A

REPORT TO THE ASIA FOUNDATION AND THE ROCKEFELLER BROTHERS FUND

ON

THE MACHINE TRANSLATION PROJECT

1975-1976

By

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Acknowledgements

The research in machine translation from Chinese to English carried out at the Chinese University of Hong Kong during the past years was made possible by a grant from The Asia Foundation and the Rockefeller Brothers Fund, to whom appreciation is expressed herewith for the generous financial assistance rendered.

Special thanks go to Mr. L.Z. Yuan of The Asia Foundation who has kept the machine translation project alive with not just words but deeds, and whose keen interest in all its aspects facilitated this study.

The publication of ACTA MATHEMATICA SINICA and the compilation of the Glossary of the Mathematical and Computing Sciences were greatly facilitated by the assistance of Dr. Tsou Siu-Tong, Dr. Wong Yau-Chuen and Dr. Ng Kung-Fu of the Mathematics Department, and I record my deep appreciation for all they did so willingly and graciously to ease my task.

Last but not least I wish to thank my two colleagues Dr. H.S. Hung and Mr. L. Kong for their time and unfailing co-operation in all aspects of the research.

Abstract

This report describes briefly the research efforts, covering a period of two years (1st January 1975 - 31 December 1976) in the machine translation from Chinese into English, carried out at the Computer Science Department of the Chinese University of Hong Kong, under a grant from The Asia Foundation and the Rockefeller Brothers Fund.

The primary objective of the project is to evaluate the capability and potential of the machine translation system, CULT, developed earlier. The successful translation and publication of ACTA MATHEMATICA SINICA and ACTA PHYSICA SINICA adequately demonstrated such ability. Appendix II gives a list of publications by the project including the translated mathematics and physics journals, and Appendix IV gives a list of regular subscribers to the translated journals.

Introduction

Machine translation research at the Chinese University of Hong Kong was initiated in late 1969, to study the possibility of automatic translation from Chinese into English by computer techniques, at a time when most of the machine translation research centres in Europe and the United States had just terminated their activities because of the limited progress made as well as lack of available funds. The APLAC report published in 1967 concluded positively that the success of the machine translation system seemed most unlikely to materialize in the near future and recommended that the federal funds should be directed to applied linguistics and computational linguistics rather than machine translation.

Having studied in detail the work done elsewhere in machine translation research particularly from Chinese into English (see Appendix V), we found that most of the proposed systems were based either on the model used by Georgetown University or the "Faculum" method suggested by Professor Paul Gavin. Both of these methods achieved limited success.

The method we adopted subsequently is a step-by-step approach: to study from the live data the types of sentence structure which are most used and easy to translate and program; those which are less used, but easy to translate; and those which are rarely used but difficult to translate and program. For the last category, pre-editing techniques were used, simply to convert these complicated structures into other manageable types.

A machine translation system called "CULT" (Chinese University Language Translator) was programmed in October 1972. A total of ten scientific papers, including one Biochemistry, one Physics and eight Mathematics, taken from KEXUE TONG BAO (科學通報) was successfully translated. The quality of the translation was commendable.

In June 1974, Professor James J. Wrenn of Brown University and Professor Elizabeth Barber of Occidental College were invited by The Asia Foundation to visit the machine translation project at the Chinese University and to attempt to assess it in terms of the soundness of the linguistic concepts on which the programs were based, the feasibility and technical soundness of various aspects of the project, and the specific limitations and promise of the CULT system.

In their report to The Asia Foundation, they concluded "the approach taken by CULT toward machine translation can be made quite useful, within its inherent limitation. It is not of a sort to make major breakthroughs in the field of machine translation, let alone of Chinese linguistics. But it is an excellent specimen of what it is; and if it is to be used, it should be used with both its strengths and limitations in mind".

