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## Protecting and Propagating Nu Shu with Information Technology

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**Abstract:** Nu Shu (lit. women's script) is a special written language used and understood only by women in Jiangyong county, Hunan province, China. Discovered by linguists 30 years ago, this mysterious language has been handed down from mother to daughter for generations. However, it is now facing the threat of extinction. In order to protect and propagate information about Nu Shu, a character set for the language was designed to produce a computerized record of Nu Shu. An input method was then used for editing. Using the character set and input method, a website and virtual steles were developed to protect and propagate various aspects of Nu Shu, including its graphemes, phonetics, semantics and songs. An online handwritten recognition system of Nu shu is designed to help people learn how to write Nu Shu. The latest research results are introduced one by one in this study.

**Key words:** Nu Shu, character set, input method, website, virtual reality

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### INTRODUCTION

Nu Shu is a character system which can demonstrate gender awareness in a unique manner. It is a script invented and used only by women and has been handed down by local women for many generations. It is distributed in several townships of Jiangyong county and some neighboring counties in Hunan Province, South Central China. Male residents of this region are unable to read or understand the characters of Nu Shu. It was only in the 1980s that this language was discovered by linguists.

Each character in the language had to undergo a long period of revision and augmentation before reaching its final form. The characters reflect the collective wisdom of the women who invented them. The distinctiveness of Nu Shu lies in the fact that it does not belong to a specific nationality but instead is distinguished by the gender of their users. In addition, these characters are not taught in schools but are handed down from woman to woman. The cultural value of Nu Shu, which derives not only from its uniqueness but also its persistence over a long period, merits its continued protection as a non-material cultural heritage (Li, 2003).

**Anthropological and sociological value:** Nu Shu is distributed in the rural areas of Shangjiangxu Township in Jiangyong County in Hunan Province. The language, culture and living environment of these areas show certain distinctive characteristics. Southwest Mandarin and the local Southern Hunan dialect are spoken here. This region is not only bounded geographically by three

counties in three different provinces but it is also an area where there is merging of the Confucian culture of the Central Plains with southern ethnic minority cultures (Wang and Zhu, 2010; Dong, 2005).

The Han Chinese and Yao ethnic groups co-exist peacefully in this region, with customs from both cultures being integrated into their daily lives. Nu Shu has developed from this integrated culture and truly unusual women's script has been preserved through female friendships, songs and needlework. Nu Shu reflects a lifestyle which has been preserved in writing, recording the thoughts of female friends, songs proclaiming spiritual happiness and with needlework as its material basis.

Nu Shu is a subculture within the mainstream culture with men at the centre. Convergence of the psychology and culture of women who had been constrained to the bottom rung of society gives Nu Shu its cohesiveness and ensures its survival. Nu Shu unites rural women through the process of making female friends, which ultimately strengthens their collective identity and group consciousness (Fig. 1).

Through the sharing of confidences and exchange of opinions, Nu Shu helps to ease the psychological pressure experienced by women who have to bear heavy burdens in their daily lives. It brings consolation to and provides support for those rural women who belong to the bottom rung of the social and economic ladders. Even in modern society, Nu Shu is still fulfilling an important social function. Thus, by providing a means of communication, entertainment and the transmission of customs, Nu Shu promotes



Fig. 1: Jiangyong women use Nu Shu to exchange ideas

cohesion among female communities and has significant sociological value (Xie, 2003; Xie, 2001).

**Philological value:** Nu Shu is first and foremost a set of characters. It is a set of systematic characters which are used to symbolize elements of the lives of rural women. There are only four strokes in Nu Shu: the bit, vertical, oblique and arc, as opposed to the eight different strokes used in Chinese. Its most characteristic stroke is the “arc”, whose radius is variable and can be long or short. Each character usually takes the form of a long, oblique diamond, with its peak in the upper right corner and its end in the lower left corner. Nu Shu characters are written from top to bottom and from right to left. There are no punctuation marks and no dividing paragraphs. All the characters are written without any gaps (Zhong *et al.*, 2009).

Nu Shu characters are thin and beautiful, appearing neat and well-balanced. There is a certain classical elegance in the Nu Shu script, which encompasses the style of xiao zhuan characters (the Official Script of Qin), as well as the forceful and vigorous style of inscriptions found on bones or tortoise shells.

Not only has the discovery of Nu Shu provided new material for philological research but it has also raised some important academic questions. Topics that would benefit from further study include the relationship between Nu Shu and the inscriptions on bones or tortoise shells, the association between Nu Shu and the ancient Yue ethnic group or the Miao and Yao ethnic groups and the relationship between Nu Shu and Chinese characters.

