displayed in real time on the LabVIEW interface. The overall block diagram of the design scheme is shown in Figure 1 (the picture is quoted in Real-Time Edge Software).

The system mainly includes two parts: virtual instrument control part and AVR microcontroller part. The control part of AVR adopts ATmega16L microcontroller, and uses MAX3232CPE chip to change its level, and communicates with the serial interface of the computer [4]. After receiving the control command, the work of the relay is operated, and then a control command with feedback information is returned from the serial interface. By photoelectric isolation of MCU and relay, so that they are not interfered by the protection device, so that they work stably and reliably. The design part of LabVIEW completes the configuration of Lab-VIEW Web server, the release of remote panel, data collection and processing, and serial communication.

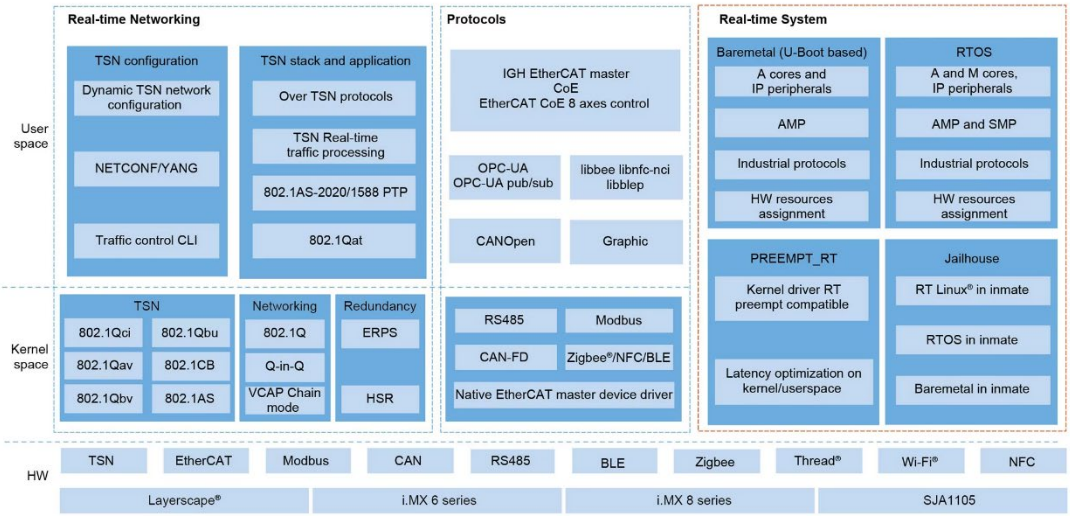


Fig. 1. Block diagram of the overall remote intelligent control scheme

B. Function module design

1) Temperature acquisition circuit

The ADN8830 is a single chip semiconductor thermoelectric cooling control system with high conversion efficiency. Electronic tube (TEC) uses the Pearl effect, applying an alternating current to the tube to transfer the heat between the two tubes to the two tubes, so that the temperature difference between the two tubes gradually increases [5]. The end that goes down is called the cold end and the end that goes up is called the hot end. If the current loaded on the tube is reversed, the refrigerant and the heat generating end are reversed. The temperature control circuit automatically adjusts the amplitude and direction of TEC excitation current by monitoring the thermal resistance in the laser, so as to achieve the purpose of temperature control of the laser.

2) Current regulation and amplifier excited by thermoelectronic converter

The ADN8830 is a semi-PWM semi-linear drive mode that utilizes the FDW2520 to improve its drive performance. FDW2520 adopts N and P channel structure, and both devices adopt complementary structure [6]. The power loss of H-bridge circuit is reduced by using PWM mode. The PWM mode of operation requires that the output pulse current be filtered out on the TEC. The design of the filter circuit should consider the rated current of the capacitor, the ripple coefficient of the filtered output and the switching frequency of the pulse width modulation circuit.

3) Temperature control system with PID control

According to the principle of ADN8830 chip, the measured temperature signal and the temperature to be measured are differential amplified, and then the internal compensation amplifier circuit is used to compensate the whole, so as to realize the response speed of the tube and the stability of the temperature control system. PID regulation is generally used to realize the temperature control of the laser system.

