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The Project Synopses

Advanced Information Processing

Volume 4 of a series of 7

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The Project Synopses

Advanced Information Processing

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LEGEND

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ADVANCED INFORMATION PROCESSING

Introduction

This directory contains information on forty five of the projects supported within the Advanced Information Processing area of the ESPRIT programme. The entry against each provides a summary of its objectives together with information on the progress made and results obtained. Further information can be obtained from the persons named on the project sheets.

The objective of this part of the ESPRIT programme has been to develop the necessary technologies for the implementation of the next generation of computing systems, by supporting three main action lines:

- the development and application of knowledge engineering techniques;
- the development of new computer architectures for symbolic and numeric processing, and fault tolerant systems; and
- the development of advanced system interfaces for effective communication between computing systems, the computer and its environment, and the computer and the user.

Priority has been given to consolidating and accelerating the industrialisation of the results emerging from the projects. Results have been achieved particularly in the knowledge engineering and computer architecture projects where a firm base is being built for the future enhancement and exploitation of these technologies and techniques by European industry.

The Advanced Information Processing programme has concentrated on three key sub-areas:

i) Knowledge Engineering

The development and application of knowledge-based systems. The approach adopted has been to:

- develop the methods and techniques for knowledge acquisition and knowledge representation;
- develop application independent knowledge-based system shells, supporting languages and user interfaces;
- develop domain specific systems; and
- evaluate knowledge-based systems in the industrial environment.

(ii) New Computer Architectures

The development of high-performance computers capable of processing symbolic and numerical information, concentrating on highly parallel architecture machines.

Such computers will provide the computing capacity needed as the results of knowledge engineering work and advanced man-machine interfaces become embedded into a wide range of applications, eg. CAD and office systems.

(iii) Advanced Systems Interfaces

The work has concentrated primarily on image processing, natural language understanding and speech processing, and is complemented by studies of multi-sensor operation.

ADVANCED ALGORITHMS AND ARCHITECTURES FOR SPEECH AND IMAGE PROCESSING

Project Number : 26

The objective is to develop the techniques, both algorithmic and architectural, required for recognising and understanding spoken or visual signals, and to demonstrate these techniques by means of suitable applications. The work has been planned in three parallel areas: Speech analysis, Image analysis, Pattern recognition and understanding. With respect to speech, the initial application target will be to extend as far as possible current state of the art techniques for speech recognition. The resulting system will be tested using a vocabulary of the order of 1,000 words with constrained syntax and using continuous speech. For image processing, the project is attempting to go behind treating the image merely as sampled data. Applications involved in medical imagery and industrial inspections will be used to test the tools and to study architectural and implementation issues. At the higher level of processing, close commonality can be expected between techniques for speech and image processing. Subsequent work will study architectures suitable for the higher levels, which can interface with the lower level systems.

Progress on speech processing is along two complementary lines: a statistical approach and a knowledge-based approach. Preliminary results on the first approach, based on first implementation using very large lexicons, have been obtained. On the second approach a methodology for representation of the lexical and acoustic knowledge has been chosen and development tools are being developed. Moreover the architecture of the acoustic front end is being realized and the first Digital Signal Processing boards are being tested. The lexical access and the verification based on Hidden Markov Model were demonstrated on a set of short sentences uttered by one speaker in a noisy environment. The demonstration was carried out on a VAX machine. Methods to incorporate syntactic and semantic information are studied to achieve understanding of uttered sentences. A small question answering system running on a Symbolics machine was demonstrated. The system starts from the word lattice produced by the speech system, builds a representation of the query using syntax and semantics and finally answers the query.

In image processing, analysis and comparison and implementation of various algorithms was performed. Concerning the architecture for image feature extraction layer approaches based on Single Instruction Multiple Data (SIMD) and Multiple Instruction Multiple Data (MIMD) machines were considered and are being realised. An heterogeneous approach was taken linking together an SIMD GAPP Array for the low level processing and an MIMD Transputer based machine or an Array Processor for the medium level processing. The interfaces and the I/O of the data are being developed and optimised. A set of algorithms running on the different parts of the architecture has already given an idea of the expected performances. This will be improved by setting up real benchmarks. Specific work was done to provide a coordinate set of

algorithmic tools for digital angiography applications.

Implementation aspects of the physical architecture for high level processing, based on transputers fully interconnected through a switching network, have been analysed in detail; a switching element for non-local communication has been designed outside the project and the first building block comprising two processing elements and part of a hardware emulating the interconnection network is now available. A parallel dialect of PROLOG based on "OR" parallelism has been defined and demonstrated and will be implemented on the high level architecture for Speech and Image understanding tasks.

Achieving successfully the combination of statistical techniques and Knowledge-Based techniques for Speech Recognition will result in a major breakthrough in the field. The complete real time standalone system displaying uttered words in Italian under development, will be adapted for French and German. In image processing, simultaneous studies of algorithms and architecture will result in major gain of performance. Moreover, implementation in suitable architectures able to fully exploit parallelism in order to achieve high performances will open the way to industrialisation by the end of 1988.

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Start Date: 01-SEP-83 *Duration: 60 months*

EXPERT SYSTEM BUILDER

Project Number : 96

The objective of the project is to investigate the extent to which the production of Expert Systems can be industrialised. The project will provide a system enabling expert systems to be developed and tested by personnel not experienced in Artificial Intelligence. An expert System Builder (EBS) will be developed. Three simple Expert Systems for diagnosis of electronic equipment and one for the diagnosis of a process control system are being developed by the partners to provide practical feedback. A Demonstrator Expert System will be produced combining the lessons from earlier work, and will be applied to a single large representative experiment.

Layers in the ESB model have been identified:

- The domain independent inner layers (called the Basic Expert System Builder or BESB).
- The outer Domain and Product layers.

A detailed requirements list for the layers and related tools has been produced, as well as the complete specification and design of the tools. A preliminary version of the BESB based on Sypruc has been implemented and demonstrated. A partial implementation of a higher performance version has also been demonstrated and a full version is available. A preliminary version of the outer Domain and Product layer tools has also been demonstrated, and ESPRIT project 1570 is using the first release.

The Expert System Builder will be implemented and tested by June 1988. A preliminary version of the ESB is available for experimental use by third parties.

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Start Date: 01-JUL-83 *Duration: 60 months*

A LOGIC-ORIENTED APPROACH TO KNOWLEDGE AND DATA BASES SUPPORTING NATURAL USER INTERACTION (LOKI)

Project Number : 107

A Logic Oriented Approach to Knowledge and Data Bases, supporting Natural User Interaction (LOKI) applies logic programming in a number of novel ways, to systems software and to knowledge-based applications. The systems software work is all based on a new Prolog, and special tools allow access to databases at source level by a variety of Prolog-Type languages. These tools will form the implementation language for a high-level knowledge representation formalism. A conceptual modelling language (CML) will be developed for general real world application, based on frames definable within predicate calculus. Two application domains are considered : project management and aircraft design.

Preliminary results have been achieved in three different fields :

- Knowledge Representation : development of three formalisms, LOLA and CML to support Natural Language interfaces and STRUDEL to support a CAD system for Aircraft design.

- Knowledge Use : development of a parser-generator pair (LOQUI) for English and German to support access to Data Bases in Natural Language, and of a constraint propagator mechanism used for the Aircraft design application (ADROIT).

- Knowledge Consultation : development of tools to support inspection of knowledge structures suitable for the Project Management Application and to support explanation facilities in ADROIT.

A first prototype of the aircraft design system, restricted to wing design, is already complete.

The partners are already lining up concrete prospects for the exploitation of the work done. BIM-Prolog is already on the market and benefiting from the comprehensive testing afforded by the project. LOQUI will lend itself as an immediate enhancement of the SCS project management materials, and independent developments are already in train within Scicon International Ltd. The constraint propagation tools being developed for aircraft design are being evaluated for use in other contexts.

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Start Date: 01-AUG-83 *Duration: 60 months*

KNOWLEDGE INTEGRATION & MANAGEMENT SYSTEMS

Project Number : 112

The project was designed to investigate key areas of information such as knowledge representation, inferencing techniques and human computer interfaces. Emphasis was given to a language for knowledge representation and management based on LISP and PROLOG; an expert system suited to assist sales engineers in designing computer configurations and to an expert system serving office personnel to perform complex office procedures (eg. resource planning). These complementary tasks focused on the development of hardware and software components to manage the problems resulting from the size and complexity of large knowledge-bases, and the associated reasoning mechanisms.

The wide potential applications were underpinned by an engineering approach where existing tools like OMEGA were studied to investigate the fundamental structure. A development system for the combination of knowledge sources and for communities of cooperating knowledge-bases was implemented. The development of a manipulation system for large knowledge-bases was planned. The project was terminated on 1.4.86. The contractors agreed that the project could not succeed within the terms defined. They had, however, been successful in integrating the AMORD, CSSA and OMEGA representations, and introducing time dependencies. The reviewers were impressed by the work done.

A book relating the progress of the project is being produced. The OMEGA/AMORD/CSSA time reasoner work will be exploited by partners in other development efforts such as message passing architectures and logical programming environments.

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Start Date: 01-OCT-83 *Duration: 60 months*

TIME DEPENDENCY AND SYSTEM MODELING IN KBS DESIGN FOR INDUSTRIAL PROCESS APPLICATIONS

Project Number : 256

The project addressed some of the research topics connected with the design of KBSs that have to interact closely with complex processes (eg. industrial diagnosis, plant monitoring, process control, etc.). It thus developed the capability of dealing with a type of reasoning where time dependency is crucial, and where there is a specific need for representing and using qualitative models of physical systems.

A detailed study at the level of system design assessed the state of the art and defined effective architectures for distributed KBSs.

The project has produced a literature survey of three topics namely time-dependent reasoning, qualitative modelling, and distributed expert systems. It has produced a detailed example of the application of three different approaches to modelling the behaviour of physical systems in a qualitative way, and a functional study of two approaches to distribution in expert systems. Finally, an initial specification of a toolkit for the development of KBSs for process monitoring was produced.