In January 1975, the project was reactivated by a generous grant from The Asia Foundation (later the Rockefeller Brothers Fund) and the main aim is to test and evaluate the capability and potential of the CULT system, thus developed, by means of translating the Chinese mathematics and physics journals, ACTA MATHEMATICA SINICA and ACTA PHYSICA SINICA respectively. These journals are published by the Academy of Sciences, Peking.

The successful translation and subsequent publication of these journals demonstrate not only the capability of CULT to translate Chinese scientific text into readable English but also its potential which may be readily extended to other fields of interest and other languages.

The difficulties experienced in the translation of new mathematical terms in the translating texts made it necessary for the project to compile a more up-to-date glossary of mathematical and computing sciences. From it results the publication of the Glossary of the Mathematical and Computing Sciences, containing a feature which other similar glossaries lack - an index for easy reference.

Language Translator - CULT

During the past two years (1975-76) many improvements and modifications have been made to the language translator in order to improve the performance of the translator. The present translator is significantly different from the earlier version and requires practically no pre-editing procedures.

During the first year (1975), the project was mainly concerned with the evaluation and the testing of CULT by means of translating two Chinese scientific journals published by the Academy of Sciences, Peking, ACTA MATHEMATICA SINICA and ACTA PHYSICA SINICA respectively. The successful translation and eventual publication of these machine translated journals prove without doubt the capability of the language translator.

Though the translation of ACTA PHYSICA SINICA has since been suspended, the difficulties are mainly related to the unavailability of an up-to-date physics dictionary and our major efforts are concentrated on the compilation of a mathematical glossary in order to continue the publication of ACTA MATHEMATICA SINICA.

At the same time the translator has constantly been modified and up-dated with a view to reducing the pre-editing procedures.

In the second year (1976), having translated a number of mathematics and physics journals, our acquired knowledge and experience with the working of the translator as well as Chinese linguistics, made it possible for us to redesign the language translator, which is based on a single language model comprising all sentence structures we have so far encountered. The main objective is to reduce the pre-editing procedures to a bare minimum and the textual editing will merely be the adding of space(s) or line(s) indicators which are required for the insertion of mathematical symbols or equations and formulae.

Other Activities

Many activities, relating to machine translation research, were undertaken by the project. A few interesting ones are listed below:-

(1) A FEASIBILITY STUDY FOR IGCC AND ESCAP

The presentation of a paper entitled "Machine Translation: Past, Present and Future" by the author at the ESCAP Expert Group Meeting on the Translation of Population Materials in Bangkok in December 1975 created unusual interest among the delegates. At the end of the meeting, a resolution was passed unanimously recommending that pilot projects be conducted in several countries of the region in order to explore the possibility of utilizing machine translation for overcoming the language barrier and shortages of trained manpower.

A feasibility study of the pilot machine translation project was undertaken at the request of Dr. L.S. Sodhy, Secretary General of the Inter-Governmental Co-ordinating Committee Southeast Asia Regional Co-operation in Family & Population Planning (IGCC) and the Population Division of United Nations Economic and Social Commission for Asia and the Pacific (ESCAP).

A questionnaire dealing with the national languages concerned was sent out in late January and a programme of visits to various countries was carried out in June-July. Subsequently, a report was prepared by the author and published by ESCAP in October 1976.

The plan for implementation is being under active consideration by organizations concerned.

(2) COMPILATION OF A GLOSSARY OF THE MATHEMATICAL AND COMPUTING SCIENCES

The increasing difficulties experienced in translating ACTA MATHEMATICA SINICA have been the translation of new mathematical terms which have not been translated and cannot be found in mathematical and scientific dictionaries available. In order to continue the publication of ACTA MATHEMATICA SINICA, we have enlisted the assistance of our colleagues in the Mathematics and Computer Science Departments in compiling a new glossary.

A Glossary of the Mathematical and Computing Sciences has since been compiled by the project and is published in two separate versions, i.e. English-Chinese and Chinese-English. Each version of the glossary has a total of more than 30,000 terms including the basic vocabulary used in connexion with mathematics and computing science. For easy reference, an index is given at the end of the book.