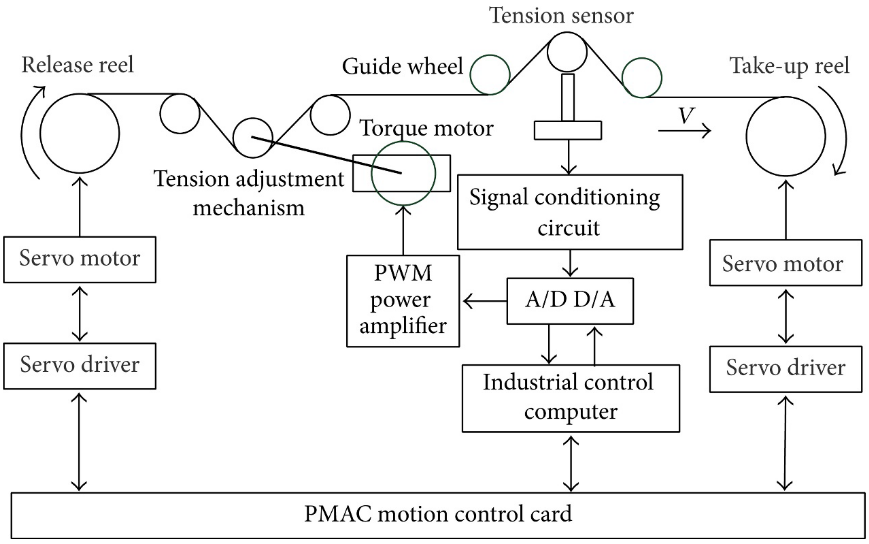


Fig. 2. Block diagram of drive circuit system

4) DC transmission device

Due to the large fluctuation of laser output current, it is easy to be affected by static electricity, high voltage, wave current and power grid pulse, so it needs to be carefully regulated. A new type of DC driver is designed with ADN2830 as the main control chip. The ADN2830 regulates the output of the laser by adjusting the bias of the input laser. Figure 2 shows that the voltage on the PSET terminal of the chip is kept constant at 1.23V, and the PSET has the following resistance 5 (Figure cited in Compound Tension Control of an Optical-Fiber Coil System: A Cyber-Physical System View). Therefore, by adjusting the RPSET value, the injection current of the laser can be changed, and the output optical power of the laser can be regulated.

5) Interface programming of the host computer

C# programming PC interface, through the CAN interface PC and PC to communicate, so as to complete the communication between PC and PC, and the network can be real-time monitoring of each node. The parameter upload setting, node management setting, CAN parameter setting and so on. The parameter setting of uploads is used to update and save the data of the subordinate node [7]. The Node Management Settings are used to update the state of the Save. The parameter setting of the CAN bus is used to set the port number and baud rate. The system realizes the communication between the host and the lower computer, and stores the running status of each node into a database, and then displays it on the PC. When the program starts to run, the system will check the operation of each subordinate unit, and the obtained results will be displayed in the upper computer. This paper presents a basic flow of query and storage management based on database. Figure 3 shows the main flow diagram of the query entry module (the picture is quoted in Bayesian optimization with active learning of design constraints using an entropy-based approach).