One participating organisation is using the experience gained in qualitative modelling in the project it is working on. The three deliverables mentioned above are publicly available. Project 1220(820) is implementing and validating through demonstrators the toolkit initially specified in this project.

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Start Date: 19-DEC-84 *Duration: 12 months*

INTELLIGENT HELP FOR INFORMATION SYSTEMS USERS

Project Number : 280

The project investigates approaches towards helping users of information systems learn to exploit optimally the functions of these systems. These approaches will be operationally implemented in the form of a prototype HELP system to provide guidelines, instructions and explanations to user requests for information systems facilities. Among the trial implementations will be a help system for UNIX-Mail and for a planning system.

A prototype system to provide guidance (both instruction and help) to users of Unix mail has been demonstrated. The results of experimental sessions have been recorded and analysed.

- A formalism to describe the application model has been developed.
- Work is in hand to prototype a help system for an SQL interface to a relational database.
- A first prototype of the generic Help System Development System will be available in April 1988.

The Help System Design and Development System will be implemented and ported to a target environment by November 1989.

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Start Date: 01-OCT-84 *Duration: 60 months*

DESIGN OF TECHNIQUES AND TOOLS TO AID IN THE ANALYSIS AND DESIGN OF KNOWLEDGE-BASED SYSTEMS

Project Number : 304

This pilot project investigated the types of tools and design techniques necessary for the analysis, design, implementation and testing of Knowledge-Based Systems. The purpose was to specify the techniques which will aid in the building of expert systems. In particular valuable work was done on analysing the process of Knowledge Acquisition.

The knowledge elicitation system KADS demonstrated at the end of 1984 is the most relevant result of this project. The project was terminated, because the initial participants to this pilot project did not manage to find in due time the additional industrial participation indicated by them and required by the Commission.

P12/304 terminated in February 1985.

The findings of the project were used for the proposal of project Ref. 1098.

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Start Date: 01-SEP-83 *Duration: 18 months*

ADVANCED DATA AND KNOWLEDGE MANAGEMENT SYSTEMS (ADKMS)

Project Number : 311

ADKMS will allow an intelligent and efficient management of information, with the following features :

- Storage and management not only of explicit data and facts, but also, by utilizing knowledge of a specific domain, of implicit information (meta-knowledge).

- A natural language interpreter, for an easier and quicker access to the information.

ADKMS is structured in four layers :

- Natural Language Handler - the focus will be on the efficient and flexible simultaneous use of syntactic, semantic, pragmatic, dialogue and domain-oriented knowledge sources.

- Knowledge Representation and Inference Engine - based on further development of the knowledge representation language KL-ONE.

- Knowledge-Base Management - where database engineering techniques like conceptual modelling and entity-relationship models will be extended.

- Extended Relational Database Management where the DBMS will be enhanced with computational and inferential functionalities like the efficient implementation of the transitive closure.

The BACK knowledge representation system has been convincingly demonstrated. Very good results have also been achieved in the work on extended relational data base management systems. These two topics are state-of-the-art, and can be compared with the best developments in the USA. Work on the three Natural Language Handlers is still too diverse, both in terms of technical approaches and cooperation. For the German parser, Chomsky's "Government and Binding" technique is being implemented on a computer for the first time, with very promising results. Work on integration of the different subsystems, issues related to very large data bases, and the definition of the interface levels is at an early stage.

The results of this project are to help satisfy an urgent need of enhancing database management system with greater functionality ("intelligent", "deductive" database systems), non-restricted natural language handlers, allowing sophisticated A. I. applications to cope with very large data and knowledge-bases. In general, the expectation is to bridge the giant gap between Expert Systems and Database Management Systems and to combine their respective advantages.

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Start Date: 01-DEC-84 *Duration: 60 months*

AN ARCHITECTURE FOR INTERACTIVE PROBLEM SOLVING BY COOPERATING DATA AND KNOWLEDGE-BASES

Project Number : 316

The objective is the design and implementation of an expert system architecture for advice-giving. The original goal of a user seeking advice may be ill-defined and there may be a large number of potential solutions for the user to choose amongst. The purpose of an automatic advisor is to help the user articulate his goals and then to generate candidate solutions for the user to accept or reject. The main computational problem to be solved is one of controlling the cooperative functioning of several sources of knowledge, which may use different representational schemes interpreted by different inference engines. A promising architecture appears to be one which considers each knowledge source to be an independent agent, which only communicates with other such agents via a global data structure, under the supervision of a flexible scheduler capable of reasoning about control. In addition to architectural issues, the project emphasizes the importance of user modelling in man-machine dialogue and the use of large databases to provide an advisor with comprehensive information.

Advice-giving is a complex task requiring the integration of knowledge and data from a variety of sources. During the first phase of the project, research was developed on expert system architecture, interactive dialogue and intelligent database access. In the meantime, an application study (financial investment adviser) was performed; as a result, a first prototype was demonstrated in January 1987.

During the course of this phase, it was realised that the architectural research of ESTEAM was dividing into two complementary threads (so-called "Yin and Yan" threads), one dealing with concepts and tools to design and implement architectures for distributed advice-giving systems, the other dealing with methods and tools to model knowledge in advice-giving expert systems ("cooperative agents").

After this exploration phase, emphasis has now been put on an industrial approach, which gives priority to prototype construction. High level languages and protocols have been defined in order to allow communication between the different modules. The Dialogue Manager component of this architecture has made noticeable progress.

Investment planning was thought of as a suitable application domain for prototype and development systems because the domain is complex enough and representative of some typical problems a financial expert has to solve. The major contribution of this project will be the Definition of an architecture for advice-giving systems.

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Start Date: 01-JAN-85 *Duration: 60 months*

KNOWLEDGE REPRESENTATION AND INFERENCE TECHNIQUES IN INDUSTRIAL CONTROL

Project Number : 387

The objective is to design and implement two Expert Systems to assist maintenance, fault diagnosis, optimisation of data flows, and control in an industrial process-control environment. The major attributes of this class of Expert systems are:

- High level of organisational complexity.
- Time dependent reasoning.
- Large number of inputs and outputs.
- Learning/adaptation.

A set of tools for the development of Expert systems in this area have been implemented.

Two demonstrators, the first for the control and diagnosis of advanced Telecom switching systems, the second for the control of power distribution networks, are complete and are available to the partners for experimental purposes. A basic set of tools for the development of expert systems in complex industrial process-control environments is also complete and is being consolidated. The tools include : a knowledge representation language, AVALON; a rule-based expert system shell, MIKIC; two graphical description languages, G-MOD and V-GRAPH; a blackboard system, BBF; a planning system incorporating dependency-directed backtracking, CELL-PLAN; and a high-level environment for explicitly specifying the control flow, CELL/TISSUE. The tools have benefitted from use in building the demonstrators. For example, MIKIC, which originated from an academic development, was used in the two demonstrator applications. This resulted in two sets of extension, which were then merged into a "Common MIKIC". The work done in the research track of the project has been well integrated in tools, validated by the demonstrators. For example, the work on truth maintenance systems (TMS) resulted in a novel use of the TMS to limit search in the rule base that, in turn, resulted in a combined MIKIC/TMS tool used in one demonstrator.

The demonstrators and a set of tools for building expert systems for project control are ready. Each partner intends to use them in other projects. Moreover, it appears highly likely that some of the tools will be packaged and documented, to facilitate their use by other organisations in ESPRIT projects.

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Start Date: 01-JAN-85 *Duration: 36 months*

CONSTRUCTION AND INTERROGATION OF KNOWLEDGE-BASES USING NATURAL LANGUAGE TEXT AND GRAPHICS (ACORD)

Project Number : 393

The ACORD project focuses on a trilingual (French, German and English) system for the automatic construction of a knowledge-base output of a natural language text and a retrieval and manipulation system aimed at casual users. The knowledge-base will be built from documents combining text and graphics (encyclopedia or technical type) and will be based on PROLOG. The analysis of texts will be based on recent results in theoretical linguistics (discourse representation theory and functional grammars). The knowledge representation will also be based on recent results in formal semantics and on logical theory of data bases. To support dialogue, the system will select appropriate presentation of output, text or graphics, and identify relevant information for output. The system interface will feature a symbiotic interplay of graphics and natural language.

First results have been obtained in specifying and implementing grammatical theories and parsers for the different languages: Unification Categorical Grammar (UCG) for English and French, and Lexical Functional Grammar (LFG) for German. All the parsers for text and dialogue deliver a common semantic representation based on Discourse Representation Structures (DRS). On the graphics side the PROLOG/GKS binding has been completed. A detailed scenario for the prototype and the demonstrator system has been decided on. A first implementation of the knowledge-base using network (KL-ONE) has been developed.

A prototype and demonstrator of advanced linguistic and AI techniques will be built so as to show the relevance of the research to existing business practice. As it stands, the project is working towards a system for computer-aided decision making in the field of logistics.

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Start Date: 01-JAN-85 *Duration: 60 months*

PARALLEL ARCHITECTURES AND LANGUAGES FOR AIP - A VLSI DIRECTED APPROACH

Project Number : 415

The project aims to investigate the different non von-Neuman architectures and implement some of them. The prime objective is to reduce the execution times required by AI applications by a substantial factor. Concurrency will be achieved through a large number of identical processing elements implemented in VLSI. Ideally, a concurrent machine should support all three programming styles (object-oriented, functional and logic) which will allow the full exploitation of concurrency, but the principles upon which such a machine could be based are not yet fully understood. All three styles will be explored through studies into machines which support each programming style separately, and through common working groups which will explore several areas of general relevance.

The project is divided into a series of subprojects.

In subproject A, the relation between an object-oriented style with active and passive objects and a highly parallel architecture is investigated and developed. The parallel architecture will contain up to typically 1024 PCM modules (Processor/Communication Modules). Three applications; a natural language translator, a knowledge-based system and a multi-level VLSI simulator will be implemented on the machine.

