King-Sun Fu
(1930–1985)
King-Sun Fu (1930–1985): A Biography

Professor King-Sun Fu, an eminent scholar and a pioneer in the field of pattern recognition and machine intelligence, passed away on April 29, 1985, in Washington, DC, while attending a banquet given by the National Academy of Engineering to honor the directors of the six engineering research centers newly established by the National Science Foundation. At the time of his death, Professor Fu was the Goss Distinguished Professor of Engineering and the Founding Director of the Engineering Research Center on Intelligent Manufacturing Systems at Purdue University, West Lafayette, Indiana. His sudden death is an irreparable loss to the scientific community and to all of us who have known him as a great friend, extraordinary teacher, and an inspiring colleague.

King-Sun was born on October 2, 1930, in the city of Nanking, one of China's historical capitals. His father, Tzao-Jen Fu, was a general in the Chinese Army. King-Sun had one elder brother, Tse-Sun, and two younger brothers, Run-Sun and Yuen-Sun. He pursued his middle school education at the Chinese Air Force Youth Preparatory School. After his father died on duty during the war in 1949, his mother, Tzao-Wen Hsiang Fu, took him and two younger brothers to Taiwan. In the Fall of 1949, King-Sun succeeded in overcoming the hardships imposed by the dramatic move and matriculated in the National Taiwan University where he began to set the pace of an academic life in which he was to excel over the next 36 years. At the time of King-Sun's enrollment, the University's Electrical Engineering Department offered two paths for students to follow: electric power engineering and communication engineering. King-Sun chose the power engineering option. He and Mo-Shing Chen (IEEE Fellow, 1978) did their joint B.S. thesis on electrical machinery. In retrospect against his later achievements, it is hardly surprising that King-Sun was one of the top students in the college. Not only did he excel in mathematics and engineering subjects, but he also cultivated interests in classical music and literature. Perhaps the latter pursuit laid the foundation for his own prolific writing in serial journals and scientific books. His writing was distinct: clearly expressive and succinct. The demands of academia did not serve to stifle his personal exuberance and vitality in life, however, and, in finding a balance to his studies, King-Sun was also active on the basketball and volleyball teams in the school. He was indeed a versatile student on the campus.

After graduating from the National Taiwan University with a B.S.E.E. degree in 1953 and completing one year of ROTC training, King-Sun received a graduate assistantship from the Electrical Engineering Department of the University of Toronto, Canada, and went there in September 1954 to start his graduate study. He wrote his master's degree thesis on dynamic analysis of large electric machines and received the M.A.Sc. degree in the summer of 1955. In September 1955, he transferred to the University of Illinois, Urbana, for his doctoral study and completed his Ph.D. dissertation on "An Approximation Method for Both Magnitude and Phase by Rational Functions" in February 1959 under Professor M.E. Van Valkenburg, who is currently the Dean of Engineering at the University of Illinois, Urbana-Champaign.

During his three and a half-year's stay at the University of Illinois, King-Sun became immensely interested in statistical methods, information theory, abstract algebra, and modern analysis. Attracted by the noted mathematical treatise written by N. Bourbaki (the pseudonym of a group of renowned French mathematicians), he confided to his close friends that he intended to gather together a group of scholars and follow the example of Bourbaki in writing similar treatises in electrical engineering subjects in future years. This desire to produce important scientific tracts became manifest through King-Sun's authorship of five books and his editorship or co-editorship of eighteen others during his lifetime. On the Urbana campus, King-Sun fell in love with Miss Viola Ou, then a graduate student in library science. They were married in Urbana, Illinois, on April 7, 1958.

