

Research on the Progress and Application of Yi Language Information Processing

Chengping Wang^{1,*}, Qingya Zeng^{1,2}

¹*Minzu Languages Information Processing Lab (Provincial Key University Lab of Sichuan Province of China), Southwest Minzu University, Chengdu, Sichuan 610041, China*

²*School of Chinese Language and Literature, Southwest Minzu University, Chengdu, Sichuan, 610041, China*

**Corresponding author*

Keywords: Yi language, Information processing, Research progress, Application

Abstract: Under the background of informatization and intelligence, with the new round of development of information processing technology and the increasing demand for diversified information development in the Minzu Areas of China, several outstanding achievements have emerged in the field of information processing in Yi language, including Yi characters, words, sentences, chapters, paragraphs, speech, and resource database construction. Among them, the development of information processing technology and application plays an increasingly important role in helping the long-term development of Yi language information processing and the construction of informatization in Yi regions.

1. Introduction

Since the 1980s, the rapid development of information technology with network technology as its core has entered various fields of social life at an astonishing speed and has profoundly affected the transformation and development of society. As the most critical communication tool and information carrier for humanity, the technology and use level of language information processing has become an essential indicator of national modernization.

As the sixth-largest minzu in China, the Yi has more than 9 million people living in Yunnan, Sichuan, Guizhou, and Guangxi provinces. It is of great practical significance to carry out Yi language information processing research with abundant language and cultural information resources. Yi language information processing began in the 1980s and has made remarkable achievements in the development of nearly 40 years, including Yi characters, words, sentences, chapters, paragraphs, speech, and resource database construction.

This paper combs the research progress and application to have a deeper understanding of Yi information processing, provides a reference for relevant researchers in Yi information, and explores the further development direction of Yi information processing.

2. Yi Character Processing

2.1 Yi Coded Character Set and Font Library

Characters are the most basic abstract element for the computer processing of text information. Encoding of characters is the technical basis of information processing. In the 1980s, the study of the Yi character set began. In a broad sense, the character set includes the Yi character sets in Yunnan, Sichuan, Guizhou, and Guangxi. In a narrow sense, the character set the standard, which refers to a national standard mainly drafted and formulated by Professor Shamalayi: “Yi coded character set for information exchange”[1], and an international standard: “universal multi eight-bit Yi coded character set”.

The font library is the realization of the character set on the computer. The characters in the character set rely on the font library to be stored, processed, displayed, input and output on the computer. As a whole project of Yi language information research, the font database has been paid attention to by scholars, and many excellent results have been produced on this basis. From the perspective of font representation methods, the font database is divided into two different representation methods, dot matrix and vector. The Yi font library includes the “Yi 15×16 Dot Matrix Font Set and Data Set for Information Exchange” [2]and “Yi Character 24×24 Dot Matrix Font Set and Data Set for Information Exchange”[3] mainly drafted and formulated by Professor Shamalayi; the vector font library includes two different font formats based on the Unicode standard, Open Type[4] and True Type[5]. From the perspective of regional division, the research on font includes the font research of Yunnan[6], Guizhou[7], Guangxi[4], Sichuan[8], and Chuxiong Prefecture[9]. From the perspective of the research objects, there are character libraries developed for the ancient Yi language, and there are also general Yi character libraries[10] established based on the six major Yi dialects. This shows that the coded character set and related research at the character level of Yi language information processing have been an essential foundation, and there have been relatively affluent results. However, researchers in the field are still constantly improving and optimizing related designs.

2.2 Yi Character Input Method

In the 1990s, the computer Yi input method led by Professor Shamalayi was applied to the computer Yi laser phototypesetting system, which filled the gap of minority information processing in China. The “Shamalayi input method” was named by Academician Wang Xuan of the two academies. This achievement significantly promoted the development process of Yi information processing. After that, in addition to standardizing the Yi language, the research on general Yi language input[11] and ancient Yi language input has attracted the attention of more and more scholars. Most ancient Yi language input research focuses on specific regions, including the ancient Yi language input method based on the Yunnan Sichuan Guizhou Guangxi Yi language character set[12], the Chuxiong stroke input method[10], and the southern Yunnan Yi language input method[13].