In subproject B, the relation between a functional style and a highly paralleled architecture is investigated. Here the approach is how a paralleled reduction machine can be supported by maybe upto 10,000 PCM modules.

In subproject C, the relation between a logic programming style and a highly parallel architecture is studied. The approach here is how a parallel inference machine can be supported by PCM modules.

The relation between a mixed logic and functional style and a highly parallel architecture is studied in subproject D. Here, the algorithmic parts of an application will be handled within the functional part, while the nondeterministic (inferential) parts are treated within the logical subset of the language. This improves the efficiency. Of course, an important point here is the relation between the semantics of functional and logic styles. The question here, is again how this style can be supported by PCM modules.

In subproject E, the relation between functional programming and data flow is investigated. The approach is how the data flow machine could be structured of some 100 PCM modules and could be supported by a high level applicable language.

Finally, subproject F addresses the three main styles of new generation programming: functional programming, parallel programming and logic

programming. The long-range objective is to arrive at a VLSI implementation of a highly parallel inference machine. On the way to that objective the connection method will be used.

All subprojects are based on messages passed between identical units, called PCMs, consisting of communication hardware, processing hardware and local memory. In addition to the subprojects, an application study group will be formed to select applications with which the various styles may be evaluated and their suitability for various fields of application established.

A first version of the compiler POOL-T (Parallel Object Oriented Language - Transputer) has been developed on a sequential system. Licence agreements have been offered to a number of research institutes and in the project, this is used to estimate performance aspects of the system. A final version "DOOM" (Distributed Object Oriented Machine) has been specified and developed.

SILKE (Simple Logic Specification) is being used to compare POOL-T with other solutions, and determine how to exploit parallelism at the application level. Execution model and hardware design for logic programme execution are in progress. The integration of functional and logic programming is progressing. (Different execution mechanisms have been evaluated) The language FP2 (Functional Parallel Programming) has been designed, a micro FP2 prototype is running and being used by some partners, for example AEG used it for SILKE specifications. Implemented theorem provers are being actively used to debug various designs.

The result of this project will provide computer architectures on a chip (processor, communication, memory) and highly parallel computer architectures by 1989. A machine for the efficient execution of Logic Programming will be available by end 1987. This project has the potential to provide a European standardisation for a generic architecture for logic, functional and object-oriented language.

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Start Date: 01-NOV-84 *Duration: 60 months*

IMAGE AND MOVEMENT UNDERSTANDING

Project Number : 419

The proposed research is directed to understanding the computational bases of vision and movement, with particular reference to scene understanding and cursive script understanding. In scene understanding (based on stereo pairs or multiple views of pictorial images as input to the system) the project is focused on the interface between the "early stages" of computation, which provide a rich but ambiguous description in terms of low-level features, and the "knowledge-based" processing which generates descriptions of 3-D organisation of the visual world compatible with the properties of the physical world. Cognitive modeling techniques based on a functional description of objects and perceptual rules will be studied. The ultimate goal is to merge the data-driven and the knowledge driven recognition approaches.
With regard to cursive script, basic knowledge still needs to be acquired about the mapping from linguistic material to hand trajectories; the goal of the project is to understand the writing process more than recognize it. Techniques to code cursive script signals into symbolic descriptions will be studied.

After 30 months of work, the following results have been obtained:

- Development of basic libraries of computational modules that perform early processing of image data (including stereo and motion algorithms) and cursive script data (cursive script is the topic of attention of the project as regards "movement").

- Development of a portable interactive software environment called VIS where it is possible to generate and interrogate multiple regional representations of images or image sequences (iconic representations, regional representations, contour representations).

- Development of cognitive driven modules that interface with low-level representations of images:

    - Using basic perceptual rules for dealing with occlusions of surfaces in low level representations;

    - Using semantic representations of objects for interpreting perceptual representations and describing scenes.

- Development of the firmware necessary for the real-time acquisition of sequences of stereo pair of images on the VDS Eidobrain workstation.

The results of the project will serve the R&D community, both academic and industrial, as conceptual/computational support when developing specific applications of image or movement analysis. Moreover the VIS system incorporating well engineered implementations of advanced algorithms can be

the basis for a marketable product.

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Start Date: 01-JAN-85 *Duration: 60 months*

MESSAGE PASSING ARCHITECTURES AND DESCRIPTION SYSTEMS

Project Number : 440

The project will build three levels of tools for the development of Expert systems :

- Message passing languages.
- Description languages for knowledge representation.
- Reasoning and strategy programming.

The project will develop techniques for implementing message passing languages that will exploit new highly parallel architectures. The techniques will cover issues of run-time support like allocation, migration, garbage-collection and persistency of actors. A description system will be developed to support the basic mechanisms of knowledge representation : conceptual hierarchies, inheritance, attributions. To perform reasoning on the description system, rather than providing a fixed strategy, primitives and constructs will be developed that will allow the programming of deductive strategies tailored to specific applications. Strategy execution will be performed concurrently by a large number of actors each exploring a small portion of the knowledge-base.

At the end of the project, there will be a solid implementation of message passing, techniques for exploiting specialised concurrent hardware to implement actors efficiently, a package of knowledge representation primitives, and a description system and related interaction tools, with applications ranging across the KBS and MMI spheres.

Up to now the main results of the project are two description systems, OMEGA and KRS developed respectively by DELPHI and VUB, which are considered as leaders in the state of the art.

- OMEGA is a description oriented knowledge representation which allows reasoning and includes viewpoints mechanism. Graphical tools provide an efficient environment to support the knowledge engineering activity.
- KRS is a concept system which allows reasoning and includes inheritance mechanisms and a consistency maintenance system. A graphical user interface is under development. Parallelism in Knowledge Representation is currently under study.

Prototypes of both systems have been implemented and are the first steps to a future industrialisation. Experimentation in workable environment would be desirable and a next step is to port OMEGA onto PCTE, making it widely available to the European Community.

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Start Date: 01-NOV-84 *Duration: 60 months*

COMMUNICATION FAILURE IN DIALOGUE : TECHNIQUES FOR DETECTION AND REPAIR

Project Number : 527

The aim of this project is the development of a robust and portable natural-language interface to a relational database system.

The initial stages of the project involve the study of human dialogues in a simulated database-query environment, including recovery from various types of communication failure. From an analysis of these dialogues a formal model of the dialogue process will be developed. The formal model will serve as a basis for a computer implementation of an English and Italian natural-language front-end to a student record database. An important element of the implementation will be the use of non-verbal systems (e.g. graphics, pointing, icons) in roles analogous to the non-verbal components of human dialogues. The robust dialogue component of the project has potential applications outside the database domain. Elements of it can be used in the development of a front-end expert systems, or for information retrieval in an office environment.

A review of the various approaches to human-computer dialogue has been completed; particular care was taken to exploit possibilities of multidisciplinary cooperation. A system for the classification of dialogue was developed, and tools were defined; some of these were implemented. A series of experiments was carried out to evaluate the proposed approach. The development of a hardware and software configuration for the collection of dialogue data is complete.

The construction of a formal model of dialogue and communication breakdown has potential applications to more user-friendly natural language interfaces for systems of various kinds. The integration of non-verbal information, such as gestures, in this model, could form the basis of very intelligent interfaces, although this is a longer-term prospect. By February 1989, fault-tolerant natural language interface to a database workstation will be demonstrated.

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Start Date: 01-FEB-85 *Duration: 48 months*

ADVANCED KNOWLEDGE-BASED MANAGEMENT SYSTEM (EPSILON)

Project Number : 530

The objective of this project is to build an environment for the development and use of knowledge-based management systems (KBMS). The system is based on standard technologies : relational data base and Prolog. It is portable and extensible and will be available on a wide range of mini computers and workstations.

In order to achieve these objectives the project has set three technical goals :

- Integration of Logic Programming and Data Base technologies.
- Linguistics extensions and analysis and verification tools.
- A user interface for non-expert users.

The project has made progress in the following four areas :

- The prototypal integration of the general system.
- The development of a kernel inference engine that allows the construction of different inference machines by specifying the control structure.
- The graphical user interface using window-techniques.
- Connection of distributed data and knowledge-bases through local area networks.

The project has developed the notion of theories, and the object-oriented concept of links between theories. This could prove to be a very flexible and powerful approach to the development of knowledge-based systems, especially in a Prolog environment.

A first prototype will be available by the end of 1987 and the final system at the end of the project (1989).

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Start Date: 01-NOV-84 *Duration: 60 months*

REAL TIME GENERATION AND DISPLAY OF THE 2.5D SKETCH FOR MOVING SCENES (GENEDIS)

Project Number : 532

The project will develop and implement a demonstrator prototype of an imaging system which is capable of producing a form of 2.5 D sketch directly. This sketch in which image intensity will be related to range, will be in one-to-one pixel correspondence with an illumination intensity representation generated simultaneously. Statistical operations performed on successive range estimates should permit a marked improvement over the single measure resolution.

At the conclusion of the project conception phase, it was decided that the system should be composed of four parts:

- Two cameras arranged "in correspondence" delivering two images of the same scene.

- Two feature extractors for extraction of relevant features in both images.

An edge-based stereopsis approach was chosen:

- One correlator which detects the corresponding features in both images and computes the range of the imaged point in the viewfield from their disparity.

- One interpolator which interpolates range from the ranges delivered by the correlator, allowing determination of the range of all the points in the viewfield.

A prototype of a low price system to deliver range images for industrial scenes is under development. The expected performances are 2mm error at 1 meter for a 512 x 512 pixels images for a system working at a video rate and 1.3 mm of lateral resolution. At the moment, no similar low price system exists on the market. Further developments to upgrade the system for image processing will be necessary prior to the industrialisation of a complete low price system.