After receiving the Ph.D. degree from the University of Illinois in 1959, King-Sun worked for a year and a half as a Research Engineer at Boeing Airplane Company, Seattle, Washington, from February 1959 to August 1960. During the Spring Semester of 1960, he also taught as a Special Lecturer at Seattle University, Seattle, Washington. In September 1960, he accepted a faculty position at Purdue University, West Lafayette, Indiana, as an Assistant Professor in the School of Electrical Engineering. The following semester, he was selected by Purdue to be a Visiting Scientist with the Research Laboratory of Electronics at Massachusetts Institute of Technology, Cambridge, from February to June, 1961. During the Summer of 1961, he was with the IBM Thomas J. Watson Research Center, Yorktown Heights, New York. After returning to Purdue University in September 1961, he began to pursue his research in pattern recognition and machine intelligence—a field which he played a prominent role in developing during the next quarter of a century. He became an Associate Professor in September 1963, and was promoted to the rank of Professor of Electrical Engineering in September 1966. In 1967, he was a Visiting Professor of Electrical Engineering and Computer Science at the University of California, Berkeley. He was the Assistant Head for research at the School of Electrical Engineering at Purdue from 1969 to 1972. In 1972, he was awarded a prestigious Guggenheim Fellowship, and was a Visiting Professor of Electrical Engineering both at Stanford University, Stanford, California and the University of California, Berkeley. After returning to Purdue, he established the Advanced Automation Research Laboratory in the School. He was named the Goss Distinguished Professor of Engineering at Purdue University in 1975. During the Fall of 1984, he, along with other colleagues
at Purdue, initiated the highly innovative program of research in intelligent manufacturing. This program resulted in the start-up of the National Science Foundation Engineering Research Center for Intelligent Manufacturing Systems during early 1985. King-Sun was the founding director of the Center.

During the earlier years he first focused his study on statistical pattern recognition and learning systems. From 1961 to 1970, he and his students developed sequential methods for feature selection and pattern recognition, nonparametric procedure for pattern classification, stochastic approximation approach to learning control systems, and stochastic and learning automata. His first research monograph entitled *Sequential Methods in Pattern Recognition and Machine Learning* (New York: Academic) was published in 1970. By the late 1960's, he began his unique research on syntactic pattern recognition, which was introduced by the earlier efforts of Murray Eden, R. Narasimhan, R. A. Kirsch, Robert S. Ledley and Alan Shaw. King-Sun initiated and launched in-depth studies on stochastic context-free programmed languages and stochastic syntax analysis for pattern recognition and image analysis.

His book *Syntactic Methods in Pattern Recognition* (New York: Academic) was published in 1974. In the ensuing years, he and his students made the greatest and foremost impact on syntactic pattern recognition research. His school developed fundamental methodologies of stochastic error-correcting syntax analysis, error-correcting parsers for formal languages, and, in particular, for attributed and stochastic tree grammars, and error-correcting isomorphisms of attributed relational graphs for pattern recognition. The syntactic methods for texture analysis, shape recognition, and image modeling were introduced in the late 1970's, and the three-dimensional plex grammar in 1984. Attributed grammars were developed from the viewpoint of combining syntactic and statistical pattern recognition. In the meantime, the contextual information was also introduced into statistical pattern recognition. The unification of both syntactic and statistical approaches was always in his thoughts. Inference procedures of context-free programmed grammars, multidimensional grammars, transition network grammars, and stochastic tree grammars were developed one after another in the late 1970's and early 1980's. It is probably appropriate to say that all these constitute what we may call Fu's theory of syntactic pattern recognition. His treatise "Syntactic Pattern Recognition and Applications," published in 1982, made this subject material more easily understandable to contemporary researchers in various disciplines.

King-Sun and his colleagues also made important contributions to pattern recognition applications. His work on pattern classification of remotely sensed agriculture data (1969) and earth resources (1976) is considered classic in the field. During the mid 1970's through early 1980's, his biomedical pattern recognition research extended to chest radiographic image analysis, automatic recognition of irradiated chromosomes, nucleated blood cell classification, Pap smear and cervical cell image analysis and classification. The Moayer–Fu paper on fingerprint pattern recognition based on the syntactic approach received the 1977 Outstanding Paper Award of the IEEE Computer Society. His work on seismic signal discrimination and bright spots detection appeared from 1982 to 1985. His research on industrial automatic inspection and compute vision included IC chip inspection (1980), metal surface inspection (1984), and inspection of industrial assemble (1984). An expert system was developed by his group for the assessment of structure damage caused by earthquake (1983).