The coding design methods of the Yi input method can be summarized as based on font and based on word sound. The former includes the Yi shape code input method and coding optimization scheme designed according to Yi shape structure and writing stroke order[14], font classification[15], accessible splitting mode[16]. The latter design Yi character input code according to vowel characteristics, tone, etc.[18], and exhalation symbols. The input coding mode should be displayed through a specific input platform and system. In addition to the existing Yi input methods primarily based on Windows systems, there are also Yi input methods that can be connected to a variety of Western Linux systems[19], which further promotes the diversified and international development of

Yi information processing.

2.3 Yi Character Detection and Recognition

People are no longer satisfied with inputting characters for computer recognition in the information age but expect the computer to automatically recognize characters and be understood and processed by the computer. With the development of technology, deep learning is gradually applied to detecting and recognizing ancient characters[27]. The current research on Yi language detection mainly uses the Maximally Stable Extremal Regions (MESR)and Convolutional Neural Network(CNN) [20]to detect the characters of Yi language ancient books. On this basis, the automatic recognition system[21] of Yi language ancient books is realized. The research on Yi character recognition includes the application of deep learning in offline Yi character [22]and handwritten Yi character [23]recognition, and the ancient Yi character recognition method based on a neural network expansion model.

2.4 Other Yi Character Processing

Other studies on Yi characters include segmentation, conversion, and repair of Yi characters. It is embodied in the design of the Yi character segmentation algorithm based on the connected domain[24], the research of converting Yi-Win into founder Unicode Yi language in line with international standards[25], and the restoration method of ancient Yi character symbols using double discriminator Gan[26].

3. Yi Word Processing

3.1 Yi Automatic Word Segmentation

Yi language information processing is a vast system engineering, which covers multi-level information processing tasks. Yi texts are written in sentences, and there is no gap between words. Therefore, word segmentation is a necessary basis for Yi information processing. Machine translation, text classification, emotion analysis, and natural language understanding all require to be carried out on the plane of words. Moreover, the accuracy of automatic word segmentation directly affects the accuracy of corpus labeling, machine translation, information retrieval, and speech synthesis.

The existing research on Yi automatic word segmentation technology mainly adopts rule-based methods, such as Yi word segmentation technology based on the established word list[28], Yi dictionary[30], case grammar combined with the dictionary[31], and statistical hidden Markov model[29]. Due to the complexity of Yi language knowledge, it is not easy to organize various language information into a form that the machine can read directly. Therefore, the word segmentation system based on understanding is still in the experimental stage. In automatic word segmentation, the standardization of Yi word segmentation, the segmentation and recognition of ambiguous words, and the recognition of unregistered words have always been the difficulties. The Yi information processing also explores the types of word segmentation ambiguity[32] and the norms of Yi word segmentation[33], but there is still room for improvement and development.As one of the core technologies of Yi language information processing, word segmentation research is still an important topic that needs to be focused on and studied for a long time in the future.

3.2 Other Yi Word Processing

In addition to the relevant research on Yi word segmentation, the processing of other Yi words also

includes the research on standardizing the word frequency statistical system of Yi characters[34], the part of speech of Yi for information processing[35], and the alignment technology of Yi Chinese bilingual words[36].

4. Yi Sentence, Paragraph, and Chapter Processing

4.1 Yi Language Information Retrieval and Extraction

Information retrieval and extraction refer to organizing and storing information in a certain way and searching and extracting relevant information according to users' needs, involving multiple links such as information representation, storage, organization, and access. The Yi information retrieval and extraction involve Yi ancient books, including network graphic Yi ancient book retrieval system[37] and Yi ancient book text extraction method[38] designed by integrating edge and texture features. Furthermore, the construction of the Yi network information acquisition platform is based on the structural characteristics of Yi web pages[39].