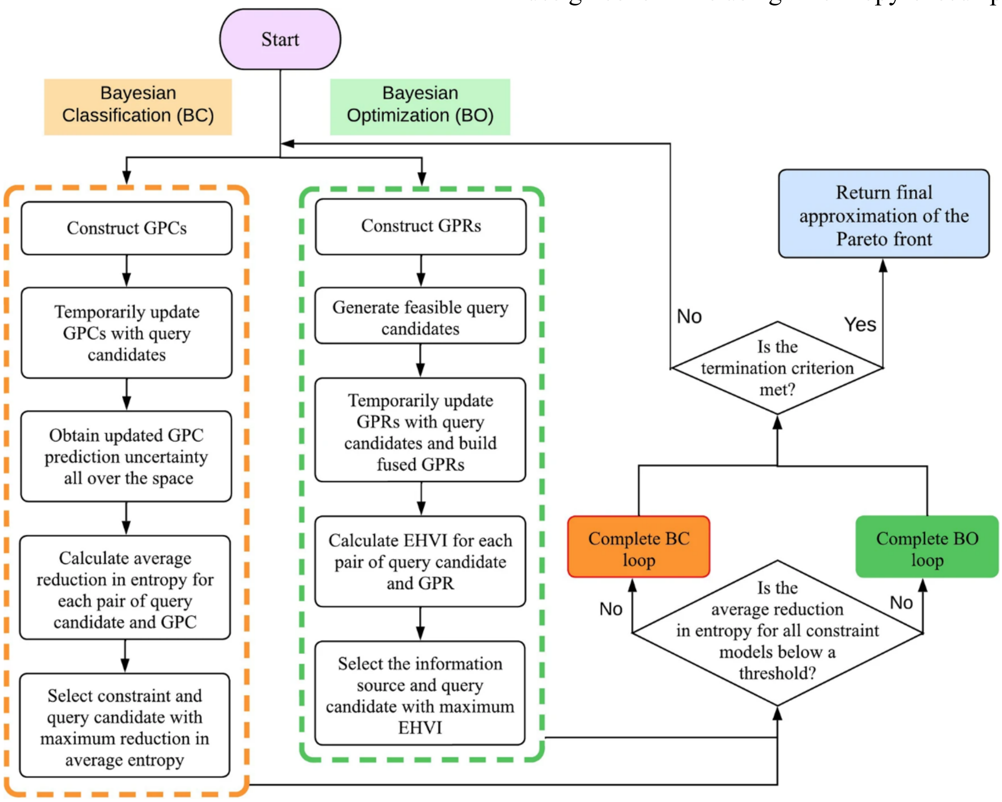


Fig. 3. Main flow diagram of query entry module

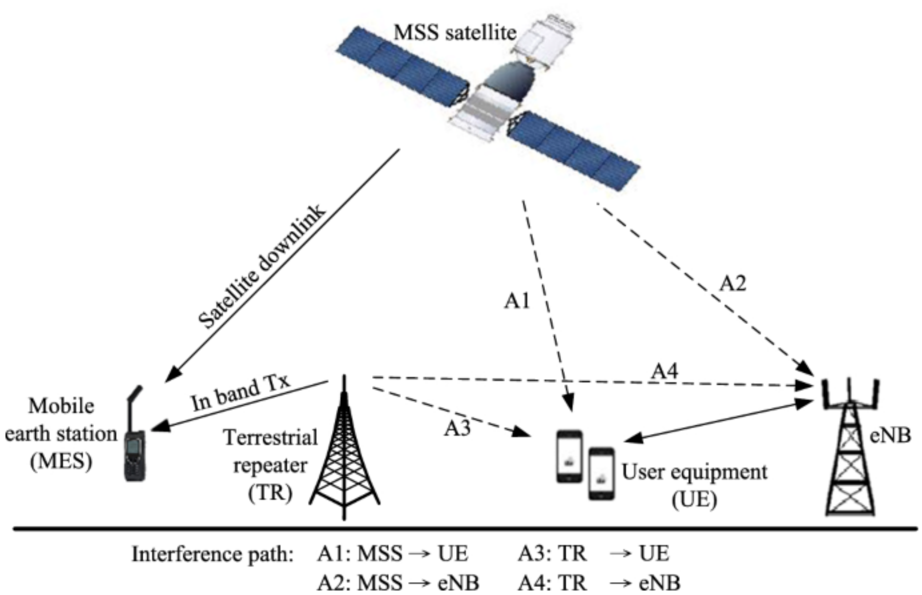


Fig. 4. Wireless communication system with interfered links

III. SYSTEM MODEL

There is only one communication link between the receiving and transmitting ends of the radio terminal device, and the transmitting and receiving devices on each communication link are fixed. And no Interference occurs between links (Figure 4 cited in Enabling LTE Services Under Interference from Mobile Satellite Service System).

Suppose that the transmitting terminal device of link t $(1 \le t \le t)$ at time t has a transmitting power of $W_t(t)$, a transmitting signal of $u_t(t)$, and a receiving signal of

$$v_t(t) = l_t(t)\sqrt{W_t(t)}u_t(t) + \sum_{j \ne t} l_{j,t}(t)\sqrt{W_j(t)}u_j(t) + c_t(t) \quad (1)$$

Where, $l_t(t)$ is the link t at time t. $l_{j,t}(t)$ is between the transmitter of link j at time t and the receiver of link t, that is, $\sum_{j \ne t} l_{j,t}(t)\sqrt{W_j(t)}u_j(t)$ is the interference signal received by link t at time t from other links. $c_t(t)$ is an independent uniformly distributed complex Gaussian white noise, and the noise power is N_0.