Since the late 1970's, he envisioned the importance of integrated and special computer architectures and parallel algorithms for pattern recognition, image processing, and database management. This led to his works in the 1980's on parallel parsing of tree languages, query languages for image database systems, and VLSI implementation of parallel parsing algorithms and hierarchical scene matching. In the meantime, his research on three-dimensional object representation and shape description, orientation estimation, overlapping workpiece identification, knowledge organization, and robotic vision for path planning laid the foundation for the establishment of the Engineering Research Center on Intelligent Manufacturing Systems by Purdue University and the National Science Foundation in 1985. As mentioned earlier, King-Sun was the chief architect and the first director of the research center.

He wrote 5 books, edited or co-edited 18 books, authored or coauthored 43 book chapters, and 156 serial journal papers. These are listed in the Biography at the end of this Biography. In addition, he authored and coauthored 248 conference papers. Seventy-two Ph.D. dissertations were completed under his supervision; these are also listed at the end of this Biography. Naturally, his research works were supported by a number of funding agencies including the National Science Foundation, Air Force Office of Scientific Research, Office of Naval Research, the Defense Advanced Research Projects Agency Department of Agriculture, etc. Particularly worth mentioning is that he had received National Science Foundation research grants continuously without any interruption since his first grant in 1961. We know that he was deeply appreciative of this special honor and privilege.

Of course, King-Sun was literally showered with honor in recognition of his monumental research contributions and contributions to the profession. He was elected a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) in 1971. He was elected a member of the National Academy of Engineering in 1976, and a member of the Academia Sinica in 1978. He served on the National Science Foundation's Advanced Automation Panel in 1973, Automation Research Council for 1972–1978, and Committee on Cytology Automation of the National Institutes of Health, 1978–1981. He was a Member of the Engineering Committee of the Council for the International Exchange of Scholars from 1976 to 1979, and served as its Chairman from 1977 to 1979. Among many awards which he received are the Herbert N. McCoy Award in 1976 for Contributions to Science; American Society of Engineering Education (ASEE) Senior Re-
search Award in 1981 for outstanding loyalty and contributions as a pioneer in the contemporary engineering disciplines of pattern recognition, image processing, and machine intelligence; IEEE Education Medal in 1982 for contributions to engineering education through inspired teaching and research in computer engineering, system theory, and pattern recognition; American Federation of Information Processing Societies (AFIPS) Harry Goode Memorial Award in 1982 in recognition of his contributions in pattern recognition and its applications, and his leadership in education in information processing; Chinese Institute of Engineers-USA (CIE-USA) Achievement Award in 1983 for leadership in engineering education and contribution to pattern recognition; and the IEEE Centennial Medal in 1984.


In order to provide an international forum to promote advances in pattern recognition, he and the contemporary leaders in the field organized the First International Conference on Pattern Recognition in Washington, DC, in 1973, for which he served as Chairman. The biannual conferences evolved into the formation of the International Association for Pattern Recognition by 1976; he was elected to be its President from 1976–1978, a Member of its Executive Committee (1976–1980), Chairman of its Long Range Planning Committee (1979–1981), and a Member of its Governing Board (1976–1985). In the meantime, he reorganized the Pattern Recognition Committee into the Machine Intelligence and Pattern Analysis Technical Committee (later renamed as the Pattern Analysis and Machine Intelligence Technical Committee) of the IEEE Computer Society and was its first Chairman (1974–1977). He was an Associate Editor of IEEE Transactions on Computers during 1977–1978. His initiative led to the founding of the IEEE Transactions on Pattern Analysis and Machine Intelligence and he served as its first Editor-in-Chief (1978–1981) as well as a Member of the Editorial Committee (1981–1985). He also served as an Associate Editor of the IEEE Transactions on Geoscience and Remote Sensing (1984–1985). He was on the IEEE Computer Society Governing Board (1978–1981), and served as the Society’s Vice President for Publications and as a Member of the Executive Committee (1982–1983) and Fellow Committee (1972–1976, 1984–1985). He served as the President of the Chinese Language Computer Society (1983–1985). He was the Vice President (1984–1985) and President-elect of the newly formed IEEE Robotics and Automation Council. He was on the IEEE Fellow Committee (1977–1979), IEEE TAB Awards and Recognition Committee (1977–1978), AFIPS Harry Goode Memorial Award Committee Chairman (1982–1985), ASEE Award Committee (1983–1985), and IEEE Award Board, Education Medal Committee (1983–1985).