4.2 Analysis of Yi Language Emotion and Public Opinion

Emotion analysis, also known as opinion mining, is a field of natural language processing. It constructs a system for identifying and extracting views from the text. Yi language emotion analysis mainly realizes the double-layer feature of Yi language data emotion automatic annotation method through the corresponding feature fusion and automatic annotation algorithm [40]. And a sensitive content classification system for Yi web pages [41] is proposed to solve the safe dissemination of Yi network information and the stability of public opinion.

4.3 Yi Machine Translation

In the context of the information age, as an essential communication tool for human beings, language has significant human-computer interaction functions. Yi language machine translation research has paramount significance for strengthening the communication between different minzu, inheriting and developing national culture, and has a strong research value. However, translation quality is vital for machine translation, and researchers have been trying to improve translation quality with different technologies and models. The research of Yi language machine translation mainly includes using “X-order standard theory” and syntactic tree structure diagram from the perspective of machine translation [32]. It also includes the research on machine translation of Chinese and Yi sentence pattern transformation based on temporal transformation matching rules [42], Chinese-Yi translation based on the neural network[43], and Chinese-Yi bilingual ordering model based on syntactic rules[44].

5. Yi Language Speech Processing

Speech processing is also called digital speech signal processing. It is a general term used to study the process of speech production, statistical characteristics of speech signals, automatic speech recognition, machine synthesis, and speech perception. The research on Yi language speech processing in China started late, mainly including Yi language speech reading program design[45], Yi language speech synthesis using Deep Neural Networks(DNN) and End-to-End(E2E) methods[46], and the noisy man based on the Empirical Mode Decomposition(EMD) “Teager” algorithm design[47], comparative study on endpoint detection methods of isolated words in Yi language.

6. Yi Language Resource Database Construction

Any information processing system is inseparable from the support of data and corpus. Especially in the era of information society and digital survival, the collection, protection, and development of language resources have been raised to the height of China's national resources. China's National Language and Writing Committee mentioned the need to enhance the awareness of language resources and strengthen the protection, development, and use of language resources. To meet the needs of the development of the language and writing industry and the needs of the society, we will strengthen the construction of language resources and build a minority language resource database and a large-scale corpus of traditional and universal minority languages.

The development and construction of the Yi language corpus are mainly based on the National Language Information Processing Technology Research and Development Center of Southwest Minzu University. From a language perspective, it includes monolingual, bilingual, and multilingual knowledge bases; from a stylistic view, it involves written and spoken language; from a media perspective, it is divided into text knowledge bases and phonetic knowledge bases.

The specific performance is the Yi language corpus, Chinese-Yi contrastive labeled thesaurus, Yi language full document database, Yi research literature database, Yi language document database, Yi language dialect basic vocabulary comprehensive corpus, Chinese-Yi bilingual alignment fundamental corpus, Yi language vocabulary semantic database for information processing, Yi traditional medical term database, Yi language basic example sentence corpus database, Yi, Chinese, and English parallel corpus for information processing, Chinese-Yi bilingual vocabulary database, Yi language archival database[48], Yi for information processing, Yi, Chinese and English trilingual parallel corpus[49], Yi language corpus resource database[50]. And phonetic knowledge base: Yi acoustic parameter database, Yi vowel acoustic parameter database, Chinese-Yi name, and Chinese character transliteration database, Yi six dialect phonetic database, Yi Adu primary phonetic resource database[51], Yi web page information resource database[52], Yi oral, classic corpus in Wujiao Township[53].

7. Application of Yi Language Information Processing

At present, most of the research results of Yi language information processing have been applied, many of the results developed by the Minzu Languages Information Processing Laboratory of Southwest Minzu University. Including PGYW Yi computer, YWPS desktop office system, Yi-win system 2002, and other system software. Furthermore, application software and mobile terminals such as Chinese Yi comparison electronic dictionary, “learn Yi language with me”“easy learning Yi language” multimedia teaching software, Chinese-Yi comparison electronic dictionary, Yi, Tibetan, Dai language learning platform, Tibetan, Yi mobile phone based on Android and Spreadtrum platform, electronic multimedia CD-ROM of Chinese Yi classics translation series.