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Start Date: 01-FEB-85 *Duration: 36 months*

KNOWLEDGE-BASED ASSISTANT FOR ELECTROMYOGRAPHY

Project Number : 599

The aim of the project is to develop a knowledge-based assistant to support physicians in all stages of an electromyographic (EMG) examination of patients with neurological disease. Phase II of the project will continue the process of development by prototyping but with a number of changes of emphasis :

- There will be a much stronger emphasis on a number of critical user acceptance issues, including those identified in the mid term review of P599, particularly adapting the system to national and individual laboratory practice(s). End users will be actively involved in the definition of requirements and in the evaluation of the final prototype.

- Much more effort will be needed to develop the KBs to a fully functional state. This work will involve formalising empiric and causal medical knowledge into a form that is machine accessible and forms the basis for the inference methods in the system.

- Any Medical Expert System must in the first place be seen by the expert user to be transparent, not a black box. Facilities such as explanation facilities, and access to the system (KB's) are critical to user acceptance.

The project has achieved good results on many of the facets which go into the design of a knowledge-based expert system, eg., user interface, distribution of knowledge-bases, and issues related to the acceptance of expert systems in medical applications.

The first phase resulted in the construction of a prototype EMG expert system. The system not only supports the examiner in the analysis of EMG signals (diagnosis), but advises as to what test procedures be performed, includes a report generator, and contains a data base of case studies.

Whereas previous expert systems for diagnostic purposes were based on causal or probabilistic models, this project adapted a very new approach, an integration of both ideas into a causal-probabilistic network model. The causal-probabilistic network model serves as a unified approach to planning, diagnosing, explanation and reporting. It is therefore very well suited to medical expert systems.

This first prototype served as a testbed and had limited functional capabilities. For example, data (EMG curves) was entered only manually - in the meantime, a serial interface connects the measurement unit and the expert system. Other ongoing work is directed to the improvement of the user interface (graphical anatomic guidance), a browsing facility, and maintenance of the knowledge-bases. These improvements are geared towards the final prototype for this project.

What exactly these intermediate states should be, and whether they should model physical reality, or whether they should merely be a convenient abstraction has been the subject of considerable attention in phase I. Significantly more medical expertise across a broad range of opinions, will be required to resolve these questions. It is desirable to have a system that is steerable and modifiable. The knowledge in the system therefore has been separated into :

- Static domain knowledge.

- Problem solving principles.

- Empiric "how to do it" knowledge.

KEE is an excellent development tool for initial prototyping. It is however likely that for much of the coding, the project will move away from KEE to Lisp or an imperative language, in order to speed up the iterative design-test software development process.

An integrated EMG knowledge-based assistant is expected to be completed by January 1989, and would broaden the scope of use of electrophysiological techniques.

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Start Date: 01-DEC-84 *Duration: 50 months*

DEFINITION AND DESIGN OF AN OPEN DEFENDABLE DISTRIBUTED COMPUTER SYSTEM ARCHITECTURE (DELTA 4)

Project Number : 1226(818)

The objectives of the project are to formulate, develop and demonstrate an open system, fault tolerant, distributed computer connection architecture, conforming to the OSI model. The architecture will be capable of being configured to support a range of performance and dependability and to manage distributed processing. It also offers transparent fault tolerant and network management to the user. These features, plus the ability to connect heterogeneous computer systems into one architecture, will be directly applicable to the Computer Integrated Manufacturing and Office Systems areas. Emphasis will be placed particularly on new communication techniques (optical and electrical) and concepts. Finally a key feature of the project will be a series of progressive demonstration prototypes, which will form the basis for rapid commercial exploitation of the results.

The initial phase (first year) concentrated on the 3 main topics needed to build an open dependable distributed system.

- Specification and implementation of a multicast communication system on a LAN. A prototype of the MCS has been demonstrated.

- Specification of a high-performance and cost effective "network station" to support the DELTA-4 system architecture. Specifications have been produced and 2 demonstrators have been developed:

  - A RT unix prototype.

  - A RSR (Remote Service Request) prototype.

- Delta-4 network management to guide the overall work on dependability. A first level of specification has been achieved, but this work will continue during the whole project.

These developments are continued in the main phase. Additional work concerns:

- The design and development of an Application Support Environment, to support dependability via replication of tasks over the network.

- The validation of protocols through the use of the ESTELLE formal description technique (ref P410).

- The study of pilot sites, to be used in a possible next phase.

These results provide the project with:

- A network which supports advanced protocols.

- A node architecture.

- The global framework to integrate dependability into a distributed system.

The project will deliver interconnection equipments for heterogeneous systems which is particularly relevant for distributed application in Computer Integrated Manufacturing and Office Systems.

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Start Date: 01-MAR-86 *Duration: 36 months*

DESIGN, EXPERIMENTATION OF A KBS ARCHITECTURE AND TOOL KIT FOR REAL-TIME PROCESS CONTROL APPLICATIONS

Project Number : 1220(820)

The project aims at the design and implementation of a KBS building tool kit for a class of applications in the area of process control/supervision; the tool kit comprises a general system architecture, a set of special-purpose building modules, a set of support tools for the construction and testing of the knowledge-base, aids to construction of interfaces to traditional software packages and sensors, a KBS analysis and design methodology.

The kernel toolkit and the three demonstrator projects have been specified.

The application domains for the three demonstrators have been analysed and implementation started. The representation languages to be used in the toolkit have been specified: the toolkit will contain a facility for qualitative simulation, a rule-based component based on fuzzy logic, a production rule system and two very high-level languages (event graphs and recursive transition networks). Implementation of the tools has started and is proceeding concurrently with their preliminary validation on the three demonstrators. Most of them have been applied in this way recently.

The project is viewed as a way of developing and reviewing a technology, in terms of methodology and tools. A continuous fall-out to similar projects developed at the participating institutions is expected: this will take place throughout the duration of the project, starting from January 1987.

The toolkit, which will be ready in March 1990 will be used in the commercial development of process control applications and it will be incorporated in commercially available expert system shells. The demonstrators, which will be ready by September 1988, will be used by the partners. They are :

- A system for control of a thermal power plant.
- A support system for operators in the control room of a geostationary satellite for telecommunications.
- A system for the control of a cement manufacturing plant.

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Start Date: 01-MAR-86 *Duration: 48 months*

GRAPHICS AND KNOWLEDGE-BASED DIALOGUE FOR DYNAMIC SYSTEMS (GRADIENT)

Project Number : 857

This project will develop improved user/system interfaces for dynamic large-scale industrial control systems, by the design of intelligent graphics and knowledge-based dialogue systems. Three co-operating knowledge processing expert systems will be built, that will give the operator of a supervision and control (S&C) system intelligent support in diagnosing and recovering from faults, and will provide an intelligent graphic interface. A further aim of the project is to assemble different KBS Demonstrators for use in "hard-tech" industrial environments and to identify appropriate metrication aspects and methods. The project will develop expertise by building a set of dialogue, design and specification tools for use in solving problems identified during a survey of users of S&C systems. These tools will then be used and tested throughout the project, to build these systems. The project attempts to identify metrics which are of significance, and methods for their assessment.

A survey of dialogue systems has been completed. A report on picture element standards and graphic editors has been completed and used to design a new graphic editor, currently being implemented, with novel characteristics, such as dynamic binding of colour pictures to process variables. A pioneering study specifying the criteria and methods by which expert systems can be evaluated has been completed. A preliminary version of an expert system that monitors a data communication network has been demonstrated. A pre-prototype of an integrated system for operators of a conventional power plant has been implemented in KEE. The prototype includes mock-ups of all the modules that will be present in the final system.

A collection of decision support systems for materials and treatment selection in the field of corrosion will be available by October 1988. The study on metrication of expert systems is predicted to have a major impact on their industrial application. Tools for the construction of interfaces to operators of large industrial systems, with particular attention to the iconic and dialogue aspects will be available by October 1990.

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Start Date: 01-OCT-85 *Duration: 60 months*

NON-MONOTOMIC REASONING TECHNIQUES FOR INDUSTRIAL PLANNING APPLICATIONS

Project Number : 1220(865)

The project aims to design planning techniques and integrate them into the prototype of a flexible tool package for knowledge-based planning systems. These techniques are to be refined by developing demonstration systems in design and manufacturing applications. The tool package is to be interfaced to engineering tools, such as CAD solid modeling, technical databases, and numerical calculation packages.

A definition document providing guidelines based on the requirements in the intended application fields has been produced. The preliminary design for the planning system can be described as follows. The goals to be pursued by the planning system and their interaction must be extracted from CAD and other data. Each goal generates a process plan corresponding to a form feature of the piece to be manufactured. Inconsistency among the plans will be removed by a constraint propagation mechanism.

A preliminary toolkit organisation, centered around a simple representation language, has been designed and partially implemented. Prototypical frame and rules interpreters have been implemented and tried on simple problems. Knowledge engineering work has led to the identification of the attributes of form features and to the analysis of the task of a human process planner.

A planning shell will be ready by May 1990. One of the partners will use this system as a tool for the development of knowledge-based turn-key applications and as a basis for a product. Another partner intends to use a planning capability in its existing products. The demonstration system for the machining of mechanical parts, which will be ready, in a preliminary version, by March 1988, and, in a final version, by May 1990, will be used internally by one of the contractors. Another contractor intends to incorporate a planning capability in its existing products.

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Start Date:	*01-MAY-86*	*Duration:*	*48 months*

INTEGRATED OPTIC TECHNOLOGIES FOR REAL-TIME WIDEBAND OPTICAL SIGNAL PROCESSING (COUSTO)

Project Number 866

The objective is to develop an integrated acousto-optical device including processing in the 0.1-1 GHz range. It will include various optical elements as well as the radiation source and suitable detectors for one-dimensional signal. Applications for such a device range from super-fast LAN connections to (1-D) correlation in radar processing systems (for dynamic clutter rejection). The device is to be rugged and compact.