King-Sun helped the Republic of China with his scientific advice in various ways. Over the past fifteen years, he gave invited lectures there almost every year. He was the Program Chairman of the Academia Sinica International Computer Symposium, Taipei in 1978. He helped found the Institute of Information Science, Academia Sinica, and was instrumental in establishing the Microelectronics and Information Science and Technology Research Center at the National Chiao Tung University, Taiwan, in 1984. He nurtured a number of young scholars who have become the principal researchers and engineers for the vital development of computer engineering and information science in Taiwan. Likewise, he educated scholars from the People's Republic of China; he was honored as a Distinguished Visiting Professor of Beijing University, an Honorary Professor of Qinghua University, Beijing, and an Honorary Professor of Fudan University, Shanghai.

Because of an extraordinary sense of efficiency and organization in his professional life, King-Sun was proud to enjoy successes in both his career and his family life. He took great pride in his two sons, Francis and Thomas, and one daughter, June. When they were young, he always spent his leisure time playing ball or other sports with them. Together with Viola, he provided their children with the best education in the home and at school; Francis is now a computer systems engineer; Thomas, a doctoral student in oceanography; and June, a student in biochemistry. Reflecting the highest traditions of his Chinese heritage, King-Sun felt great piety for his parents. His mother was happy to share the joy of his early success until her passing away in Taiwan in 1958. He never forgot to pay special tribute to the memory of his father, who had been buried amidst the chaos of war in Chowsan, Chekiang, China in 1949. In 1979 when King-Sun was invited to give lectures to the Institute of Automation, Chinese Academy of Sciences, he made a special effort to locate his father's grave and have his father's remains reinterred in the Fu family's native city, the scenic Hangchow, Chekiang, after thirty years.

In spite of his overwhelming achievements, King-Sun was a modest man with great sensitivity, especially in dealing with junior colleagues. Considerate and generous to his friends and students, he exemplified the notion of greatness both professionally and in his personal relationship with others. Anyone could literally knock on his door and talk to him. It was not uncommon to see him advising a doctoral student at 10:00 p.m. in his office. He, of course, worked long hours—an eighty-hour week was the norm. As his colleagues at Purdue University have remarked, King-Sun inspired trust and confidence in many persons of all types of temperament. He had a deep appreciation of human nature and its complexities, the flexibility in reconciling and synthesizing different opinions, and the ability of extracting out essentials of a complex problem. His foresight in choosing research areas and forecasting their developments was nothing short of amazing. Standing alongside his outstanding contributions to the scientific world, King-Sun's great wisdom and human warmth will always be remembered as a constant inspiration to all of us.

