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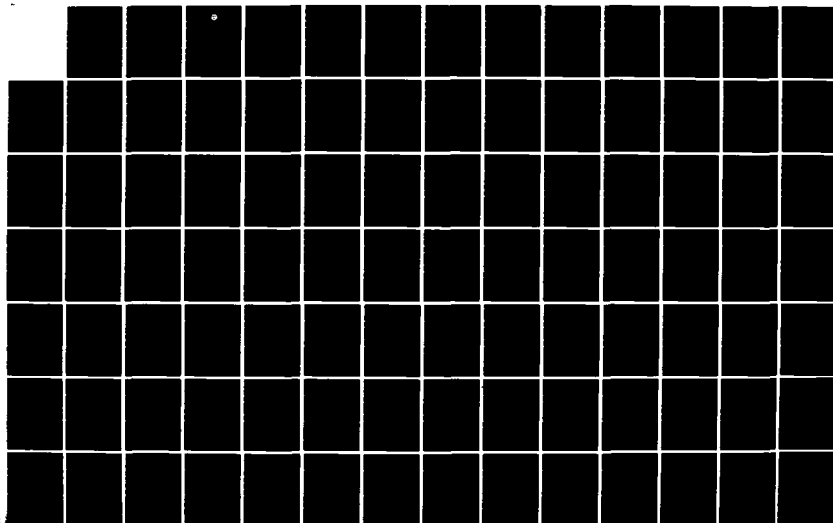
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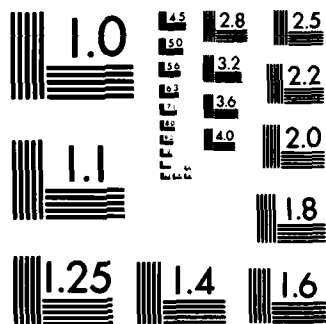
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NOSC/ONR ROBOTICS BIBLIOGRAPHY (1961 - 1981)

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September 1982

Prepared for
Office of Naval Research

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EXECUTIVE SUMMARY

This document contains a bibliography of the literature directly related to robotics published in the period from 1961 to 1981. This bibliography contains 1066 references. These references are organized into ten topical categories including: (1) general and historical topics; (2) modelling, simulation, design, testing and evaluation; (3) sensors and sensor data processing; (4) operating systems, software development, programming languages and computer architectures, (5) knowledge management; (6) communications and direct robot/human interactions; (7) dynamics and control; (8) effectors; (9) systems and applications, and (10) safety, human factors, standards, management, social, economic and political issues.

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PREFACE

This bibliography began almost five years ago as a personal resource to support individual applied research in completely autonomous robot systems. In this case, the definition of robot is a device consisting of sensor(s), processing (and memory) and effector(s) which interfaces with the physical world to accomplish specified goal(s) completely without assistance from external intelligent entities. Two years ago, support was made available to put this bibliography (at the time over 400 entries) into electronic format as well as to expand it. With this opportunity the scope of the bibliography was enlarged to represent industrial robot interests as well as those of autonomous systems. However, foreign references were neglected for about a year due to difficulties in authenticating them. This situation was corrected about a year after formal support started despite the difficulties. Unfortunately, there still exists a regrettable paucity of foreign coverage in this bibliography.

Through the existing life of this bibliography numerous decisions had to be made regarding its scope and form. As a result of some of these decisions the details of such areas as automatic control, pattern recognition, artificial intelligence, image processing and image understanding except where specifically directed towards robot applications are left for other bibliographies. Several such bibliographies are referenced in this one as pointers to these other massive bodies of literature. Entry form and content decisions were agonizing and such information as key words and abstracts was omitted in favor of more complete coverage of the literature. The style of the entry presentation was chosen for clarity.

In spite of the considerable effort that has been expended to bring this collection of robotics references to the present state there remain several problems with this bibliography aside from those mentioned above. Some inconsistencies have crept into the bibliography as a result of several successive groups of people developing it. However, these inconsistencies are strictly of minor nature.

Once the decision was made to publish the bibliography the resources of a sophisticated text editor to act as an interface to the bibliographical information were lost and another more traditional method of organization had to be chosen. The interdisciplinary nature of this literature makes partitioning this data into manageable and meaningful pieces extremely difficult. One method of organization of this data was chosen. Undoubtedly, this selection will not be convenient for all.