Various alternatives for the different components were studied and compared with respect to the required performances:

- The Lithium Niobate ($LiNbO_3$) substrate on which the waveguides are fabricated were found to be the best option for the acousto-optic interaction zone. The most significant alternative material, Silicon, has been put aside because of its poor acoustic properties in spite of the possibility of integrating the optical detectors directly on the Silicon substrate. The Protonic Exchange technique has been selected to build the waveguides on the Y-cut of $LiNbO_3$. The two signals, the received and reference signal, are launched in opposite directions and their correlation taking place in the interaction zone, results in the deviation of the incoming light produced by a laser source.

- The Nb_2O_5 Fresnel option has been selected to build the collimating lens (between the laser source and the acousto-optic interaction region) and the detector lenses (between the acousto-optic interaction region and the detector).

Optical techniques constitute a new field of investigation for the future. The project will develop in the context of real-time signal processing. By February 1990, a first prototype of a space integrating correlator will be built. Envisaged applications range from multiport switching to wideband signal detection.

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ADAPTING REAL-TIME STRATEGIES FOR IMAGE PROCESSING: A CASE FOR SATELLITE DATA (ARTS-IP)

Project Number : 867

This focusing project consisted of a definition phase for the development of new architectures for processing satellite SAR (Synthetic Aperture Radar) images .

An implementation workplan was prepared, covering aspects of real-time signal processing both on-board and on-ground, image interpretation through expert systems, and the related hardware and software.

The design of end-to-end remote sensing systems for crop monitoring and maritime surveillance were formulated in conceptual terms. This work included an initial feasibility study, with Landsat SAR images taken from different orbits. A comparative review of several texture analysis algorithms was carried out.

The feasibility study revealed the European interest in this technical domain. Advances are foreseen in the signal processing area through the study of new algorithms for the production of custom high-speed integrated circuits, and the application of knowledge-based techniques for automated image interpretation.

However, the definition phase has also shown that many basic technological problems remain to be solved, and that the project goals need reformulating vis-à-vis the objectives of ESPRIT.

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Start Date: 01-FEB-86 *Duration: 9 months*

INTEGRATED ENVIRONMENT FOR RELIABLE SYSTEMS

Project Number : 874

This project aims at providing an environment which integrates a set of hardware and software mechanisms and components to facilitate the construction and support the operation of reliable distributed application systems based on local area networks.

The intended architecture will provide a programming model which integrates the communication needs of distributed software with the various mechanisms required for fault-tolerance.

The model will allow the construction of fault tolerant systems based on the concept of active stand by with Software redundancy supported by hardware redundancy in the network.

The project ended on 30 November 1986, having completed a System Architecture specification and a demonstration Task Specification.

The environment provides for a computational model in which objects communicate by means of Remote Operations Calls. Objects are replicated at different nodes of the system for reasons of back-up in the event of a node-failure.

Checkpointing is invoked automatically during the Remote Operations Calls, thus ensuring that a back-up object will start executing from a known state in the event of a failure.

The results of the project, mentioned above, are being utilised in P818.

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Start Date: 01-DEC-85 — *Duration: 12 months*

EXTERNAL INTERFACE FOR PROCESSING 3-D HOLOGRAPHIC AND X-RAY IMAGES FOR ANALYSIS AND CONTROL

Project Number : 898

The aim of the project is the development of an external interface system, to link physically generated 3-D images to inspection and analysis procedures. While this has to be a general and flexible system, it is used in this project for holographic interferograms and X-ray radiographs for applications in areas such as real time testing and inspection and 3-D measurement. For this task, optical and electronic methods have to be combined in order to extract the relevant information from multiple 3-D images. A further aim of the project is the automation of the holographic interferometry and the X-ray radioscopy for on-line testing in the manufacturing process.

The challenge of the project is to combine two Non Destructive Testing methods: deformations of the surface of materials are first detected by an holographic method and then interpreted in terms of stress and constraint on the material, using Finite Element Methods. The stress and constraint are then further explained by X-ray Image Processing that gives information on the inside of the materials.

Various techniques for quantitative Holographic Interferometry have been investigated and the phase stepping method as well as a method based on the Fourier Transform has been selected for the project; initial specifications of the interface have been defined. Concerning X-ray Radiography, requirements of the interface (mainly due to noise) were identified. The quality of the images depends on the X-ray source, the geometrical structure of the inspection system and on the detector and image processing system; it was therefore necessary to develop the controlling hardware and software to automatically optimise the conditions for performing the testing. The manipulator and its control have been produced and the source control (microfocus X-ray control) is still under development. Low level image processing techniques adapted and common to X-ray images and interferograms are under study. A common set of objects (turbine blades and honeycomb structures) have been selected to test the methods developed for holographic interferometry and X-ray radioscopy and their combination.

Improving the existing technologies of design and testing engineering structures is a priority for increasing product quality. The project will develop along this line. By March 1988, a prototype combining optics and electronics technologies will demonstrate that a low cost system for on-line testing with good performance is achievable.

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Start Date: 01-MAR-86 *Duration: 24 months*

DEPTH AND MOTION ANALYSIS (DMA)

Project Number : 940

The objective is to develop a vision system integrating passive information from stereo and optical flow (motion) for industrial robotics and passable navigation, with hardware realization of real-time vision modules to be integrated in two demonstration systems:

- A mobile vehicle to be able to move in different environments, avoiding obstacles and making visual maps of the scene.

- A manipulating arm for industrial robots for object manipulation and inspections, and tool assembly. The project has been organized in 7 different tasks covering passive stereo vision, the computation of optical flow, integration of stereo and flow, the computation and representation of 3-D shapes and motion, hardware implementation for the mobile vehicle (demonstration) and manipulating arm (demonstration).

All partners have concentrated on the study and subsequent harmonization, or standardization, of software (e.g. the "C" language for low-level processing, and LISP for high level processing) and hardware tools (e.g. tape formats, performance study of TV cameras, and interfaces).

The workplan has been refined. Three strongly inter-related lines of research have been followed: a study of algorithms for (passive) stereo and motion analysis, a hardware feasibility study, and a specification of the demonstrators (mobile vehicle and robot manipulator). Research on stereo algorithms resulted in two approaches (matching either image regions or image edges). These algorithms were implemented using a set of three cameras. Research in motion analysis has concentrated on the recovery of 3-D structure from already available feature correspondence in temporal image sequences, rather than from optical flow.

The achievement of the project objectives will represent a substantial progress in image understanding and a considerable technological improvement for factory automation. Demonstrations for both the mobile vehicle and the manipulating arm planned by the end of the project (1991), will provide advanced solutions for most applications of factory development, testing and integration of different algorithms for stereovision, motion analysis and 3-D object reconstruction. This will provide an essential contribution to basic research in scene understanding.

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Start Date: 01-JUN-85 *Duration: 60 months*

HIGH DENSITIES MASS STORAGE MEMORIES FOR KNOWLEDGE AND INFORMATION STORAGE (ATOMS)

Project Number : 957

The objective is to develop vertical and (reversible) magneto-optical recording technologies for mass storage of data on rotating discs. Compared with classical recording techniques, these technologies promise much higher storage densities, as well as improved access times, high storage reliability and competitive storage costs. Vertical recording technology will be investigated and developed for both, floppy and rigid discs. These topics include media and substrates, as well as the read/write heads. Magneto-optical recording requires optical read heads and magnetic write heads. In addition to the development of basic components and technologies, work will be carried out for simulations of the mechanical dynamics, defining the internal coding of data including error correction and detection, and designing electronic interfaces to computing systems.

The technical objectives aimed at are in the case of vertical recording: a linear density of 70,000 fci and a radial density of 140 tpi for floppy discs, a linear density of 60,000 fci and a radial density of 1000 tpi for rigid discs. The magneto-optical system should provide a linear density of 20,000 bpi and a radial density of 10,000 tpi. In terms of the capacities, the objectives for 5,25 inch drives are: 15 to 20 MB on a floppy disc, 150 to 200 MB for vertical rigid discs, and 400 to 500 MB for magneto-optical discs.

(Task I, Floppy Disks) - The main problem is linked to Cr-Co tribology. Nevertheless, linear densities have been achieved as high as 120 Kbpi. However, the head-media interface is a major problem, especially when compared with the emerging Ba-Fe technology. Life time is still below expectation.

(Task II, Rigid Disks) - Optimisation of composition came very close to the target. The problem remains in increasing the linear density from 30 Kfci to 45 Kfci; a new sublayer is under development. Glass substrates have shown excellent mechanical and structural characteristics. 3380-like heads for vertical recording have been developed.

(Task III, Magneto-optic Media) - Magnetic recording properties were studied for TbGdFe amorphous alloys and garnets, and excellent results have been achieved. This medium supports linear densities of more than 25 Kfci, and radial densities of more than 10 Kfci, with no aging effects; however the coercive force is still too low. Tri-layer alloys were deposited on both plastic and glass substrates. An initial optical pick-up system has been presented.

(Task IV, Simulation) - Specification of the head interface has been completed, and software tools for testing different coding schemes have been developed.

This project aims at three major objectives which are currently considered worldwide as strategic targets: vertical magnetic recording for achieving extremely high storage densities, reversible optical recording, and the magneto-optic technology to achieve extremely high surface densities.

The first products emerging from this project are expected for the late eighties.

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Start Date: 01-FEB-86 *Duration: 36 months*

PARALLEL ASSOCIATIVE DEVELOPMENT MACHINE AS A VEHICLE FOR ARTIFICIAL INTELLIGENCE

Project Number : 967

Time critical applications, such as "real time" speech and image understanding need high performance computer systems. This project PADMAVATI, is intended to develop such a computer. The machine architecture will be based on an array of computational notes, each containing a high performance multiprocessor, memory and communication interfaces (the first development will be based on the TRANSPUTERS. The memory architecture will be investigated to develop associative memories (hashed DRAM and cache). The programming environment will be based on standard PROLOG and LISP with extensions to support parallel execution. The resulting hardware architecture and software system will be tested by implementing experimental, computationally intensive tasks from the field of natural languages, speech and image understanding on the completed machine. Signal processor interfaces will be developed (use of bit-serial parallel array machines).