In addition, there are ancient Yi language information processing system software designed based on Windows platform[54], Yi-Chinese bilingual multimedia network examination system[55], Chinese-Yi bilingual question bank management system[56], Chinese-Yi bilingual government website constructed by using “Yi-win Yi language system 2002”[57], Yi language primary learning platform[58], Yi-Chinese bilingual e-commerce system platform[59], multi-functional Chinese Yi e-dictionary[60-63].

8. Conclusion

In the era of information intelligence, with the new round of development of information processing technology and the increasing demand for diversified information development in Yi

districts, several outstanding achievements have emerged in computer information processing in the Yi language. It has played an active role in promoting the economic development, social progress, and cultural inheritance of the Yi area. By combing the research status of Yi information processing, it is suggested that the research of Yi information should pay attention to the following aspects:

(1) Unify standard: Yi language is divided into six dialect areas. Due to various social and historical development reasons, Yi language has differences in pronunciation, writing, and meaning. On this basis, information processing is carried out. The lack of unified standards and low compatibility will hinder the exchange and sharing of information and make subsequent information processing difficult. To achieve long-term development, we need to unify standards and use standardized Yi language.

(2) Find out the actual language: Language and writing are communication tools belonging to all members of society. With the development of the times, new situations and characteristics constantly appear in people's language lives. Carrying out a large number of investigations on the use of Yi language and writing to understand the actual language conditions can enable researchers to obtain better the development needs of the computer Yi language information field so that the related research results of information processing can genuinely meet and serve the language facts.

(3) Establish a professional team: Yi language information processing research is an interdisciplinary subject formed by linguistics, computer science, and ethnology. To carry out relevant research, the knowledge structure of the researchers should be constantly updated, and the knowledge of the subject areas involved should be integrated and integrated. Therefore, various scientific research institutions should strengthen exchanges and cooperation, build professional teams, and improve scientific research efficiency.

(4) Promote intelligence development: The information revolution currently sweeping the world is about to trigger a more profound intelligence revolution and promote the development of information processing towards intelligence. On the existing basis, Yi language information processing needs to be refined and intelligent, and cutting-edge scientific and technological achievements should be grafted into Yi language information processing promptly.

(5) Realize multilingual interconnection: With the rapid development of information technology such as artificial intelligence, 5G, and big data, language communication and information interconnection are particularly important in the current era. Cross-language, multilingual intelligent information processing, communication, and exchange demand are unprecedentedly high. Moreover, language is the most crucial communication tool and cultural carrier of humankind. It has long been an indisputable fact that language communication has become an essential link of human connection. Therefore, it is necessary to break the language barriers and promote the inter-communication and interconnection of languages.

Acknowledgment

This paper is the phased achievement of National Natural Science Foundation of China, Project number: 72174172 in 2021; The Humanities and Social Science Research Project of the Ministry of Education “Research on the Construction of Yi Dialects Comprehensive Resource Database”, Project number: 17YJA740051 in 2017; Special fund project of basic scientific research of Central University of Southwest Minzu University-Key Laboratory Project of Minzu Languages Information Processing Lab in Sichuan Province, Project number: 2021PTJS32 in 2021; The Higher Education Talent Training Quality and Teaching Reform Project Of Sichuan Province, Project number: JG2021-440 in 2022; The Key Research Base of Social Sciences in Sichuan Province-Yi Culture Research Center, Project number: YZWH2210 in 2022.