(3) AUTOMATIC TRANSLATION OF ENGLISH INTO CHINESE

Some work has been done in the area. Because of the limited use of the computer facilities allocated to the project as well as the inavailability of a Chinese character printer, the work has since been suspended.

Figure 1 shows the Chinese translation, output by a plotter, of a short English text (Figure 2).

(4) TRANSLATION OF OTHER NATIONAL LANGUAGES

The feasibility study indicates the distinct possibility of using the CULT system for translating English into other national languages, such as Malay, Thai, Napeli, and Farsi, and vice versa.

Figure 1

在未來五至十年中　輸入和輸出中文或者其他非字母的機械或可會以合理的價錢供應　這是　目前　面對除那些使用字母外的語言處理的主要問題

更多適用于機器翻譯的語言學研究可能產生有用的結果　因而在語言之間的更多豐富的文法規則和句子結構可以有系統地組成

在中文大學　我們目前正在從事于設計將會能使我們翻譯中文至英文同時翻譯英文至中文的一個語言翻譯器　一個模擬研究已經進行且顯示出成功的可能性　我們希望　在幾個月內　一個模型可以設計來示範這個系統　如果成功我們認爲一個萬用翻譯器可以被設計因而我們僅需要一個翻譯器來進行在語言之間的翻譯

不要問電腦可以爲你做什么　問你自己　以電腦的幫助　可以爲人類的改進做什么

Figure 2

FUTURE

IN THE NEXT FIVE TO TEN YEARS, DEVICES MIGHT BE AVAILABLE AT A REASONABLE COST FOR INPUTTING AND OUTPUTTING CHINESE OR OTHER NON-ALPHABETIC CHARACTERS. THIS IS, AT PRESENT, THE PRINCIPAL PROBLEM FACING THE PROCESSING OF LANGUAGES OTHER THAN THOSE USING ALPHABETS.

MORE LINGUISTIC RESEARCH APPLICABLE TO MACHINE TRANSLATION MAY YIELD USEFUL RESULTS SO THAT MORE COMPREHENSIVE GRAMMATICAL RULES AND SENTENCE STRUCTURES BETWEEN LANGUAGES CAN BE FORMULATED.

AT THE CHINESE UNIVERSITY, WE ARE AT THE PRESENT WORKING ON A LANGUAGE TRANSLATOR WHICH WILL ENABLE US TO TRANSLATE CHINESE INTO ENGLISH AS WELL AS TO TRANSLATE ENGLISH INTO CHINESE. A SIMULATION STUDY HAS BEEN DONE WHICH INDICATES THE POSSIBILITY OF SUCCESS. WE ARE HOPING THAT, IN A FEW MONTHS, A MODEL MAY BE DESIGNED TO DEMONSTRATE THE SYSTEM. IF IT IS SUCCESSFUL, WE ARE OF THE OPINION THAT A UNIVERSAL TRANSLATOR MAY BE DESIGNED SO THAT ONLY ONE TRANSLATOR WILL BE REQUIRED TO DO TRANSLATION BETWEEN LANGUAGES.

" ASK NOT WHAT THE COMPUTER CAN DO FOR YOU. ASK WHAT YOU, WITH THE AID OF THE COMPUTER, CAN DO FOR THE BETTERMENT OF THE MANKIND. "

Remarks

Though the machine translation research was initiated at The Chinese University of Hong Kong more than seven years ago, at a time when other people had already abandoned the hope in the future of such research, the present language translator, the result of many years' research efforts, has demonstrated its capability and potential. The continuous publication of our machine-translated mathematical journal ACTA MATHEMATICA SINICA for the past two years and increasing subscriptions received from the leading university libraries and institutes around the world have indicated positively that the quality of our machine-translated texts is not only acceptable but also highly satisfactory.

Our success in the research of the present language translator and in the continuous publication of the machine-translated journals has undoubtedly contributed, in some small way, to the recent renewal of activities in machine translation research elsewhere.