The basic hardware architecture of the system originates from Project 26. It consists of a set of nodes built around transputers enhanced by associative memories and linked together through a local communication bus or through a multi-stage packet switched delta network for non-local communication. The transputer was chosen for its implementation language OCCAM and for a rapid prototyping. The delta network was chosen for having a high bandwidth and a high output rate. The target machine will contain 16 nodes. The switching element, designed for the network outside ESPRIT, is at the foundery. The first building block of the architecture is available and ready for replication : it consists of a board of two nodes and of hardware emulating the switching elements. To support an efficient implementation of PROLOG mainly, two kinds of nodes have been identified :

- Processing nodes each of which consists of a processing element (transputer) and a content addressable memory (CAM) to perform fast unification.

- Dispatching nodes allowing the distribution to the processing nodes of clauses contained in the Associative Memory Systems (AMS).

Each AMS consists of a DRAM, a Hash Coding Operator and a CAM. Each DP + AMS is able to perform pre-unification and filtering of clauses and manages the resolution.

Each node is organized around a transputer, whose bus is extended to interconnect the other elements of the node. The CAM and the Hash Coding Operator are now ready for implementation.

The software architecture is organized around two tasks :

- The implementation of a lisp concurrent model (extended LeLISP).

The implementation of a sequential Prolog, where microparallelism in the interpreter is investigated; parallel prolog for which a synthesis of the various approaches in parallel prolog is being developed. An "AND" parallelism with distributed backtracking and shared variables has been chosen.

The orientation taken consists of a Prolog and a LISP annotated by the user when parallelism is required, the implementation being done through OCCAM.

A first evaluation of the performance of the system for a restricted number of processors has been carried out using Generalised Stochastic Petri Net models to study the delay introduced by the interconnected network and the level of multitasking of the Processing Element to overcome the latency problem. On the application side, a set of distributed algorithms for Speed Processing written in LISP are now ready to be tested on a small network of Lisp machines.

Efficient real time sub-systems will be available by 1990 and tested on three different applications : speech processing, natural language and image processing. A flexible mock-up will be built to demonstrate the viability of the concept of associative devices in an efficient implementation of concurrent LISP and sequential and parallel Prologue.

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Start Date: 01-FEB-86 *Duration: 48 months*

ADVANCED LOGICAL PROGRAMMING ENVIRONMENTS (ALPES)

Project Number : 973

The project aims at an analysis and definition of a complete programming environment, based on logic programming. It will analyse program synthesis from first-order logic specifications, (namely develop a specification interpreter allowing to verify the validity of specifications, compare the different synthesis systems constructed by partners and try to combine their best features, apply program synthesis techniques to program certification), theorem proving and meta-reasoning, distributed logic programming and abstract data type specifications (namely check the use of new equality handling systems in order to define datatypes properties, investigate polymorphic typing).

The application of these results to classical environment tools, such as debuggers, browsers, editors and interfaces with graphic systems to the specific needs of logic programming will be developed in parallel.

Finally these results will be integrated in programming environment modules.

A major step has been achieved in the adoption of a common Prolog Kernel (C-Prolog). This was supported early in the project by a workshop on the implementation of C-Prolog.

The specification of the Kernel is now under way, together with the prototyping and integration work. The following tasks have been launched in parallel covering both theoretical and implementation aspects:

- Prolog and Graphic Systems.
- Editors.
- Program Synthesis.
- Program Analysis.
- Non-classical logics.

Early versions of prototypes for all the 12 working tasks of the project were demonstrated in October 1987.

The work will now be focused on the refinement of these prototypes and on their integration in a common environment.

The expected results of this project include several prototypes of components of an Advanced Logic Programming Environment, which will be presented in September 1988. Due to the characteristics of some of the partners (Software houses that are already selling versions of Prolog) it is expected that some of these components will lead to short-term industrial implementations. An

ntegrated prototype will be available in June 1989.

'he main impact of this project is the use of a common Prolog Kernel for the :onstitution of a logic programming environment. In this sense this project :an constitute an important step towards a European standard on logic ›rogramming.

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Start Date: 01-JUN-86 *Duration: 48 months*

NEXT GENERATION DATA BASE MANAGEMENT SYSTEM (MUST)

Project Number : 1005

The objective of MUST is to establish the basis for the development of a new generation Data Base Management System with the following features:

- Treatment of new data types (documents, images, sounds, time).
- Use of inference techniques to ensure data integrity, to deduce new data from recorded data, and to help the user to set up his queries.
- Compatibility with the existing Data Base Management Systems (DBMS), through the use of the actual interface SQL.

In order to accomplish these objectives the project started by a market inventory, both in what concerns the potential users of such a system and the DBMS manufacturers, to establish clearly the application that the users envisage for such a system and the expected market response to these requirements. In what concerns the deductive facilities, two approaches will be prototyped: the first consists in adding a deductive layer to the DBMS and the second consists in embedding the inference engine into the DBMS. To assure compatibility with the existing DBMS's a strong effort will be made in the study and development of a powerful Data Dictionary.

During the first months of the project, the task dedicated to the market survey has been achieved. This prospective study identified the user requirements and the manufacturer perspectives for the next generation DBMS's. Work is currently being done in what concerns the treatment of new data types, the development of the Data Dictionary and the integration of a deductive component. The presentation of two prototypes, corresponding to the two approaches mentioned above is scheduled for the end of February 1988.

If successful, the impact of MUST will be predicated on the compatibility with the existing DBMS's, on the one hand, and on the treatment of new data types and the inclusion of a deductive component, on the other hand.

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INTEGRATION OF ARTIFICIAL INTELLIGENCE, VOCAL I/O AND NATURAL LANGUAGE DIALOGUE - APPLICATION TO DIRECTORY SERVICES (PALABRE)

Project Number : 1226(1015)

The PALABRE project aims at defining and realising an acquisition and interrogation system for a large evolving knowledge-base. Information, interrogation and updating are performed by using natural language. The input-outputs are to be either textual or vocal (speech understanding and synthesis). Common tools and methods will be developed independently so that several languages (French, English, Italian) can be used. Requests will be converted with the help of inference rules and will be sent to an intelligent retrieval process based on semantic knowledge representation. LISP and PROLOG on a LISP machine will be used. The feasibility of such a system will be demonstrated through a phone directory "Yellow pages" prototype application, in Italian, English and French.

The first year was devoted to the design of the system. Different parts of the system were identified and their interfaces defined. The general architecture is based on a blackboard approach to combine several sources of knowledge. Two different approaches are proposed to parse a query inputted by the user: a deterministic parser for a written input, and an Augmented Transition Network (ATN) parser for a spoken input. These two approaches are likely to be combined. The knowledge is represented using KL-ONE. The deduction module allowing the interpretation of a user query by the knowledge-base and the answer generation module have been investigated .

The first prototype will be a major breakthrough in the domain of the information systems; this multilingual user-friendly system combining the most advanced techniques of speech processing, natural language processing, and knowledge engineering will open the way to the next generation of information systems.

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Start Date: 01-MAR-86 *Duration: 48 months*

2D COHERENT OPTICAL DYNAMIC PROCESSOR

Project Number : 1035

The objective is to develop and implement an optical processor for pattern recognition based on the most recent technological developments. The feasibility of parallel optical signal processing will be demonstrated by using a spatial light modulator (electrically and/or optically), a solid state laser, and non linear components based on the Four Wave Mixing (FWM) process, allowing real time modification of the correlation function. By improving the spatial light modulator and FWM components technology, a corresponding improvement in processor performance is expected, that will lead ultimately to a resolution of 1200 x 1200 pixels in parallel at a standard TV frame rate.

Intermediate results of several component development activities (laser sources, SLM, correlator and detector) are very promising. In particular the development of the Spatial Light Modulator optically addressed (using BSO crystal) and electrically addressed (using thermo-optic effect and more recently Thin Film Transistor technology) has progressed rapidly so that a first successful demonstration was given at the first annual review; the initial 32 x 32 TFT SLM is being extended by building a 200 x 320 TFT matrix.

For performing correlation two approaches are pursued: the static one using match filters and the dynamic one using the FWM technique.

Multichannel match filtering is under study; test and reference images are decomposed into patches which are correlated independently allowing the computation of an overall score.

Patches of the reference images may be synthesized using the Synthetic Discriminant Function technique (linear combination of rotated and scaled reference images) to obtain properties of invariance.

A first correlator using a pulsed laser and a BSO crystal has demonstrated the FWM approach (multiplication of spectra using a non-linear material, presently the BSO crystal).

From the material side, the technique to grow BSO crystals has improved to obtain good photorefractive performances.

By March 1989, an early prototype of an optical processor able to perform up to 400 x 400 pixels image correlation will be demonstrated. Optical processing by its very nature allows real-time and wide-band applications. In the future, it could become an alternative technology to the current one. The project will investigate this new domain and possible applications such as quality control.

This project provides the opportunity for a European supplier of BSO crystals, at the moment mainly obtained from Japan.

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Start Date: 01-MAR-86 *Duration: 36 months*

INTEGRATION OF SYMBOLIC AND NUMERIC LEARNING TECHNIQUES (INSTIL)

Project Number : 1063

The objective is to improve knowledge acquisition for KB Systems by the application of machine learning techniques. The project will identify the best features from different approaches to knowledge acquisition, in order to improve the quality of rules extracted from "noisy" data.

The project uses existing software: MAIN which is based on Michalski's INDUCE and AQ11, a symbolic learner: AGAPE and AGAPE-C which use theorem proving techniques and taxonomies of descriptors of example sets: and NEDDIE which is an extended version of Quinlan's ID3, which uses numerical manipulation to constrain its search space.

An example application was demonstrated in 1987 showing integrated learning of rules using symbolic and numerical methods.