Every effort was made within the available resources to verify the existence and accuracy of each entry by going to the original source when possible. This process of entry checking is called authentication and has added considerably to the accuracy and coverage of this bibliography. Unfortunately, every entry could not be authenticated due to the unavailability of the sources.

Finally, this bibliography is flawed in the ways typical of all bibliographies. It is incomplete in both time (by not having a complete set of historical entries) and space (by containing less than all of the recent work published). Surely, this curse, commonly the burden of bibliographers, is related to the Heisenberg Uncertainty Principle.

In spite of its problems, with 1066 entries, this bibliography is the largest and most complete robotics bibliography known to the authors to date and contains nearly all of the most important references of the time. However, there are undoubtedly oversights and errors in this document despite authentication procedures and repeated proofreading. Therefore, all readers of this bibliography are encouraged to bring any errors or omissions to the author's attention. Future updated versions of this bibliography are planned and any suggestions for future editions are welcome.

This work could not have been accomplished without considerable assistance from numerous people. Mr. E. Maynard, Code 19, NOSC and CDR R. Schulman (ret.), formerly of Code 19, NOSC, had the foresight to see this effort as useful enough to fund for over two years. References have been collected from numerous sources. The most valuable of these sources were the people in the field who provided us with their own bibliographical collections and references. These people include but are not limited to Mr. M. Denicoff, Office of Naval Research, Dr. J. Hollerbach, Massachusetts Institute of Technology, Mr. J. Nevins, Charles Stark Draper Labs, Dr. C. Brown, University of Rochester, Dr. H. Moravec, Carnegie-Mellon University, Dr. R. McGhee, Ohio State University, Dr. G. Saridis, Rensselaer Polytechnic Institute, Dr. T. Johnson, Bolt, Beranek and Newman, Dr. C. Kelly, Defense Advanced Research Projects Agency, Dr. J. Albus, National Bureau of Standards, Dr. W. Gevarter, National Aeronautics and Space Administration, Dr. T. Binford, Stanford University, Dr. N. Nilsson, SRI International and Dr. W. Park, SRI International. Without even one of these people this work would surely be less complete than it is today.

INTRODUCTION

Robotics as a technology has grown explosively in the past few years and promises to continue such a growth rate for the foreseeable future. With the rapid growth a large number of new people are entering the field as technicians, engineers and research scientists with each bringing their own perspective and understanding. Robotics is a highly diverse field which combines the influence from numerous technical disciplines, ranging from manufacturing engineering to artificial intelligence. The diversity of robotics makes new entry a difficult experience. Nearly immediately an individual new to the area must become familiar with the assets of a vast body of literature. Collections of references make this process considerably easier. Compared with other newly developing technologies robotics has relatively few such collections and the scopes of these are limited to a particular specialization.

This bibliography is the result of an effort to help fill the need for organized expansive collections of references related to the many aspects of robot systems for a variety of application domains. The scope of this bibliography has not remained constant throughout its development but has evolved. This evolution has resulted in a usefully diverse collection albeit with somewhat uneven coverage. This bibliography consists of 1066 entries with references from 1961 through 1981.

TECHNIQUES

Several techniques had to be developed throughout the course of assembling this collection. In general, these techniques can be divided into two categories, those used during collection of the references and those used to improve the accuracy of the information contained in each entry.

Collection Techniques

The entries for this bibliography were collected from a number of sources. Initially, entries were collected from existing bibliographies and from the references of important technical papers. Sources such as Engineering Index, Science Citation Index, Computer and Control Abstracts and Science and Technology Index were also used as preliminary reference sources. Of course, once the original reference is located its list of references (if any) can be used for further references. This recursive procedure for collecting references produces wide coverage very rapidly and enables estimation of the percentage of coverage from the number of new references found in each referenced paper or report. Several groups of robotics researchers contributed bibliographies of their work to be added to this collection which further increased its coverage.