The present language translator, if used with care and understanding may, together with other means, go a long way in overcoming the language barrier and shortages of trained manpower.

APPENDIX I

Personnel

During the period covered by this report the following have worked on the project.

Professor LOH Shiu-Chang		
Dr. HUNG Hing-Sum	Ph.D. (Wisconsin)	Computer Science
KONG Luan	B.Sc. (London)	Computer Science
LI Kin-Keung, Dennis	B.Sc. (Hong Kong) (1.1.75-31.7.76)	Mechanical Engineering
*CHAN LEUNG Po-Tin	(1.1.75-1.9.76)	
*CHIANG Ching-Ching	B.A. (SUNY, Platts.) (1.1.75-1.9.76)	Mathematics
*CHAN Yim-Fat	B.Sc (Ling Nam) (1.3.75-1.10.76)	Physics
*YU Kim-Choi	B.Sc. (CUHK)	Mathematics
*FUNG Shek-Kong	B.Sc. (Jong-Shan) (1.7.75-31.12.75)	Mathematics
*CHAN LAM Yuk-Ling		
*LI LIN Shu-Man	B.Sc. (Taiwan) (1.2.75-31.12.75)	Entomology
*CHOW TSANG Lai-Wah		
*LEUNG Yuk-Chu		
*CHU So-Chun		
*TU Yuan-Haw, Joseph	B.Sc.E. (New Brunswick) (1.1.75-31.3-75)	Electrical Engineering
*CHOW Kin-Hong, Donald	B.Sc. (Chiau-Tung) (1.1.75-6.6.75)	Electrical Engineering

*Research assistants paid by the grant from The Asia Foundation and the Rockefeller Brothers Fund.

APPENDIX II

Publications

(1) MATHEMATICS

ACTA MATHEMATICA SINICA	Volume 17	No. 1	March 1974
數學學報		No. 2	June 1974
		No. 3	September 1974
		No. 4	December 1974
	Volume 18	No. 1	March 1975
		No. 2	June 1975
		No. 3	September 1975
		No. 4	December 1975
	Volume 19	No. 1	March 1976
		No. 2	June 1976

(2) PHYSICS

ACTA PHYSICA SINICA	Volume 24	No. 1	March 1975
物理學報		No. 2	June 1975

(3) BOOK

電腦翻譯 (MACHINE TRANSLATION) 樂秀章 林明岳 周乾康 江鑾 著

(4) DICTIONARY

(a) A GLOSSARY OF THE MATHEMATICAL AND COMPUTING SCIENCES (ENGLISH-CHINESE)

(b) A GLOSSARY OF THE MATHEMATICAL AND COMPUTING SCIENCES (CHINESE-ENGLISH)

COMPILED BY LOH SHIU-CHANG, HUNG HING-SUM, KONG LUAN, WONG YAU-CHUEN AND NG KUNG-FU

(5) REPORTS

(a)	"Translation of Chinese Scientific Text into English by Computer"	August 1972
(b)	"Final Report on Machine Translation"	February 1973
(c)	CULT	
(d)	Machine Translation Progress Report	1971
(e)	Machine Translation Progress Report	1972 (2 Vols.)
(f)	Machine Translation Progress Report	1973 (2 Vols)
(g)	Annual Report on Machine Translation	1975
(h)	"A Report to United Nations Economics and Social Commission for Asia and The Pacific and the Inter-Governmental Co-ordinating Committee Southeast Asia Regional Co-operation in Family & Population Planning on the Feasibilities Studies of the Pilot Machine Translation Project"	August 1976

APPENDIX III

International Conferences

(a) "MACHINE TRANSLATION"

Presented at the CETA meeting held in March 1972 in Washington D.C.
Published in Proceedings of CETA Workshop on Chinese Language and Chinese Research Materials July 1972

(b) "MACHINE TRANSLATION: PAST, PRESENT AND FUTURE"