Improved versions have been produced of the programs previously developed separately by project team members at their locations, and ported to the chosen development environment. Prototypes integrating MAIN, NEDDIE and AGAPE were completed and distributed to the partners for experimentation. The most promising prototype uses MAGGY (augmented AGAPE) to generalize cluster descriptions obtained by NEDDIE. The integrated learning system is being strengthened by studies on dealing with noise in knowledge acquisition. It is also being tested by a trial application study to disease diagnosis in crops as the foundation for the development of a rule base whose expert evaluation has begun.

It is expected that the lessons learned from this three-year project which has a particularly impressive array of publications will be incorporated in tool environments for expert system construction, in the form of an automatic rule refinement and acquisition module. The final prototype of this module will be available by October 88. It is also expected that an improved version of an expert system for the diagnosis of plant disease will be available by October 1988.

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SHIPBOARD INSTALLATION OF KNOWLEDGE-BASED SYSTEMS CONCEPTUAL DESIGN

Project Number : 1226(1074)

The objective of this project is the implementation and integration of collaborative expert systems on board merchant ships. The systems will advise crews on the safe and economic operation and maintenance of their ships. They will also be embedded in automatic control systems.

The viability of the systems will be tested with real data.

Appraisal and classification criteria will be developed for the onboard deployment of expert systems.

The focus of the work will be the development of a small number of KBSs related to the expert navigation prototype of the definition phase, where a workplan drawn up based on:

- Studies of the characteristics of on-board information systems.
- A requirement study which included a review of other advanced ship programs and ESPRIT projects.
- A test of the viability of the project concept by the development and implementation of a prototype of an expert system for voyage planning and navigation.

The project is expected to influence international standards for local area networks onboard ships, and the design of maritime surveillance and control equipment. Installation of knowledge-based systems will contribute to the efficiency of ship operations, and hence to improving the competitiveness of the European merchant fleets. The first ships using on-board knowledge-based systems are expected for the early 1990's.

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Start Date: 01-MAR-86 *Duration: 36 months*

DEVELOPMENT AND APPLICATION OF A LOW-COST, HIGH PERORMANCE, MULTI-PROCESSOR MACHINE (SUPERNODE)

Project Number : 1085

The objective is to develop a high performance, multiprocessor, prototype computer with a flexible architecture, suitable for a wide range of scientific and engineering problems.

The machine will be implemented as an array of supernodes, each node consisting 18 transputers. The interconnections of transputers will be configurable at the node level, and the interconnection of nodes will also be configurable.

Progress is measured on three fronts, Hardware, Software and Research.

In the hardware area, a T800 version of the transputer has been produced, a gate array (72*72 way) switch is ready, and the boards for a single node prototype machine have been made.

Digital switching applications have been used extensively as tests for establishing parameters in Supernode. A high speed input/output interface (100M bits/sec) has been developed.

A 16 node machine is planned for February, 1988.

A software model has been elaborated with three levels: base level, development system level and user environment level.

The basis for software development is OCCAM and the INMOS transputer development system. The software development host is either MSDOS or UNIX using TDS with extensions. The target code is downloaded to Supernode over a transputer communications connection.

Research on high level programming languages for Supernode is concerned with implementing concurrent logic languages.

Graphics imaging work has continued using a ray tracing method and distributing parts of the screen across the transputer array. Working models are available and progress continues in finding the best model using current research and optimising this model on the transputer array.

Methods of implementing neutron absorption algorithms on the Supernode are being studied.

An examination is also being made of mapping quantum mechanical problems and Laplace's equation onto Supernode.

The project has attracted wide interest in the architectures community, particularly through several international presentations.

The T800 transputer is a significant industrial result from INMOS and is now available for use in the industry.

Supernode technology will soon be available commercially.

In the CAD for VLSI area, APSIS have developed their LUCKY LOG logical simulator to run on the Supernode. This is undergoing field testing.

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Start Date: 01-DEC-85 *Duration: 36 months*

A METHODOLOGY FOR THE DEVELOPMENT OF KNOWLEDGE BASED SYSTEMS (KADS)

Project Number : 1098

The objective is to assist the transfer of Knowledge Based Systems technology into use, by providing methodological guidance for the development process. It is believed that Knowledge Based Systems development can be treated as a particular case of software engineering and that the same requirements must be placed on the development of Knowledge Based Systems as on other types of software. In short KBS must be produced to specification and to acceptable standards by a controllable process.

Work is progressing according to schedule. The conceptual modeling methodology and tools have been applied in eleven projects with well-documented success in at least one revenue-earning study for a commercial client in the U. K.

Theoretical work on the production of design specifications from conceptual models has already generated a useful classification of existing design tools. Several tools were demonstrated in March 1987. A detailed lifecycle model of the analysis phase has been produced and used as an interpretative schema to extract guidelines for future developers of KBS's.

The KADS (Knowledge Acquisition and Design Support) methodology is currently supported by a suite of tools, including:

- A hypertext editor for protocol analysis.
- A domain concept editor.
- An interpretation model librarian.
- A cognitive model editor.

Each tool has been implemented using a configuration of Prolog and the object-oriented graphical language, PCE. Final integration and implementation of the toolkit, probably in a PCTE-based environment, will be completed by September 1990.

PCE, developed at the University of Amsterdam, is to be marketed in Europe and America through non-exclusive licensing agreements.

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Start Date: 01-SEP-85 *Duration: 60 months*

FURTHER DEVELOPMENT OF PROLOG AND ITS VALIDATION BY KBS IN TECHNICAL AREAS

Project Number : 1106

The project aims to design and implement a new Prolog called Prolog III. The new language includes the possibility of adding inequalities and arbitrary propositional well-formed formulae as constraints.

The project aims to demonstrate the usefulness of Prolog III for the construction of knowledge-based systems in technical areas, in particular for the diagnosis of an electro-mechanical system in automobile repair shops.

On the language side, the following results have been obtained :

- Design, implementation and testing of a new algorithm to verify the degree of satisfaction of arbitrary well-formed formulae in propositional logic. This algorithm exhibits satisfactory performance in a class of practical cases.

- Choice of a sufficiently general subset of arithmetic operators to be allowed in the inequalities appearing as constraints in Prolog III clauses. This subset was chosen in a way that the solution of sets of such inequalities would be computationally efficient.

- Design, implementation, and test of algorithms to solve inequalities.

- Implementation of an initial, complete version of Prolog III for project testing.

On the application side, the following preliminary results have been achieved :

- Construction of a simple expert system using an expert system shell developed by one of the partners before the start of the project.

- Study of the strategies for diagnosis and repair used by human specialists and their classification of knowledge.

- Specification and full implementation of a pilot expert system.

- Specification of a comprehensive expert system which models components, and which is designed to test the new features of Prolog III.

Some tools for the development of expert systems have been developed by the partners, although final tools using the new language Prolog III are not expected to be completed until the first half of 1989.

The language Prolog III is scheduled to be completed by the end of the project, after the expert system is integrated, tested, and optimised. It is

expected that the knowledge-based system itself will be displayed in the field. Besides its use in the development of the application expert system it can be expected to have an impact on the industrial partners, both as a learning experience, and as an organised record of possibly unstructured information. The achievement of a working relationship between the inventor of Prolog, Professor A. Colmerauer, and two large industrial companies, Daimler Benz and R. Bosch, is in itself significant.

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Start Date: 01-JAN-86 *Duration: 50 months*

KNOWLEDGE BASED USER FRIENDLY SYSTEM FOR THE UTILISATION OF INFORMATION BASES (KIWI)

Project Number : 1117(1218)

The objective of this project is to develop a knowledge-based user-friendly system for managing the access to external information bases. Four subjects will be emphasized:

- A knowledge representation formalism, by the development and use of the language OOPS, based on an object-oriented approach.
- An Advanced Database Environment (ADE), based on the combination of logic programming and databases.
- The integration of the knowledge representation formalism and ADE within a simple concept.
- An intelligent interface between the end-user and the system, based on graphic capabilities.

This project was originated by another ESPRIT project (P641) which was a feasibility study of such a system and whose results constituted the starting point.
The definition of the OOPS language and its prototype implementation, together with specification of the architecture of the global system are available. Following a study period, the user interface for the KIWI system is now being developed. An early prototype running on an Apple Mackintosh was demonstrated in October 1987.

Also, work has been carried out on the handling of recursive queries, where a useful result called the magic counting method is being developed. The architecture of the ADE layer has also been established and theoretical work on the concept of bottom-up execution of Prolog programs is in progress.

The impact of KIWI can be stressed by the fact that the combination of the deductive powers of logic programming with the data management capabilities of large relational databases will result in powerful computing environments, which will dominate computing in the 1990's. In this context, KIWI will innovate especially in the area of knowledge representation formalisms and in the areas of recursive queries handling and execution of Prolog programs. These are a key requirement for such environments.

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Start Date: 01-FEB-86 *Duration:* *36 months*

ADVANCED MODEL FOR INTEGRATION OF DB AND KB MANAGEMENT SYSTEMS - ISIDE

Project Number : 1218(1133)

The objective is to develop an advanced model for integration of data- and knowledge-based management systems.

The ISIDE team intends to work on three main tasks :

- The specification of a knowledge representation formalism.
- The specification of a logical inference formalism.
- The definition of the architecture of an efficient storage and access layer using specialized VLSI hardware (Database machine).

Starting from practical observations (ARS/AGUSTA Helicopter Maintenance Training System ITS and CRIL's Software Engineering Documentation System, CACAO), ISIDE consider rather realistically that no universal paradigm will resolve the DB programming problems; instead, both a rule-based approach (RDL1) and an object-oriented approach (ODL1/LDR2) are advocated, with capabilities to switch from one to the other. More mature, RDL1 already has a computational model (Predicate Transition Networks), but still lacks some features for handling complex domains. An upgrading of OLD1 is planned by incorporating the multiple inheritance feature.

Both approaches are being intensively experimented upon, and prototype support systems should be demonstrated at the next review (April 1988).