Authentication Techniques

The purpose of the authentication process is to verify, correct and complete the information contained by each entry. This process involves searching for the actual reference depicted by each entry in the collections of several libraries until the reference is found. Then, the actual information provided by the original source is compared with that information in the entry. Having obtained access to the real paper, its references can be exploited to expand the bibliography. In addition, often the information in an entry with an unavailable reference can be improved from the references contained by other verifiable entries. Conversely, inappropriate entries can be deleted from the collection if upon access the entry proves to represent work not directly related to robotics. Overall, the authentication process has increased the accuracy as well as the coverage of this bibliography. This process has increased the probability that the entries contained by this collection are pertinent to the topic and that the references listed in this bibliography can be located. Authentication makes this bibliography significantly more useful and less frustrating than those bibliographies which were assembled with less concern for accuracy.

ORGANIZATION

The information contained by this bibliography has been organized in a number of ways to make it more accessible. The size of the bibliography necessitates structure. Topical organization has been chosen to impose this structure. In addition, each individual entry has a structure.

Topical Organization

The references in this bibliography have been distributed into ten topical categories. These categories represent an attempt to enumerate and organize all of the disciplines that influence robotics now and in the future. Some of the categories encompass significant portions of the robotics literature (e.g., robot sensors and sensor data processing, robot control, robot effectors). These areas could usefully have been subdivided further. However, publication and circulation of this information is seen by the authors as more important than perfect organization of the references. The topical organization of this information is simply a means to make the bibliography more tractable to those less familiar with the literature than experts in the field.

The topical categories are:

GENERAL & HISTORICAL TOPICS - includes surveys, reviews, historic articles and those entries containing information relating to multiple other specific categories.

MODELLING, SIMULATION, DESIGN, TESTING & EVALUATION - includes references discussing mathematical modelling and computer simulation techniques for robot components (e.g., manipulators) and systems (e.g., integrated work cells) as well as those approaching testing and performance evaluation of both components and systems.

SENSORS & SENSOR DATA PROCESSING - includes references dealing with all sensors for robots as well as algorithms, software and computer hardware for processing and understanding sensor information.

OPERATING SYSTEMS, SOFTWARE DEVELOPMENT, PROGRAMMING LANGUAGES & COMPUTER ARCHITECTURES - includes entries pertaining to most aspects of computer science and engineering as related to robotics; only image processing computer architectures not included (see SENSORS & SENSOR DATA PROCESSING).

KNOWLEDGE & MANAGEMENT - includes references related primarily to artificial intelligence and learning control including knowledge representation, knowledge acquisition, problem solving and planning.

COMMUNICATIONS & DIRECT ROBOT-HUMAN INTERACTIONS - includes references pertaining to communications between robots and humans as well as with other robots; encompasses speech communications as well as electronic forms.

DYNAMICS & CONTROL - includes entries related to robot control as well as kinematics where not directly related to robot simulation (see also MODELLING, SIMULATION, DESIGN, TESTING & EVALUATION).

EFFECTORS - includes entries encompassing all means by which robots affect the task environment except the human aspects; includes manipulators as well as end effectors (e.g., hands) and locomotion.

SYSTEMS & APPLICATIONS - includes references to work combining components into complete systems (e.g., vision systems with manipulators) and to work directing robot technology toward specific applications.

SAFETY, HUMAN FACTORS, STANDARDS, MANAGEMENT, SOCIAL, ECONOMIC, & POLITICAL ISSUES - includes information relating to management and legal issues as well as broad nontechnical issues.

The references within each topical category are alphabetized by the first author's last name.

Entry Format

The information within the individual entries is structured into a typical bibliographic format beginning with the authors when known. Titles follow authors and if the title is enclosed within quotation marks it is from a larger work (this is also typical). If the entry information includes an authentication symbol (an at-sign, @) the information within the entry has been compared with that contained by the original source. The general form of the entry format and specific examples for illustration are given below.

General format

Author(s), Title, Reference designation number(s) (e.g., NTIS accession numbers), Source or publisher, Editor(s) (if from collection), Source volume, Location of origin, Publication date and Authentication symbol (if authenticated), Page numbers or reference size, Second sources (if available from multiple sources)

Examples

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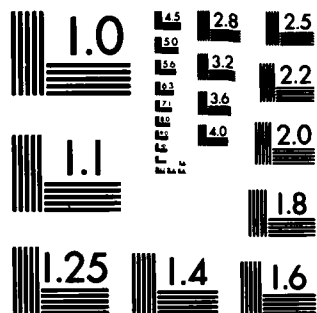
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