Let $L(t) = \{L_{j,t}(t), \forall j, t\}$ represent the global CSI, where $L_{j,t}(t) = |l_{j,t}(t)|^2$ represents the instantaneous channel gain between the transmitter on link j and the receiver on link t at time t. In this project, Rayleigh attenuation theory is used to model the wireless network, and Yax fading model is used to decompose it into a complex Markov process to describe the dynamic behavior of the system.

$$l_{j,t}(t) = \varphi l_{j,t}(t-1) + \sqrt{1-\varphi^2}\, e_{j,t}(t) \quad (2)$$

$l_{j,t}(t)$ and the channel update process, $e_{j,t}(t)$ are independent and equally distributed cyclic symmetric complex Gaussian random variables with unit variance. Correlation coefficient $\varphi = F_0(2\pi g_s T)$, where $F_0(\cdot)$ is the zero-order Bessel function and g_s is the maximum Doppler frequency. Signals on one communication line and signals from other transmitters are treated as noise, and the signal transmission rate of the device is also determined by the signal-to-noise ratio. Given the channel state information $L(t)$ and transmit power $W(t) = \{W_t(t), \forall t\}$, the receiver t receives data rate is

$$\psi_t(t) = lb\left(1 + \frac{L_t(t)W_t(t)}{\sum_{j \ne t} L_{j,t}(t)W_j(t) + N_0}\right) \quad (3)$$

The mathematical model of interference management problem for multi-user transmit power control is established, as shown in equation (4).

$$\begin{aligned} &\max_{W(t)} \sum_{t=1}^{t} \lambda_t \psi_t(t) \\ &s.t.\ 0 \le W_t(t) \le W_{\max}, t \in \{1, 2, \cdots, t\} \end{aligned} \quad (4)$$

The goal of formula (4) is to maximize the weighted data rate of the wireless communication system, where λ_t is the positive weight corresponding to device t, representing the importance of the link. The optimal variable in (4) contains both the numerator and the denominator of lb function, and its biggest problem has high complexity and non-convexity, which has become an important research direction in current wireless communication systems [8]. The existing research methods have strong dependence on the model and large amount of calculation, so it is difficult to adapt to the complex and dynamic environment in the future mobile communication system where multiple nodes access at the same time. Since transmission power is a continuous problem, this project intends to study the distributed optimization model based on deep reinforcement learning and the intelligent wireless transmission energy control algorithm based on DDPG in Figure 5.

Because the wireless channel environment has the Markov property, the dynamic decision-making process of power control is modeled as the Markov decision process. Set $R = L$ as the global state value and $a(t) = \{W_t(t) \mid 0 \le W_t(t) \le W_{\max}\}_{t=1,2,\cdots,t}$ as the action set. In the process of intelligent power control, it is assumed that a centralized controller can collect all the channel state information and input the state value to the agent. The agent will make a decision based on the state value and its own random strategy, output a specific action $a(t) \sim \pi(a(t) \mid R(t))$, and then enter the next state $R(t+1) \sim \Pr(R(t+1) \mid R(t), a(t))$ according to the state transition function. In addition, the agent will receive a corresponding reward function $q(t) = q(R(t), a(t))$ and obtain its own observation of the new state $R(t+1)$. The training goal is to maximize the long-term return $R = \sum_{t=1}^{T} \mu^{t-1} q(t)$, where μ is the discount coefficient and T is the time range. According to the optimization problem formula (4), the reward function can be defined as

$$q(t) = \sum_{t=1}^{t} \lambda_t \psi_t(t)$$

This project proposes a power optimization method based on reinforcement learning, that is, through repeated trials, repeated evaluation and optimization algorithms. However, the deep reinforcement learning method based on neural network has great advantages in evaluating and optimizing decision making, but its correlation between forward and backward is large, which makes it difficult to converge the "action-evaluation" method. The gradient algorithm with better convergence performance is used in this paper.