**Literary works value:** The literature in which Nu Shu characters are used comprises mainly conversations and songs, which take place in courtyards and are designed for self-recreation. Nu Shu is unique, not only because it

is only used by women but because it arose out of the experiences of a poorer group who have not had opportunities for formal education. Nu Shu is an emotive language, revealing the strong feelings of married women to the south of the Five Ridges and including descriptions of their social interactions, religious beliefs and folk customs. The growing academic and international recognition of Nu Shu has brought hope to women with hard and bitter lives.

**A crisis in the preservation of Nu Shu:** Since the 1980s, the value of Nu Shu has been increasingly recognized. However, preservation of Nu Shu has fallen short of both academic and local expectations. When Nu Shu was discovered, those with a comprehensive knowledge of Nu Shu, Gao Yinxian and her six “sworn” sisters, were still alive. Several years ago, however, with the demise at over 90 years of age of the last surviving member of this group, Yan Yihuan, many unsolved secrets in Nu Shu may remain hidden. When Hu Meiyue, one of Gao Yinxian’s granddaughters, was interviewed, she said that with the loss of this group of Nu Shu writers, fewer and fewer women can now read or write Nu Shu. With the lack of sufficient funding, manpower and organization, it is unclear how long the transmission of Nu Shu will continue.

## THE NU SHU’S INFORMATIONIZATION

In order to preserve the unique features of Nu Shu for future generations, the authors decided to create a computer program which will allow the inputting of Nu Shu characters. This will provide a way in which Nu Shu may be typed, printed and recorded digitally (Fig. 2).

In order to accomplish this, a character set for Nu Shu had to be created. An input method was then designed, so that Nu Shu can be used in computers. A website was then designed in which materials in the form of letters, pictures and videos could be posted and publicized. This will enable Nu Shu to be taught, as well as promoting communication between scholars and non-academic readers. In addition, virtual reality technology will be used to preserve important Nu Shu literature in the form of virtual steles. Through the website and virtual steles, the characters, pronunciation and songs in Nu Shu can be publicized.

**Creation of a Nu Shu character set:** In creating a Nu Shu character set, it was important that only genuine Nu Shu characters would be included. As most ancient books of Nu Shu have been lost with very few existing historical records, it has been difficult to conduct historical research

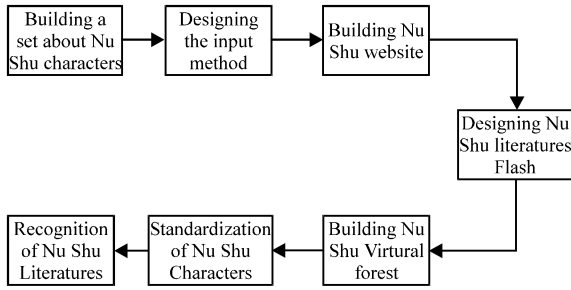


Fig. 2: The Nu shu informationization project

into Nu Shu. After much consideration, the following work was adopted as the source of our Nu Shu character set: the Chinese Nu Shu Dictionary, representing half a lifetime of effort by Professor Xie Zhimin (Fig. 3).

The compilation of the dictionary began with a glossary of Nu Shu characters in 1983 and was completed by the end of 2006. The material used includes the following:

- Professor Xie Zhimin’s own collection: 25 Nu Shu works dating from before 1983 and comprising 36,462 characters; Gao Yinxian’s copies of 390 ancient Nu Shu works, comprising 84,008 characters; Gao Yinxian’s 45 Nu Shu works, comprising 8,937 characters; Yi Lianhua’s copies of 117 ancient Nu Shu works, comprising 10,287 words; and Yi Lianhua’s 5 Nu Shu works, containing 5294 words. There are 582 ancient traditional Nu Shu works altogether, totally 144,988 characters
- China’s Nu Shu Collection (compiled by Zhao Liming, Zhonghua Book Company, 2005). The first volume consists of 62 anonymous Nu Shu works handed down from previous generations, with 35,000 characters; the second volume, Gao Yinxian’s 180 Nu Shu works, contains 62,000 words

After careful and extensive analysis of the above materials, Professor Xie selected 2,435 individual Nu Shu characters. The original appearance and structure of each character was retained, with its phonetic notation and meaning being provided by Gao Yinxian and Yi Lianhua. The source of each character was also clearly documented. This dictionary was sponsored by the General Administration of Press and Publication of the People’s Republic of China and is published by the Ethnic Publishing House (Luo, 2006).