References

- [1] GB/T 13134-1991, Yi coded character set for information exchange [S].
- [2] GB/T 13135-1991, Yi character 15×16 dot matrix font set and data set for information exchange [S].
- [3] GB/T 16683-1996, Yi character 24×24 dot matrix font set and data set for information exchange [S].
- [4] Xuanxuan Tian. Research on the font library of Guangxi Yi language ancient books based on OpenType technology [J]. *Information and Communication*, 2020(07):282-284.
- [5] Xie Wu. Development and Design of True Type Fonts in Guizhou Ancient Yi Language [J]. *Journal of Bijie University*, 2012, 30(11): 30-33.
- [6] Yunshan Li, Jiamei Wang, Sheng Zheng. Research on the design of Yunnan standard Yi font library and its character set encoding [J]. *Electronic Science and Technology*, 2011, 24(05): 97-101.
- [7] Xie Wu, Yuping Lu, Minggui Wang. On the Construction of Guizhou Ancient Yi Coded Character Set[J]. *Chinese Information Journal*, 2014, 28(04): 153-158.
- [8] Shunqiang Chen, Yang Zhang, Jian Xiong. The design of Sichuan ancient Yi font library and its character set coding [J]. *Journal of Southwest Minzu University (Natural Science Edition)*, 2009, 35(04): 913-918.
- [9] Gao Yi. Chuxiong Yi language computer font production and stroke input method software. Yunnan Province, Chuxiong Prefecture Minzu Affairs Commission, 2008-08-06.
- [10] Xie Wu. General Yi language information font library construction[J]. *Journal of Bijie University*, 2010, 28(09): 23-26.
- [11] Qing Wang, Jiamei Wang. Research on the general information input platform of Yi language [J]. *Journal of Honghe University*, 2019, 17(04): 47-51.
- [12] Chengping Wang. The design and realization of ancient Yi input method based on the Yi character set of Yunnan, Sichuan, Guizhou and Guangxi [J]. *Computer and Information Technology*, 2012, 20(02): 28-30.
- [13] Gang Hu, Jiamei Wang, Jianying Zhang, Shantong Sun, Xue Tang, Huiyun Zhao. Implementation of South Yunnan Yi Character Input Method Based on Windows Platform [J]. *Computer System Applications*, 2015, 24(12): 34-43.
- [14] Xie Wu. Design and Implementation of Guizhou Yi Language Computer Code Input Method [J]. *Journal of Yunnan Minzu University (Natural Science Edition)*, 2014, 23(05):387-390.
- [15] Weilin Ning, Jiamei Wang, Hui Wang, Zhiyuan Ming. Research and realization of shape code encoding of Yi input method [J]. *Journal of Yunnan Minzu University (Natural Science Edition)*, 2011, 20(04): 310-312 .
- [16] Hao Feng, Hui Wang, Jiamei Wang. Design and implementation of Yi input method based on free split mode [J]. *Computer Applications*, 2010, 30(S1): 306-308.
- [17] Hao Feng, Ying Zhou, Jiamei Wang. The promotion and application of the free coding scheme of Yi input method [J]. *Modern Computer (Professional Edition)*, 2011(09): 3-5+11.
- [18] Xu Han, Xiaoyu Lin, Shanxiong Chen. An input coding design of ancient Yi characters[J]. *Science Technology and Engineering*, 2019, 19(16): 212-215.
- [19] Bing Wu, Jun Shi, Yuping Liu, Nan Zhang, Li Wang. Dynamic connection of Yi input based on Linux system [J]. *Journal of Southwest Minzu University(Natural Science Edition)*, 2005(04): 606-610.
- [20] Shanxiong Chen, Xu Han, Xiaoyu Lin, Yun Liu, Minggui Wang. Character detection method of ancient Yi language documents based on MSER and CNN[J]. *Journal of South China University of Technology (Natural Science Edition)*, 2020, 48(06): 123-133.
- [21] Xu Han. Research and realization of character detection and recognition in ancient Yi language books [D]. Southwest University, 2020.
- [22] Jiwa Aying. Exploring the application of deep learning in offline Yi character recognition[J]. *Modern Computer (Professional Edition)*, 2018(10):41-44.
- [23] Xiaodong Jia. Research on the application of handwritten Yi recognition technology based on deep learning [D]. Central Minzu University, 2017.
- [24] Sai Liu, Zongxiao Zhu, Zhiqiang Ma, Fei Tong, Rong Xie. Design and Implementation of Yi Character Segmentation Algorithm Based on Connected Domain[J].*Journal of South-Central Minzu University (Natural Science Edition)*, 2009, 28(02): 86- 89.
- [25] Jinfa Li. On the conversion of computer Yi character encoding[J].*Journal of Yunnan Minzu University (Natural Science Edition)*, 2008(01):80-84.
- [26] Shanxiong Chen, Shiyu Zhu, Hailing Xiong, Fujia Zhao, Dingwang Wang, Yun Liu. A double discriminator GAN based ancient Yi character restoration method[J/OL].*Acta Automatica Sinica*:1-13[2021-03-28].<https://doi.org/10.16383/j.aas.c190752>.
- [27] Shanxiong Chen, Xiaolong Wang, Xu Han, Yun Liu, Minggui Wang. An ancient Yi character recognition method based on deep learning [J]. *Journal of Zhejiang University (Science Edition)*, 2019, 46(03):261-269.
- [28] Chengping Wang. Design and research of computer automatic word segmentation technology in Yi language[J]. *Journal of Natural Science of Xiangtan University*, 2012, 34(03):107-113.