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CHING-CHUNG LI
Univ. Pittsburgh
Pittsburgh, PA 15261

R. L. KASHYAP
School Elec. Eng.
Purdue Univ.
West Lafayette, IN 47907

THEODOROS PAVLIDIS,
Editor-in-Chief
AT&T Bell Laboratories
Murray Hill, NJ 07974
A Bibliography of Published Works of the Late Professor King-Sun Fu

A. Books Authored or Coauthored


B. Books Edited or Co-Edited


C. Book Chapters


[15] K. S. Fu, "Learning with stochastic automata and stochas-


D. Serial Journal Articles


# Ph.D. Dissertations Supervised by the Late Professor King-Sun Fu at Purdue University

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Dissertation Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kline, Raymond M.</td>
<td>August 1962</td>
<td>Analysis and Design of Digital Control Systems</td>
</tr>
<tr>
<td>Lopresti, Philip V.</td>
<td>August 1963</td>
<td>On the Control of Discrete Random Parameter Systems</td>
</tr>
<tr>
<td>Waltz, Marion D.</td>
<td>August 1964</td>
<td>A Study of Learning Control Systems Using a Reinforcement Technique</td>
</tr>
<tr>
<td>Lebo, Jerry A.</td>
<td>January 1965</td>
<td>On the Selection of Decision Criteria and the Estimation of Probabilities in Pattern Recognition</td>
</tr>
<tr>
<td>Knoop, Donald E.</td>
<td>January 1965</td>
<td>An Adaptive Model of the Human Operator in a Control System</td>
</tr>
<tr>
<td>Hill, Jack D.</td>
<td>January 1965</td>
<td>An On-line Learning Control System Using Modified Search Techniques</td>
</tr>
<tr>
<td>McMurtry, George J.</td>
<td>January 1965</td>
<td>A Study of Stochastic Automata as Models of Adaptive and Learning Controllers</td>
</tr>
<tr>
<td>Chen, Chi H.</td>
<td>June 1965</td>
<td>A Study of Pattern Recognition Systems with a Sequential Learning Procedure</td>
</tr>
<tr>
<td>Maurer, Harold E.</td>
<td>August 1965</td>
<td>An Approach to the Design of Reliable Radiation Hardened Integrated Logic and Sequential Circuits</td>
</tr>
<tr>
<td>Kirvaitis, Kestutis</td>
<td>August 1965</td>
<td>Identification of Nonlinear Systems by Stochastic Approximation</td>
</tr>
<tr>
<td>McLaren, Robert W.</td>
<td>January 1966</td>
<td>An Application of Stochastic Automata to the Synthesis of Learning Systems</td>
</tr>
<tr>
<td>Brockman, William H.</td>
<td>January 1966</td>
<td>A Stimulus Conditioning Learning Model and Its Application to Pattern Recognition</td>
</tr>
<tr>
<td>Nikolic, Zivorad J.</td>
<td>January 1967</td>
<td>A Study of Learning Systems Operating in Unknown Stationary Environments</td>
</tr>
<tr>
<td>Wee, William G.</td>
<td>August 1967</td>
<td>On Generalizations of Adaptive Algorithm and Applications of the Fuzzy Sets Concept to Pattern Classification</td>
</tr>
<tr>
<td>Mow, William C.</td>
<td>August 1967</td>
<td>Analysis and Synthesis of Multi-Threshold Threshold Logic</td>
</tr>
<tr>
<td>Cardillo, Gerald P.</td>
<td>August 1967</td>
<td>Optimum Finite Sequential Pattern Recognition</td>
</tr>
<tr>
<td>Lemke, Ronald R.</td>
<td>June 1968</td>
<td>On the Applications of the Potential Function Method to Pattern Recognition and System Identification</td>
</tr>
<tr>
<td>Min, Pyung J.</td>
<td>February 1969</td>