Presented at the Group Expert Meeting (ESCAP) in December 1975
Published in the Report of Economic and Social Commission for Asia and The Pacific United Nations in April 1976
Also published in the Bulletin of the Association for Literary and Linguistic Computing March 1976

(c) "CULT (Chinese University Language Translator)"

Presented at the FBIS Conference in Washington D.C. March 1976 (paper read by Mr. James Mathias of CETA)
Published in American Journal of Computional Linguistics

(d) "COMPUTER TRANSLATION OF CHINESE SCIENTIFIC JOURNALS"

To be presented at the Third European Congress on Information Systems and Networks "Overcoming the Language Barrier" Luxemburg, 3-6 May 1977

APPENDIX IV

List of Subscribers to ACTA MATHEMATICA SINICA

U.S.A. & CANADA

1. Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico, U.S.A.
2. Wesleyan University Library, Middletown, Connecticut, U.S.A.
3. The General Library, University of California, Berkeley, California, U.S.A.
4. University of Houston Libraries, Houston, Texas, U.S.A.
5. University of California Library, Irvine, California, U.S.A.
6. Bibliotheques-Periodiques, Universite de Montreal, CANADA
7. University of Kentucky Library, Lexington, Kentucky, U.S.A.
8. Library, The University of Alberta, Edmonton, Alberta, CANADA
9. University of Hawaii Library, Honolulu, Hawaii, U.S.A.
10. Michigan State University Libraries, Michigan, U.S.A.
11. Cornell University Library, Ithaca, N.Y. U.S.A.
12. Mr. R.L. Graham, Bell Laboratories, Murray Hill, New jersey, U.S.A.
13. Stanford University Library, Stanford, California, U.S.A.
14. Library, University of Illinois, Urbana, Illinois, U.S.A.
15. Library, University of British Columbia, Vancouver, CANADA
16. Cabot Science Library, Cambridge, Mass., U.S.A.

EUROPE

1. Periodicals Department, University College of Swansea, Swansea, U.K.
2. University of Trondheim, Norwegian Institute of Technology, The Library, Trondheim, Norway
3. Mr. S.I. The, Chief Librarian, Library, Mathematisch Centrum, Amsterdam, The Netherlands
4. Mathematisches Institut, Universitat Graz, Graz, Austria
5. Bibliotheek, Technische Hogeschool Twente, Enschede, The Netherlands
6. Bibl. du Dept de Mathematiques Pures., Bat M.2. - Cite Scientifique d'Annappes, Villeneuve D'Acsq, France
7. Mathematics Dept., University of Erlangen, Erlangen, Federal Republic of Germany
8. Mathematisches Institut, Universitat Zurich, Zurich, Switzerland
9. Scientific Periodicals Library, Cambridge, U.K.
10. The British Library, Lending Division, West Yorkshire, U.K.
11. ULP. Dept de Maht de Strasbourg 1. Bibl. Strasbourg Cedex, France
12. Fachbereich Mathematik, Der Philipps-Universitat, Lahnberge, Bibliothek, Federal Republic of Germany

OTHERS

1. Periodicals Section, CSIR Library, Pretoria, South Africa
2. CSIRO, Central Library, East Melbourne, Vic., Australia
3. The Library, The University of Jordan, Amman, Jordan
4. The Library, University of Canterbury, New Zealand
5. Professor J.O.C. Ezeilo, Dept. of Mathematics, University of Nigeria, Nsukka, Nigeria
6. Instituto de Matematica-Library, Universidade Federal do Rio de Janeiro, Brazil
7. Kurukshetra University Library, Kurukshetra, India
8. The University of Nigeria, Nsukka, Nigeria
9. The Librarian, Tata Institute of Fundamental Research, Bombay, India
10. Central Library, Arya-Mehr, University of Technology, Tehran, Iran
11. Rigakubu Toshoshitsu, Hokkaido Daigaku, Sapporo Japan
12. Periodicals Department, University of South Africa, Pretoria, South Africa

APPENDIX V

Biblography on Machine Translation Involving Chinese

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