- [29] Shunqiang Chen, Ma Heimahuo. Design and development of Yi word segmentation system based on hidden Markov model[J]. *Journal of Southwest Minzu University (Natural Science Edition)*, 2012, 38(01): 146-149.
- [30] Abie Muxia. Research on Word Segmentation Technology of Yi Dictionary Based on Python [D]. Southwest Minzu University, 2018.
- [31] Chun Lin, Jiamei Wang, Jianying Zhang, Jinyu Fan. Research on Sensitive Information Monitoring System of Yi Language Web Pages[J]. *China New Telecommunications*, 2013, 15(24):41-42.
- [32] Xia Cai. Research on the Ambiguity Types of Normative Yi Text Segmentation from the Perspective of Machine Translation [J]. *National Translation*, 2020(01):81-86.
- [33] Shunqiang Chen. Research on the Standardization of Yi Word Segmentation for Information Processing [J]. *Journal of Southwest Minzu University (Natural Science Edition)*, 2011, 37(01): 158-160.
- [34] Shunqiang Chen. Design and implementation of a statistical system for standardized Yi characters' word frequency[J].*Journal of Southwest Minzu University(Natural Science Edition)*, 2010, 36(04):644-648.
- [35] Shunqiang Chen, Shamalayi. Research on the Part of Speech in Yi Language for Information Processing[J]. *Minority Languages*, 2011(04):49-51.
- [36] Chengping Wang. Research on Yi-Chinese Bilingual Vocabulary Alignment Technology for Information Processing[J].*Computer CD Software and Application*, 2012(11):3-4.
- [37] Muge Yuebu, Xiaoling Yang. The construction basis and preliminary ideas of the network version of the Yi language ancient book retrieval system[J].*Science and Technology Information (Science Education and Research)*, 2008(15):360+343.
- [38] Rong Xiao. Research on text extraction methods of ancient Yi language books under complex background[D]. South-Central Minzu University, 2011.
- [39] Shantong Sun, Jiamei Wang, Bingze Li, Pan Gong, Gang Hu. Research on Yi Language Network Information Acquisition Platform[J].*Electronic Technology and Software Engineering*, 2015(13):44-46+168.
- [40] Jun He, Caiqing Zhang, Yunfei Zhang, Dehai Zhang, Xiaozhen Li. Automatic emotional annotation method of Yi language data based on two-layer features[J]. *Computer Applications*, 2020, 40(10): 2850-2855.
- [41] Qing Wang, Bingze Li, Jiamei Wang. Research on the sensitive content grading system for Yi language web pages [J]. *Journal of Yunnan Minzu University (Natural Science Edition)*, 2019, 28(02):177-185.
- [42] Gaga Mao, Xianze Yang. An Analysis of Chinese and Yi Machine Translation[J]. *Journal of Southwest Minzu University (Natural Science Edition)*, 2016, 42(01):81-84.
- [43] Muji Tian. Research and implementation of Yi-Chinese translation based on neural network[D]. University of Electronic Science and Technology of China, 2020.
- [44] Zhengli Wang. Research on Yi-Chinese Bilingual Ordering Model Based on Syntactic Rules[D]. Guizhou University, 2016. Chen Min, Ma Dejiang, Wu Xie. Design of Yi Language Voice Reading Program[J].*Technology Economic Market*, 2006(08) :259.
- [45] Min Chen, Dejiang Ma, Xie Wu. The design of Yi language phonetic reading program[J].*Technology Economic Market*, 2006(08):259.