In addition to the above, a set of handwritten Nu Shu characters was also required to serve as a templates for recording or reproduction. In order to preserve their original forms, reason, the granddaughter of Gao Yinxian,

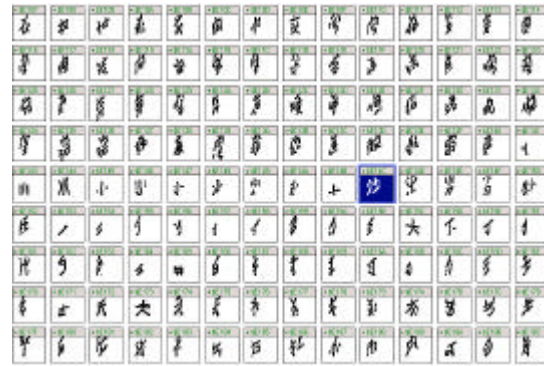


Fig. 3: The Nu Shu character set

Ms. Hu Meiyue, was invited to the South-Central Ethnic University to act as a research consultant for the project. Using the technique of writing Nu Shu that her grandmother Gao Yinxian had taught her, Ms Hu was able to write all 2,435 Nu Shu characters for us. Every single character was carefully examined by Professor Xie to ensure its accuracy.

**Designing an input method for Nu Shu:** An input method was required to display Nu Shu characters on a computer screen. The process of digitalization is essential to enable continued teaching, transmission and development of Nu Shu. Every character had to be individually designed and inputting would not depend on the installation of Chinese character sets.

The pronunciation of every character was also indicated using the International Phonetic Alphabet (IPA), based on the pronunciation of Gao Yinxian and Yi Lianhua. However, as the IPA is not commonly used in China, Professor Xie Zhimin had used IPA symbols together with Mandarin Chinese *pinyin*. We also decided to adopt this approach and “translated” the IPA symbols for the Nu Shu characters into Chinese pinyin using her comparison tables. An input method based on this “Nu Shu *pinyin*” was designed (Fig. 4).

However, as it may be difficult for users to become familiar with the pronunciation of more than 2,300 Nu Shu characters in order to use the *pinyin* input method, another input method based on individual components of each character was designed (Tian, 2010). This was similar to the Five-Stroke input method for Chinese characters (Fig. 5). Nu Shu characters were broken down into different components in accordance with certain rules. Inputting of these components in a specific order will enable display of complete Nu Shu characters. These two input methods were used to input more than 200 Nu Shu works, comprising more than 30,000 characters.

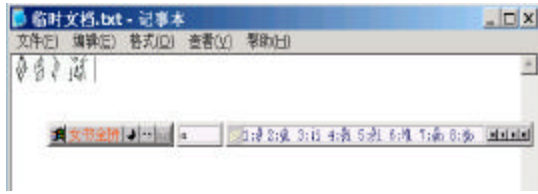


Fig. 4: The Nu Shu character set

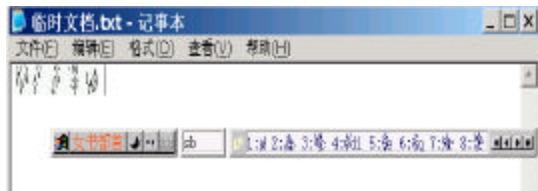


Fig. 5: Input method for Nu Shu based on individual components of the characters

**Construction of a Nu Shu website:** Although Professor Xie Zhimin had worked hard to introduce Nu Shu both within China and abroad for some 20 years, through academic papers, monographs, lectures and teaching, he was only able to reach a fairly small audience within certain geographical confines. With the growth of information technology, however, the internet has now become the best channel for dissemination of knowledge to users throughout the world.

Therefore, the Nu Shu character set and input method were used to create a Nu Shu website with a dynamic, interactive design (Fig. 6-7). The data used on this website comprises the following:

- 272 pieces of original Nu Shu texts, comprising about 90,000 characters. These represent the very essence of Nu Shu
- 51 pieces of recorded Nu Shu materials, comprising reading and singing files by Gao and Yi
- Other Nu Shu language data: over 10,000 vocabulary items, on 26 tapes
- Historical data concerning Nu Shu. These comprise 15 tapes of Jiangyong customs, 5 tapes relating to women's culture and other materials related to Nu Shu study, including family trees and tablet inscriptions
- More than 3000 cards of documents and materials related to Nu Shu study and original spoken language materials in locations such as Fuchuan, Jianghua and Jiangyong
- Local chronicles of the geographic area where Nu Shu is distributed



Fig. 6: The first page of Nu Shu Website



Fig. 7: One of the Picture Frames in the Nu Shu Literature Flash Scroll

**Recordings Nu Shu in virtual reality with a “Forest of Steles”:** Stone engravings and tablets have long been used to store information. This is exemplified by the Forest of Steles in Xi’an and the pictographs of the Mayans which were carved on stone tablets. Professor Xie Zhimin had hoped to select the 300 most representative texts in Nu Shu literature and engrave them on stone tablets in Nu Shu, Chinese and English, to be preserved as a permanent record. However, finances for this ambitious project would be difficult to obtain.