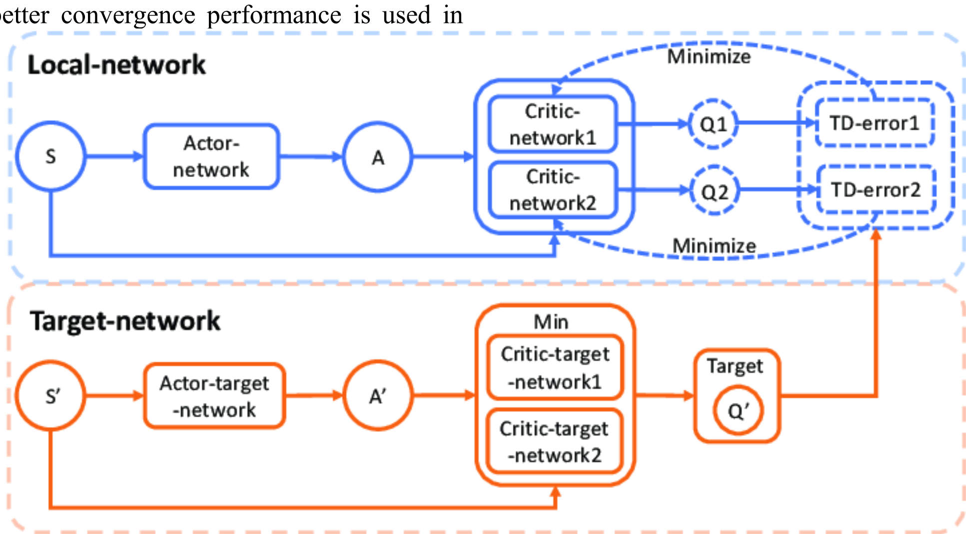
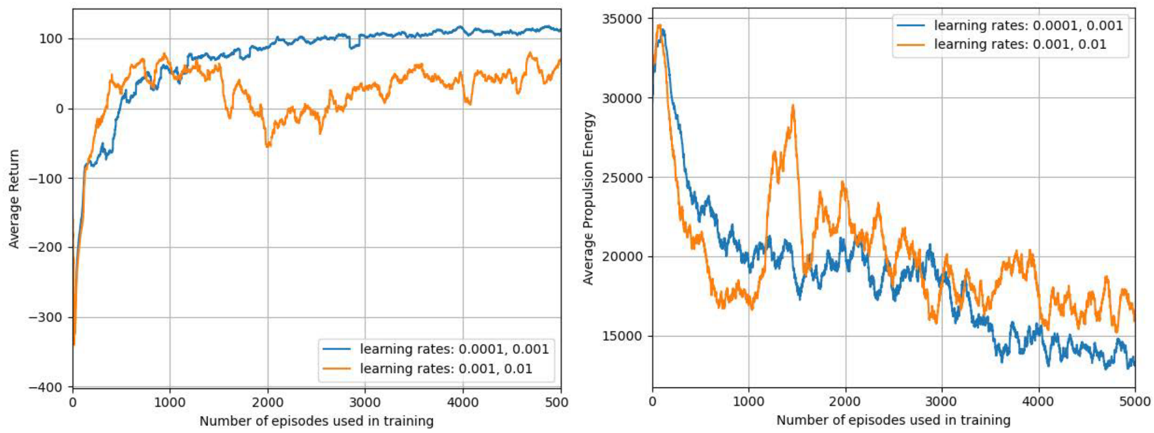


Fig. 5. Overall framework of intelligent wireless transmission power control algorithm

IV. SYSTEM INSPECTION

The simulation results of 5 and 10 pairs of transceivers are also given. The maximum power sent by the sender is 1 W, and the whole transmission process is divided into 100 periods, and the weighted kα of each period is 1. This project intends to use open source Tensorflow2.4.0 and Keras to construct and train deep neural networks. Figure 6 shows the convergence of the intelligent wireless transmission power control algorithm based on DDPG. The algorithm is designed to capture specific experiences, and the gains from reinforcement learning have hardly increased over time. The experimental results show that the performance index of the cycles after obtaining enough data, thus verifying the effectiveness and fast convergence of the model.



(a) (b)

Fig. 6. Convergence of intelligent wireless transmission power control algorithm based on DDPG

V. CONCLUSION

This project uses LabVIEW as a graphical virtual instrument system. Through remote monitoring of VI front panel on remote server, remote data collection is carried out by remote communication, data acquisition, data processing and remote control, and relevant processing results are displayed in real time, so as to realize remote monitoring. VISA card is used to realize a simple, stable and reliable serial port communication mode, communicate with AVR microcontroller, realize the remote intelligent monitoring of various power supplies, can monitor the running status of each power supply in real time, and effectively protect the power supply and various equipment of the test platform and reduce human interference.

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