<td>On Feature Selection in Multi-Class Pattern Recognition</td>
</tr>
<tr>
<td>Jones, III, Lloyd E.</td>
<td>February 1969</td>
<td>A Learning Control Systems—Design Considerations</td>
</tr>
<tr>
<td>Henrichon, Ernest G.</td>
<td>February 1969</td>
<td>On Nonparametric Methods for Pattern Recognition</td>
</tr>
<tr>
<td>Ackerson, Guy A.</td>
<td>February 1969</td>
<td>Control and Estimation in Markov Switching Environments</td>
</tr>
<tr>
<td>Li, Timothy J.</td>
<td>August 1969</td>
<td>Automata Games, Stochastic Automata and Formal Languages</td>
</tr>
<tr>
<td>Swain, Philip H.</td>
<td>June 1970</td>
<td>Nonparametric and Linguistic Approaches to Pattern Recognition</td>
</tr>
<tr>
<td>Gilstad, Dennis W.</td>
<td>June 1970</td>
<td>A Two-Dimensional Adaptive Model of a Human Operator in a Time Varying Control System</td>
</tr>
<tr>
<td>Cockrell, Larry D.</td>
<td>June 1970</td>
<td>On Search Techniques in Adaptive Systems</td>
</tr>
<tr>
<td>McFerran, James B.</td>
<td>August 1970</td>
<td>Feature Extraction in Pattern Recognition</td>
</tr>
<tr>
<td>Northhouse, Richard A.</td>
<td>February 1972</td>
<td>Dynamic Scheduling of Large Digital Computer Systems Using Adaptive Control and Clustering Techniques</td>
</tr>
<tr>
<td>Lowe, Murray H.</td>
<td>June 1972</td>
<td>Computer-Aided Medical Diagnosis Using Sequential Pattern Recognition Techniques</td>
</tr>
<tr>
<td>Huang, Teddy</td>
<td>February 1972</td>
<td>Stochastic Languages and Their Applications to Pattern Recognition</td>
</tr>
<tr>
<td>Name</td>
<td>Date</td>
<td>Dissertation Title</td>
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<tr>
<td>Lee, Harry C.</td>
<td>June 1972</td>
<td>Stochastic Linguistics for Picture Recognition</td>
</tr>
<tr>
<td>Chen, Zen</td>
<td>August 1973</td>
<td>Nonparametric Methods for Nonsupervised and Supervised Pattern Recognition</td>
</tr>
<tr>
<td>Lissack, Tsvi</td>
<td>August 1973</td>
<td>Error Estimation and Its Application to Feature Extraction in Pattern Recognition</td>
</tr>
<tr>
<td>Robertson, Thomas V.</td>
<td>August 1973</td>
<td>Multispectral Image Partitioning</td>
</tr>
<tr>
<td>Su, Lo-Soun</td>
<td>December 1973</td>
<td>Automatic Speaker Identification Using Nasal Spectra and Nasal Coarticulation as Acoustic Clues</td>
</tr>
<tr>
<td>Bhargava, B. K.</td>
<td>May 1974</td>
<td>Tree Systems for Syntactic Pattern Recognition</td>
</tr>
<tr>
<td>Chien, Y. P.</td>
<td>May 1974</td>
<td>Preprocessing and Feature Extraction of Picture Patterns</td>
</tr>
<tr>
<td>Persoon, Eric</td>
<td>May 1974</td>
<td>Sequential Decision Procedures with Prespecified Error Probabilities and Their Applications</td>
</tr>
<tr>
<td>Moayer, B.</td>
<td>December 1974</td>
<td>Syntactic Pattern Recognition of Fingerprints</td>
</tr>
<tr>
<td>Fung, L. W.</td>
<td>December 1974</td>
<td>Syntactic Decoding for Computer Communication and Pattern Recognition</td>
</tr>
<tr>
<td>Chou, S. M.</td>
<td>December 1975</td>
<td>Transition Networks for Pattern Recognition</td>
</tr>
<tr>
<td>Sargent, D. C.</td>
<td>December 1975</td>
<td>Computer Algorithms for the Extraction and Applications of Stress Contours from Continuous Speech Sentences</td>
</tr>
<tr>
<td>Brayer, J. M.</td>