- [46] Xiaolong Bu. Research on Yi language speech synthesis based on deep learning[D]. Northwest Normal University, 2020.
- [47] Xijing Yang. Comparative study on endpoint detection methods of noisy Chinese and Yi language isolated words [D]. Kunming University of Science and Technology, 2015.
- [48] Yunyan Yang, Meiling Yang. The construction of the archival database of Yi language ancient books[J]. *Lantai World*, 2014(32): 37-38.
- [49] Chengping Wang. The construction of Yi, Chinese, and English parallel corpus for information processing and research on corpus alignment technology [J]. *Science and Technology Bulletin*, 2012, 28(02): 131-133.
- [50] Chengping Wang. The realization of the design and sharing of Yi language corpus resource database[J]. *Chinese Information Journal*, 2016, 30(01): 129-132+139.
- [51] Mougou Sun. Research on the construction of the basic phonetic resource database of Yi language Adu dialect [D]. Southwest Minzu University, 2020.
- [52] Jianying Zhang, Jiamei Wang, Xue Tang, Gang Hu. Research on web information collection technology in Yi language [J]. *Network Security Technology and Application*, 2014(12): 6-8.
- [53] Ziyang Shen. Research on the construction of the corpus of oral classics of the Yi people in Wujiao Township, Muli County, Liangshan Prefecture [D]. Southwest Minzu University, 2020.
- [54] Shunqiang Chen. The design and development of Sichuan ancient Yi language system under Windows platform[J]. *Journal of Bijie University*, 2008(05): 26-31.
- [55] Jinpin Hu. Design and implementation of Yi-Chinese bilingual multimedia network examination system [D]. University of Electronic Science and Technology of China, 2009.
- [56] A Niu Muzhi. Research and implementation of the Chinese-Yi bilingual question bank management system [D]. University of Electronic Science and Technology of China, 2009.

- [57] Xiaoling Yang. Overview of Yi-Chinese bilingual government website development [J]. *Journal of Southwest Minzu University (Natural Science Edition)*, 2004(02):245-249.
- [58] Delian Fei. Design and platform implementation of Yi language basic learning model based on self-built corpus [D]. Yunnan Normal University, 2020.
- [59] Liangjie Shen. Development and realization of office automation system in Yi language of Xichang University [D]. University of Electronic Science and Technology of China, 2009.
- [60] Xia Guo. Software design and implementation of multifunctional Chinese-Yi electronic dictionary [D]. University of Electronic Science and Technology of China, 2010.
- [61] Shamalayi. Development and Prospect of Yi language information processing technology in the past 30 years [J]. *Chinese Journal of information technology*, 2011 (6): 170-174.
- [62] Chengping Wang, Ying Zhao, Dongyan Sun. Research on Design and Sharing of Yi Language Corpus Resources Database Based on Syntactic Rules [J]. *Solid State Technology*, 2020(5):10563-10574.
- [63] Chengping Wang, Qingya Zeng, Dongyan Sun, Xuanxuan Tian. Yi Language Information Processing Technology Based on Character Matching Algorithm. *Solid State Technology*, 2021(5):10618-10629.