On the Architecture side, a first draft has been proposed, which puts heavy emphasis on future core memories large capacities. The kernel of such systems is the existing RDBMS Sabrina, to be completed by GEODE ("Gestionnaire d'Objets Dynamiques Extensibles").

Some partners envisage developing a knowledge-based training product within the 2 coming years.

Last, it must also be said that the technology transfer occurring in this project is extremely successful, due to a tight integration between the industrial and research partners of the Consortium.

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Start Date: 01-MAY-86 *Duration: 36 months*

A PRELIMINARY STUDY OF A VECTOR PROCESSING-ORIENTED PARALLEL ARCHITECTURE

Project Number : 1532

This project is a preliminary study (1 year) of a vector oriented-processing parallel architecture for a supercomputer. It will combine a user and a technological approach:

- With the help of some qualified users the architectural concepts for a high performance scientific and numeric supercomputer working in the 10-30 GFLOPS range will be defined. Compatibility with existing programmes and applications will be a major criteria.

- The defined architecture will be evaluated by simulations at the hardware and software levels. The different technologies usable to develop this type of machine will be analysed (circuits, memories, interconnections, packaging, cooling). Reliability and maintainability will be two of the main criteria for selection.

Reports of the first results are expected in February 1988.

The results of this pre-study could be used in ESPRIT II projects to develop high performance computers, an area where Europe is very weak at the moment. It also establishes a link with the potential users on the market.

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Start Date: 01-JUN-87 *Duration: 12 months*

INTELLIGENT DOCUMENTS PRODUCTION DEMONSTRATOR

Project Number : 1542

The project INDOC has the purpose of verifying the practical aspects of AI techniques within Advanced Information Systems for complex documents. Complex documents (a contract, a licence, an insurance etc.), require the merging of operational information (data and images), handled by traditional tools, with advanced text processing. This project investigates A.I. techniques that can be used to develop and maintain large sets of conceptual descriptions of documents and organizational procedures. The purpose of INDOC is to build a demonstrator which will test the feasibility of the approach on a narrow, but real-life application. An evaluation of the results will assess the portability of the approach on a larger application, and the cost/benefit ratio of introducing it in real application environments.

The project started on 1 January 1987. The partners agreed to a methodology of knowledge acquisition and analysis which provides a reference pattern for questioning experts and classifying the knowledge acquired. The current approach is towards the use of a general implementation language,.such as Prolog or Lisp. A structured shell system may be adopted later if it is adequate for the system implementation. Decisions were also made on the application domain, and the types of documents for the demonstrator (notary acts and bank documents like mortgage or import/export contracts).

The INDOC project will constitute a strong contribution to the fundamental harmonization of AI techniques, by proving/verifying their effectiveness in real-life application. The demonstrator produced by INDOC, and the following cost/benefit analysis, can be exploited by the European Industry to evaluate the use of AI and KB techniques, within real-life Information Systems.

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Start Date: 01-APR-87 *Duration: 18 months*

EFFICIENT QUALITATIVE AND QUANTITATIVE USE OF KNOWLEDGE-BASED SYSTEMS IN FINANCIAL MANAGEMENT (EQUUS)

Project Number : 1558

The area of application of the planned knowledge-based system(s) is financial portfolio management. This is not a new area for knowledge-based computing : it was identified early in the USA as a profitable area for expert system development. However, success has been limited, because of deficient appreciation of clients' needs and of shortcomings in the standard rule-based model for knowledge representation when applied to financial problems. A major direction of the project is therefore to supplement standard tools and methodologies with facilities for mixed quantitative reasoning and to organise the collected knowledge accordingly.

A second aim of the project is to optimise the demonstration software by applying symbolic-computing trace and transformation techniques to convert knowledge which is non-procedural or which relies heavily on list processing to procedural form with compact data structures that use as few pointers as possible.

The project started very recently. The results are expected to :

- Support the main activities of portfolio management by the KBS which will be developed.

- Support the creation of KBS, by giving a handbook of procedures for production of such systems, with measures of performance and also of the costing of the introduction of AI.

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Start Date: 01-MAR-87 *Duration: 39 months*

SIGNAL AND KNOWLEDGE INTEGRATION WITH DECISIONAL CONTROL FOR MULTI-SENSORY SYSTEMS (SKIDS)

Project Number : 1560

The purpose of the project is to provide a basic, generic approach, both software and hardware, in the area of integration of sensory information and knowledge. Sensory information is understood as information coming from an outside, physical, real world; knowledge corresponds to high-level symbolic representations and models of the external world and of the system's features and abilities; such models are dynamically updated and partially acquired through learning.

The ultimate goal of the research programme is a perception machine represented by the SKIDS demonstrator prototype and realising:

- A unified perception of the "observed" world.
- Real-time reasoning, planning and adaptation of the whole software and hardware configuration to the "actual" observations strategy.

The precise specification of goals and functional requirements is in progress.

The approach is basically a generic one, but is driven by two classes of application:

- Mobile robots for public safety applications in nuclear plants, etc.
- Surveillance systems for offshore oil fields, nuclear plants, airports, etc.

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Start Date:	*01-JUN-87*	*Duration:*	*24 months*

APPLICATION OF EXPERT SYSTEMS TO INDUSTRIAL CHEMICAL ANALYSIS

Project Number : 1570

The project will replicate a specific area of chromatography and chemistry knowledge by artificial intelligence systems. There are two main areas of research. One is the formalization of the knowledge-base in this area, and the other is the selection of the most suitable expert system shells and tools to represent this type of knowledge-base.

The first workpackage is to select a suitable specific area of chromatography application to pharmaceutical analysis, where the knowledge is sufficient to provide a valid test of an artificial intelligence system.

The second workpackage is to formalize the knowledge of this specific area by a set of logical rules and facts suitable for expression as an expert system.

It is planned to select about eight candidate shells and tool sets and to evaluate their suitability for representing this type of knowledge. The next step is to evaluate these candidates, in order to make a final selection of three for the implementation task.

The final product will be a comparison of the performance of these three expert systems (using different characteristics, but with identical knowledge) for real chemical analyses.

The project started on 16 March 1987, with the selection of the chemical area of analysis, and the selection of candidate expert system tools. It has been decided not to limit the initial choice of application to the liquid-chromatographic analysis of pharmaceutical compounds.

Chromatography is a major analytical tool in pharmaceutical research, but the technique requires the skills of expert chromatographers to ensure that a suitable chromatographic method is selected and parameters are optimised for each analysis.

The project will lead to the application of expert systems to a real-life analytical problem: method development for the analysis of novel compounds in the pharmaceutical industry.

It is expected that the results of the comparison study will accelerate the introduction of expert-systems in real-life industrial applications.

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Start Date: 01-MAR-87 *Duration: 30 months*

PARALLEL COMPUTER SYSTEMS FOR INTEGRATED NUMERIC AND SYMBOLIC PROCESSING (SPAN)

Project Number : 1588

The objective is to investigate programming languages and parallel architectures for the integration of symbolic and numeric processing. The project is organised in distinct layers: application software packages; high level languages and tools: the "virtual machine" kernel system; and parallel architectures.

The kernel system comprises a target machine language (TML) and its associated virtual machine code (VMC) through which all high level languages will be compiled onto a range of architectures for execution. It forms a focal point of the project. Two high level language compilers will be produced, together with an object-oriented framework for language integration. Three types of parallel architecture will be evaluated, and an investigation will be conducted into novel VLSI architectures for efficient execution of the VMC. To demonstrate the utility of these techniques, a range of applications software will be developed.

The initial work packages have led to the definition of the Virtual Machine Code and a Compiler Target language embodying the requirements for supporting several applications. Work on these applications has started as has work on a VLSI implementation of the VM.

The development of a successful Virtual Machine will establish a de facto standard software-hardware interchange on parallel computers.

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Start Date: 01-JAN-87 *Duration: 36 months*

THERAPY ADVISER FOR ONCOLOGY

Project Number : 1592

The project aims to evaluate clearly the effects consequent to the development and introduction of a knowledge-based system to advise in the chemotherapy of lung cancer. The early phase of the project is concerned with the refinement of knowledge-bases now in development, the construction of the patient specific data base and the design of the man-machine interface. The second phase of the project consists mainly of the implementation of the knowledge and inference architecture, using a skeletal system already developed by one of the partners.

The final phase focuses especially on the evaluation of the system in the context of its use. This will take into account the attitude of staff and patients, the impact of the tool on work practices, with measures of efficiency, safety, and analysis of costs. The description of the evaluation scheme is an early deliverable.

The project started January 1, 1987.

The evaluation of expert systems in themselves and in an operational environment is a prerequisite for their use in industry. The project consortium has the experience and skills necessary to produce a useful evaluation in a domain where data analysis techniques are already heavily used.

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Start Date: 01-JAN-87 *Duration: 39 months*

EVALUATION OF AN INTELLIGENT TUTORING SYSTEM SHELL FOR INDUSTRIAL/OFFICE TRAINING (ITS)

Project Number : 1613

The project will evaluate the ITS (Intelligent Tutoring System) shell on the basis of data gathered from commercial, scholastic and industrial field trials.

The field trials will be on office automation procedures, on scholastic skills and on maintenance procedures.

This project will identify how to use intelligent tutoring systems to cut training costs and increase training effectiveness. A new prototype (DOMINIE) will be designed and implemented.

The analysis of the results coming from the first field trials phase has lead to the identification of shortcomings in the initial prototype.

Improvements dealing with teacher's help in choosing tutorial material and in refining the tutorial control loop and tutorial strategies are now in the design phase.

A second field trials phase will evaluate the implementation of the enhanced prototype (DOMINIE).

This project has a strong commercial potential: the lack of advanced tools for training people in new disciplines is well known. The strong involvement and experience of the industrial partners in the field and in the field trials will lead quickly (by 1989) to concrete results which will improve the effectiveness of training tools.

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