<td>December 1975</td>
<td>Web Grammars and Their Applications to Pattern Recognition</td>
</tr>
<tr>
<td>Fordon, W. A.</td>
<td>August 1976</td>
<td>Computer-Aided Differential Diagnosis of Hypertension</td>
</tr>
<tr>
<td>Lu, S. Y.</td>
<td>August 1977</td>
<td>Error-Correcting Syntax Analysis for Syntactic Pattern Recognition</td>
</tr>
<tr>
<td>Keng, Janmin</td>
<td>December 1977</td>
<td>Syntactic Algorithms for Image Segmentation and a Special Computer Architecture for Image Processing</td>
</tr>
<tr>
<td>Yu, T. S.</td>
<td>May 1978</td>
<td>Statistical Pattern Recognition Using Contextual Information</td>
</tr>
<tr>
<td>You, K. C.</td>
<td>August 1978</td>
<td>Syntactic Shape Recognition Using Attributed Grammars</td>
</tr>
<tr>
<td>Chang, Jo-Mei</td>
<td>December 1978</td>
<td>Dynamic Clustering Techniques for Physical Database Design</td>
</tr>
<tr>
<td>Tsai, W. H.</td>
<td>December 1979</td>
<td>Recognition of Patterns with Syntactic and Semantic Deformations</td>
</tr>
<tr>
<td>Chang, N. S.</td>
<td>May 1980</td>
<td>An Integrated Image Analysis and Image Database Management System</td>
</tr>
<tr>
<td>Lin, Jack Y. K.</td>
<td>December 1980</td>
<td>An Application of Pattern Recognition Techniques to Pap Smear Inspection</td>
</tr>
<tr>
<td>Fan, T. I.</td>
<td>May 1981</td>
<td>A Syntactic Method for Time-Varying Pattern Analysis</td>
</tr>
<tr>
<td>Yen, W. C.</td>
<td>December 1981</td>
<td>Memory Organization and Synchronization Mechanism for Multiprocessing Computer Systems</td>
</tr>
<tr>
<td>Lee, H. C.</td>
<td>December 1981</td>
<td>A Computer Vision System for Generating Object Description</td>
</tr>
<tr>
<td>Tsao, Y. F.</td>
<td>May 1982</td>
<td>Skeleton Processing for Shape Analysis and Image Generation</td>
</tr>
<tr>
<td>Chiang, Ye-Tung Paul</td>
<td>December 1982</td>
<td>Parallel Processing and VLSI Architectures for Syntactic Pattern Recognition and Image Analysis</td>
</tr>
<tr>
<td>Liu, Hsi-Ho</td>
<td>December 1982</td>
<td>A Syntactic Approach and VLSI Architectures for Seismic Signal Classification</td>
</tr>
<tr>
<td>Huang, Kuo-Yuan</td>
<td>December 1983</td>
<td>Detection of Bright Spots in Seismic Signal Using Pattern Recognition Techniques</td>
</tr>
<tr>
<td>Lin, Wei-Chung</td>
<td>May 1984</td>
<td>A Syntactic Approach to 3-D Object Representation and Recognition</td>
</tr>
<tr>
<td>Lee, Yung-Chia</td>
<td>August 1984</td>
<td>Integration of Solid Modeling and Database Management for CAD/CAM</td>
</tr>
<tr>
<td>Eshera, M. A.</td>
<td>May 1985</td>
<td>Image Understanding by Hierarchical Symbolic Representation and Inexact Matching of Attributed Graphs</td>
</tr>
<tr>
<td>Name</td>
<td>Date</td>
<td>Dissertation Title</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Chen, Ye-Sho</td>
<td>May 1985</td>
<td>Theoretical Foundation and Empirical Phenomena of Text Generation in Artificial Intelligence</td>
</tr>
<tr>
<td>Cheng, Hengda</td>
<td>August 1985</td>
<td>Space-Time Domain Expansion Approach to VLSI and Its Application to Pattern Recognition and Image Processing</td>
</tr>
<tr>
<td>Don, Hon-Son</td>
<td>August 1985</td>
<td>Parallel Approach to Syntactic Image Analysis</td>
</tr>
</tbody>
</table>