In recent years, virtual reality technology has become very popular, providing users with realistic experiences and enabling users to travel to remote places which would have been beyond their reach. An immersion virtual reality system uses audiovisual equipment or a helmet display device to enhance hearing and other sensory stimuli, producing an illusion that the user is actually in a fictitious environment rather than in the real world. The “Forest of Steles” of Nu Shu were realized in the Virtual

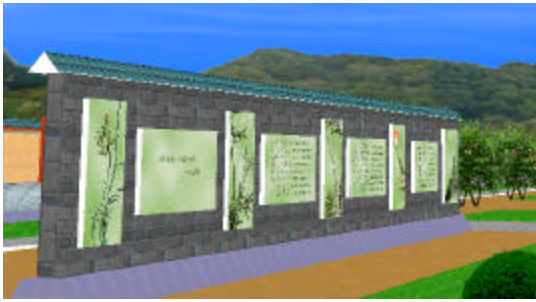


Fig. 8: The Forest of Steles of Nu Shu in Virtual Reality



Fig. 9: Online Handwritten Nu shu Recognition System

Reality Laboratory of the College of Computer Science, South-Central Ethnic University (Zhong *et al.*, 2009) (Fig. 8).

**Online handwritten Nu shu recognition system:** Using stroke features of Nu shu, an online handwritten recognition system of Nu shu is designed (Li and Wang, 2012, 2013; Wang and Zhu, 2010). This system recognizes the basic strokes of Nu shu first and then recognizes the whole Nu shu character through stroke feature coding and similarity (Fig 9). The distance calculating method can be seen in Eq. 1-3:

$$\max \text{str} = \max(\text{CharInputStrNum}, \text{DicCharStrNum}[i][m]) \quad (1)$$

$$\min \text{str} = \min(\text{CharInputStrNum}, \text{DicCharStrNum}[i][m]) \quad (2)$$

$$\text{distance}[i][m] = (\max \text{str} - \min \text{str}) + \sum_{j=0}^{\min \text{str}} (\text{fuzzy}[\text{InputChar}[j].\text{code} + \text{DicChar}[i][m][j].\text{code}] * \text{StrokeTypeNum}) \quad (3)$$

In the above formulas, ChasingputStrNum is the strokes number of a test sample, DicCharStrNum[i][m] is strokes of the No.m sample of No.i character in the stroke feature coding dictionary, InputChar[j].code is the type of No. j stroke of the test sample. DicChar[i][m][j].code is the No. j stroke of the No.m sample of No.i character in the stroke feature coding dictionary. StrokeTypeNum is the number of stroke's types.

Finally the min distance of all distances with all samples in the dictionary is used to output result, as Eq. 4 shows:

$$\min \text{distance} = \min_{i=0}^{\text{DicCharNum}} ( \min_{m=0}^{\text{DicCharNumNum}[i]} (\text{distance}[i][m]) ) \quad (4)$$

In Eq. 4, DicCharNum is the total number of samples in the dictionary and DicCharNumNum[i] is the number of No. i's samples.

## CONCLUSION

Nu Shu is one of the gems of Chinese culture. Protecting and propagating Nu Shu with information technology is an inter-disciplinary project involving linguistics, philology, ethnology, codes, statistics and computer skills. In this study, the information technology is used to protect and propagate Nu Shu. This Nu shu informationization project is divided into seven aspects, including Creating Nu Shu character set, designing the importing method for Nu Shu, developing Nu Shu website, designing Nu Shu Literature Flash, designing the forest of Steles of Nu Shu in Virtual Reality, the normalization of Nu Shu character and Nu Shu Literatures' OCR. The seven aspects are gradual with have different emphases: The former five aspects focus on using information technology protect and spread Nu Shu. The latter two aspects carry out scientific research by Nu Shu in the field of pattern recognition and artificial intelligence. Our goal is both to protect and develop the use of Nu Shu, a unique cultural heritage which is an integral part of Chinese culture.

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